

National Underwater Robotics Challenge

June 8-10, 2007

Chandler, Arizona

Organized and Sponsored by

APASE

**Arizona
Promotors of
Applied
Science in
Education**

Rules & Mission Specs

When Is The Competition?

The competition will be held on June 8-10, 2007.

Where Will The Event Take Place?

The event will be held at Chandler High School in Chandler, Arizona

Who May Enter?

The competition is open to any home school, jr. high, high school, jr. College or university as well as private corporations. Teams may consist of combinations of students, industry mentors, faculty members and parents. Students must however be the ones competing in all the parts of the competition. Adults can be team members, but the students do all the competing at the competition. Private corporations are the exception, unless they have students. Jr. high, high school, colleges and universities, and corporations will be scored separately as categories, but they will all compete in the same mission.

What Is The Entry Fee?

The entry fee is \$250.00 which is non-refundable. It is due by January 5th 2007. After January 5th the entry fee will be \$300.00

How Many Teams Can Enter The Event?

A total of 24 teams will be allowed to compete in this competition. Being that this is the first year of the event, quality is of utmost concern to the event organizers. In the future, more teams will be allowed to enter. The teams will be taken on a first come first served basis contingent on submission of an entry form and the entry fee.

Why Is This Event Being Held?

The event organizers want to bring another technological competition to the state of Arizona. to complement the F.I.R.S.T. Robotics Arizona Regional for high school students. The event organizers want to encourage students participate in science and technology. The event allows students from jr. high to university to be exposed to one another in a competitive and fun venue where ideas can be exchanged and friendships developed.

Who Is Putting On This Event?

Arizona State University, Chandler High School and Carl Hayden High School, As members of the Arizona Promoters of Applied Science in Education, a non-profit organization dedicated to promotion of science and technology education in Arizona.

Mission Scenario

Germany's Lost Sub

The mission scenario is based on the Nova documentary Hitler's Lost Sub, (<http://www.pbs.org/wgbh/nova/lostsub/>) and also on a book called Shadow Divers by Robert Kurson "The true adventure of two Americans who risked everything to solve one of the last mysteries of World War II." (<http://www.robertkurson.com/book.html>) While the actual story took place in 70.11 meters of water with extreme SCUBA divers, the event organizers changed a few things to make it fit more for an ROV Scenario. It would be great if each team got the Nova Video from the P.B.S. website and watch it to get the "flavor" of the mission or get the book which chronicles the story of the father and son team that explored the sub for years trying to identify it.

The mission scenario for this competition goes like this. In 2006, professional ROV developer John Jacobson, testing a video ROV, accidentally discovered a sunken German U-boat from World War II, lying undetected only 96.6 km off the New Jersey shore. The U.S. and Germany have no record of any German sub ever sunk in this location, yet there it lies, 914.4 meters down with unexploded torpedoes and the bodies of its crew still aboard. One year later you, (*John Jacobson*), and your ROV team have built an ROV to conduct a salvage and identification operation for history's sake. The sunken sub is too deep for divers so ROV's are the only solution. The amount of light at 914.4 meters is basically zero, so your ROV must also be equipped with lights. Based on video surveys from the video ROV and technical drawings of typical German Submarines you plan your mission. The goals are as follows:

1. Retrieve without detonating the two surviving armed torpedoes to the surface where they will be disposed of in a detonation chamber.
2. Retrieve any artifact that will help identify any crew member.
3. Locate the sonic pinger used to mark the location of the Sub, and verify its condition and decipher its coded message.
4. Retrieve the submarine's military identification plaque to the identity of the submarine.
5. Measure the depth of the top of the blast opening that sank the sub.
6. Measure the temperature of the gassing volcanic vent that the submarine landed on when it sank.
7. Place a commemorative plaque on the deck next to the blast opening.

Since the location of this event is in a desert, some accommodations have been made to help make this event interesting. Being that in June the day time temperatures could be in the 100's, and the fact that the event is being held at an outdoor pool, the event will be held at night. This will allow the teams to operate their ROVs in lighting conditions that simulate 914.4 meters and will not subject teams to the heat of the southwest desert.

