



14th Annual Greater Philadelphia SeaPerch Challenge 2019

Executive Summary

SeaPerch is a Remotely Operated Vehicle (ROV) Science, Technology, Engineering and Mathematics (STEM) educational program and competition. SeaPerch consists of an educational tool kit that centers on a curriculum-designed program that teaches students about the basics of naval architecture, marine engineering, and basic electrical circuits. The program is designed to provide middle and high school students with the materials and knowledge to construct a simple ROV. The students are then encouraged to build upon that basic knowledge to innovate and create unique ROV design to meet specific mission scenarios.

The Greater Philadelphia SeaPerch Challenge, (GPSPC) is held in early spring at Temple University's Pearson Hall located at 1800 N. Broad St, Philadelphia, PA 19122. The competition begins with team check-in and compliance checks followed by an opening ceremony, competition rounds, and the presentation of awards.

The GPSPC is the culminating competition that consists of three technical sections where the students are able to showcase their final designs. The three technical sections are the engineering notebook, design presentation, and operational performance evaluation in the pool. An engineering design notebook is delivered for judging on a predetermined submittal deadline in advance of the competition date. The engineering design notebook emphasizes engineering process documentation and captured the lessons students learned during the design, build and test phase. The design presentation is the opportunity for the students to sell their designs to Navy. The design presentation is a slide presentation. Students discuss their design philosophy, construction challenges, and answer questions posed by the judges. The operational performance evaluation takes place in the pool, where the students compete in two separate challenges. There is a performance and speed course and an underwater mission based course.

Specifications for the underwater events are outlined and posted on the www.phillynavalSTEM.com website to aid teams with building, practice and test setups prior to the competition.

What is the Greater Philadelphia SeaPerch Challenge (GPSPC)?

The GPSPC is an innovative, mentor-based underwater robotics program that includes classroom visits by engineering professionals. Teams purchase a SeaPerch kit and are challenged to design; build, and compete with their underwater ROVs at the GPSPC at Temple University in downtown Philadelphia. Since the SeaPerch Challenge was created in Philadelphia 14 years ago, more than 65,000 students have participated in the SeaPerch program nationally and internationally. GPSPC is a fun, educational and challenging way to get students not only interested in Science, Technology, Engineering and Math (STEM), but excited about it.

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Section 1 Program Structure and Format

1.1 Eligibility and Registration

a. *Eligible Participants*

The GPSPC is open to middle schools, high schools, home schools, and youth organizations in the Pennsylvania, New Jersey, and Delaware tristate area. Teams may only register for one (1) regional challenge in the tristate area to qualify for the SeaPerch International Competition.

b. *Registration*

Registration opens in early Fall until capacity is reached. Only one high school level team, (9th - 12th grade), and one middle school level team, (5th - 8th) per school or organization is accepted. A middle school team may compete on a high school level if there is a high school level student on the team. High school level students may not compete down to the middle school level. A team may register for only one local qualifying regional SeaPerch competition.

c. *Fees*

There is no fee to participate in the SeaPerch Challenge.

d. *SeaPerch Kits*

Teams purchase their own SeaPerch kit through the SeaPerch.org web site. A team may also request a kit through the phillynavalstem.com web site.

1.1.1 *Phase I: Program Kickoff*

1. The SeaPerch Challenge Program Kickoff Phase includes all activities associated with the challenge mission and rules, team registration, and new advisor training. Advisor training is provided to new advisors. Teachers attend a one-day training session and build a SeaPerch.

