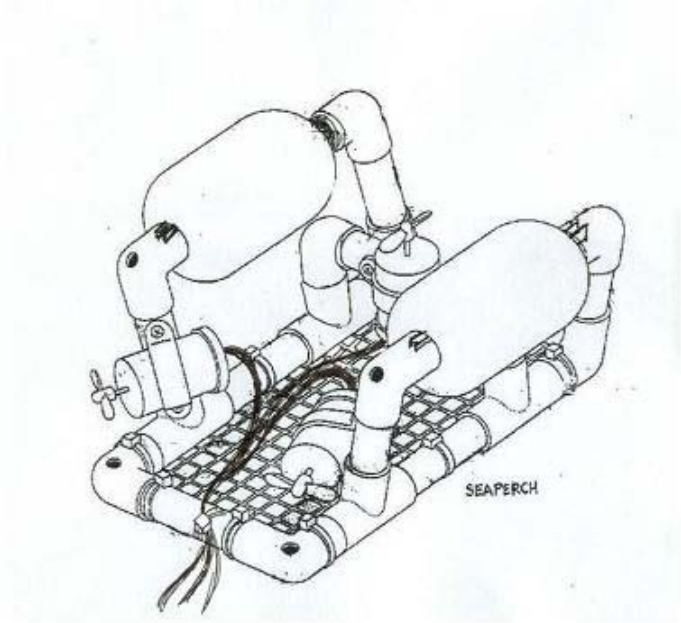
Sea Perch

Construction Manual



MIT SEA GRANT

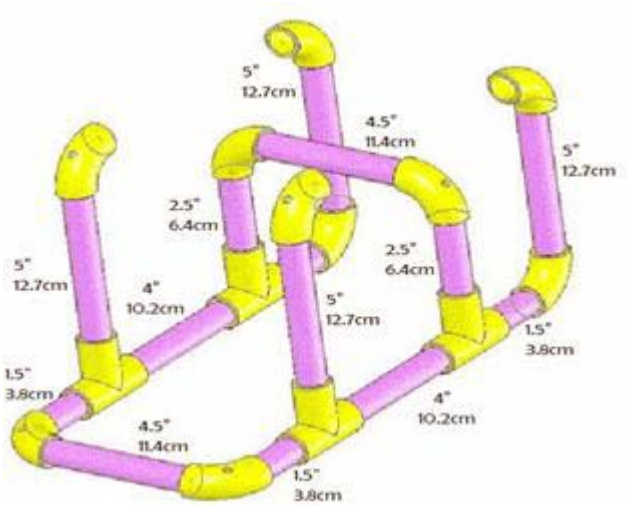
seaperch
TEACH • BUILD • BECOME

UNIT 1
ASSEMBLY OF SUBSYSTEM ONE
THE VEHICLE FRAME

FOR THIS UNIT YOU WILL NEED:

Tools & Materials

Ruler
Marker
PVC pipe cutter or saw
Phillips Screwdriver
Drill
1/4” drill bit
3/32” drill bit
Vise or clamp
5 ft. (1.5 meters) of 1/2” PVC pipe
(10) 1/2” PVC elbows
(4) 1/2” PVC T’s
15” Plastruct H-beam
(2) Football Floats or noodles
(3) Motor Mounts
(6) #6 x 3/4”Screws
(6) #6 washers
Netting
Tie Wraps (zip ties)
(2) Pairs of pliers and/or a pair of pliers and a bench vise



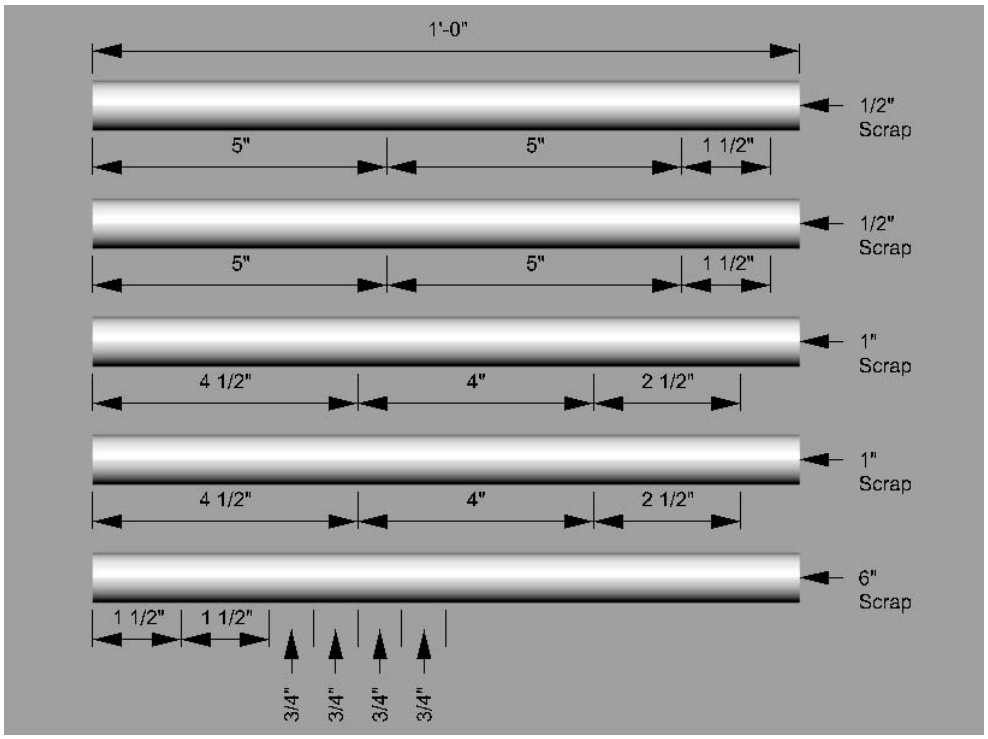
STEP 1 : Cut the frame parts

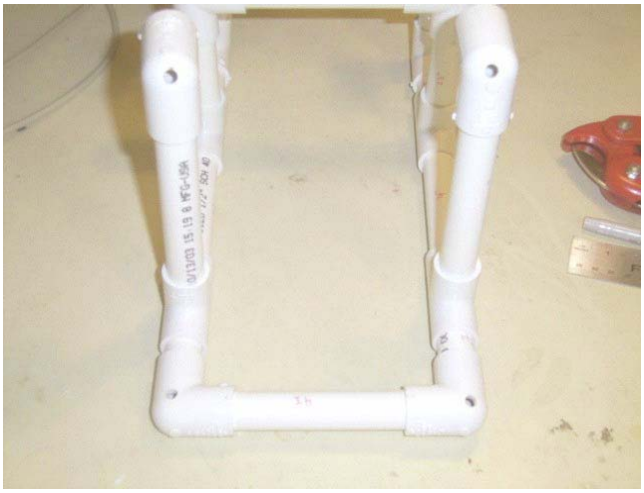
MATERIALS:
5’ (1.5m) of 1/2” PVC pipe
TOOLS:
Ruler
Marker
PVC Pipe cutter
(or saw)

