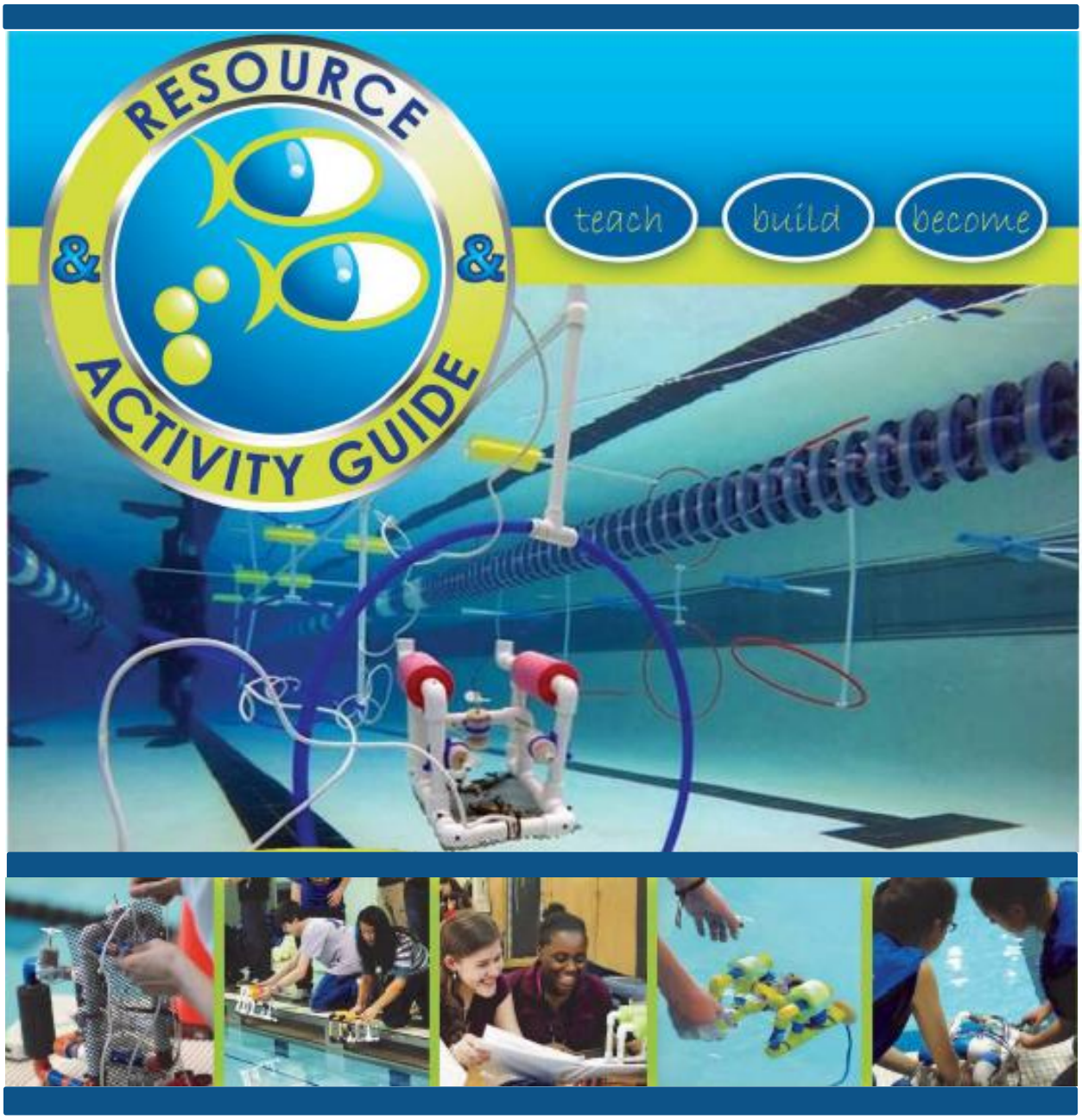
seaperch

Resource and Activity Guide

Legacy SeaPerch Resource www.seaperch.org



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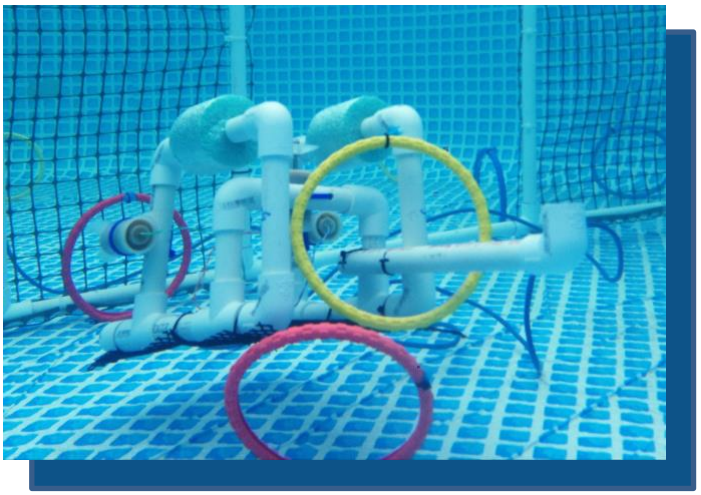


OVERVIEW

What is SeaPerch?

SeaPerch is an innovative underwater robotics program that teaches teachers and students to build an underwater Remotely Operated Vehicle (ROV) in either a classroom or out-of-school setting. Students build the ROV from a kit comprised of low-cost, easily accessible parts, following a curriculum that teaches science, technology, engineering and mathematics (STEM) with a marine engineering theme. Throughout the project, students will learn engineering concepts, problem solving, design skills, and teamwork. In addition, they are exposed to all the exciting careers that are possible in naval architecture and marine/ocean engineering.

Purpose

Building a SeaPerch ROV teaches basic skills in ship and submarine design and encourages students to explore naval architecture and ocean engineering principles. Additionally, students gain knowledge of tool safety and technical procedures.

SeaPerch…

- Is a hands-on educational program
- Is fun and challenging
- Integrates STEM (Science, Technology, Engineering, Mathematics)
- Provides training for teachers
- Builds teamwork and inspires young minds
- Introduces STEM career discussions

Students learn best by doing, and during the SeaPerch program they follow steps to completely assemble an underwater ROV. After the SeaPerch ROV is constructed, students are encouraged to test their vehicles, deploy them on missions, and compete in a competition (a SeaPerch Challenge), to take what they have learned to the next level. SeaPerch Challenges foster an end goal, reward sportsmanship, spirit and presentation skills, as well as mastery of engineering and science concepts. Events at the Challenge can include:

- Vehicle performance - maneuvering and object recovery
- Innovative design
- Team presentations
- Engineering Notebooks - document planning, design, construction, testing, and learning
- Team spirit and sportsmanship at the event

Winners of recognized regional or state challenges may qualify to compete in the International SeaPerch Challenge held each spring.

