# Making Waves

by Beckie-Ann Thain

**Four young Canadians know how to make a splash in the engineering world—build their own underwater robot for a competition at the Kennedy Space Center in Florida.**

Sponsored by the Marine Advanced Technology Education Center and the Marine Technology Society, the 1st Annual ROV Design and Building Competition challenged high school and university students to whip up an underwater Remotely Operated Vehicle (ROV).

Students from across the United States competed. Canadians Virginia Davis, Aubrey Senyard, Lydia Burnett, and Beckie-Anne Thain took the challenge too—creating a robot that had to operate underwater for 20 minutes and pick up objects from the bottom of a pool.

The girls, ages 13 to 16, are part of the White Rock/South Surrey Home Educators group in British Columbia. They began their project in January—at a pool party. Five months later, the girls created GIGO (Cree for "fish", or English for Group Inspired and Girl Operated), a working submersible ROV. Well, sort of working. Because of airline security, the team had to completely disassemble GIGO before boarding the plane to Florida. When they arrived in Florida, the girls faced a lot more challenges.

GIGO creators from left to right: Aubrey Senyard, Lydia Burnett, Virginia Davis, and Beckie-Anne Thain.

**May 18, 2002**

Exiting the plane in Florida we were hit with a wave of humid heat. It was like walking into the Amazon exhibit in the Vancouver Aquarium. When we arrived at the hotel, we met several teams working on their ROVs and tethers. That made us feel better—we thought we were the only team whose ROV wasn't operational.

We went to sleep at about 3 a.m.

**May 19, 2002**

Virginia, Lydia, Aubrey, and I woke up to the sound of blaring music at the lovely hour of 7 a.m. After breakfast we boarded a bus for the Kennedy Space Center (KSC). At the KSC we set up

Photos courtesy White Rock/South Surrey Home Educators; Water background by Photodisc

our posters, then for the rest of the afternoon we wandered around and took in the amazing space exhibits.

Later in the afternoon we met the judges. There were seven judges, and most worked for offshore diving companies like Oceaneering and Stolt Offshore.

After supper, we worked on GIGO and increased the flotation in our tether while Lydia finished the technical paper. It ended up being about 28 pages! That night we worked until 1:30 a.m.

**May 20, 2002**

Monday morning we woke up tired and stumbled out of bed. I found a team with a printer and they kindly let us print our

Using power tools to construct GIGO.

technical paper for our display. Then we loaded GIGO on the bus and we were off to KSC.

The students in the ROV Competition were invited to attend opening speeches for a NASA symposium on space and subsea exploration. Listening to Drs. Sylvia Earle and Joe McGinnis, two renowned ocean scientists, was inspiring. What was even more exciting was that we met them both in person!

We set up GIGO at our display table along with our poster, the Bissell Missile (our earlier ROV project), GIGO's old base, and the control system. Poor GIGO, she was overshadowed by the Bissell Missile—people were amazed

The GIGO display at the Kennedy Space Center.

**The ROV's tether contains wires that control the motors, lights, camera, and anything else electronic on GIGO. It also contains flotation to make it neutrally buoyant. The tether attaches to the termination can on the vehicle and feeds into the control box above water.**

that we had built an ROV out of a vacuum cleaner! We stayed at our display all day answering questions from other competitors and teachers.

We also had two interviews with the Discovery Channel film crew, who were shooting a documentary on underwater exploration.

At 4 p.m. we were judged for our knowledge and display. We talked—without interrupting each other—and the judges seemed impressed with our knowledge of the ROVs. At first they weren't even going to look at the technical paper, but one decided to "glance" at it. After reading a couple of pages, she asked if she could take it and read it

Being interviewed for a Discovery Channel documentary.

**Neutrally buoyant is when the vehicle is placed anywhere in the water and it stays there, neither sinking nor rising.**

thoroughly. That was totally fine with us!

An hour later we were packing up when we were asked to take GIGO to a special reception for the NASA symposium delegates. Only five teams were chosen to show their ROVs at the symposium reception—we felt honoured!

After the reception, we returned to the hotel for another late night working on GIGO.

**May 21, 2002**

Tuesday morning we boarded the bus headed for Brevard Community College where we would take care of last minute problems and practice piloting.

We spent nearly four hours re-ballasting and trimming GIGO for the saltwater pool. The ROV was either negatively buoyant or positively buoyant—we could not achieve neutral buoyancy. As we worked, we were interviewed for the Discovery Channel again. By the end of the morning all our nerves were fried. We were not working very well as a team. Finally, in the last 25 minutes, we got GIGO neutrally buoyant. But we had other problems—a lot of other problems.

We went back to the hotel tired and discouraged. Desperate, we prayed for a miracle!

Then, who should show up, but Bryan Shaeffer from Team MATE. (An ROV team sponsored by the Marine Advanced Technology Education Center and available to help competitors.) He asked if we needed any help—boy did we ever!

Fiddling with GIGO before the big competition.

For the next 12 hours Bryan helped us troubleshoot. First we began by fine-tuning the ballasting on the ROV. When we tested GIGO's ballast in the hotel pool, it turned like it was crab walking. When we had tested it in Canada, our turning speed was extremely fast. After looking it over, we realized that GIGO had been re-assembled with the motors opposing each other. Next we rebuilt the tether to reduce the electromagnetic interference that was killing the video signal. We also replaced the video power supply circuit.

