ROV'S IN A BUCKET

This document has been prepared for those interested in building ROV's (Remote Operated Vehicles – Underwater Robots). Contacts for purchasing the pieces to create the ROV are provided as suggestions, not endorsements. The pieces listed in this document were used to construct the pictured ROV (Figure 1.1). Its suggested operating medium is a freshwater pool. The detailed manual that shows how to build and wire all of the components follows In this introductory chapter, you will see what is necessary to get started. Estimates of costs to build one ROV is just under $100. This does not include your need for power, cameras, lights or tools. A detailed parts list and recommended tool kit can be found in Appendix 1.

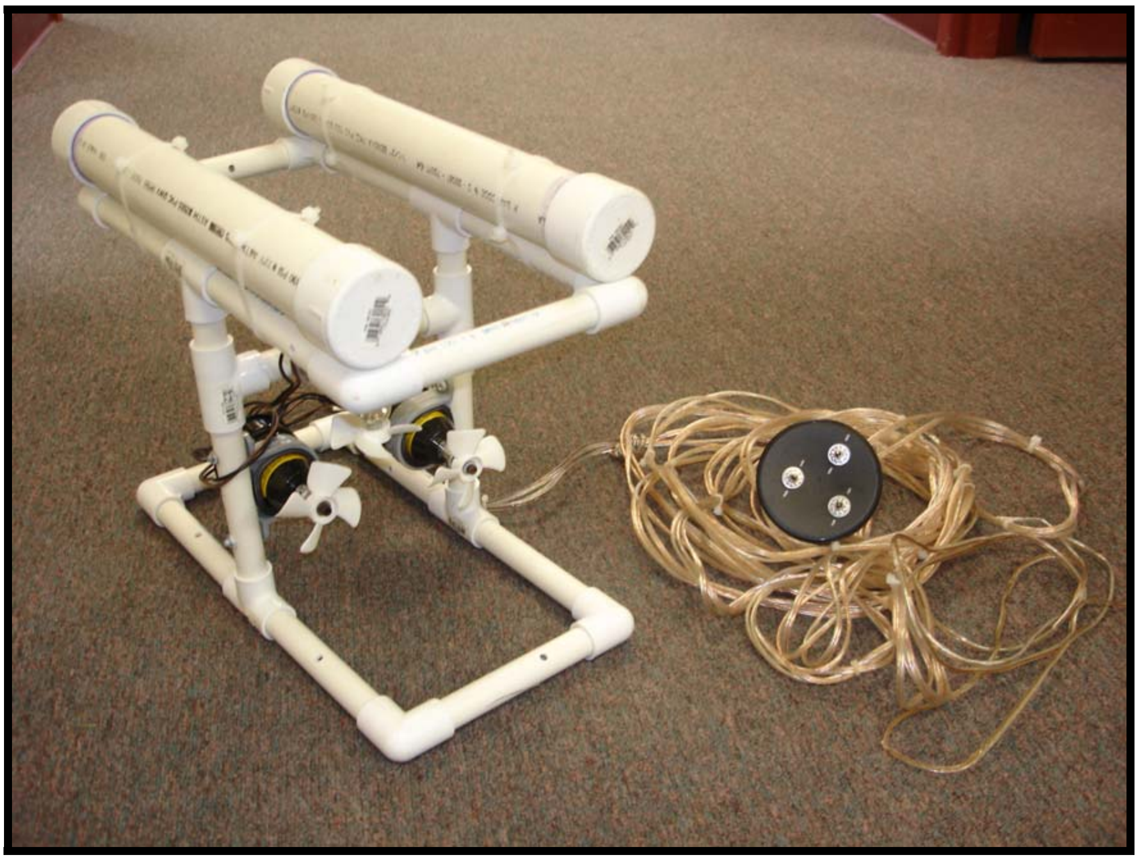

Figure 1.1: An ROV built from PVC & Bilge Pump Cartridges. The design can change depending on the builder's desires and the robot's underwater objective.