1.1.2 *Phase II: Design – Build – Test*

1. The SeaPerch Challenge Design Build – Test Phase is all the time between Kickoff and Competition. It is the time to learn, teach, experiment, and practice. Teams function as companies competing for a simulated Navy contract by designing an underwater ROV that meets the technical requirements while staying within the specified budgetary restriction of \$20.00. Phase II is when the competition products are developed. The recommended schedule is at a minimum, 10 hours of build time. The remaining time should be spent on designing, modifying and testing. Following the sample Plan of Action & Milestones (POA&M) published on the phillynavalstem.org website is recommended. A complete 32 page SeaPerch build manual can be found at the SeaPerch website under “Build”: <http://www.seaperch.org/build>. The manual is updated annually to give students and teachers the most recent instructions.
2. The GPSPC is an innovative, mentor-based underwater robotics program that includes classroom visits by engineering professionals. Teams are encouraged to sign up and take advantage of the Challenge's mentoring resources. Details of the mentor program are explained in section 5 of this handbook.

1.1.3 *Phase III: Competition*

1. The SeaPerch Challenge Competition Phase is designed to give students and advisors an overall appreciation of the scientific process at work. The competition consists of two competition ranks within each of two competition classes competing in four competition categories.

Competition Classes:

- (1) Middle School 5th-8th
- (2) High School 8th-12th

Competition Ranks:

- (1) Captain – similar to Stock Class in International SeaPerch Challenge
- (2) Admiral – similar to Open Class in International SeaPerch Challenge

Competition Categories:

- (1) Engineering Design Notebook
 - (2) Presentations
 - (3) Two Part Vehicle Pool Performance
 - (4) Team Spirit and Sportsmanship
2. Each team will receive a score for each of the four competition categories listed above. Scores from all categories except Team Spirit & Sportsmanship are combined to determine the overall GPSPC Champion.
 3. The first place pool performance winners from each class and rank move on to the International SeaPerch Challenge.

Captain Rank (Stock Class) is defined as:

- Teams may utilize materials (quantity and components) equivalent to one SeaPerch kit.
- Teams have a budget of \$20.00 in addition
 - The actual value of the modifications must be \$20 or less.
 - Donated material will be assessed at what the cost would be to procure the material.
 - The \$20 limit is for cost of the materials utilized on the final competition vehicle.
 - Reasonable spare parts (one set of thrusters (3) and one controller) are not included in this budget.
 - Proof of budget compliance should be made available to the judges upon request.
- 3D printed parts will be costed out at \$0.025 per gram.
- All motors must be waterproofed.
- Hooks and attachments **MAY NOT** be added/removed between competition rounds.
- Additional **NON**-stock motors may be utilized for actuation or other non-propulsion uses.
- Teams may only utilize stock SeaPerch motors for propulsion (Jameco Electronics P/N 232022).
- Teams may only utilize three (3) thrusters.
 - A thruster is defined as a means of propulsion for the SeaPerch, normally but not limited to a motor and propeller assembly.
- Teams will design for and utilize a 12-volt power source.
 - Power source other than the included kit battery or venue supplied power is not permitted.
 - Over charging or stacking batteries is not allowed.
- ROV thruster controls shall use simple switches only, no power conditioning or pulse-width modulation (PWM) controls are allowed in Stock Class. Use of a fixed or variable resistor to reduce voltage is acceptable.
- No dimension shall be larger than 22" (minimum obstacle diameter)
- Hooks and attachments may be added/removed depending on the competition round and have cleared safety compliance.

Admiral Rank (Open Class) is defined as:

Vehicles should consist of the parts and components utilized within the SeaPerch kit to the maximum extent possible and shall be subject to the following:

- Teams have no budget limit. (Budgets should be tracked for presentation to judges upon request.)
- Hooks and attachments **MAY NOT** be added/removed between competition rounds.
- Teams may only utilize stock SeaPerch motors for propulsion. (Jameco Electronics P/N 232022)
- **NON**-stock motors may be utilized for actuation or other non-propulsion uses.
- Teams will design for and utilize a 12-volt power source.
 - Power source other than the included kit battery or venue supplied power is not permitted.
 - Over charging or stacking batteries is not allowed.
- No dimension shall be larger than 22" (minimum obstacle diameter)
- Hooks and attachments may be added/removed depending on the competition round and have cleared safety compliance.