One of the most important aspects of SeaPerch is that it includes training for teachers. The two methods of training are online or on-site. Please visit https://robonation.typeform.com/to/IIy34tO6 and submit a request if you are interested in discussing SeaPerch training at your location.

SeaPerch has been designed to meet many of the national learning standards identified by the U.S. government. With one project, schools are able to teach many of the concepts required for their grade level using a fun, hands-on activity for students. Some of the concepts the students learn while building the SeaPerch ROV include the following:

- Ship and submarine design
- Buoyancy/displacement
- Propulsion
- Soldering/tool safety and usage
- Vectors
- Electricity/circuits and switches
- Ergonomics
- Waterproofing
- Depth measurement
- Biological sampling
- Attenuation of light
- Moment arm, basic physics of motion
- Career possibilities

Program Benefits

Meets National Learning Outcomes:
The SeaPerch Program meets many national learning outcomes. Visit https://www.seaperch.org/educational-standards for current standards mapping.

Encourages STEM Education:
SeaPerch focuses on science, technology, engineering, and mathematics to support future scientists in these important areas.

Supports Diversity:
The program presents the possibilities of technical careers to minorities, girls, and other underrepresented populations.

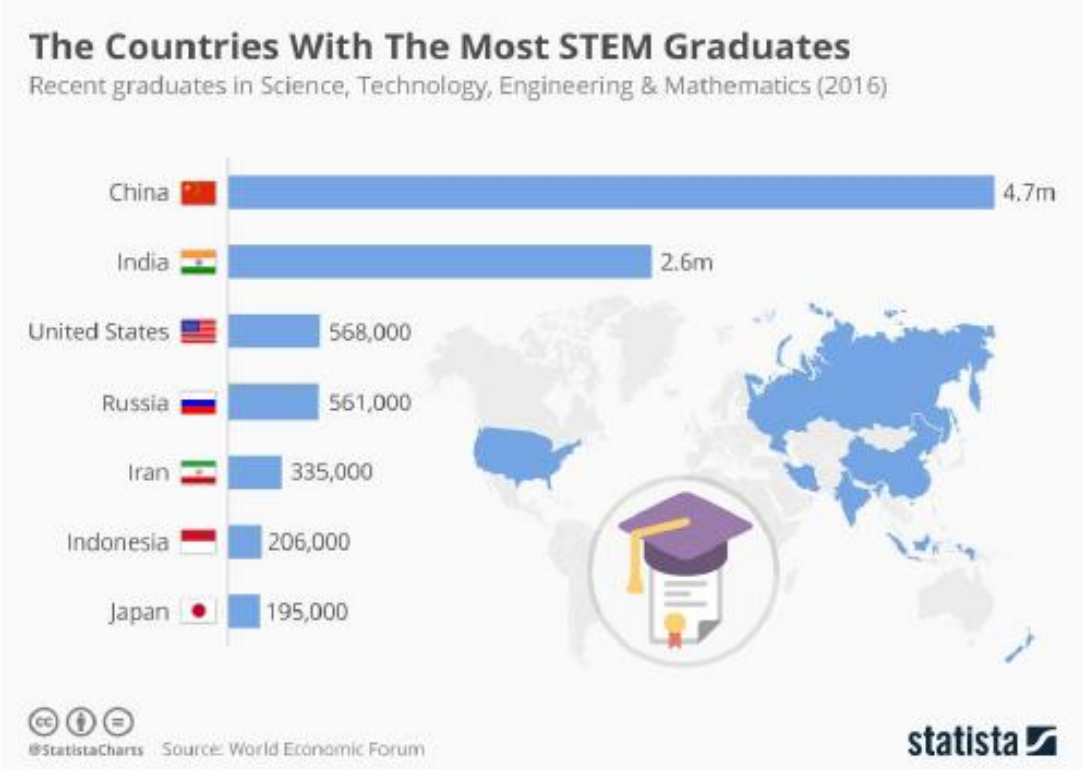
Costs Per Student Are Low:
The price per kit is $179, and a single kit can be used for a group of up to six students (depending on age range). Please visit https://shop.robonation.org/collections/seaperch for current pricing.

Provides Web Resources & Community:
The SeaPerch website, https://www.seaperch.org, provides resources, tools, information, and an active community.

The STEM Challenge

The world is changing. Every job of the future will require a basic understanding of math and science. STEM (Science, Technology, Engineering, and Mathematics) education is vitally important for our students to learn and become excited about. The demand for STEM-educated workers continues to grow exponentially each year.

In 2016 the U.S. ranked 3rd in the world in the number of college graduates in STEM related programs. However, the number of U.S. STEM graduates was only 12% compared to the number of STEM graduates in China. Only 5% of science degrees are awarded in engineering, as compared with 50% in China. If it is not addressed, the expected shortage of skilled workers could decrease the nation's global competitiveness and result in a lack of expertise in critical areas.



These statistics show how few students are engaged in STEM fields:

- 33% of eighth graders are interested in STEM careers…
- …but only 6% of them will graduate college with a STEM degree.
- Only 18% of high school seniors are ranked science-proficient.
- Only a third of high school seniors are ranked math-proficient.
- Undergraduate programs in science and engineering report the lowest rate of retention of all college disciplines.

Although the numbers of students interested in and working towards degrees in STEM fields is very low in the United States, the benefits of a STEM education are high:

- Students with bachelor's degrees in engineering had the highest average starting salaries of all their peers.
- Jobs in mathematics are increasing four times faster than the average job growth.
- More than 30% of current science and technology professionals are expected to retire in fewer than eight years.
- More S&P 500 CEOs earned their undergraduate degrees in engineering than in any other field.
- Scientific innovation has produced roughly half of all U.S. economic growth in the past 50 years.

The STEM challenge is to increase enthusiasm for these vital fields of education, and SeaPerch is committed to doing just that through innovative, hands-on, and engaging activities and curriculum.

Impact

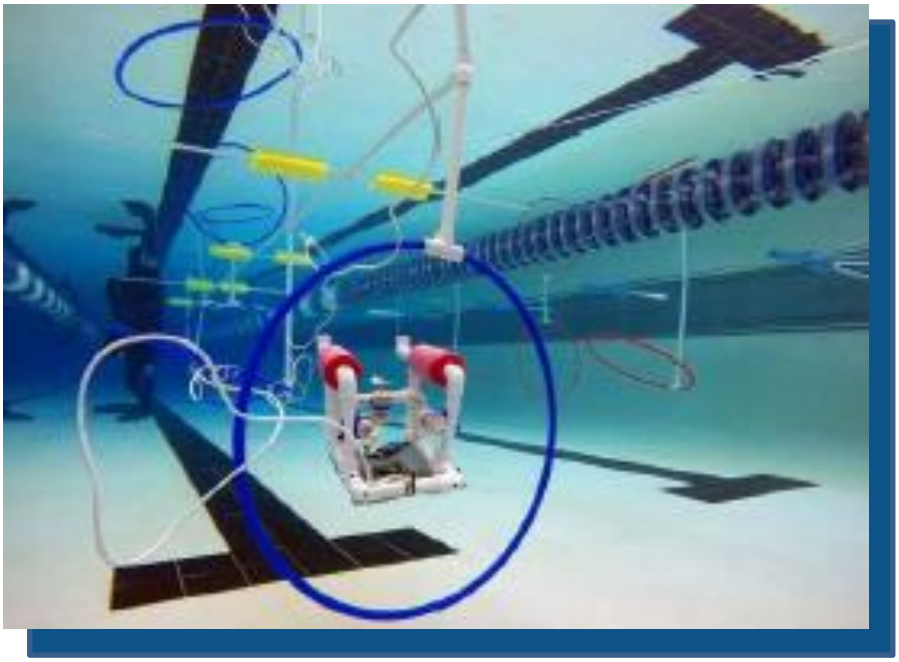
SeaPerch can make a huge impact on the student who may be on the fence about entering a STEM-related field, as well as on the one who has never even been exposed to STEM education. In order to take the first steps towards majoring in a STEM program in college, a student must be interested and proficient in STEM. SeaPerch is an ideal opportunity to foster a passion for STEM and teach important concepts and standards.