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Power Restrictions:

The ROV power must come from team supplied batteries. Console, pilot monitors and such pool side equipment can use venue supplied 120v AC GFI protected power. (Teams need to supply power strip, if needed)

There is a **power limit of 1700 watts** direct current (DC) for the ROV. In addition, no ROV system may use more than 56 volts (nominally a 48 volt system). No ROV may draw more than 120 amps. There must be an appropriate sized fuse or circuit breaker that will insure the 1700 watt limit.

The size of the circuit protection will depend upon the voltage of the system. A 12 volt system powered by fresh batteries, may, in reality, be a 13.7 volt system.

Using the power formula, Power= voltage * amps will determine the maximum current. $1700w = 13.7v * \text{amps}$; $\text{amps} = 1700w/13.7v$; 124 amps. Since 120 is the legal limit, a 120 amp breaker should be used.

Using the same formulas, a 36 volt system may charge to 40 volts, thus $1700w/40 = 42.5$ amps. A 40 amp breaker would be used to insure the system does not exceed 1700 watts.

Once the main breaker is determined, it is advisable, but not required, that ROV subsystems are fused to protect your ROV.

If an independent subsystem power supply is used (e.g. four 12v 3 amp underwater flashlight with their own batteries), the $(4 * 12 * 3)$ 144 watts must be deducted from the 1700 watt total. If more than one ROV is deployed, the total power budget is 1700 watts

Judges will be concerned that the gage of wires are appropriate for the current, that there are no exposed wires nor other safety issues during inspection and during the competition.

If there are any power limit questions, please contact the event personnel for clarification. See attached chart.

voltage	amperes
6	283.3
7	242.9
12	141.7
14	121.4
24	70.8
28	60.7
36	47.2
42	40.5
48	35.4
56	30.4

ROV Dimensions:

There are no restrictions on the size and weight of ROV. The mission props may provide you with guidance on what might be appropriate dimensions for this mission.

Number of ROV's per team:

There is no limit to the number of ROV's a team may use in the competition, however, the total power of all of the ROV's combined must not exceed the 1700 watt limit with all the ROV's combined.

Number of people per team:

There is no limit to the number of people who can be on a team, but, only students may participate in the underwater mission and the oral presentation. Private corporations without students are exempt from this rule, but will be scored in the Pro division.

Number of teams per school: There is no limit to the number of teams allowed from each school.

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Components:

This competition is designed to strengthen problem solving skills and encourage learning in systems integration. Use of off the shelf, plug and play systems is allowed. That is, while, an ROV cannot be bought and used off the shelf, separate ROV components can. Each team must design and build its ROV, integrating a series of components into a ROV system. A team may chose to design and build components or find components that fit its needs from any commercial vendor. A team must be able to explain all the functions of the ROV and all of its components. Use of a component without a general understanding of the component's fundamental theory of operation could result point deductions during the oral presentation.

Price Limit:

There is no limit to the amount of money that may be spent on the ROV. Functionality is of primary importance and cost effectiveness is secondary. Higher scoring may, however, result if a capable ROV is built for less money. A detailed itemized price list that includes donated items and lists vendors is required for each team's ROV system.

Website:

Each team is encouraged to have a website which documents and showcases the team's participation and learning through all phases of ROV construction. The teams that have websites will get 20 points that contributes to their overall scores and teams that do not maintain a website will not get the 20 points. Students and audience will judge websites during the competition for a special website award. Team websites will be listed and linked through the event website as they become available.

The competition will be broadcast on the world wide web with live, video and audio stream. All video footage will be archived and available through the event website after the competition.

Video Feed:

Each team **must** have **a live video feed** available to show the video from the ROV to the public in the viewing room and the world wide web via the live stream. This connection must be a female RCA connector. The event staff will connect to this feed.

Audio Feed:

Each team is encouraged to have a **live audio** feed available. They will be connected with female RCA Jacks as well. A 5 point bonus will be awarded if audio is present.

Team ROV video Footage:

Each team will be able to pick up a DVD of its mission after completing the mission. This video will contain angles of the mission as recorded from the various vantage points in the pool, as well as the video feed from the ROV itself. Teams may use this footage to showcase their ROV's performance and promote the event.