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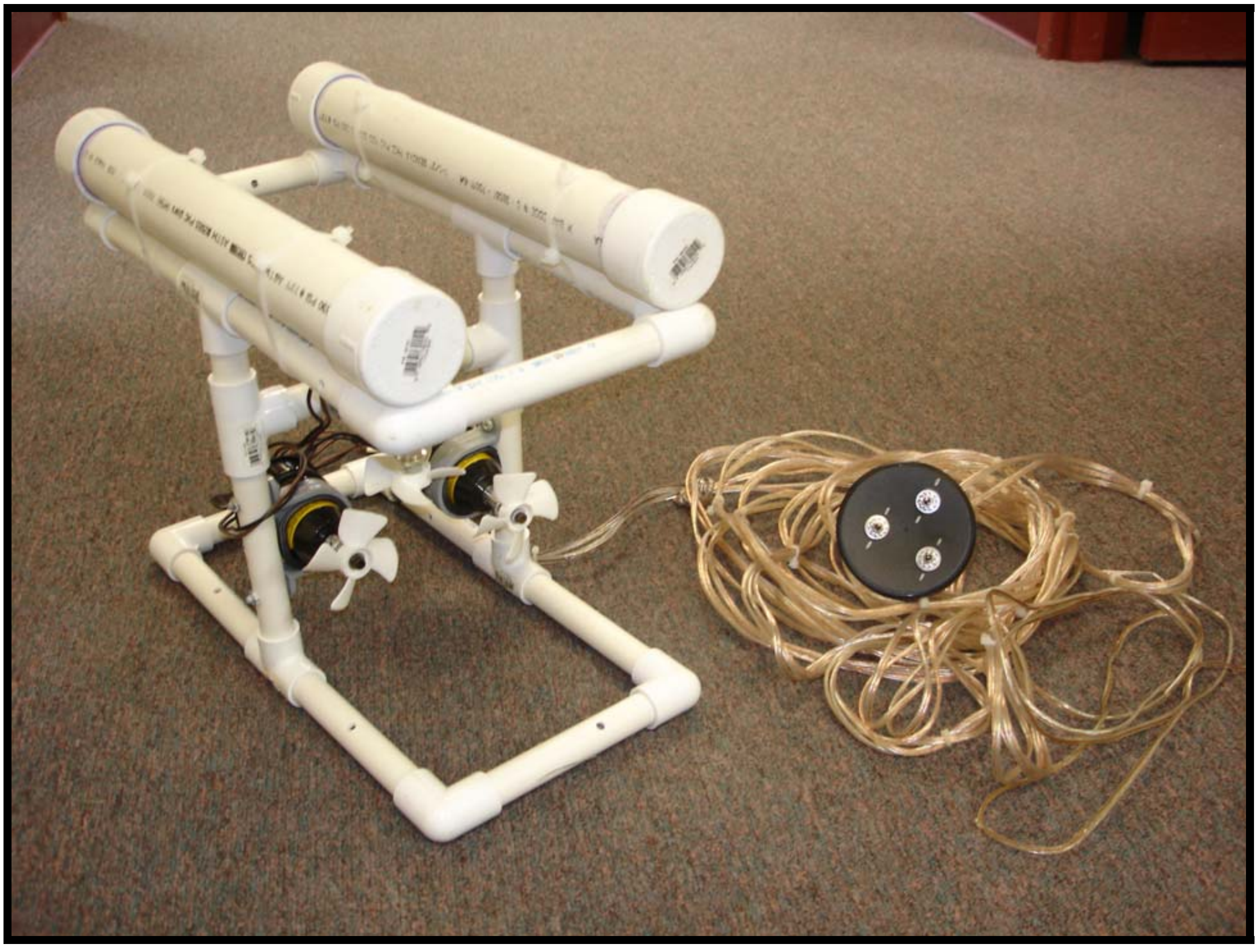

Figure 1.2: This is a side view of an ROV created from parts described in the following pages. The buoyancy pontoons are attached to the PVC frame with plastic tie wraps. A bundle of three pairs of speaker wire transfer the information from the controller jar to the underwater robot.