PROCEDURE:
1. From a straight end of the pipe measure and cut:

- (4) pieces – 5” (12.7 cm) long
- (2) pieces – 4 1/2” (11.4 cm) long
- (2) pieces – 4” (10.2 cm) long
- (2) pieces – 2 1/2” (6.4 cm) long
- (4) pieces – 1 1/2” (3.8 cm) long
- (4) pieces - 3/4” (2 cm) long

Try to cut straight, so that the ends of each piece are square with the sides and MARK THE LENGTH ON THE MIDDLE OF EACH PIECE





STEP 2 : Create Drain Holes

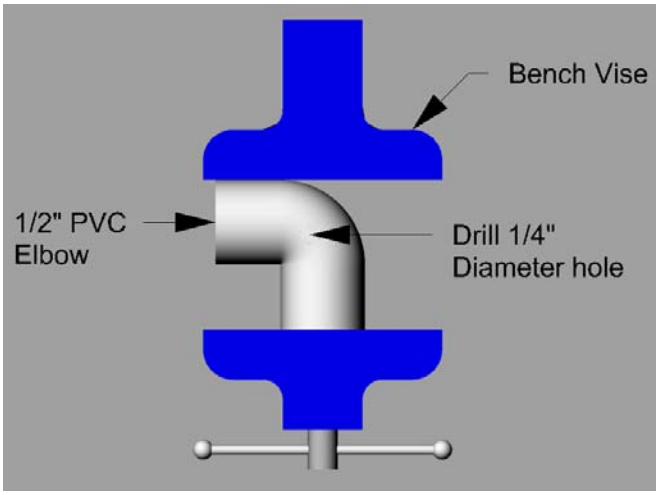
PURPOSE: Create drain holes in vehicle frame to let water fill the frame when you put your SeaPerch in the water and for the water to drain out when you take the SeaPerch out.

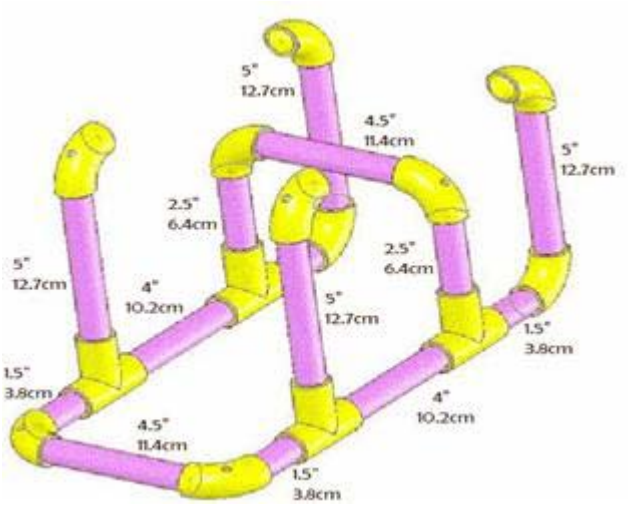
MATERIALS:
(10) 1/2” PVC elbows

TOOLS:
Hand drill or
drill press
1/4” drill bit
Vise or clamp
Sharpie

PROCEDURE:

1. Mark a locator dot with a sharpie on the flat side of the elbow.
2. Secure a PVC elbow in the vise or clamp.
3. Place the 1/4" drill bit in the drill (or drill press), and drill a hole in the side of the bend of each elbow where you placed the locator dot. Only drill one hole. Do not drill all the way through to the other side and make 2 holes.
4. Repeat for each of the ten PVC elbows.





STEP 3 : Assemble the vehicle frame

MATERIALS:
Cut pieces of pipe from step 1
(10) 1/2" PVC elbows with holes drilled from step 2
(4) 1/2"PVC T's

PROCEDURE:
1. Assemble the frame using all the PVC parts as shown

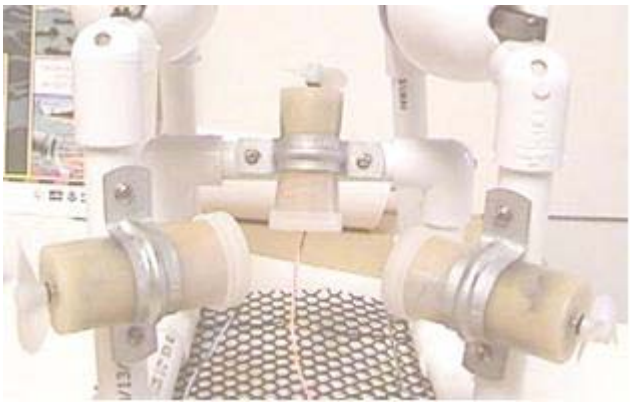
STEP 4 : Assemble the float supports and tighten the frame

MATERIALS:
Assembled frame
15" Plastruct H-beam
2 Floats
Rubber mallet
TOOLS:
PVC Pipe Cutter

PROCEDURE:

1. Cut the 15" Plastruct H-beam into two 7 1/2" pieces.
2. Insert one of the 3/4" (2cm) PVC pipe pieces into the open end of each of the four PVC elbows on the top of your vehicle.
3. Insert an H-beam through each of your floats and between each pair of PVC elbows.
4. Push all parts of your vehicle frame together HARD, so that the H-beams cannot fall out of the PVC angles. You can do this by placing the frame on the floor so the H-beams are vertical and pressing down on the frame to squeeze it together. You can also use the rubber mallet to tap the pieces of the frame together.