STEM Interest

- SeaPerch provides many venues for teachers to encourage enthusiasm for STEM, as students learn about, build, operate, and compete with their robots.
- SeaPerch provides teachers with the opportunity to talk with their students about majoring in STEM, as well as careers in those fields.
- The engaging, fun, and hands-on activities SeaPerch offers can spark an interest in STEM even in students who previously showed no enthusiasm for these areas.

STEM Proficiency

- SeaPerch aligns to many national educational standards
- The activities in SeaPerch teach proficiency in STEM areas in a way that is appealing and fun for students.
- SeaPerch lends itself well to interdisciplinary projects, giving teachers the opportunity to increase proficiency in many areas of science, mathematics and literacy.
- Areas of SeaPerch that students find interesting - building, problem solving, etc. - have direct correlations to skills needed for a career in a STEM field.
- STEM careers can have a huge impact on the world and are challenging and satisfying for students.



Why Naval STEM?

Inspiration, discovery, and innovation are the hallmarks of the U.S. Navy's Research Enterprise. Maintaining a technological edge requires a dynamic portfolio of scientific research and technology development, a culture of innovation, and the capacity to draw upon diverse ideas and approaches. Tomorrow's scientists and engineers will be at the heart of this innovation process. Without a steady stream of civilian and enlisted scientists and engineers, the Navy's ability to maintain its science and technology superiority will falter over time. Consequently, increasing the STEM pipeline has become a critical priority for the Navy to tackle the challenges of the future.

By offering a broad range of STEM education and outreach programs, the Navy seeks to address the national crisis of decreasing college enrollments and careers in science and engineering. Through programs like SeaPerch, the goal is to engage and inspire young people by exposing them to exciting, hands-on, and mentor-based programs that build science, engineering and technology skills, while at the same time fostering self-confidence and life skills.

Cost

Educators are Able to Control Costs
Among the virtues of the SeaPerch program is the available leverage to spend as little or as much as you want. Some teachers/leaders borrow tools from school shops or parents for the construction. Some teachers/leaders reuse every part from year to year. The program lets teachers be creative and figure out how SeaPerch best fits into their classroom or program.

Parts are Inexpensive, Easy to Find & Replace
SeaPerch uses the low cost, good quality, and easily accessible parts that are easy to find and replace. Some replacement parts are available on the website at a low cost.

Frequently Asked Questions (FAQs)

Who sponsors the program?
The SeaPerch program is generously supported by the Office of Naval Research and multiple other sponsors. For a full list of current sponsors, please visit https://seaperch.org/about/#sponsorsandpartners.

Who manages the program?
The SeaPerch program is managed by RoboNation, Inc., an independent, tax exempt, 501(c)3 nonprofit with a mission to provide a pathway of hands-on educational experiences that empower students to find innovative solutions to global challenges. SeaPerch is the entry point for this pathway of programs. Visit http://www.robonation.org/ to learn more.

How do I get kits?
All kits must be ordered online at https://shop.robonation.org/collections/seaperch. We do not accept telephone, fax or email orders.

Can I buy just one kit?
Yes. Just visit the website, https://shop.robonation.org/collections/seaperch, and you will be on your way! Consider whether you need to purchase a tool kit if you don't have the tools – a list of them can be viewed from the order page.

What age group is SeaPerch appropriate for?
Any age from 5th grade through college freshmen can benefit from the program, as it is easily scalable for those ages depending on how you wish to use it.

The tools and supplies that are used during a build (drills, soldering irons, PVC pipe cutters, etc.) require manual dexterity and good hand-eye coordination for effective and safe use.

Using the kits and tools with younger students would require some modification as well as additional supervision. Suggestions include, at a minimum:

- pre-drilling the PVC pipe
- pre-soldering the controllers
- keeping the group size small (three students per kit)
- having at least one adult assigned to each small group of students

As you make the decision as to whether SeaPerch is right for your students, please refer to the Build Manual as well as the training videos on our website to get a better idea of what your kids would be doing during their build.

These are recommendations as schools/clubs/organizations are ultimately responsible for their programs and for the safety of their participants.

Who can build a SeaPerch?

Families, in-school programs, after school clubs, private clubs, and individuals of all ages and interests have built the SeaPerch ROV. Just about any group of upper elementary, middle, high school, or college students gathered with an interest in STEM can participate in SeaPerch!

How long does the build take?
SeaPerch is scalable to meet the desired needs and learning outcomes. The actual build process takes between four and eight hours depending on the skill level of the individual or group building the ROV. When the build process is incorporated into a curriculum it is usually spread over a semester and science and engineering lessons are taught in conjunction with the build. It's all up to you and what concepts/outcomes you want to teach and achieve with the SeaPerch and your students.

How many kits are required for my group of students?
One SeaPerch Kit is recommended for each group of 4-6 elementary level students and one kit for each group of 2-4 middle or high school level students.

Do I need tools?
There is a tool kit that can be ordered via the website which provides everything needed to build a SeaPerch. Tools can be shared by students and reused yearly. Personal tools may also be used.

Is training available?
Our Build Manual may be all you need to get started as it is designed with the needs of new SeaPerch users in mind. The manual includes easy to follow step-by-step instructions and is supplemented with detailed images, videos, illustrations and helpful tips to guide you through the process. Additionally, we have online training videos that can be viewed at any time and stopped and started as needed. Please visit https://robonation.typeform.com/to/IIy34tO6 and submit a request if you are interested in discussing SeaPerch training at your location.

What if we don't have a pool?
Many local hotels, YMCAs, community centers, colleges, universities and even retirement communities may allow access to their facilities, once the SeaPerch program and its purpose are explained. If all else

fails, an above-ground pool, large tub, or other tank can be used. The minimum recommended size is 4' x 4' (18" deep).

What does it cost?
The SeaPerch Kit (including battery and charger) costs $179. A tool kit that can be reused year after year costs $249. There are also special parts and replacement parts available on the website for various other needs. For current prices, please visit https://shop.robonation.org/collections/seaperch .