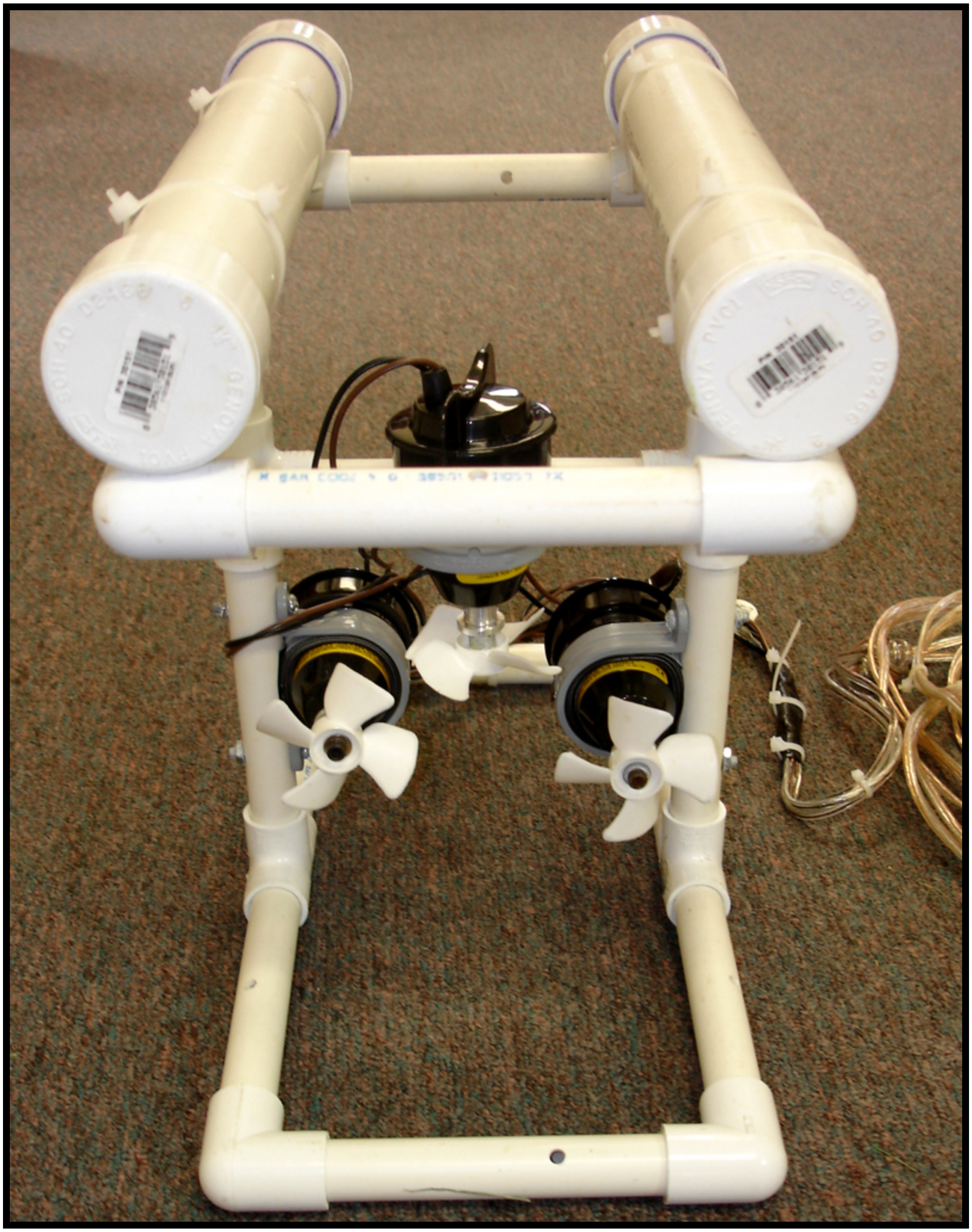

Figure 1.3: In this front view of the ROV you can see that three thruster assemblies have been constructed and attached to the area inside of the frame. The function of the frame is to provide structure for the ROV and protection to the propellers which allow it to move through the water.