STEP 5: Attach the motor mounts to the frame



MATERIALS:
Vehicle frame
(3) Motor Mounts
(6) #6 x 3/4" Screws
(6) #6 washers
Film canister

TOOLS:
Marker
Phillips Screwdriver
Drill
3/32" drill bit
(2) Pairs of pliers and/or a pair of pliers and a bench vise

PROCEDURE:

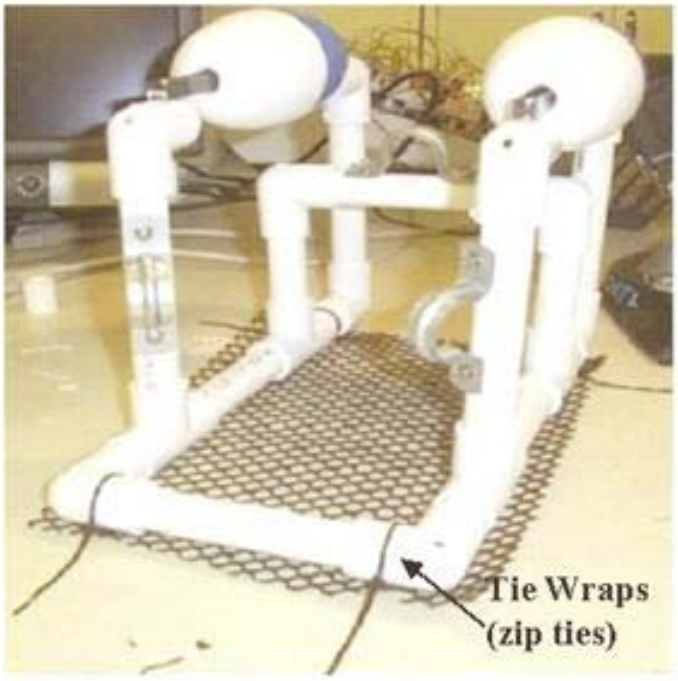
1. Hold motor mounts against frame in locations shown in the above picture. It's more important to center them between the joints on the pipe than to get the right angle around the pipe. The pipe, with motor mount, can be twisted to the desired angle later. Holes should be about 2.5" apart. With a marker or pencil, mark vehicle frame through the holes in motor mounts.
2. Using the 3/32" drill bit, drill holes through the marks on the frame.
3. Place washers over the outside of the holes in the motor mounts, and place a screw through each washer and motor mount hole into hole in vehicle frame. If the heads on your screws are large enough that they don't pass through the holes in the motor mounts, then the washers are optional.
4. Using the screwdriver, LOOSELY attach the motor mounts to the frame. **DO NOT over-tighten and strip the holes in the PVC!!** You will be removing the motor mounts later anyway to get the motors under them.

STEP 6: Attach the payload netting

MATERIALS:
Netting
(6 to 8) Tie wraps (zip ties)
Assembled Vehicle frame
TOOLS:
Scissors, Pliers

PROCEDURE:

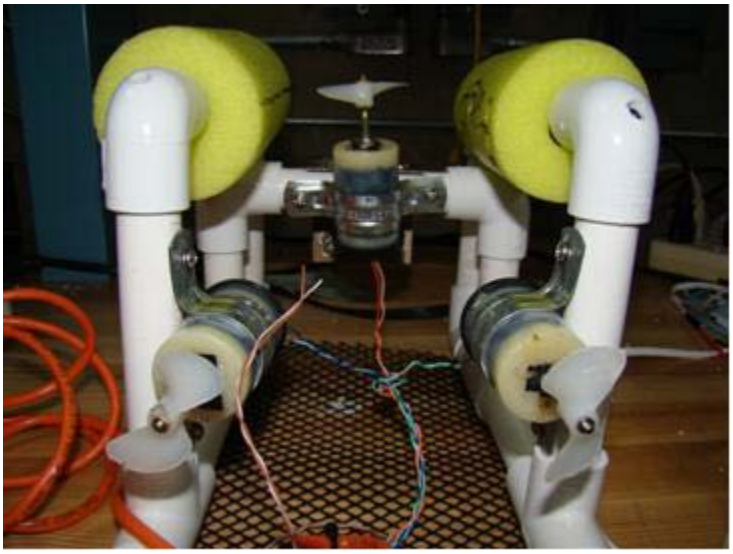
1. If you wish to paint your vehicle's frame, do so before attaching netting, and make sure to use waterproof paint.
2. Place the netting underneath the vehicle frame and attach one side of the netting with cable ties to the PVC frame. Trim to size with scissors if necessary.
3. Attach the other side of the netting to the frame with cable ties. Pull them tight, using pliers if necessary. In all, 6-8 cable ties should be used.
4. Trim off the tie wrap ends with scissors.
5. You have now completed the vehicle frame of your SeaPerch ROV!



UNIT 2
ASSEMBLY OF SUBSYSTEM TWO:
THE THRUSTER ASSEMBLY

FOR THIS TASK YOU WILL NEED:

Tools & Materials
Assembled potting holder
Drill
Drill Bit: 3/32”
Hot pot for melting wax
Pliers
Marker
Ruler
Scissors
Soldering Iron and solder
Phillips Screwdriver
Eye Protection
Tether wire
(3) film cans with caps
(3) 12 volt DC motors
(3) Propellers
(3) Propeller Shafts
(6) small brass nuts (#4-40)
Epoxy and mixing stick
Wax bowl ring
Water
Electrical tape
Butyl Rubber tape
12 volt battery
Paper towels
Rubbing Alcohol or Alcohol Wipe



WARNING - TO AVOID ELECTRIC SHOCK , SEVERE BURNS AND DAMAGE TO THE BATTERY:
DO NOT touch exposed wires to the battery terminals.
DO NOT touch the battery terminals with ANY metal object, especially tools!

STEP 1 : Seal the three 12-volt DC motors

TOOLS:
black or red “sharpie” marker
Scissors
Electrical tape

PROCEDURE:

1. Find the red dot on the white part of the motor, next to one of the gold terminals.
2. Depending upon the color of the Sharpie pens provided, either color the terminal near the red dot (+) with the red marker or the other terminal (-) with the black marker.
3. Completely wrap each motor with electrical tape to seal all the holes. Try to use small pieces and strips of tape to cover the major holes on the motor sides and ends. Then make one long continuous tape wrapping around the motor and tape pieces, down the length of the motor. Make sure the shaft can still spin freely. Try not to use too much tape since the motors must fit inside the film canisters easily.

STEP 2: Drill holes in the film canisters

MATERIALS:
(3) film cans with caps
1 12 volt DC motor
1 pair of test wires
TOOLS:
Drill
3/32” drill bit
1/8” drill bit

PROCEDURE:

1. Using the Sharpie marker, mark the exact center of each film canister cap and film canister bottom with a dot, as seen in the above figure.
2. Using the 3/32” drill bit, drill a hole in the center of each film can cap.
3. Now using the 1/8” drill bit, drill a hole in the bottom of each film can. The holes in the cans are where the motor shafts pass through the cans, and form the shaft seals, so it is **VERY IMPORTANT** that these holes are drilled extremely carefully. Carefully and slowly drill the hole straight into the very **CENTER** of the can. Pull the drill straight out to avoid enlarging the hole.
4. Check each can to make sure that the hole is drilled exactly in the center, and that a motor fits inside easily.