What do we need to make a successful program?
A committed champion willing to advocate for the program! The more people that can provide support for the program, the better. It is always helpful to have a larger group of teachers working together, as well as an administration willing to provide support. If possible, a university, college, or community college partner, local industry support, community volunteers/mentors, and/or tech support can all help your program reach great heights!

Starting a Program

This guide contains information on everything needed to start a SeaPerch program, from lists of necessary materials to competition framework, to information about building the ROVs. Additional information can be found on the SeaPerch website, https://www.seaperch.org .

National and International Framework

SeaPerch embraces all new groups and regions that wish to become involved. No matter how small your group might be, you can impact students for lifelong learning through the SeaPerch program.

Since 2011, students in all 50 United States and in over 35 countries have participated in the SeaPerch program. It is estimated that over 250,000 students engage in the program annually. Program growth is attributed to focused local outreach and relationship development regional and national stakeholder engagement, and inter- and intra-community collaboration.

Need for a Champion

In order to make SeaPerch run smoothly and successfully for your school or organization, you need a committed champion who is willing to advocate for the program and its impact for students. This person can be a parent, teacher, administrator, local industry or university partner, or anyone else who is able to promote the program and its benefits while helping students succeed. A champion should be able to support the students from beginning to end, including the build, testing, and competitions. They should also be the one to maintain contact with other regional and/or state teams, and the SeaPerch website.

Target Audience

Any age from 5th grade through college freshmen can benefit from the program, as it's easily scalable for those ages depending on the intended goals. When deciding whether SeaPerch is the right program, refer to the Build Manual as well as the training videos on the SeaPerch website to get a better idea of what your students will be doing during the build.

Managing a Program Build

There are many things to consider when starting a SeaPerch program for your school or organization. What materials are needed? How many students can work on one ROV? How will I (the teacher/leader) learn how to build the robot in order to teach my students?

All the necessary information for starting a SeaPerch program build can be found in this manual. Additional information, including build videos and connection links, can be found on the SeaPerch main website, https://www.seaperch.org.

Prerequisites

SeaPerch is appropriate for students from fifth grade through their freshman year in college. In general, students should have at least a fifth grade understanding of science and mathematics. Beginning-level students will learn a great deal while building the basic design. As they use and practice with their ROV in the water, they will also begin to learn the connections of the build to the ROV's maneuverability and speed. More advanced students will be able to integrate additional physics and engineering concepts into their designs and competition strategies.

In order to start a SeaPerch program, at least one teacher/leader should have the knowledge and ability to support a build after viewing the supporting materials provided here and on the website, including build videos.

Materials

SeaPerch kits are available online at a cost of $179.00 per kit. One SeaPerch Kit is recommended for each group of 4-6 elementary level students or 2-4 middle or high school level students. Additionally, one Tool Kit is recommended for every 5 individual SeaPerch kits and are available for sale for $249 each. To check current pricing and make purchases, please visit https://shop.robonation.org/collections/seaperch.

Many of the materials needed to build a SeaPerch ROV can be found in a parent's toolbox, or a school's wood or theater shop. Also, most tools can be purchased inexpensively and reused for many years.

Below is a list of recommended tools:

1 PVC pipe cutter (ratchet style)
1 Phillips screwdriver, small
1 Pair scissors
1 Slip-joint and/or needle-nose pliers
1 Diagonal cutter pliers (wire cutters)
1 Wire stripper (for 26-16 AWG stranded wire)
1 Pair safety glasses (1 pair per student actively working)
1 Hand drill, variable speed
1 Drill bit, 1/4"
1 Drill bit, 3/32”
1 Soldering iron
1 Digital Multimeter for testing and troubleshooting (optional)
1 Desoldering pump (optional)
1 Soldering stand
1 Soldering iron tip, conical
1 Soldering iron tip cleaner
1 Sharpie (marker)
1 Ruler
Pens and pencils
1 Lab notebook (Engineering Notebook)
1 Enamel paint set (optional)
1 Paint brush set (optional)
1 Plastic tote/container (optional)

Mentors and Volunteers

A single teacher or leader, though vital, is not enough to ensure the success of a SeaPerch program. Mentors and volunteers play a critical part in the building and testing process, as well as the competition. Their encouragement of students is so important to the success of the program. Reach out to parents and community members – often they will be more than happy to mentor students and help during the build. If there is a local college, students (and sometimes even professors based on availability) make excellent mentors.

If you are holding a local SeaPerch competition, many volunteers will be needed to ensure the competition runs smoothly. Volunteers can help set up the competition area and challenges beforehand. During the actual competition, volunteers are needed in registration, lane judging, a swimmer to reset challenges or retrieve lost parts, people to direct participants and spectators, etc. Finding volunteers to help might sound like a challenge, but it can be easy. Finding the right people who can support and back the program will allow your school or organization SeaPerch program to run smoothly and can provide the most benefit for your students. Below are some tips to help find volunteers:

- Ask parents and older siblings if they can help with the program. Anyone with a STEM background is ideal for becoming a mentor, but anyone with an interest in supporting students can help.
- Call local college professors and ask if they or their students might be interested in helping with the program.
- Remember to ask for mentors specifically to help with engineering notebook judging and presentations. These mentors do not necessarily need to have a STEM background but should be able to help the students present the material and improve their public speaking abilities.
- Ask for a specific time commitment so as not to overwhelm potential volunteers – for example, “Can you come in for just one hour a week to mentor our students as they build their ROVs?”
- Stress that everyone can help with the SeaPerch program – not just science or engineering professionals. Something as simple as bringing a snack for hard-working students can be a huge help.
- Don’t forget to thank everyone who has helped to make your SeaPerch program a success!

Water Access

For some schools and organizations, access to water may not be a problem. However, if your school or organization does not own a pool, there are several things you can do:

- A 50-gallon trashcan or large tub is ideal for testing in the classroom.
- Local lakes or ponds often have free water access.
- If a student's family owns a swimming pool, ask if you can have access to that resource.
- Local YMCAs may offer access to their pools.
- Local hotels with pools may also be willing to let you use their resources.
- A small inflatable pool (at least 2 to 3 feet deep) may be set up outside.
- Fire departments may be willing to bring in their reservoir for students to use.
- Even a clean cow trough can be used for buoyancy testing.

Be sure to always call ahead of time and make sure that the water resource you are planning to use is accessible and that you are permitted to use it.

Group Size and Teamwork

SeaPerch works best when students are encouraged to cooperate and work together in teams. There is a great deal of material to be learned in order to complete a build. When students each choose an area to study more fully, they can share their knowledge with the team.