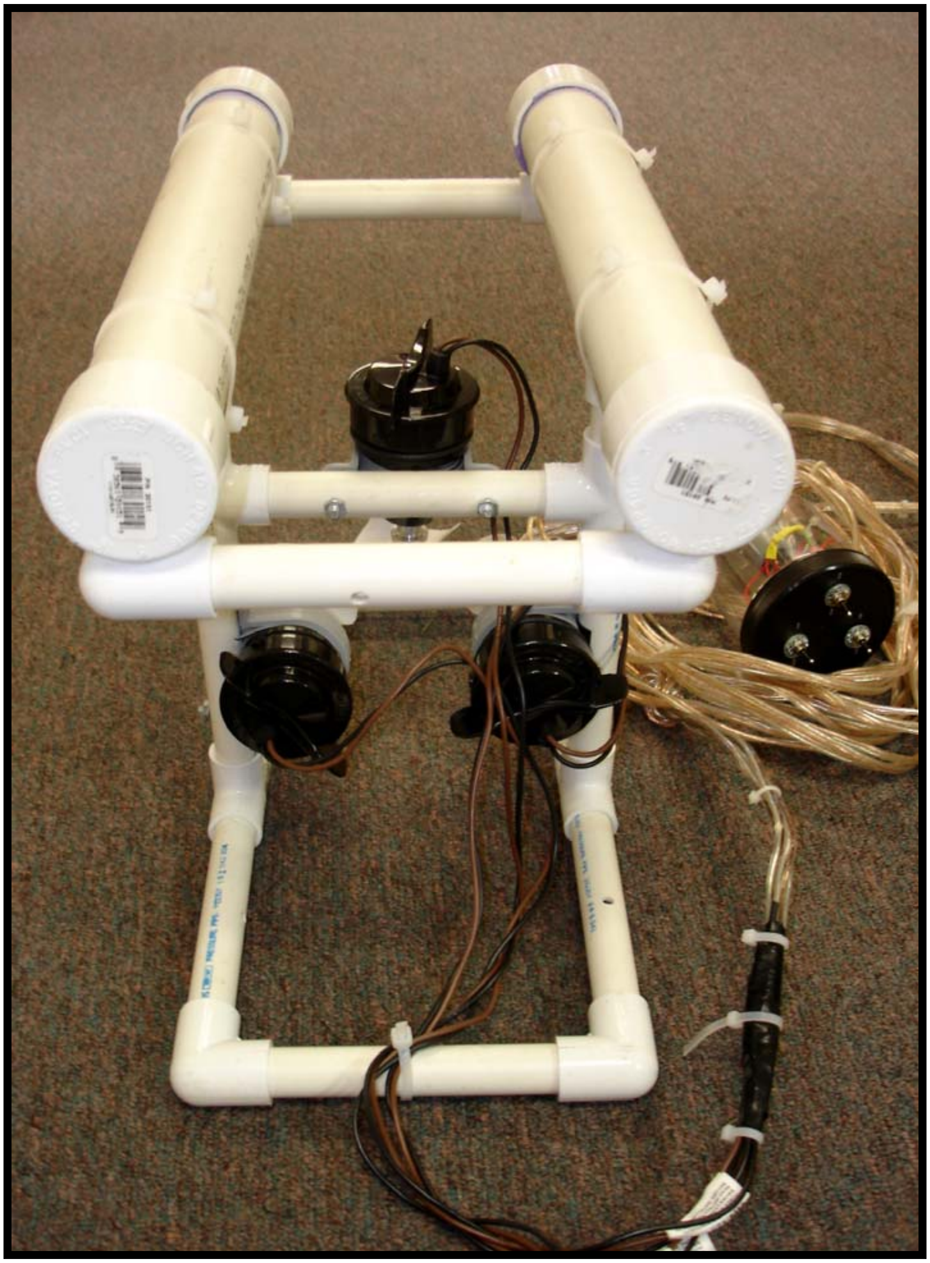

Figure 1.4: This is a rear view of the ROV. The wire tether is attached to the thrusters from the rear. This enables the ROV to move forward without getting tangled. The tether will have to be managed manually (i.e. by hand) when the thrusters are operated in reverse.

THE CONTROLLER

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The controller contains all of the switches and wires that make the ROV go up, down, forward, backwards, and turn (Figure 1.5 and 1.6).

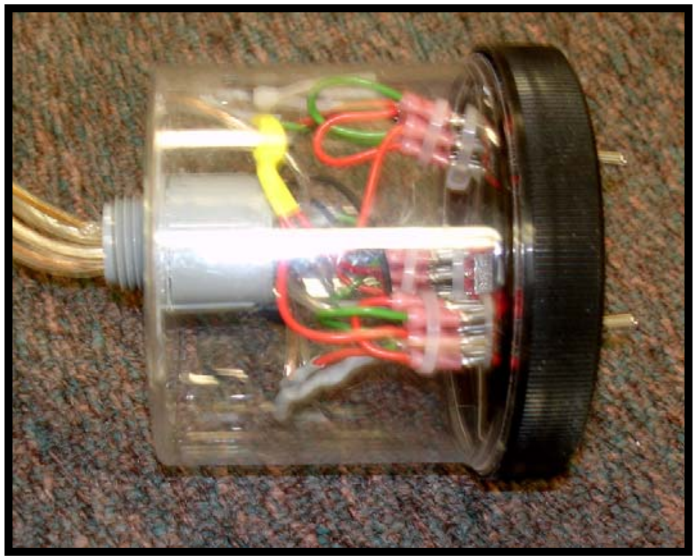


Figure 1.5: The inside of the controller jar.

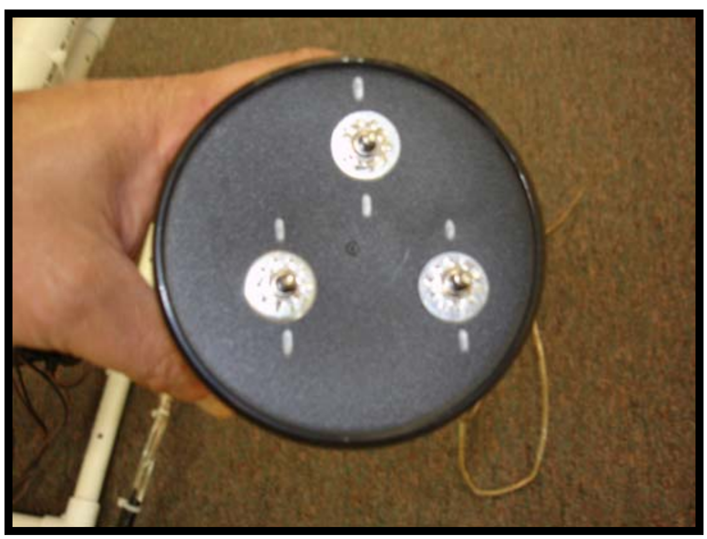


Figure 1.6: The labeled controller jar lid. The silver vertical lines show the direction that the switches can be pushed or pulled.

The completed controller w/ the wired switches is shown in figures 1.5 and 1.6. All of the "guts" are contained within a 16 oz container with a plastic lid.

2 DPDT Switches – on-off-on moment – this means that the switch is off when the toggle is in the center position. When it is pushed in one direction the thrusters will turn in one direction. When the toggle is released it will return to the center position and be off. When the toggle is pulled in the opposite direction the thrusters will turn in the opposite direction. These two switches will control the two horizontal thrusters and allow the ROV to move forward and back, to the left and to the right.