Section 2 The SeaPerch Challenge Categories

Category I Engineering Design Notebook

2.1 The Engineering Design Notebook category measures a team's ability to document the scientific process in a meaningful and organized manner. The Engineering Design Notebook must document how teams implemented the engineering process. The Design Notebooks shall include the following sections:

- I. Front Matter
- II. Naval Engineering Research
- III. Design, Engineering, and Manufacturing Process
- IV. Naval Scenario for SeaPerch
- V. Teamwork
- VI. Bill of Material
- VII. Supporting Documentation

The Engineering Design Notebook Guide and rubric can be found on www.phillynavalstem.com web site.

Category II Vehicle Performance

1. Obstacle Course
2. Underwater Mission

2.2 Obstacle Course Pool

An underwater remotely operated vehicle (ROV) must be able to maneuver successfully under its own power. If a vehicle cannot maneuver to the appropriate location to perform its task, the vehicle is of no use. A submerged obstacle course gauges whether an ROV design is capable of maneuvering successfully under its own power. Teams must navigate through the obstacle course, surface, then re-submerge and return through the course to the end. The basic obstacle course may vary slightly from year to year, but the layout remains the same. Detailed information on the Obstacle Course challenge can be found on www.phillynavalstem.com under the Obstacle Course link.

2.2.1 Underwater Mission

The Vehicle Performance category is a series of tests that determine how well a team did in designing and building an underwater Remotely Operated Vehicle. A deep water mission objective tests a craft's ability to perform a common function of ROVs: the underwater retrieval of objects from complex locations at different depths, and then placing them in designated locations. The Underwater Mission is new each year and is announced at the GPSPC Kickoff event in the Fall. Detailed information is posted on www.phillynavalstem.com under the Underwater Mission link.

Category III Presentations

2.3 Overview

Teams present as though they are the sales team for a company competing to design and build a SeaPerch ROV in response to a US Navy Contract Solicitation. The Panel of Naval Engineering Clients, (the panel of judges) has a mission and they are screening possible companies to determine which SeaPerch design is the best option to meet their need. It is the Presentation Sales Team's job to prove to the Panel of Naval Engineering Clients that their company's design is the best all-around solution for the Underwater Mission.

The Presentation session is the best time for teams who modified the standard SeaPerch design to discuss their modifications. They should highlight experiments they conducted during Phase II and what modifications came from them. Demonstration of the team's knowledge and understanding of Naval Engineering principles used in the design and performance of the SeaPerch are key selection criterion that judges will consider. At the conclusion of the question, answer, and discussion period, judges should have a clear understanding of how students implemented their knowledge of design and engineering. Bonus points may be awarded based on the technical merits of the SeaPerch design and/or supplemental items. The Oral Presentation guide and rubric can be found on www.phillynavalstem.com.

Category IV Spirit and Sportsmanship

2.4 Overview

Teams are encouraged to show their team spirit during the competition. Judges watch throughout the competition to determine the teams with the highest levels of team spirit. The sportsmanship award is determined through a voting process. Teams are observed by competition judges. Teams displaying sportsmanship are nominated by the judges and the nominations are placed in a voting box. The lead Spirit & Sportsmanship judge makes the final decision on the winner by calculating the combined Spirit & Sportsmanship scores. Complete rules and details on the Spirit and Sportsmanship category can be found on www.phillynavalstem.com.

Section 3 Competition Day

3.1 Vehicle Compliance

All SeaPerch ROV entries are subjected to two (2) compliance reviews upon entry into the competition. A vehicle receives its first review consisting of an overall safety compliance check and a 2nd review to check the craft for maneuverability in the water. A team cannot proceed to any of the follow-on events unless these requirements are fulfilled. A sticker is provided to show the ROV has passed Compliance #1 and #2.