Any size of group can work to build a SeaPerch, from a single student to a large group. However, the following list of recommended group sizes will maximize the SeaPerch experience, reducing the need for excessive kits while allowing each student to participate:

- Elementary: 4-6 students
- Middle School: 2-4 students
- High School: 2-4 students

In middle and high school, we recommend that each student take a particular area of engineering and apply it to their team and their SeaPerch ROV build. They can then prepare short lessons on their particular area of expertise in order to share with their teammates. The following student "specialties" are recommended:

- Mechanical Engineer: In charge of motors and mechanical systems.
- Materials Engineer: In charge of structural systems. Checks quality of structure on daily basis.
- Electrical Engineer: In charge of control box and control systems. Maintains battery charge.
- Systems Engineer/Project Overseer: Maintains positive flow, oversees project and maintains a record of the build.
- Presentation Designer: In charge of creating the final SeaPerch presentation.
- Technical Writer/Illustrator: In charge of maintaining the engineering notebook.

We also recommend a certain number of adult supervisors in order to keep the build experience flowing smoothly and to prevent safety mishaps:

- Elementary: 1 adult per team
- Middle School: 1 adult per 2-3 teams
- High School: 1 adult per 4+ teams

Scheduling Options

SeaPerch is a program that can be used in many different venues, from public and private schools to homeschools, to clubs and extracurricular activities. Therefore, scheduling activities, lesson plans, build sessions, and quality testing/practices are up to the discretion of the teacher/program supervisor. In a school setting, lesson plans may be set up so that teachers can use one or several class periods.

You may choose to do an entire unit with SeaPerch, or you may spread it out throughout a year or semester, interspersing SeaPerch activities with other classroom lessons. In a homeschool or club setting, you may choose to only focus on the build and testing procedures to fit the available meeting times. Whichever you choose, SeaPerch is flexible enough to fit any time constraint and availability!

Example I: Embedded in a Semester of High School

Sessions during class, 1 time per week

Weeks 1-3	Underwater Oceanography
Week 4	Buoyancy
Week 5	Density
Weeks 6-7	Electrical Circuitry
Weeks 8-9	Scientific Method and Presentations
Weeks 10-14	SeaPerch ROV Build
Weeks 15-17	Testing/Data Collection
Week 18	School Competition

Example II: Club or Group Meetings

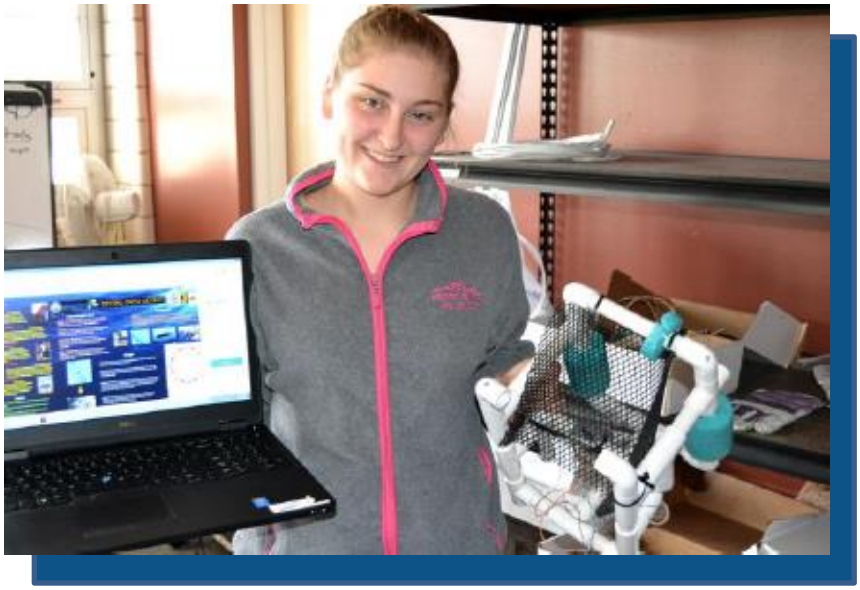
Meetings 1 time per week

Week 1	Introduction to SeaPerch
Week 2	Exploration of Navy and underwater challenges
Week 3	Materials and build discussion; watch beginning build videos
Weeks 4	Building the Control Box
Week 5	Constructing the Frame
Week 6	Adding Motors
Week 7	Propellers and Battery Connections
Week 8	Adjusting Flotation and Water Testing

Computer Access

Computer availability for all students can be helpful, especially if you plan on having the students research topics and discover answers on their own time. Some lesson plans can benefit from each team having computer access.

However, in order to complete the SeaPerch build and to compete, it is not necessary for students to have computer access. As long as a teacher or volunteer can get onto the SeaPerch website and provide necessary instructions and materials, the students can have a complete SeaPerch experience.



Managing a SeaPerch Competition

Students benefit greatly from having the opportunity to demonstrate their new knowledge and their SeaPerch ROVs. They have the chance to interact with other students interested in engineering and STEM and will gain confidence through presenting and competing. The following information will assist you in managing a local, regional, and/or state competition.

Local and Regional Competitions

Local competitions are small events to allow for exploration and friendly competition between students from the same school, small school district, or area and provide a chance to showcase their SeaPerch ROVs and optionally compete on a small scale.

Regional competitions are larger events that welcome teams from large cities, counties, and even multiple states. Regional competitions , when properly registered, may be used as qualifiers to send teams to the annual for the International SeaPerch Challenge.

Please see specific guidance at https://www.seaperch.org/competition for team entry rules for the International SeaPerch Challenge.

If you plan on creating a local or regional competition, contact teachers and mentors from other schools and clubs in your area to see who might be interested. If they have not yet begun a SeaPerch program in their area, mention that they can find all the necessary information on the SeaPerch website: https://www.seaperch.org .

A competition, no matter how small, can really serve to pique interest in the SeaPerch program. When parents, teachers and friends see for themselves how fun and educational SeaPerch is for the students, they will be more likely to support the program and help ensure its continuation.

Challenges during an event can vary, but there are several that are consistently used. These tried-and-true events are easy to set up and prepare, and are both fun and challenging for students:

- Obstacle Course: Students must maneuver their ROVs through an underwater obstacle course. This can be constructed of PVC pipe structures, weighted hula hoops, etc.
- Salvage: Students use their ROVs to retrieve diving rings from the bottom of a pool or from clips hanging on a simple metal or PVC frame.
- Sprint: Students race their ROVs on the surface of the water.

Planning a SeaPerch competition may sound challenging, but it can actually be condensed into a few simple steps:

1. Schedule the event
2. Find and secure a location with a pool
3. Engage volunteers and judges
4. Create and set obstacles
5. Event day!

More specific information to help you plan a successful and stress-free local or regional event can be found under “Planning an Event” in this guide.

State Competitions

State competitions are a terrific opportunity as regional competitions begin to grow in your area. This tiered system allows the winners of regional competitions to refine their ROV designs as well as their presentation skills, and to compete at a higher level against other champions at the state level.

International SeaPerch Challenge

Winners of registered qualifying competitions have the opportunity to attend the annual International SeaPerch Challenge. This is an exciting event for students who love the chance to travel and to meet other science- and technology-minded students from around the country.