Contact: Demar Electronics – www.demarelectronics.com
Suggested Switch: 8012A
Estimated cost $2.30 each

Figure 1.7 – A DPDT Switch w/ center off that automatically shuts off when not physically engaged.

1 DPDT Switch on-off-on - this means that the switch is off when the toggle is in the center position. When it is pushed in one direction the thrusters will turn in one direction. The toggle must be physically moved to the center to turn the device off. When the toggle is pulled in the opposite direction the thrusters will turn in the opposite direction. This switch will operate the vertical thruster that will move the ROV up and down.

Contact: Demar Electronics – www.demarelectronics.com
Suggested Switch: 8012
Estimated cost: $2.00

Figure 1.8 – A DPDT Switch w/ center off that stays in the "on " position unless the toggle is physically moved to the center position.

Wire for one switch – 6 pieces

3 4" stranded 22 gauge wire red – both ends stripped ~ ½"
3 4" stranded 22 gauge wire green – both ends stripped ~ ½"
1 4" stranded 22 gauge wire black – both ends stripped ~ ½"

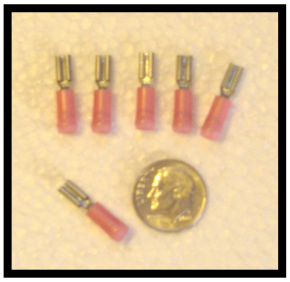
Suggested contact: Demar Electronics – www.demarelectronics.com

25' rolls @ $7 each; you will need, at most, about a foot of each color/ ROV – This works out to about $.85/ROV.

Red: $7	422-1C16	(catalog number at demar electronics.
Green: $7	422-1C17	
Black - $7	422-1C11	

Connectors

Waldom-Molex -19017-0005-C Term Female AWG22-18; these spade connectors fit over the posts of the switches you'll get from Demar Electronics. Sometimes they need to be crimped just a little bit to fit tightly over the post. When all of the wires are connected to the switch you'll slip two small plastic tie wraps around them and tighten them. You'll need **18 of these for each controller**.



Contact: Demar Electronics – www.demarelectronics.com
Suggested Connector – As labeled above
Estimated cost: $10.00/100 or $2 per 20 needed for 1 ROV

Figure 1.9: Molex connectors to hook the wires to the switch posts

Plastic Tie Wraps

6 (two for each switch) 4" plastic tie wraps that will hold the connectors in place on the switch.

4" Plastic Cable ties can be purchased for $2.00/100.

Controller Box (www.containerandpackaging.com)

Get 1 (one) 16 oz clear plastic jar, J093 (Figure 1.10a) - the softer the plastic, the easier it is to drill the hole that the tether and power connector wire will go through. The plastic jar should accept a screw on lid (figure 1.10b). (Clear plastic controller jars with lids can be found at a local Dollar store and purchased for $1/each. The problem is that they hold hair gel that needs to be cleaned out.. this could be viewed as adding to an environmental problem if the gel is not readily biodegradable or water soluble).

You'll also need the lid. I use Black Ribbed Lid unlined (L246UB) . You will drill three holes in the lid and mount the three switches that controller the thrusters, here.

When purchased in bulk these cost about .80 for the jar and lid.

Figures 1.10 a & b – Jar and Lid for Controller

1 ½" Male Adapter Lasco Pt No 436-005 – This adapter will be fixed to the bottom of the clear plastic jar. The threaded end will poke into the bottom of the jar.

Figure 1.11 www.flexpvc.com @ 0.18/ea

1 Rigid ½" Conduit Locknut – this locknut will thread over the threaded end of the male adapter from the previous step.

Figure 1.12 www.doityourself.com or Lowes @ 0.20 each

3 Bilge Pump Cartridges - West Marine sells Johnson Bilge Pump Replacement Motor Cartridges. The 600 GPH are fine @ $13.00 each. The more GPH they have on their label, the more powerful the motor will be. You'll need three of these to move your ROV forward, back, left, right, up, and down. Be certain that the impeller is visible at the top of the motor. This will make it easy to adapt to become an ROV thruster.

