

# Best of the Best National Underwater Robotics Competition 2009



Seventh Grade Class From:  
Christ the King Catholic School  
1551 E. Dana Ave. Gilbert, Arizona

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## **Best of the Best**

Strategist –  
Cole Dieterle

Vertical Driver –  
Eddie Montana

Horizontal Depth Driver –  
Travis Liddell

Cable Feed –  
David Lopez

Video Operator –  
Brian Hartman

## **The Entire Best of the Best Team**

Mitchell D tente Shawn Malkou  
Mariah Martinez  
Eddie Montana  
Tina Monteilh  
Stephanie Polk  
Liz Reasch  
Andrea Valera  
Madison Crites  
Grace Wirth  
Katie Won  
Sarah Wuest  
Christina Carrieres  
PJ del Rio  
Cole Dieterle  
Casey Filler  
Brian Hartman  
Marie Hodges  
Drew Jensen  
Rita Kazzazzi  
Travis Liddell  
David Lopez

### **Abstract**

“Best of the Best” consists of Seventh Grade Students from Christ the King Catholic School in Mesa, Arizona. Christ the King is a K-8 Elementary School and our computer/technology classes have been very traditional classes of key boarding, power point and charts and graphs. This is our first attempt at building a robot and the students were very concerned that they could not accomplish this task. After researching the website from last year’s Challenge, it was agreed that we should purchase the basic robot kit and build the basic “no frills” robot as directed on the kit. Then, changes, modifications and adjustments could be made as we thought were needed. Parents became involved as we needed to locate and purchase tools and materials. Everyone in the class agreed that our best resource was our Industry Advisor, Mr. Dave Zavaleta,

whose experience and knowledge proved so valuable to us all. This report shows the steps that we used to take to build the robot.

### **Design Rationale**

We started with the basic ROV design that we needed and started to take things from there. We went through the packages of parts, counting and cataloging everything to make sure that we had all pieces that were included in the original kit. Mrs. Rumney made copies of the directions and divided our class into teams, assigning each team a part of the construction process. We spent a great deal of time discussing the Mission of the Challenge and listing what the ROV needed to be able to accomplish underwater. We also spent a lot of time talking about how the ROV was basically designed to accomplish those tasks.

We also spent a lot of time talking about the balance of the ROV and the need to keep the weight of the parts evenly distributed. Everyone in the class seemed to have a different idea of where and how to mount the various components of the ROV. We finally agreed that the best solution was to ask Dave (Mr. Zavaleta) to help by constructing a platform on which to mount the pieces so that they could be balanced and the weight of the parts distributed equally so the ROV would not tilt to either side while it was moving in the water.

The ROV's frame is composed of a series of PVC pipes.. . The Best of the Best Robotics built a robot with three separate thrusters. One was set in the center of the ROV to move it up and down in the water. The other two are in the back to propel it forward and backward. With the basic design done, we had everything checked out to see if we had all the parts in correctly, Our ROV has one 12 volt battery to power the thrusters, camera, and light and we connected the wires to the battery from our control panel.

The robot also has a 100 foot long tether comprising of four different cables to make it easily controlled from the surface. The assembly of the tether took everyone in our class. We all went out to the school parking lot and stretched out all of the cables which would be included in the tether. We knew that the cables sent were labeled 100 feet so everyone was fairly comfortable that the tether would be within an inch or two of that length. When we put the tether together the first time, we learned that the class before us had tried using plastic wire ties .However, as they curled the tether into a loop, they realized that the plastic wire ties were catching on the sidewalk and would also catch on the bottom of the pool. So, we learned from their experience and put the tether together using electrical tape, which would be waterproof and move smoothly as the ROV moved through the water.

As we began mounting the various components of the ROV onto the frame plate, we discussed the need for the camera to be centered, so that our ROV forward and aft driver would have a clear and unobstructed view and not be skewed to one side which would make driving the ROV very difficult. We centered the camera and used a hacksaw to cut and remove the center PVC pipe. The robot's one camera is attached to the front of the main frame. With help from our light, we can see everything in front of the ROV although the range is somewhat limited.