3.1.1 Craft Compliance Inspection Overview

- a. Compliance #1 - Judges check the following:
 1. Sturdy Construction
 - a. No loose parts that will potentially fall off during competition or handling
 - b. Ballast attachment is secure
 - c. Propeller is properly and securely fastened to motor shaft
 2. Safety
 - a. No Exposed wires on controller
 - b. No Exposed live wires on SeaPerch or tether
 - c. No sharp edges
 - d. Alligator Clip covers (supplied with the kit) are installed on electrical contacts
 3. Operations
 - a. Team connects battery to demonstrate forward and reverse operation of each propeller to ensure they are in proper working order.
 4. Design Compliance
 - a. No more than 3 motors are used for propulsion (3 props)
 - b. Propeller motors are standard issue and have not been upgraded
 - c. If design modifications appear to exceed \$15, team identifies that they have valid receipts submitted with their notebook to support their design modifications are less than \$20.

- b. Compliance Station #2 - Water Compliance Maneuverability - Judges check the following:
1. Buoyancy
 2. Maneuverability - Demonstrate that the SeaPerch has the ability to submerge and can surface

Each compliance officer places a serialized tag (label tape) to the SeaPerch frame to signify the SeaPerch has passed compliance 1 and 2.

3.1.2 Additive Manufacturing Compliance

Additively manufacturing (3D printing) of SeaPerch parts is permissible as long as it is used to make contact with the mission object and:

- Shall provide technical advantage or innovation
- Rationale is documented in design notebook and presentation
- Value of 3D part is based upon the value of part it replaces
- Value of 3D printed parts shall not exceed \$10
- Included in \$20 design improvement budget limit

3.2 Competition Day Structure

The time between the morning check-in process and the first round of the competition is approximately 1½ hours. Listed below is a sample of the day's schedule.

- Team Registration and compliance
- Presentation of Colors
- Opening Remarks
- Performance Rounds and Oral Presentations begin
- Awards Ceremony (approximate time 3:00 pm)

3.2.1 Arrival and Check In

1. Team arrives between 7:30 and 8:00 am.
2. Registration begins at 8:00 am. Advisors report directly to registration.
3. Compliance checks 1 and 2.

Section 4 Awards and Competition Advancement

4.1 *The Engineering Design Notebook Category Awards:*

Trophies for first, second, and third place awarded in both Competition Classes (six total).

4.2 *Team Presentation Category Awards:*

Trophies for first, second, and third place awarded in both Competition Classes (six total).

The Team Oral Presentation category measures a team's ability to communicate ideas and market solutions to a panel of external judges made up of actual marine engineering professionals from Government, Industry, and Academia. The judges assess each team's design innovation, adherence to technical specifications, and adherence to a \$20.00 budget.

4.3 *Vehicle Performance Category Awards:*

Trophies for first, second, and third place awarded for combined score of both pool rounds for both Competition Classes (six total). First place Vehicle Performance winners receive an invitation to represent the Greater Philadelphia SeaPerch Region at the National Competition.

The Vehicle Performance category is a series of tests that determine how well a team did in designing and building an underwater Remotely Operated Vehicle. A submerged obstacle course gauges whether an ROV design is capable of maneuvering successfully under its own power. If a vehicle cannot maneuver to the appropriate location to perform its task, the vehicle is of no use. Teams must navigate through the obstacle course, surface, then re-submerge and return through the course to the end. A deep water mission objective tests a craft's ability to perform a common function of ROVs: the underwater retrieval of objects from complex locations at different depths, and then placing them in designated locations.

4.4 *Team Spirit and Sportsmanship Category Award:*

One-first place trophy is awarded. The Team Spirit and Sportsmanship category is based on a team's capabilities to recognize and encourage better solutions and engineering. Teams are encouraged to support their team and assist opposing team to show sportsmanship.

4.5 *Overall GPSPC Winners*

Each team receives a score for each of the four competition categories listed above. Scores from all categories except Team Spirit & Sportsmanship are combined to determine the overall GPSPC Champion. There is one overall Middle School Champion and one High School Champion.