Supplier: West Marine
Cost: $14/each – You'll need 3 per ROV

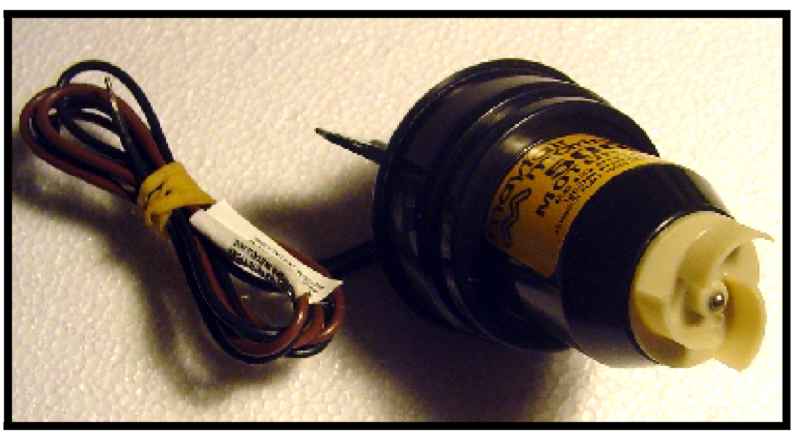


Figure 1.13 The Bilge Pump Cartridge used for the thruster motors.

Prop Adapters so you can attach Propellers

3 @ www.masterairscrew.com **Direct Drive Prop Adapter**; ¼" (0.25) output and 3 mm (.124) motor shaft; aluminum. @ $4.29 each.

Figure 1.14 : The adapter to put the prop on the thruster.

Propellers

The propellers should have a hole in the hub through which the aluminum bolt of the Direct Drive Prop Adapter will fit. Sample propellers can be obtained at no-cost from dougthegeologist@hotmail.com. The view below is of the front (left) and back side (right) of the sample propeller. You'll need three of these per ROV.

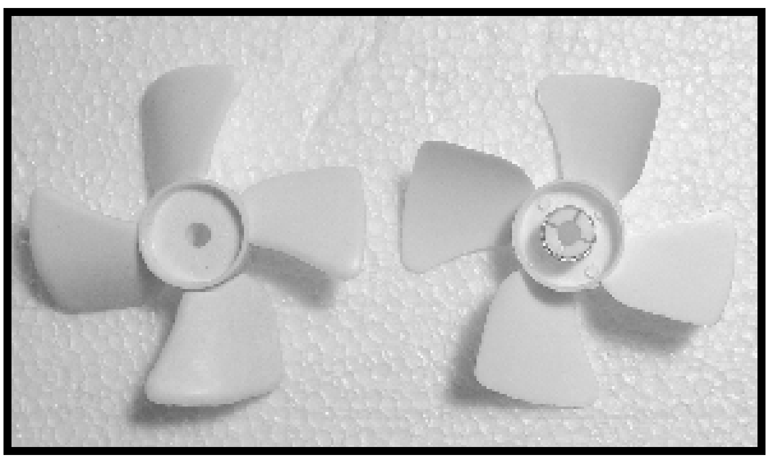


Figure 1.15 Front and back view of the muffin fan blade.

Tether Wire

100' of 18 gauge speaker wire; For the ROV you'll need 3 strands (30') long. Each of the 30 ft lengths will be attached to one of the Bilge Pump Cartridges. 1 Strand of 18

Gauge Speaker Wire (10') will enable a connection of the controller box to a car battery or other 12V DC power supply.

You can purchase the wire "In-bulk" at www.sjgreatdeals.com/pet255-318/ERL# WW103 (Bulk Speaker Wire – 18 Gauge, 1000ft) for $52.