STOP AND WAIT FOR FURTHER INSTRUCTIONS

STEP 3 : Attach the tether wires to the motors

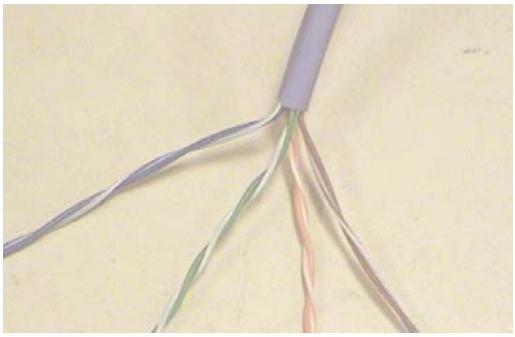
MATERIALS:
3 motors sealed with tape
3 film cans and caps with holes drilled in step 4
Tether wire
Solder
TOOLS:
Wire strippers
Wire cutters/nippers
Soldering iron

Soldering Iron Maintenance:

1. Set the iron at a power/heating level only as high as necessary (3.5 – 4 is typical).
2. When starting out, wipe the tip on the wet sponge and melt some solder on the tip and then wipe again on the sponge. This is called tinning. A properly tinned tip will have a silvery coating of solder that protects the rest of the tip.
3. If you are unable to get this coating of solder to stay on the tip, clean it with sandpaper, emery cloth, or a fine metal file to remove oxidation that prevents good heat transfer. Dipping the tip in a paste form soldering or tinning flux can also clean the tip and remove oxidation. Repeat the above steps for tinning.
4. This tinning process should be repeated as necessary while soldering, or every 2-3 solder joints. This will keep the whole soldering process working smoothly.

PROCEDURE:

1. On one end of the tether cable, strip off about 15" (38cm) of the outer sheath, being careful not to nick any of the inner wires. On the other end of the tether cable, strip off about 1" (3 cm) of the outer sheath. This will be the end that will be crimped with the RJ45 connector.



2. Thread about 4" (10cm) of the blue, orange, and green twisted pairs through the hole in each film cap, and tie a knot INSIDE the cap for strain relief. The brown wire will not be used.

3. Strip about 1/4" (7mm) of insulation from the end of each wire, for all 3 pairs.

4. Take a pair of wires with attached cap, and one of your taped motors. Solder one wire onto each of the two terminals on the motor: solid colored wire to (+), and the white striped wire to (-). Repeat for each motor and tether wire pair.

Soldering suggestions:

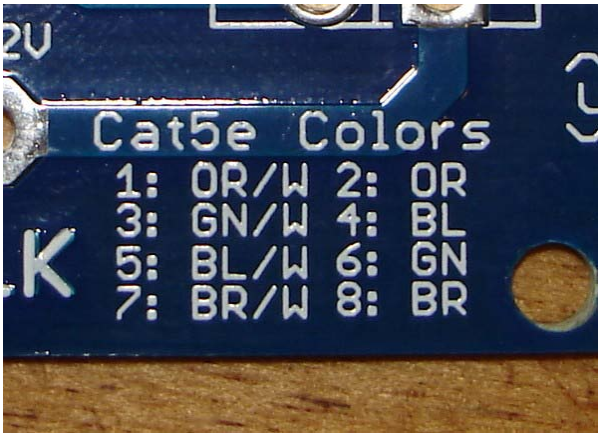
- Clamp the motor being soldered into the bench vise, terminals pointing up.
- Wrap stripped end of wire through and around terminal hole.
- Heat for five seconds by nesting the soldering iron tip into the terminal hole for approximately 5 seconds.
- The connection is hot enough when the solder melts by touching the terminal, not the iron, and flows into the gaps between the wire and terminal, filling the terminal hole.

Step 4: Tether Assembly

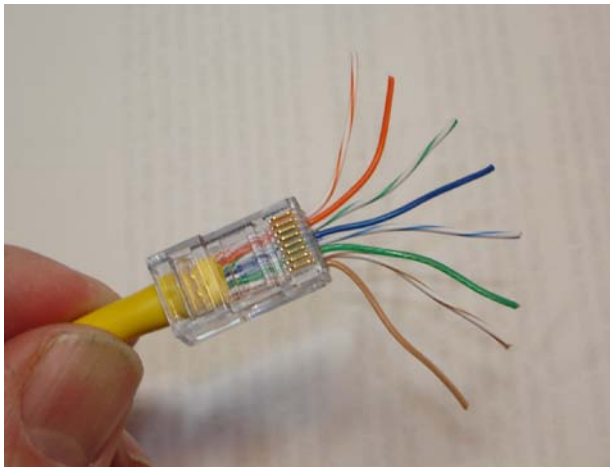
The new Seaperch tether uses a standard ethernet cable connector (RJ45) to plug into the control box. The key thing to remember here is that the color-order of the wires IS IMPORTANT to ensure that each button and switch controls the correct motor.

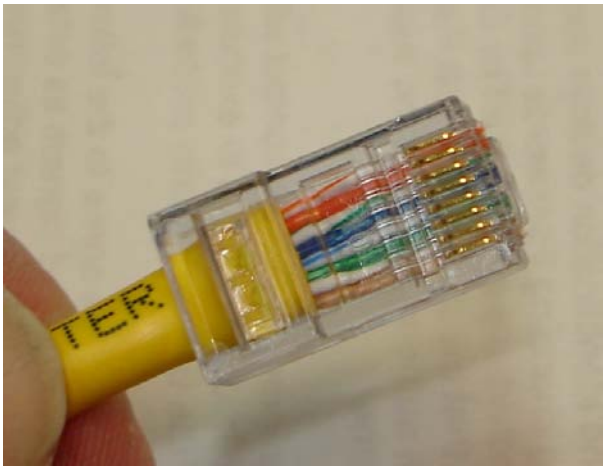
Seaperch uses the T568B wire color sequence, which is the most common color sequence for ethernet cables. Starting from pin 1 (on the left) the color sequence is:

1	Orange/White
2	Orange
3	Green/White
4	Blue
5	Blue/White
6	Green
7	Brown/White
8	Brown



Note: This color order is printed on every SeaSwitch Printer Circuit Board (PCB). See above.