It was really exciting when we tried the power through the tether for the first time and all of the components worked!

### **Skills and Techniques Learned**

While trying to build this robot, we learned so many skills. This was our first time constructing an underwater robot. We learned how to make the robot's frame, make a join wire, use a hacksaw, assemble the underwater light, make the robot's gripper, how to prepare the inexpensive water tight camera, and how to make the robot's thruster.

Making the frame took us about fifteen minutes. Doing this included our skill of making a join wire and one of our other skills of using the hacksaw. This is where our skill to use the hacksaw came in. We needed the hacksaw to cut the PVC pipe  $5 \frac{1}{4}$  inches each. We then needed those pieces and glue them in the correct order so it would make the frame.

For the underwater camera, the male side of the PVC union was used to keep the camera in place with the o-ring. The one PVC pipe was then glued to the  
Our class has come a long way in making this robot because we have never done anything like this before. We are now experienced and learn many things about how to make a robot, which will be very helpful if any of us become engineers. Our class also learned how to draw schematics; we may not be very good at it but we know how to do it!

### The Challenge of Design

It was very disappointing the first time we put our ROV into the water and found out that the glue sent with the kit wasn't very waterproof and we needed to take everything apart and start again. Additional PVC pipe was donated to us and we re-cut the frame and started again. The second frame that we made was just a little larger (5 and ¼ inches) than the original PVC frame that had been sent in the kit. The new glue proved to be watertight and seaworthy.



### The Rebuild

Christ the King Catholic School's ROV revisions are due to our opinion of the materials we were sent. We felt that the original glue we received was somewhat insecure. This proved to be correct when the first of our ROV's leaked water into some of the PVC pipes in our original design. We substituted it for *Christy's Red Hot Blue Glue: PVC Pipe Cement*.

As the second ROV was being rebuilt, we realized that the third propeller, which was mounted to power the ROV in its up and down movement was stronger if it was mounted so that the propeller was turned so that the blades of the propeller were underneath pushing the ROV up and pulling down rather than pushing down up and pulling up. We believe that this has the prop working more with the effect of gravity and the density of the water.