You need 100ft of wire per/ROV – The calculated per ROV price is $5.20/100ft

Rubber Tape – 3M Temflex Rubber Splicing Tape #2155 – You need 30" of this to wrap around the shaft hub of the bilge pump cartridge. $4.71/roll = 22ft.

Figure 1.16 The rubber tape seen here allows the cartridge to be tightened against the PVC frame.
Note the Thruster Assembly involves wrapping the bilge pump cartridge with the Rubber Tape, putting the Powerline Conduit Clamp around the tape and then bolting the assembly to a pre-drilled 6" PVC ½" pipe length.

Black Electrical Tape – 1 roll electrical tape to assist with the wire splicing and waterproofing. $5/roll

Shrink Tube 3/8" I.D. – Single Wall Polyolefin Heatshrink - 4 Foot Piece – www.wiringproducts.com HSSWB3-X/X - $2.54 ea

3 - Powerline 1-1/2" Conduit Clamps – 5133734B – These clamps fit around the smaller portion of the bilge pump cartridge, as seen below. $1.57 for 5 pack.

100 4" plastic tie wraps to bind the ROV tether strands (speaker wire) so it is easier to handle. www.wiringproducts.com - 100 pieces $2.95

6 - 1.25" machine screws with nuts and washers – These are used to fasten the Conduit Clamps to the PVC. Estimated cost $1.50/ set of 6

The Frame Pieces

1 ½"x10' piece Plain End Schedule 40 PVC Pipe $2.03/ea – cut into 6" pieces give you 20 Pieces. (cut one of the 6" pieces in half, to give you two 3" pieces)

10 ½" Lasco ½" Slip 90 Degree Elbow SCH-40 - $0.24 ea @ Lowes – 10 Pack @ $1.92

10 ½" Lasco ½" Tee 10-Pack SCH-40 = $2.56

1.5" X 10' PVC – Plain End PVC $7.43 for 10' piece – You'll use two sections of this, about 16" long to create the buoyancy for the ROV.

4 1.5" End Caps – www.flexpvc.com @ 0.50/ea

14" Plastic Tie Wraps – www.cabletiesplus.com Price/100 = $9.00 – to tie the buoyancy pieces to the ROV frame. You'll need a minimum of 4/ROV build.

ROV OPERATION CONSIDERATIONS

Power:

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The ROV operates on 12v DC power. It is suggested that operators use an emergency jump start device for power. These can be found at any store that sells batteries or autoparts. They can be purchased for under $30 each. They are rechargeable.

Cameras:

The best underwater camera located to integrate into the ROV was located at www.helmetcamera.com. The submersible helmet camera (lipstick camera) sells for $169.00. You'll have to ask me how to extend the wire another 30' to integrate it into your ROV. In addition to the camera, you'd have to pick up a TV monitor that can handle an RCA input jack (most can). A workable monitor can be purchased used for under $50.00. The monitors may not be battery powered and may have to be plugged into an outlet to work.

Lights:

Waterproof cameras are best to use. You turn them on prior to deployment and turn them off when your ROV comes to the surface. A Pelican Mitylite 4AA will run for 3.5 hrs. They cost $20.50 each (www.forestry-suppliers.com).

Storage:

Your controller assemblies will survive transportation when each is contained in a Sterelite 10Qt Container 1844-White. The snap top keeps the unit from falling out of the box. These can be purchased at most discount stores for under **$5/each**.

Transportation (Moving these things around:

Plastic 5 gallon buckets have been found to be most useful transporting the PVC pieces @ **$3.5/piece**. The buckets can be spread out a bit so the kids can come up and pull a handful of what they need out so that they can commence to building. Recommend two to hold the 6” pieces, and one each for the elbows and T’s. Another bucket would be used to hold the smaller or miscellaneous pieces you will be providing.

Tool Kit recommended (See Appendix 1)