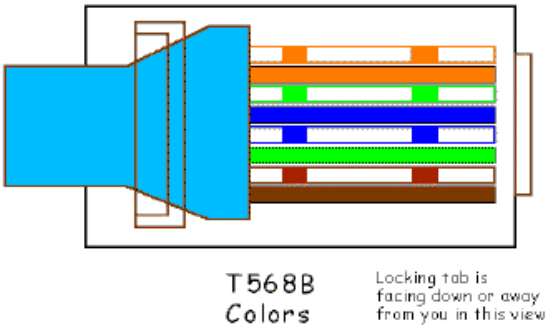




PROCEDURE

1. Untwist all of the twisted pairs and line them up next to each other, from left to right in the following order:

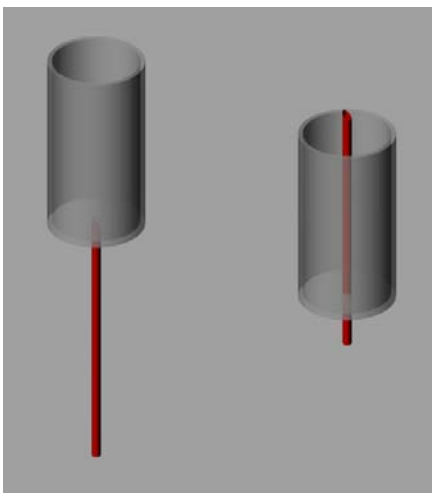
    a. Orange/white
    b. Orange
    c. Green/white
    d. Blue
    e. Blue/white
    f. Green
    g. Brown/white
    h. Brown



2. Push the wires into the connector with the flat side (side with gold pins) facing up and push them all the way through the connector, until they come out on the other side. The end of the tether cable insulation should be inside the body of the connector, as shown in the above picture. Double check that the wires come out on the other side of the connector in the correct order.
3. Place wired connector into the crimper tool, threading loose wires that passed through the connector through hole with the cutter. Squeeze down hard and while holding tightly, twist and pull extra wire pieces off of the connector.
4. Now you are ready to plug the tether cable into the control box and try running your Sea Perch motors.

STEP 5 : Potting (waterproofing) the motors with wax

MATERIALS:
(3) Drilled Film cans
Wax bowl ring (½ ring)
Electrical tape
Sealed motors
(3) Coffee Stirrer-Straws

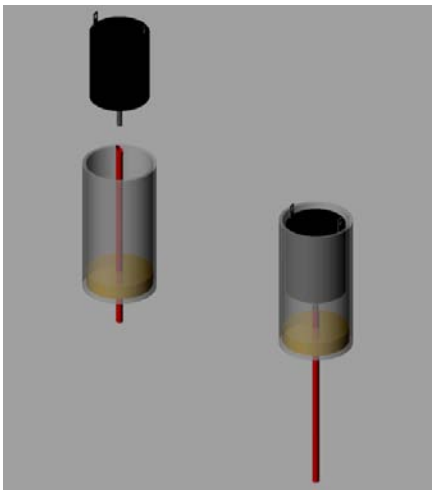


PROCEDURE:

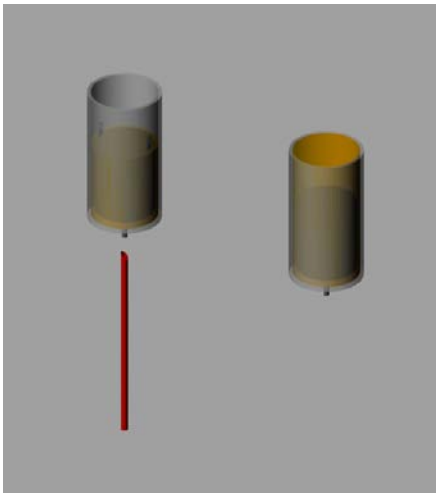
1. If coffee stirrer-straws are provided, cut each straw in half on an angle, making two 3-4” straws with a spear-point.
2. Insert the spear end of a straw into the bottom of each film canister until the cut end is near or past the open end of the

canister, but still held in the hole through the bottom of the canister.

If no stirrer straws are available, put a small piece of electrical tape over the hole in the bottom of each of your 3 motor containers (film cans). The tape should be pressed on VERY LIGHTLY, so that it keeps the wax from flowing out the hole, but pushes aside easily when the motor shaft pokes through the hole.



3. Fill one film canister with about ¼" (.5 cm) of hot wax. Carefully place one of your sealed motors in the wax by sticking the motor shaft into the cut end of the straw and continuing to push the motor into the canister, eventually backing the straw all the way out of the can. The motor shaft should now be sticking out the bottom of the canister and the straw removed completely.

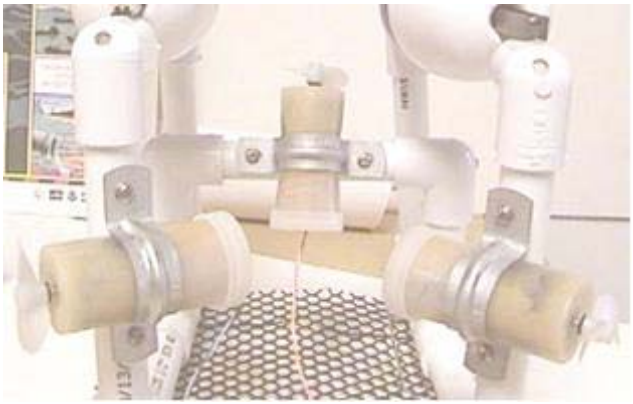


4. If you do not have stirrers, put the sealed motor into the wax and wiggle the it until the shaft pokes through the hole in the bottom of the film can. It may take a little wiggling to get the shaft to go through. The wax should push partway up around the sides of the motor, but hopefully not over the top; otherwise, use a little less wax next time.
5. Repeat for each of your 3 motors.
6. Fill the film canister with more wax until the wax just covers the tops of the motor terminals.
7. Coil the wires inside the film canister up to the strain relief knot and insert a small chunk of solid wax to fill most of the space.
8. Finally, fill the film canister the rest of the way with **cold** wax. Try to push the cold wax down into the film canister to fill up any air "holes".
9. Gently, press the lid of the film canister on. Now, attaching your crimped tether cable to a pre-made control box, run each motor for 30 seconds.