The annual International SeaPerch Challenge serves as the culminating event for the SeaPerch season. The Challenge was first held in 2011 at Drexel University. It has grown from 40 teams to an anticipated 250 teams from more than 100 registered regional qualifiers for the 2020-2021 season. This event evolved significantly over the years and now includes multiple in-pool and out-of-pool opportunities for student teams to share their designs, experience with the engineering process, and to network with other participating teams.

Each of the competition elements aim to engage students in developing a successful ROV and to promote an understanding of how purposeful design modifications impact the performance of their ROV. In addition to the exercise of STEM skills emphasized by the competitions, teams can further develop their communication and collaboration skills through oral presentations and preparation of written documentation materials and posters. To date, teams international from Australia, the Cayman Islands, New Zealand, and the Virgin Islands have participated in the International Challenge.

More information on the current International SeaPerch Challenge can be found at: https://www.seaperch.org/competition .

Planning a Competition

Timeline

Below is a timeline that may be helpful when planning a local, regional or state competition. Note that it is prudent to begin planning at least 6 months before the event is to be held.

6-9 Months Before Event:

- Secure a location. The location should have a pool as well as classrooms or other areas nearby for presentations.
  - Keep in mind the cost of using the facility, if applicable.
  - Remember that some facilities may charge usage fees and custodial expenses.
- Inquire if any insurance/liability riders are necessary.
- Set registration timeframe and determine any fees required for participation.
- Invite local business partners to support the upcoming competition (financially or with volunteers)

2-3 Months Before Event:

- Plan schedule for competition day.
- Send out competition day details to all participants and volunteers, including schedule and directions.
- Procure materials needed to construct underwater obstacle and challenge courses.
- Construct courses.
- Solicit judges and volunteers.
  - Lane judges
  - Presentation judges
  - Security, divers, first aid, and lifeguards
  - Registration workers
  - General volunteers to manage flow of participants and spectators
  - Camera men/women for stills and/or video
- Order shirts or other items for participants (optional).
- Order awards.
- Inform local news media.
- Secure materials for triage table.
- Arrange catering, if offering food.

Day of Event:

- Set up underwater courses.
- Set up ROV inspection area.
- Organize registration table.
- Set up awards and triage area.
- Set up volunteer area with information / water or refreshments, as available.
- Enjoy the competition!

Advertising and Public Relations

A SeaPerch competition is an excellent opportunity to show parents, businesses, and the community the meaningful learning that students can accomplish with SeaPerch's interactive program. Take time to plan for photo opportunities and involve your local newspapers, news agencies and local officials. By getting the word out that you are participating in a fantastic STEM initiative program, you will not only be able to grow the program, but you may also find that local businesses are willing to support your students. Below are some ways you can advertise SeaPerch:

- Invite a local news source to do a story about your SeaPerch competition.
- Hang up posters around town inviting spectators to watch the competition.
- Put a notice in a school or local newspaper.
- Have students talk about their SeaPerch experiences at a local club or guild.
- Social media is also a great means of promoting and advertising the competition.

After your competition is complete, take time to send in a brief description of the event, as well as pictures, to seaperch@robonation.org . We want to feature your competition on the SeaPerch website and acknowledge your successes!

Volunteers

Volunteers play a vital part in any SeaPerch competition. You may be surprised at the number of volunteers that want to help with your event! For a local, regional or state competition, you will need to enlist several different types of volunteers, listed below. The number of volunteers in each category will vary depending on the size of your event.

- Lane judges
- Presentation judges
- Registration volunteers
- Set-up and tear-down crew
- Swimmers/divers to reset challenges and/or retrieve dropped parts
- Photographers
- Volunteers to direct participants and spectators

When searching for volunteers, consider approaching the following groups of people:

- Local business partners
- School teachers and administrators
- Any area military installations, including contractors, government employees, and National Guard outposts
- State officials
- Parents (Note – parents should not judge events that their children may be participating in)
- University staff

Remember to thank all volunteers for their time and efforts to make your SeaPerch competition a positive and successful event!

Triage Table

A triage table is a table with spare parts and tools just in case something breaks or goes missing. In a competition with lots of kids running around with robots, be sure that something will go wrong. It's always better to be prepared rather than have to scramble for extra parts in the heat of the moment. A typical triage table might contain the following equipment and parts:

- Soldering iron and solder
- Wire
- Wax
- Glue
- Propellers
- Propeller shafts
- Pre-waxed motors
- General tools such as screwdrivers, vise grips, wire cutters, etc.
- Safety glasses

Awards

Awards are up to your discretion, but as a rule, more is better. Although there will be some teams who are clearly ahead in certain areas, all students should be congratulated and encouraged, since all students have worked hard to create and use their SeaPerch ROVs. Even the teams who do not move up in the competition will be thrilled to receive a smaller award acknowledging their efforts. Plan to celebrate the successes of all participants!

In general, awards should be given at both the middle school and the high school level. Below is a sample framework of awards:

- Obstacle Course: 1st, 2nd, 3rd
- Presentations / Engineering Notebook: 1st, 2nd, 3rd
- Challenge course: 1st, 2nd, 3rd
- Best Use of Engineering Principles
- Most Unique Build
- Most Innovative Adaptation
- Sportsmanship

TEACH

SeaPerch is more than just an opportunity for students to build a cool robot. It can be turned into an entire curriculum based on the SeaPerch ROVs. We have a collection of lesson plans, in addition to supplemental materials like PowerPoint presentations and worksheets, to help you make the most of this amazing opportunity. These materials can be found on the SeaPerch website at https://www.seaperch.org/library .

Whether you want to take a single day and learn something new through one of our SeaPerch lessons, or if you wish to delve deeper and create an entire unit, we have resources you can use to enrich your students' SeaPerch experience.

Academic Standards

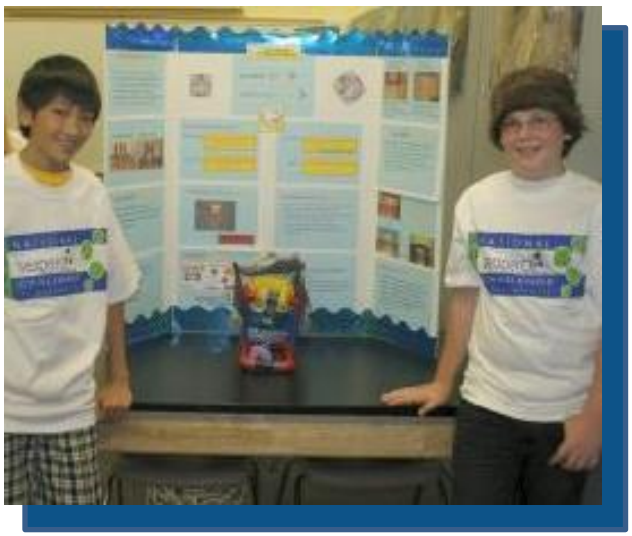
SeaPerch is committed to providing educators with the resources necessary to begin and maintain a robust program. The SeaPerch Build Manual has been mapped to Next Generation Science Standards, Common Core, and P21 standards for 5th - 12th grade.