4.6 *Simulated Navy Contract Cash Award*

A \$100.00 cash award presented to the middle school and high school teams that best meets the needs of the Navy.

4.8 *Atlantic Rangers Scuba Club, Against All Odds Award*

An award presented to one middle school and one high school team that overcomes the most significant obstacle(s) and still competes in the challenge

Section 5 SeaPerch Mentor Program

5.1 What is the Mentor Program?

The mentor program is an important part of the GPSPC. Bringing engineers and students together in a classroom environment is increasing student interest in math, science, and engineering. It increases awareness of Naval Engineering and Naval Architecture as career fields. Benefits of the mentor program include:

- Helping students prepare for college level work
- Provides students with the opportunities to:
 - work in a collaborative environment
 - experience a major university campus
 - participate in a realistic business and technical scenario
 - interface with industry, academia, and government engineers

Working with a mentor enhances a team's experience and provides the teacher/advisor with a greater chance of success.

5.1.1 How is the mentor relationship established?

SeaPerch teams register online and it is at that time they can request partnership with a mentor. Once the request is received for a mentor one may be assigned to you. Every effort is made to find the best fit between the school and the mentor. A returning team may specifically request a mentor they have had in a previous challenge. Once a mentor is assigned, an email is sent to the mentor and the first team advisors. Mentors are given the first and second advisors name, email address and telephone numbers. The advisor is contacted by the mentor via email or telephone.

5.1.2 Meeting with the Mentor

The mentor meets with their SeaPerch team at least four times throughout the Design and Build phase. The first meeting is a great introductory opportunity for the mentor to discuss their career, the fields of science and math and share the fun aspects of math and science. The mentor can provide examples of how they use science and engineering every day. Subsequent meeting times are established where the students engage in the design of the SeaPerch and then on to the building phase.

5.1.3 The Benefits of Working with a Mentor

- The mentor program is increasing student interest in math, science, and engineering.
- Increase awareness of Naval Engineering and Naval Architecture as career fields
- Provides students with the opportunities to:
 - work in a collaborative environment
 - participate in a realistic business and technical scenario
 - interface with industry, academia, and government engineers

Working with a mentor will provide your team with a greater chance of success.

Section 6 General Rules Summary

6.1 General Pool Performance Rules

1. All team members must wear shoes with rubber soles on the pool deck.
2. Teams report to the “Mission Course” or “Obstacle Course” side of the pool deck at least 5 minutes before their scheduled heat time.
3. Only 2 team members are allowed on the pool deck during competition. Teams are permitted to change drivers for each round.
4. The vehicle may be reset by the teams during the competition.
5. Hooks and other attachments may be added/removed between competition rounds.
6. Nothing other than the SeaPerch vehicle shall be put into the pool during the competition.
7. In the event that a vehicle is inadvertently interfered with during a competition, or a malfunction of a vehicle's parts (i.e., the motor) occurs that is beyond the design and construction, the lead pool judge will have the sole authority to provide the team time to fix their vehicle and to allow them to compete at a later time. Malfunctions are evaluated on a case-by-case basis and the lead pool judge is the sole authority to limit the number of times a team may retry to compete.

Challenges and Disputes

1. Sportsmanship is expected at all times. Should a protest or dispute occur during the competition it is the intent to resolve the grievance at the time it occurs, and the ruling by the Head Judge shall be final.
2. A team that wishes to have an issue considered shall send the student team captain and one additional student member (2) to the lead judge with the inquiry or question. The lead judge will make the decision on the issue, and this decision is final. The same issue may not be brought to the judge a second time by any member of the team. Adults may not approach the lead judge on the pool deck regarding any perceived issues.
3. Teams may not question the legality of other competing vehicles; it is the Lead Compliance Judge's role to determine if vehicles meet the entry and compliance requirements.
4. Unsportsmanlike conduct is grounds for the disqualification of a team. Team members and advisors are responsible for the conduct of all members and adults accompanying the team.

A complete set of rules are posted on the phillynavalstem.com web site.