STOP AND WAIT FOR FURTHER INSTRUCTIONS

STEP 6: Mount the thrusters on the vehicle frame

MATERIALS:
Assembled thrusters
Assembled frame
TOOLS:
Phillips Screwdriver



[POSITIVE (+) NEGATIVE (-)]: THRUSTER
[Green & White]: Starboard (right)
[Blue & White]: Port (left)
[Orange & White]: Vertical
[Brown & White]: Not Used

PROCEDURE:

1. Using the screwdriver, remove the motor mounts from the frame.
2. Place a thruster inside each motor mount, according to the color-coded table above. The motor mount should go over the back end of the motor. It should not be over the back of the can where there is only wax, or over the center of the motor, where it might squeeze the motor casing, but over the back end of the motor, which will best resist the pressure of the motor mount.
3. Reattach motor mounts to the frame. It's OK if the motor cans get squeezed a little. Tighten screws just enough to hold the motor firmly, but be careful not to strip the hole in the PVC. If the holes do get stripped, re-drill them on another side of the PVC pipe.
4. You can now use pliers to turn the PVC that the motors are mounted on to get the motor angles you want. This is a good time to think about thrust, vectors and propulsion. How do the angles of the motors affect the performance of the ROV? What angles will get you the best forward and backward thrust? What angles will get you the best turning ability? What is the best compromise for your mission needs?

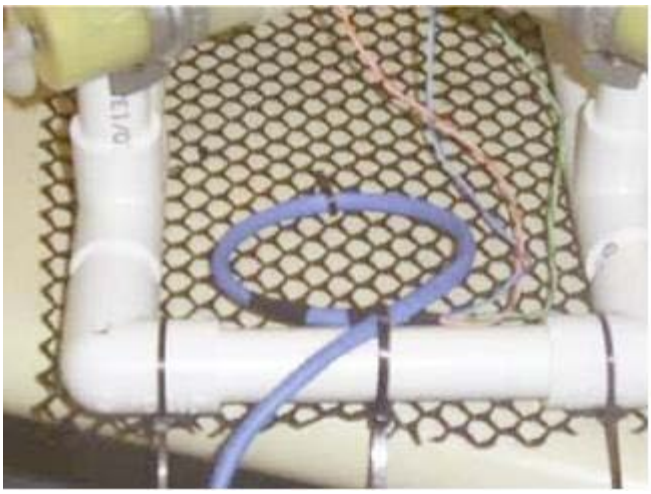
STEP 7: Mounting the propellers on the motors

MATERIALS:
3 propellers
3 prop shafts
6 small brass nuts
3 potted motors
TOOLS:
Epoxy
Rubbing Alcohol
Mixing stick
Super Glue

PROCEDURE:

1. Wipe all wax off of the motor shaft with a paper towel and rubbing alcohol.
2. Screw one of the brass nuts onto each propeller shaft, as far as they will go.
3. Prepare your workspace to quickly glue everything, since with many epoxies (including the one specified in the parts list), you will only have about **3 minutes** of working time before they get too stiff to use. Lay out your three potted motors, your propeller shafts with a nut on each, your three propellers, and your three remaining nuts. Check that each of the washers fits on the desired shaft. You may have to switch them around to find the best fit.
4. Get out your epoxy, mixing stick and a sheet of paper to mix on.
5. Mix the epoxy. If you are using the packets specified in the parts list, fold the packet so that the two halves are together. Tear off one end and squeeze the contents of both halves onto your piece of paper. Quickly mix the contents together with the mixing stick until they are fairly uniform.
6. Use the mixing stick to put a drop of epoxy on the shaft adaptor and the nut, to hold the nut in place. Put another drop of epoxy on the threaded part of the shaft adaptor to hold the propeller.
7. Look at the propeller and note that the side of the propeller with the groove in it is the side that goes towards nut.
8. Place the propeller onto the threaded part of the shaft, grooved side first. Put a drop of epoxy on the end where the threads stick out, and screw the remaining nut on finger tight, making sure it is held by epoxy.
9. Repeat steps 6 to 8 for the other two motors before the epoxy hardens.
10. Wipe each motor shaft with the alcohol wipe to clean the shaft from any wax which might be on it.
11. One motor at a time, cover the motor shafts with Super Glue and then fill the hollow end of the shaft adaptor with Super Glue. Push the hollow end of the shaft adaptor onto the motor shaft.
12. Allow the epoxy and Super Glue to harden to handling strength (60 minutes for the specified epoxy) before touching them again or running the motors.

STEP 8: Waterproof the tether cable and attach to the frame



MATERIALS:
Completed frame with thrusters
Butyl Rubber tape
Electrical tape
TOOLS:
Scissors

PROCEDURE:

1. Once the thrusters have been mounted, follow the wire pairs from the thrusters, to where they meet inside the tether sheath.
2. Take a small piece (about 1" or 2.5cm) of the butyl rubber tape (aka. monkey dung) and press it over the wire pairs and the sheath.
3. Knead and work it in well, so that it seals both around and between the wires and sheath, preventing water from getting into the tether cable.
4. Wrap electrical tape over the Butyl Rubber tape to keep it from sticking to anything.