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Oral Presentation:

Each teams will have 15 minutes to make a presentation to a panel of judges explaining the design, construction and operation of its ROV. All teams must have their ROV and surface support systems present during the presentation and **only the students team members may present to the judges** (with the exception of corporations, unless they have students). Teams may bring any additional props they like to aid in the presentation, but they must provide these on their own behalf. A table and screen will be provided, computers and projectors are the responsibility of each team, and may be used optionally. There is no limit to the number of team members who may participate, but non-presenters must remain outside the room. Each presentation will be broadcast outside of the presentation room on a closed circuit TV for the non-presenting team members and the general public to see. Video footage of each presentation will be burned to DVD and each team will be receive a copy of its presentation for its records. This video footage will also be archived on the event website, for teams that sign a waiver, so that future teams may watch and learn from them.

The total presentation time allotted for each team is 30 minutes, allowing for a 2.5 minute set up, 15 minute presentation, 10 minute question and answer period, and a 2.5 minute breakdown. The oral presentation is worth a total of 50 points.

Technical Report:

Each team must submit one week prior to the event a technical report documenting the design, construction and operation of the ROV in order to conduct the mission. This report must be submitted via e-mail in PDF format. Confirmation of the submission of the technical report will be in the form of an email verifying the date and time of the submission. The report may be written by any member of the team. Each team may decide how many people participate in writing the technical report, but it is highly advisable that the authors of the report also participate in the oral presentation, as the presentation judges will use this report as a reference. The technical report may not exceed 25 pages in length and must use 12pt Times New Roman font. It **must** include a **title page** with the school name, team name, school location, photo of the ROV, list of team members, and list of authors for the technical report. The report **must** include a **table of contents, headings** for each section, a list of **references**. An **abstract**, no longer than 250 words, must immediately follow the table of contents. The intention of the report is to communicate understanding, learning and experience gained through the stages of ROV development and testing. Sample headings might include “Mission Strategy”, “Design Revisions”, “Techniques learned”, and “preliminary Results”. Incorporate graphs and photos and other visual enhancements if so desired. Several sample reports are available on the event website for reference. Once all the teams have submitted their technical reports, these reports will be posted on the website and made accessible to all teams and the general public. The technical report is worth a total of 50 points.

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Technical Inspection:

Before any team will be allowed to participate in the competition, its ROV **must pass** a technical inspection. The ROV will be evaluated for safety and the removal or modification of exposed sharp edges, electrical hazards, and mechanical pinch points. Each team must demonstrate its ROV can **be readily turned off**. It will only pass inspection if it deemed safe to operate in the water. Keep this in mind when designing and building the ROV. During the inspection each team must also **present a schematic** of the ROV system, and **identify appropriate fuses**. Each team must demonstrate to the extent possible, all **functions of the ROV**. Teams **must show** that the ROV is the **within the 1700 watt** limit, and must present the female RCA type video connector to the inspectors so that they may test the live video feed. The audio feed will also be tested at this time, but a lack of functioning audio will not prevent a team from competing. If a team's ROV fails the technical inspection, the team may make modifications to the ROV and repeat the inspection until either the ROV complies with safety regulations and competition rules or the inspection period expires.

Measurements:

All measurements will be in SI (metric) units. .

Mission Scoring: Maximum points is 160

1. Retrieve without detonating the two surviving armed torpedoes to the surface where they will be disposed of in a detonation chamber.
 - * 5 points for locating each torpedo
 - * 15 points for bringing each torpedo safely to the surface
 - * If either torpedo is accidentally detonated the mission is over and the team retains points acquired up to that point.
2. Retrieve any artifact that will help identify any crew member.
 - * 5 points for locating each artifact (there are 4)
 - * 5 points for bringing each artifact to the surface
3. Locating the sonic pinger used to mark the location of the Sub and deciphering the message.
 - * 5 points for locating the pinger
 - * 10 points for deciphering the secret message that is being pinged in Morse code
4. Retrieve the submarine's military identification plaque to verify for the identity of the submarine
 - * 10 points for locating and reading the identification tag
 - * 15 points for bringing the tag to the surface
5. Measure the depth of the top of the blast opening that sank the sub.
 - * 10 points for measuring within 10 cm
 - * 5 points for measuring between 10 –20 cm
6. Measure the temperature of the gassing volcanic vent that the submarine landed on when it sank.
 - * 5 points for locating the volcanic vent
 - * 10 points for measuring within 5 degrees C
 - * 5 points for measuring between 5 to 10 degrees C
7. Place a commemorative plaque on the deck next to the blast opening.
 - * 15 points