By midnight we had nearly all the problems corrected and began practicing retrieving objects in the pool. The girls decided that I would be the pilot. I was so nervous that night—I kept thinking that if I mess it up on Wednesday, there goes our whole year.

The team worked hard on last minute adjustments.

**May 22, 2002**

The BIG day! All the way to the bus we sat visualizing how we would perform our jobs.

Lydia was the captain and the only person allowed to touch the objects GIGO brought to the surface. Virginia was the tether manager, making sure GIGO had just enough tether. Aubrey was co-pilot and responsible for monitoring the ammeter to ensure we kept within the allowable power budget. As pilot, my job was to "fly" GIGO.

After we arrived at the pool, the competition director, Jill Zande, explained the rules and went over last minute details. Our team was scheduled to go second at 10:30 a.m.

It was time and we carried GIGO to our station. During the five-minute prep time for set up, Virginia submerged GIGO to remove air pockets from the frame. Lydia and Aubrey connected the ROV's power system to the battery and connected the video output to the TV. I strapped on the controller belly pack and sat down in front of the monitor.

Five, four, three, two, one—GO! Virginia let go of GIGO and we were off. We had 20 minutes in the water to retrieve different objects. It took eight minutes and six attempts, but

The termination can is a watertight housing that holds all the electronic connections onboard the ROV.

**An ROV needs:**

- frame
- propulsion
- flotation
- tether
- power and control system
- video camera and other sensors
- manipulators

finally we had a wine bottle in the net and GIGO was coming up!

After another three or four minutes, GIGO brought another wine bottle to the surface. But time was running out. I pushed the z-axis thruster switch forward and GIGO went down for one last dive. I decided to go for the teacup. The teacup was stubborn; it would not go through the mouth and into the net. Finally, in a last desperate attempt to retrieve it, I turned GIGO around and pushed the teacup up against the tether. It just sat there. We only had 50 seconds remaining. I turned the up thrusters on full force, sat back, and prayed that it would not fall off.

A TV monitor helps the pilot steer GIGO.

"Thirty seconds, ladies."

Please God, let it stay there!

"Fifteen seconds remaining."

Suddenly, in the TV monitor, I saw Lydia's hand stretch out and grab the teacup. It was over and we had done it!!!!!!! That night at the awards ceremony Jill Zande got up and told us all what a wonderful job we did. She recognized certain teams with special awards such as the team who fried their electronics and the team who had the best team t-shirts. The last award—the coveted Sharkpedo Award for design and innovation—was announced. It went to us, the White Rock/South Surrey Home Educators! We were so excited!

Then came the announcement of the first, second, and third place awards for overall performance. Jill Zande started off with third place.

"Third place goes to White Rock/South Surrey Home Educators."

At first most of us thought, "Could there be another team called the White Rock/South Surrey Home Educators?" but no, they meant us!! We were all shocked and overwhelmed! That hour was the most wonderfully, overwhelmingly awesome hour of my life! It was so amazing that we had actually won third place!!!

**As a safety factor, most commercial ROVs operate with slightly positive buoyancy. If our ROV is negatively buoyant, it will sink unless the up thrusters are on at full thrust. If the ROV is positively buoyant, then the vehicle will float unless the down thrusters are on.**

A coveted award goes to GIGO's creators.

## How GIGO came to be

*GIGO from start to (almost) finish*

- Reviewed atomic structure of water molecules and unique properties of seawater. Our teacher—my dad—Peter Thain helped us learn about electronic mapping.
- Visited Dr. Phil Nuytten in North Vancouver. Introduced to submersibles he designed and built. He donated some essentials: a thruster motor, video camera, and a design concept.
- Many meetings and discussions. Decided to improve on one of our old ROV designs.
- Learned about power. Had to decide whether to use thick or thin wires to hook the ROV up to a 12-volt battery. Thicker wire means more power, but then the ROV tether is heavier.
- Norman Birch taught us how to operate a metal lathe so we could manufacture the parts.
- For weeks, we used the lathe, a drill press, sander, and other tools to build GIGO's shell. We also kept notes for the required technical paper.
- In April, we finished with the shell and started wiring. Many design discussions—any change affected everything.
- Shipment of tiny balls (macrospheres for flotation) was held up at customs, we improvised—ping pong balls, wax, and a plastic wine glass worked well together.
- Decided to use a net and mouth design as the manipulator (the scooper).
- Built the tether—cut and pushed all nine wires and flotation through a hollow polybraid rope.
- Time was getting short, met with ROV expert (and our mentor!) Dr. Harry Bohm for help. We felt encouraged!
- Attached video camera and lighting system to bottom of termination can. Dry land test of the "scoop". It worked.
- Put GIGO in water, worked on balance and ballast. GIGO more positively buoyant than expected so attached eight weights—a quarter kilogram to a kilogram.
- Thirty hours before leaving for Florida, redesigned GIGO's base. Built extremely lightweight, streamlined aluminum base to replace the big polypropylene base. Tested in pool—can reduce GIGO's ballast and go faster underwater.
- Not quite operational but ready.