More information can be found at https://www.seaperch.org/educational-standards .

Other Resources

Presentations

Students are encouraged to create presentations over the SeaPerch build and testing process. While the hands-on experiences are important, it is also crucial that students learn how to share those experiences concisely and clearly with others. These skills will be important as students begin preparing for college, internships, and jobs.



Engineering Notebooks

Engineering notebooks are used by engineers to document their ideas and the steps taken to solve engineering problems. They carefully and systematically track and analyze progress and results and provide a legal document that can be used as proof of invention for products they design. Engineering notebooks are sometimes referred to as an Engineer's Notebook, Design Notebook, Laboratory Notebook, or Inventor Notebook.

The use of an engineering notebook is highly recommended throughout the SeaPerch program. The use of an engineering notebook is part of the International SeaPerch Challenge and many Regional SeaPerch Challenges. Additional information regarding Engineering Notebooks can be found at https://www.seaperch.org/design-process .

BUILD

Students are always so excited about the SeaPerch build and the actual creation of an ROV. What they might not realize is that, during the build process, they are gaining many new abilities, from engineering to life skills such as working on a team. The SeaPerch Build Manual, found on the SeaPerch website, will show you how to help your students complete a successful, fun, and educational build. Find the Build Manual here: https://www.seaperch.org/build . A full set of build videos are also available on to assist teachers and students in the build process: https://www.seaperch.org/build .

Trick Out Your SeaPerch

One of the most exciting things about SeaPerch is that students don't have to ascribe to a to-the-letter model. They have the freedom to add enhancements and change the design of their ROV so that it reflects their personal ideas and imaginations. SeaPerch is an opportunity to think outside the box!



Enhancements

Now that you've built a SeaPerch, it's time to take it to the next level. Enhancing your SeaPerch can take on many different paths. Students who desire to move beyond the initial level of the SeaPerch's capabilities may consider adding upgrades such as:

- more powerful motors
- sensors for pressure, temperature, salinity, or turbidity
- a hydrophone
- a bank of LED lights
- a compass
- a depth gauge
- a camera

The possibilities are endless!

Hydrophone

Want to hear what is going on underwater? Build a hydrophone! How to Build a Hydrophone: http://www.coseetek.net/resources/index.cfm?FuseAction=ShowResourceDetails&ResourceID=670

Sea Star Surface Craft

The Sea Star Surface Craft project is intended to introduce students to the basic concepts of hull design, and related concepts such as buoyancy, center of gravity, center of buoyancy, righting moment, fluid dynamics, drag, etc. It is based on the forming of a hull out of foam, allowing students to experiment with varied designs. The motor and radio control system are easily movable from one hull to another.

The Sea Star Surface Craft construction manual is available at:
https://www.yumpu.com/la/document/read/10489446/sea-perch-project-mit-sea-perch

Super SeaPerch

The Super SeaPerch project is intended to introduce students to the basic concepts of hull design,
Super SeaPerch Manual: https://documents.pub/document/super-seaperch.html

BECOME

SeaPerch is a perfect avenue to direct students towards degrees and careers in STEM. In the following pages, you will find resources to offer your students and help set them on the path to success!

Career Options

Did your students enjoy building and using their SeaPerch ROVs? There are dozens of careers that will allow them to have that kind of fun every day. Engineers and scientists in the field of marine science and engineering face interesting challenges involving water, robots, marine life, complex electronics, water and pressure resistant housings, corrosion, video navigation, computer control problems, and flight dynamics (just like an airplane, but wet).

If your students found a certain part of the SeaPerch process particularly interesting, they may be surprised to find that there are careers that fit their interests perfectly. Below you can see different steps of the building and operating procedure, and a few careers that match up with them:

- **Frame Construction**
  - Mechanical Engineer - Responsible for selecting the materials, designing the structure, drawing a 3-D model, optimizing the design, and minimizing the cost. A good deal of time is spent analyzing the design in the digital 3-D world to ensure that the vehicle will work exactly as planned. Mechanical engineers need to be familiar with the concepts of structural analysis, fluid flow, material science, machining techniques, aerodynamics, and the ocean environment.
- **Waterproofing the Motor**
  - Mechanical Engineer - Responsible for designing a housing that is capable of keeping the water out of the motor at whatever depth the vehicle is designed to operate at, while allowing a shaft to protrude from the housing and rotate the prop.
  - Ocean Engineer - Responsible for understanding the properties of the ocean at the depth of interest. This person also works with or in place of the mechanical engineer in choosing materials and designing components to work in the harsh ocean environment.
- **Building the Control Box**
  - Electrical Engineer - Responsible for designing the entire control system for an underwater vehicle using switches, resistors, diodes, capacitors, and circuit boards to make it possible to push a button and have the vehicle go in the desired direction. The electrical engineer is also responsible for designing the battery charging system and the energy delivery system and ensuring that the proper voltage goes to the correct component at all times.
  - Mechanical Engineer - Responsible for designing the control housing.
- **Choosing a Battery**
  - Electrical Engineer - Taking into consideration how long the vehicle should run for and at what power, the electrical engineer will choose the most efficient battery to power the vehicle.
  - Mechanical Engineer - With the battery now selected by the electrical engineer, the mechanical engineer will fit the battery in the hull and determine how much flotation is needed to offset the added weight.
- **Adding Ballast and Flotation**
  - Mechanical Engineer - Responsible for determining how much ballast and flotation the ROV needs to either sink or float and how much space there is available for this added material.
  - Ocean Engineer - With an understanding of the forces of the deep ocean, the ocean engineer will design the ballast and flotation to withstand the forces at the surface of the ocean, the forces at depth, and extreme temperatures.
  - Marine Scientist - This is the person who will be using the vehicle and is therefore in charge of what we put onboard. If the marine scientist wants a sensor or a camera, the rest of the team needs to accommodate those needs and make sure those items fit on the vehicle.
- **Driving the SeaPerch**
  - ROV Pilot - Have you ever played a flight simulator game? This is what an ROV pilot does every day. From the safety of an onboard computer and flight control center, the pilot drives the ROV using video feedback. The only difference is that the ROV pilot's crash can cost millions of dollars, so he or she had better get it right the first time.