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Mission Details:

Set Up: Teams will be pre-staged in a designated area and the team captain will notify the staging crew of the team's arrival. When the team is given the signal to begin its mission, the team will have five minutes to set up in the mission control area. The set up timer will stop once the team captain declares its completion and all members are idle. The team will receive a **one point penalty** for every five seconds spent in set beyond the 5 minute set up period. This delay will also cut into the total mission time.

Mission: Each team will have thirty minutes to complete the mission. The mission timer will begin exactly five minutes after the team is given the start signal. The team captain can end the mission at any time. **A team that ends the mission in under thirty minutes will get one point for every minute under thirty minutes. Any team that completes, (finish all the tasks with full points for everything), the mission in under thirty minutes will receive two bonus points for every minute remaining under the thirty minutes.**

Break down: Each team will have five minutes to break down their equipment and leave the mission control area. The team will receive a **one point penalty** for every five seconds spent in break down beyond the five minute break down period.

Details on Props:

1. Retrieve without detonating the two surviving armed torpedoes to the surface where they will be disposed of in a detonation chamber.

There are two live torpedoes lying portside on the bow. They look as if they fell out after the submarine settled on the bottom. The dimensions are 5' or 1.524 meters long and 6" in or 15.24 centimeters in diameter. It is 42.5 N in Air. Detonation will be indicated by flashing green LEDs located in the frame of the torpedo. Each team will be given a two TRDs, torpedo recovery devices. These will be neutrally buoyant. They will have a car-bineer that will self lock onto the U-bolt on the torpedoes. The teams must use their ROV to attach the TRD and then activate the inflation switch which will then inflate a lift bag to ascend the torpedo to the surface. The TRD will have a rope attached to it that the ROV team can then use to pull the torpedo toward them so they can remove the torpedo from the water.

2. Retrieve any artifact that will help identify any crew member.

These items must be determined to the ROV team during the mission. There will be four of them.

3. Locate the sonic pinger used to mark the location of the Sub and decipher the coded message. You will be given a Morse code sheet to decipher the message

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4. Retrieve the submarine's military identification plaque to verify the identity of the sub.

The identification plaque is located on the starboard side of the submarine near the bow. It is near the entry way of the hatch, where a gaseous volcanic vent is protruding in the submarine directly in front of the military identification plaque. The dimensions are 5.08 cm x 5.08 cm x .635cm

5. Measure the depth of the top of the blast opening that sank the sub.

There will be a white marker on the submarine on the stern end of the submarine port side. It will be located near the top of the blast opening. It is this white marker's depth that is the desired goal of the depth measurement.

6. Measure the temperature of the gassing volcanic vent that the submarine landed on when it sank. Because the gassing vent is in front of the identification plaque, it is necessary to measure the temperature of the vent to determine if it is not hot enough to melt or damage an ROV that might pass through it. The other issue is that since it is a gas that is escaping, the ROV also needs to be able to not collect or hold gasses as it passes over the venting gas to get to the identification plaque.

8. Place a commemorative plaque on the deck next to the blast opening.

There will be a red area marked off on the submarine hull next to the blast opening. It will be a red area marked in a square. The commemorative plaque should be placed in the red marked off area. As long as the plaque is completely inside the red area, it will result in getting the score for it.

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Meet and Greet:

Teams will have a pit area in which to work on their robot and set up a display or exhibit for the public to see when they come to see the teams. This setup can be anything the team wishes it to be. Each Team must have, at all times that the pit is open, a person or group of people whose job it is to meet and greet anybody that come by to see the pit and the team. Their job is basically to act as the team's public relations officer, where they are to explain to the public how their team works and answer any questions about their ROV that might be asked. This whole part of the competition is informal although, there will be judges in the crowd who will watch how teams interact with the public when they are approached. Enthusiasm and interest in explaining about their team and ROV will be judged according to a simple rubric. Media personal may also be present and how teams interact with them will also be scrutinized. The jist of this part of the competition is to share all your knowledge and enthusiasm with the people who come to visit, as well as the other teams who are present. Teams may wish to make hand outs, pass out "freebies" and so on. Posters and video clips may also be used to showcase the team. The total points possible is 20 points. A rubric of this will be made available before the competition.