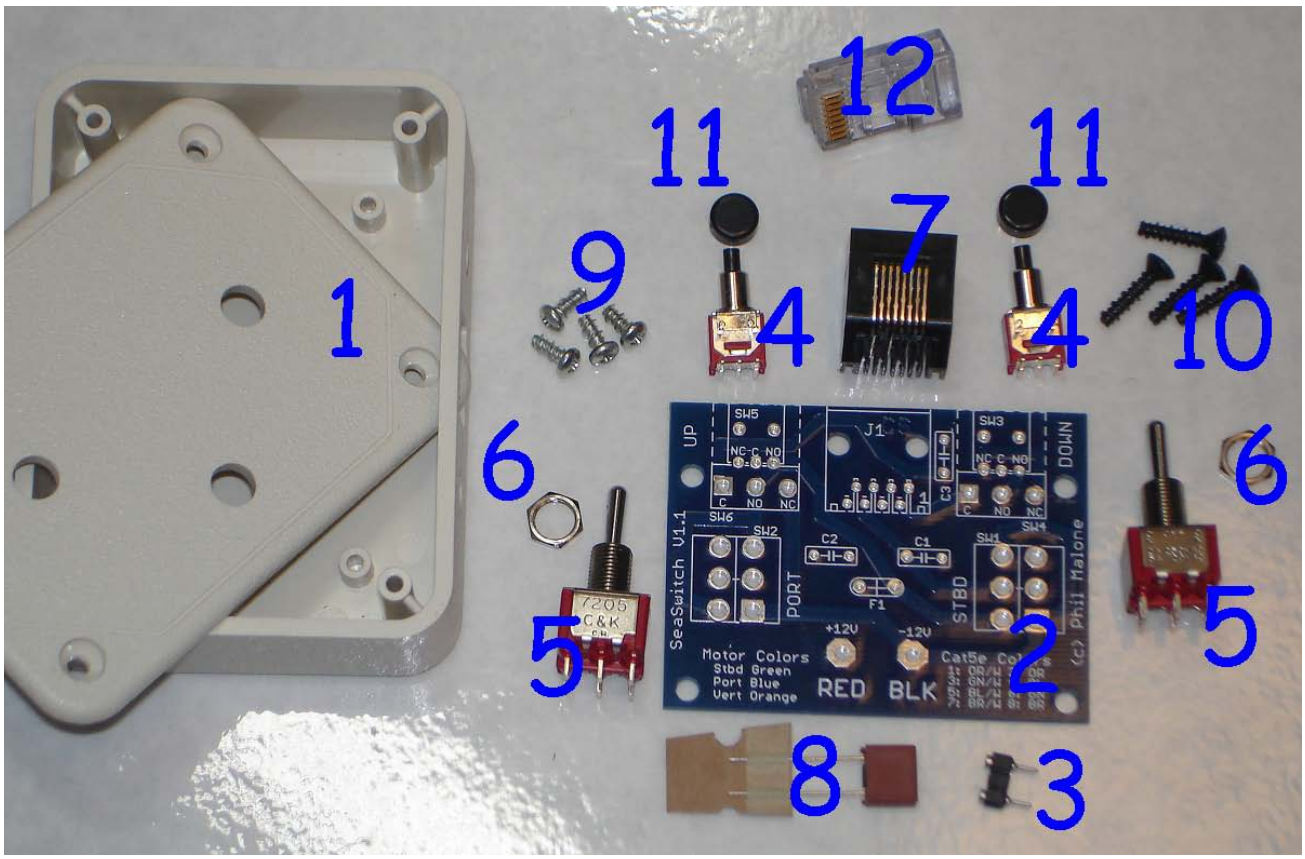
   After water proofing the tether, make a loop in the tether and attach to the vehicle frame with tie wraps (aka. zip ties). This is "strain relief", intended to prevent any pulling on the tether cable from pulling on the motors.

UNIT 3
ASSEMBLY OF SUBSYSTEM THREE:
THE CONTROL BOX

STEP 1: Identify and inventory the parts for your control box

A SeaSwitch kit for the control box should contain the following parts. They are used in the order shown.

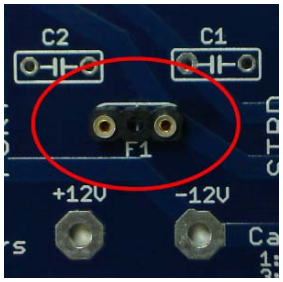
1. Box and Cover (bone)
2. Printed Circuit Board (PCB) (blue)
3. Fuse socket (black)
4. Two Push button switches (red)
5. Two Toggle Switches (red or green)
6. Two Switch retaining nuts (silver)
7. Cat5 Cable socket (black)
8. Fuse (brown, round or rectangular)
9. Four PCB screws (silver)
10. Four Cover screws (black)
11. Two Push Button caps (red or black)
12. Cat5 Cable plug (clear)



It's important to follow the correct order when adding components to the PCB; otherwise it will be difficult to hold them in place while soldering. Use the sequence below for the easiest assembly. Remember, ALL the parts go on the side of the PCB with the white writing. If you look closely on the back of the board there is a message to help you remember.

STEP 2: Solder the fuse socket on the printed circuit board

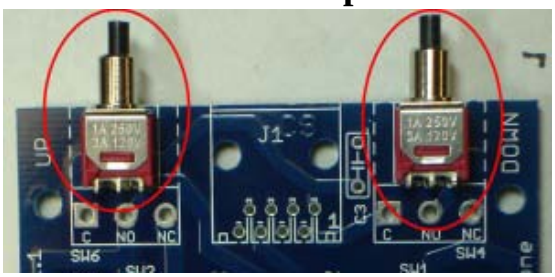
.



This is the smallest part, and it goes on first, in the middle of the board. The location is labeled F1. Put the socket pins in the two holes, and flip the board over while holding the socket in place.

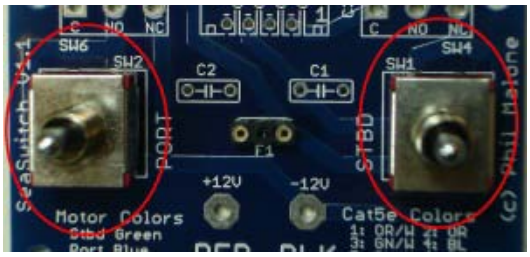
Solder the pins into the holes using minimal solder to avoid blobs. Take care not to bridge any pins or pads with excess solder.

STEP 3: Solder the push buttons on the printed circuit board



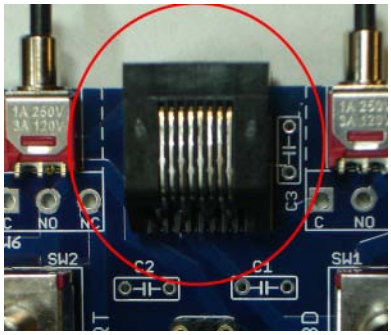
The two push button switches are snapped into their holes at the top of the board. Flip the board over and make sure the PCB is pressed FLAT on the switches while you are soldering these in. If the switches aren't down FLAT, the board won't fit in the box properly.

STEP 4: Solder the toggle switches to the printed circuit board



Your two toggle switches may look different than in this picture (they may have green cases) but they will operate the same. The switches must be firmly down and completely vertical when soldered. The best way to ensure this is to drop the box cover over the switches, and screw on the retaining nuts. This will ensure they will line up properly for final assembly.

STEP 5: Solder the tether socket to the printed circuit board

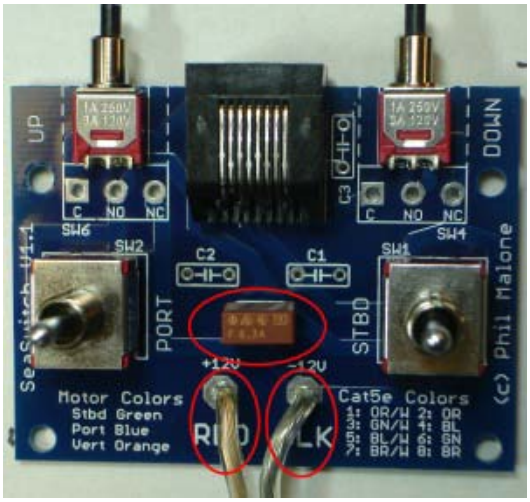


The final component is the socket for the tether. When attaching this to the board, insert the metal pins in the holes **first**, and then snap in the plastic retaining clips. Once the connector is in place, verify that all the pins are through the holes BEFORE soldering.