- **Video**
  - Communications Engineer - The communications engineer is in charge of getting information from one place to another as efficiently as possible. Have you ever watched a jumpy video feed over the Internet? The communications engineer must ensure that video feeds are stable and uninterrupted.
- **Building Sensors**
  - Electrical Engineer - If they are standard sensors and do not exist in the size and shape of interest, the EE will have to build these from scratch. This can be a very challenging process as the tolerance may be a few thousands of a volt or an amp, and that is a difficult thing to accomplish in the electronics world.
  - Mechanical Engineer - When a force or other parameter could affect vehicle performance, it needs to be monitored. Mechanical engineers design and build sensors that can track the vehicle's status.
  - Marine Scientist - When a scientist is anticipating a possible new discovery, he or she needs to work with engineers to design customized sensors. This involves knowing everything about the material to be detected and knowing how to interpret the data.
  - Computer Scientist – Sensors produce raw data that is stored and sometimes streamed live for real-time analysis and presentation. The computer scientist will design programs and algorithms to organize and store the data from multiple sensors.
- **Programming Sensors**
  - Computer Scientist - Almost all electrical sensors measure the environment and output a small proportional electrical voltage or current; computer scientists create computer programs that convert raw data into values such as temperature, salinity, or pressure. The programs must filter out electrical interference and acoustic noise.
- **Studying the Ocean**
  - Marine Scientist - Marine scientists are significant users of the ROV and AUV technology. They determine what to study in our coastal waterways and depths of the ocean. Understanding fish populations, habitats, water quality and seasonal variability are a few of the areas in which marine scientists would use ROV technology to assist them in data collection.
  - Ocean Engineer - Just like a mechanical engineer, an ocean engineer solves mechanical problems; however, the ocean engineer's specialty is applying the unforgiving parameters of the ocean environment to the mechanical design. As a result, these engineers will spend a lot of time determining what the environment consists of such as the temperature and pressure extremes.
- **Improving SeaPerch Design**
  - Mechanical Engineer - Even after the vehicle is built, there is always room for improvement. The mechanical engineer will constantly analyze the success or failure of a mission and determine what they can improve or redesign on the vehicle to make it better.
  - Electrical Engineer - There will always be a better way to use a motor, camera, and battery, and it is up to the electrical engineer to constantly make sure that those systems are in use.
  - Computer Scientist – As sensors and control systems are improved or modified, the computer scientist must update and improve the data collection and data analysis programs. As more data is collected, the computer scientist must embrace new technologies such as big data processing and machine learning techniques.
  - Marine Scientist - As a user of the technology, the marine scientist determines what needs to be improved on the vehicle so that appropriate data is collected and what new features would benefit science. The marine scientist then passes this information to one of the engineers to implement the change.

- **Adjusting the Motors**
  - Mechanical and Ocean Engineers - Pointing the motors in the correct direction isn't as simple as it sounds. There is a balance between having the fewest number of motors for reasons of power consumption and having the most maneuverable vehicle possible. As a result, small changes in force vectors make a huge difference and need constant maintenance and updating so that the vehicle is running as efficiently as possible at all times.
- **Inventing New Components**
  - Mechanical and Ocean Engineers - Just because it doesn't exist doesn't mean it can't exist. This is a motto of a good engineer. If you want to accomplish something that hasn't been done before (which is common for underwater exploration), it is up to these people to make the part or system that will allow this to happen.
  - Electrical Engineers - Again, an electrical engineer can't be daunted by the fact that a task has never been accomplished before. The electrical engineer makes the parts so that the new task can be attempted.
- **Microcontrollers**
  - Electrical Engineers - A microcontroller developer board is a quick way to build an experimental or prototype circuit. Instead of spending hours designing a perfectly efficient circuit to just try out a concept, electrical engineers will use a microcontroller developer board to test it out. And then if it works, they will build a circuit from scratch to accomplish the same task more efficiently.
  - Computer Engineers - All computers need to be programmed, so the computer engineer has to make sense of all the data coming into the microcontroller and have it perform the desired command afterwards.
- **Choosing a Propeller**
  - Mechanical Engineer - How fast should the vehicle go? How much energy can we spend? How much drag will there be? These are the questions of propeller design that a mechanical engineer must answer using their knowledge of aerodynamics and fluid properties to build a 3-D model that can be tested and optimized to perform exactly as intended.
- **Water Sampling**
  - Marine Scientist - The marine scientists need to know the conditions of the water that is being studied in order to understand any other data they may be measuring. Different temperatures, conductivities, dissolved material contents, and pH will greatly affect the meaning of any data collected, so it is important to know how to measure these parameters.

Other Careers in STEM

STEM careers are among those with the highest demand in the United States. Science, technology, engineering, and mathematics careers include (but are certainly not limited to) these interesting, challenging, and in-demand jobs:

Aerospace Engineer	Biologist	Mathematician	Physicist
Anthropologist	Chemical Engineer	Meteorologist	Professor
Architect	Chemist	Microbiologist	Psychologist
Astronomer	Computer Programmer	Neuroscientist	Science Teacher
Automotive Engineer	Forensic Scientist	Nuclear Engineer	Statistician
Biochemist	Geologist	Pathologist	Surveyor
Bioinformatics Scientist	Geoscientist	Pharmacist	Veterinarian
Biomedical Engineer	Math Teacher	Physician	

Careers Resources

Below are some online resources for teachers and students interested in the variety of STEM careers:

- The top 100 jobs in America (many of which are in STEM): https://money.usnews.com/careers/best-jobs/rankings/the-100-best-jobs
- Science and Engineering careers: http://www.sciencebuddies.org/science-fair-projects/science_careers.shtml

Marine Life Opportunities

Do your students like jumping right in and getting their feet wet – literally? A marine career might be the perfect choice for them. Some marine careers include marine biology, marine geology, seismology, coastal geography, physical oceanography, chemical oceanography, and ocean engineering. To check out more in-depth information about marine careers and other opportunities, visit the following links:

- Marine Careers: http://www.marinecareers.net/
- NOAA's Ocean Explorer page – careers and other resources: http://oceanexplorer.noaa.gov/edu/oceanage/

Naval Career Opportunities

People trained in the field of Naval Architecture, Marine Engineering, and Ocean Engineering are always in demand. In today's world of increasing international trade, amid growing awareness of our environment, and concern about maritime security and national defense, people with these skills are essential. They design, build, and operate vessels to transport and protect people and goods; they design all types of ocean structures. Maritime trade, national defense, environmental protection, and security are not temporary concerns, but permanent responsibilities. The demand for maritime professionals will continue to increase.

Facts about Naval and Maritime Careers:

- Over 95% of the world's goods arrive at their destination by ship
- A principal mission of the Navy is the protection of sea lanes and merchant ships
- The merchant marine is considered the fourth arm of our national defense

RoboNation Opportunities

RoboNation, the organization that manages the SeaPerch program, also manages or supports several other robotics programs and competitions. RoboBoat and RoboSub are natural progressions to the SeaPerch program and offer advanced competitions that will help challenge and prepare middle school through graduate level students to face real world challenges in autonomous vehicle design, fabrication, programming, and use.

Programs

STEM Education & Robotics: http://www.robonation.org/stem-education-robotics
SeaGlide: http://www.robonation.org/seaglide
RoboTour: http://www.robonation.org/robotour

Competitions

RoboBoat: http://www.robonation.org/competition/roboboat
RoboSub: http://www.robonation.org/competition/robosub
Maritime RobotX Challenge: http://www.robonation.org/competition/robotx
Intelligent Ground Vehicle Competition (IGVC): http://www.robonation.org/competition/igvc
Student Unmanned Air Systems (SUAS): http://www.robonation.org/competition/suas
International Aerial Robotics Competition (IARC): http://www.robonation.org/competition/iarc