Team Intro Video:

Each team must submit a 2 minute video showcasing their ROV and its features. This does not have to be a "super slick" production. It can be very informal. No special effects or complicated video editing needed. The purpose for the video is that before each team competes in their mission, the video will be shown to the audience in the viewing area. Each Team's video will precede the live video footage of their ROV completing the mission. The video must be as close as possible to two minutes with no more than a few seconds to spare either way. Teams will receive points for their submission of the video. If it is submitted, a team will get their 20 points. Teams must submit the video during check in on Friday, no exceptions!

Total Points:

Mission	=160
Meet & Greet	=20
Technical Report	=50
Oral Presentation	=50
Website	=20
Team Intro Video	=20
Total Points	=320

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Penalties:

Points will be deducted for the following reasons:

***5 points** for pulling the ROV by the tether for each incident, pulling the ROV all the way to the surface would be one incident or pulling the ROV to free it from an entanglement and proceeding with the mission would also be an incident.

***1 point** for every five seconds spent in set beyond the 5 minute set up period.

***1 point** for every five seconds spent in break down beyond the five minute break down period.

***5 Points** for being unable to bring the ROV back to the surface without diver assistance

***5 Points** for disturbing any human remains, respect for the dead must be maintained

***5 Points** for damaging any mission props.

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Outline of the order of events:

- **Friday:**

Check in 7:00 –8:00 am

Opening ceremony 8:00- 9:00am, introductions, safety notes, mission clarifications

Tech inspection 9:00 - 12:00 noon

Oral presentations, meet and greet, and pool practice 12:00 noon - 6:00pm

Krill Section

Team Oral presentation order

Team 1-12:00, Team 2- 12:30pm, Team 3- 1:00pm, Team 4 -1:30pm, Team 5-2:00pm,

Team 6-2:30pm, Team 7-3:00pm, Team 8-3:30pm, Team 9-4:00pm, Team 10-4:30pm,

Team 11-5:00pm, Team 12-5:30pm

Squid Section

Team Oral presentation order

Team 1-12:00, Team 2- 12:30pm, Team 3- 1:00pm, Team 4 -1:30pm, Team 5-2:00pm,

Team 6-2:30pm, Team 7-3:00pm, Team 8-3:30pm, Team 9-4:00pm, Team 10-4:30pm,

Team 11-5:00pm, Team 12-5:30pm

- **Saturday:**

Pits open at 1:00 pm

Pool practice, make up oral presentations and meet and greet 1:00 pm - 6:00pm

Missions start at 8:00pm Saturday

Missions end at 4:00am Sunday

Krill Section

Team Mission Order

Team 1-8:00pm, Team 2-8:40pm, Team 3-9:20pm, Team 4-10:00pm, Team 5-10:40pm,

Team 6-11:20pm, Team 7-12:00am, Team 8-12:40am, Team 9-1:20am, Team 10-2:00am,

Team 11-2:40am, Team 12-3:20am

Squid Section

Team Mission Order

Team 1-8:00pm, Team 2-8:40pm, Team 3-9:20pm, Team 4-10:00pm, Team 5-10:40pm,

Team 6-11:20pm, Team 7-12:00am, Team 8-12:40am, Team 9-1:20am, Team 10-2:00am,

Team 11-2:40am, Team 12-3:20am

- **Sunday:**

Awards Presentation 12:00 noon

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Contact Info:

Event Website: www.h2orobots.org

Mission Designer & Rules, Scoring
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Rules, Scoring and Mission Props
Karen Suhm

Mission Props and Mission Staging
Jerry Little

Power Limitations and Regulations
Dr. Allan Cameron
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Event Site Management & Video Production and Video Stream
Sam Alexander

Public Relations
Marcos Garcia-Acosta

Public Relations and Funding
Shawna Fletcher

Head Tech Inspector
Scott Todd

Head Referee
Ian Lao

Event Master of Ceremonies
Don Knight