This part has the closest pin spacing on the board, so take care not to use excess solder because it will cause the pins to short to each other. Remove any excess solder with a clean soldering iron tip.

STEP 6: Solder the power cable to the printed circuit board and mount the fuse

The only soldering remaining on the PCB is the power cable. **BEFORE attaching the cable, pass it through the middle hole in the box cover and tie a knot in it about two inches from the end.** Separate the individual wires from each other at the box end, and strip off about ¼" of insulation. Twist each wire's the metal strands to hold them together.



Identify the Positive wire (it may be ridged, or have copper colored wire), and pass it through the hole labeled +12V (RED). Fold it over to hold it in place. Do the same with the other wire through the –12V (BLK) hole. Flip the PCB over, and solder the wires firmly in place. Make sure there aren't any stray wire strands that may touch and short out. Trim off any excess wire on the boottom of the PCB.

The fuse is brown, but it may be round or rectangular . If need be, trim the wires down to ¼" long. Firmly press the wires into the fuse socket you installed earlier. It should snap in place. Give it a firm tug to make sure it's secure.

If you haven't attached the Alligator clips to the other end of the power cable, you should probably do it now.

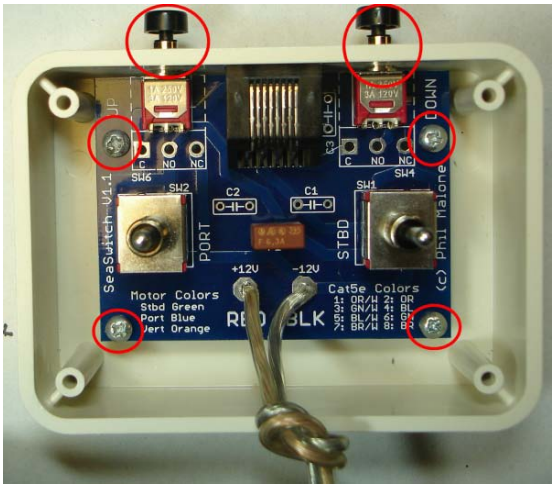
STEP 7: Attach the alligator clips to the power cable

1. On the "free" end of the power cord, carefully separate the two conductors for about 6" (15.2cm). This is best done by snipping the thin web of plastic between the wires with a small pair of scissors, or a pair of fine wire cutters. Be careful not to nick the insulation on the conductors.
2. Strip 1" (2.5cm) of insulation off of the ends of each of the wires. Twist the conductor strands to prevent fraying and breaking.
3. Slide the red alligator clip sleeve onto the positive wire on the 6-inch end of the power cord and slide the black alligator clip sleeve onto the negative side of same end of power cord.
4. Attach alligator clips to positive (+) and negative (-) ends of the power cord where the sleeves are. Stick the wire in through the back of the clip, and up through the hole near the screw. Loosen the screw and wrap the wire around it CLOCKWISE. Tighten the screw. Solder the connection.
5. Push the sleeves down over the alligator clips, using the rubber end of the wire cutters to keep the alligator clip open.

Step 8: Circuit Testing

Now is a great time to test the control board for short circuits. If you do it now, you don't have to remove the PCB from the box if there is a problem. It's also easy to flip the board over now, and just plain LOOK for short circuits. Try to find any solder joints that are blobby, and have bridged (joined) two nearby solder pads. Look at every joint, and make sure that it's got clear space all around it.

Once you've passed the visual inspection, it's time for the Ohm Meter. This can tell you if there is a hidden short on the board. Shorts will cause the fuse to blow and will stop your ROV from flying. Switch the meter to measure resistance (ohms), and make sure you can tell the difference between a short circuit (zero ohms) and an open circuit (infinite resistance). Some meters have a "beep" to indicate a short circuit.



To test for shorts, connect your meter probes to the two alligator clips (red to red, black to black). **At no time should you get a low resistance reading (continuity)**.

Now, activate each of the four switches individually and in all combinations. Make sure there is no combination that makes a short circuit.

Once you are happy there are no shorts, use the four silver screws to mount the PCB in the control box. Next press fit the two button caps onto the push button switches, and finally attach the control box cover, using the four black screws.

Checklist:

The first time you power-up your Sea Perch ROV, there are a few steps you should take to make sure everything is working properly:

1. Are all switches in an off position?
2. When attaching the battery cables, does a spark appear? If yes, you may have a short circuit. Notify your teacher.
3. If no spark appears, run your motors one at a time. If all of the switches satisfactorily engage a motor, then your system is ready to run. If a motor does NOT turn when you activate each switch, you have either a broken connection (blown fuse, unclipped battery, broken wire, broken solder joint, etc.) , a short circuit somewhere, or one of your motors is "stuck" which can be remedied by rotating the propeller by hand.
4. Turn on each motor one by one, and check that it is turning in the correct direction.

Congratulations! You are now ready to run your Sea Perch ROV!

1. To run the Sea Perch, clip the alligator clips onto the corresponding terminals on the battery (red +, black -). Be careful not to short the battery. If the Sea Perch stops working, first check the fuse to see if it has blown.
2. Place Sea Perch in the water and attach weights to the payload netting until it has just slightly positive buoyancy, meaning that it sits in the water with the floats just out of the water by about 1/4" (5mm) or less. A typical Sea Perch without cameras or other sensors on board usually requires about 4 to 10 ounces (125 to 300 grams) to achieve proper buoyancy. If your Sea Perch sinks without applying the downward thruster, it is too heavy. If your Sea Perch has trouble diving, or floats up to the surface very quickly, then it is too light.
3. Make sure to charge your battery after using it. Lead-acid batteries will last much longer if they are not left discharged.
4. Always make sure to rinse your Sea Perch with fresh water when you have finished operating it. Pay special attention to the motor shafts as they are often the first place to rust. Clean all seaweed and other buildup off of the motor shafts, and rinse them well with fresh water.
5. If working in a school, and there is no other container of water to submerge and ballast your SeaPerch in, sinks found in custodial closets are typically deep enough. Just be sure to arrange access and give the sink a good rinsing before filling it with water in which to submerge your SeaPerch.