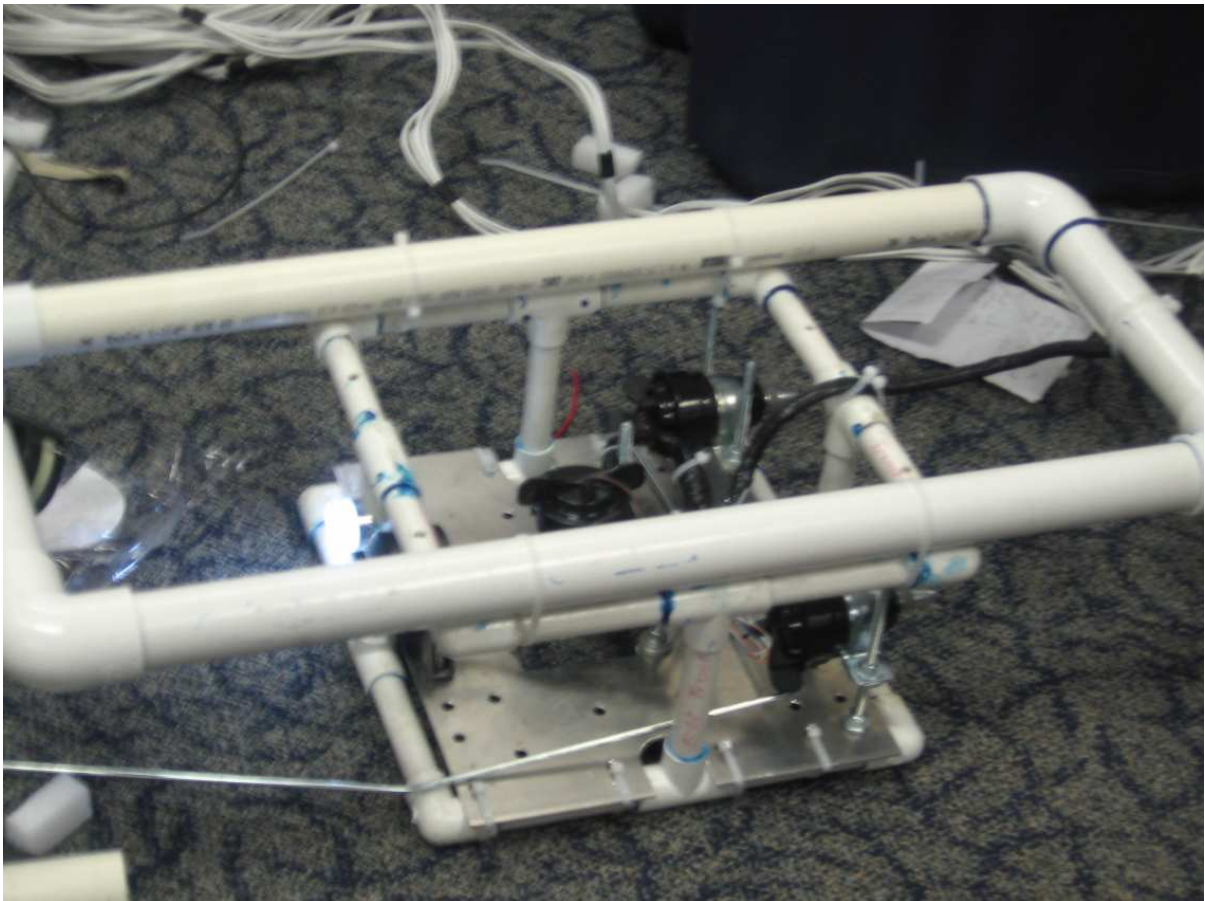
Although we purchased the grabber kit recommended on the NURC 2009 website, we were all disappointed with it when it arrived. We thought that it moved too slowly to be effective in a timed competition. Our ROV also has a small hook to easily grab most objects used in the competition. The hook is big enough to grasp the rings used in the competition, and easy enough to maneuver through them.

The ROV has one 12 volt battery to power the thrusters, camera, and light. The robot also has a 100 foot long tether comprising of four different cables to make it easily controlled from the surface. We spent quite a bit of time in discussion about how the control panel would look. We also talked a great deal about the extra points we could get if we designed a way to charge the batteries in a different way. We discussed using fruit as one way to recharge the batteries but felt that the 12 volt would be too slow to charge in this manner. The class decided that solar was the way to go.

## Buoyancy

There is a rectangular piece set on top of the main frame used as buoyancy control. Buoyancy is the tendency of a body to float or rise when submerged in a fluid. An object's ability to float or submerge depends on the density of the object when compared with the density of the fluid in which it is immersed. Water exerts pressure on an object from all directions. Buoyancy results from the differences in pressure on the upper and lower surfaces on the object. The weight of the object plus the weight of the water above the object exerts a downward force. Fluid pressure exerts pressure upward from below. The difference between the two pressure fields determines the buoyancy of the object. The force of buoyancy acting on a submerged vehicle must equal the force of the buoyancy, or the weight of the water displaced. This is called Archimedes principle. This worked much like a submarine. If we are too buoyant, we will use too much power to submerge and stay underwater. Our ROV would constantly be fighting to float and we would use too much power to stay underwater. If we are not buoyant enough, we would use too much battery power to move through the water and to raise our ROV to the surface.

To make our ROV more neutrally buoyant we put on a rectangular PVC pipe structure to make it float better and be more neutrally buoyant.



We want to build a robot  
Made out of pipes and glue  
And odds and ends of other things  
We want to paint it blue

We want to make it  
Up and down  
And backwards forwards go  
And when we spin it all around  
We'll put on quite a show

We'll send it underwater  
Far under depths and waves  
And then conduct a mission  
To rescue and to save

But until then  
We've quite a mess  
All over rug and floor  
And tabletops and hallways  
We spill right out the door

Just give us time  
and lots of smiles  
And faith and understanding  
We'll get it done  
This month or next  
It's knowledge we're expanding  
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And we did it !!!!