

Granby's Girls In Engineering



Granby High School
Norfolk, VA

Table of Contents

Company Spec Sheet.....	3
Company set-up.....	3
ROV Spec: PIPPY 2.0.....	3
The Team.....	4
Abstract.....	6
Photos of ROV.....	7
Budget.....	8
System Integration Diagrams (SID).....	10
Design Rationale.....	12
Troubleshooting Techniques.....	14
Vehicle Systems.....	15
Safety.....	16
Challenges.....	18
Lessons Learned.....	19
Future Improvements.....	20
Reflections.....	21
Teamwork.....	22
References.....	23
Acknowledgements.....	24

Granby's Girls In Engineering

Company Spec Sheet

Aim: To provide an ROV for the Thunder Bay National Marine Sanctuary to

1. Explore, document, and identify an unknown shipwreck recently discovered in sanctuary waters;
2. Collect microbial samples and measure the conductivity of the groundwater emerging from a sinkhole;
3. Remove trash and debris from the shipwreck and surrounding area.

Company set-up

CEO: Ashlee Gordon

CFO: Dr. Deborah Marshall, Mr. Roger Lagesse

Inventory/Comptroller: Tanisha Robinson

Government and Regulatory Affairs: Ashlee Gordon

Research and Development: Erika Akpa, Tytianna Williams, Vanessa Callado

Systems Engineering: Victoria Gormley, Tanisha Robinson, Lauryn Tidoe, Tytianna Williams

Mentors: Mr. Roger Lagesse, Dr. Debra Marshall

Potential Clients: Thunder Bay National Marine Sanctuary

ROV Spec: PIPPY 2.0

Appx. Total Cost: \$2109.06

Safety features: motor coverings, heat shrink, wire coverings, main fuse of 25 amps, conductivity circuitry (max. 3 amps), safety warnings on motors and claw.

Special features: tether line, multiple cameras, rotating claw wrist, individual pilot and co-pilot controls.

The Team



Company CEO; Grade 12,
Plans for Spelman college
for Nuclear Engineering

Ashlee Gordon



Research and
Development;
Grade 12, Plans for
Old Dominion
University to be a
Computer Engineer

Tytianna "Nikki" Williams



Inventory/Comptroller;
Grade 12, US Army to be
an Environmental
Engineer

Tanisha Robinson



Erika Akpa

Research and Development; Grade 12, Virginia State University, Computer Engineer



Victoria Gormley

Systems Engineer; Grade 11, US Air Force/Norwich University, Mechanical/Aerospatial Engineer



Lauryn Tidoe

Systems Engineer (Claw Specialist); Grade 9, Undecided



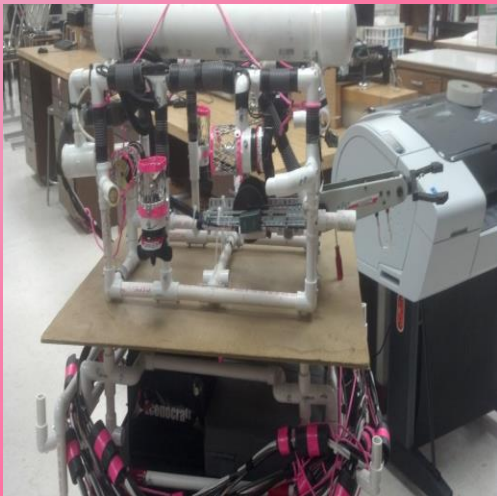
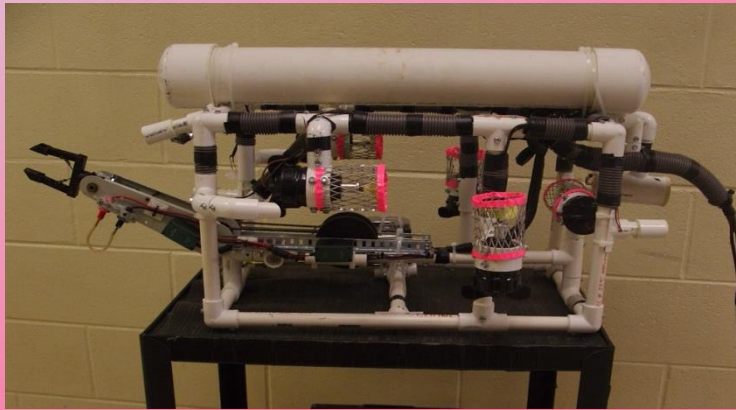
Vanessa Collado

Aesthetic Designer; Grade 9, Undecided

Abstract

Granby High School's Girls in Engineering would like to present PIPPY 2.0. This ROV was designed to: explore, document, and identify an unknown shipwreck recently discovered in sanctuary water; collect microbial samples and measure the conductivity of the groundwater emerging from a sinkhole; and remove trash and debris from the shipwreck and surrounding area. Although presented to the Thunder Bay National Marine Sanctuary, PIPPY 2.0 can serve multiple companies for their marine biological testing purposes. Furthermore, each member of this company has played a vital role in the production of this ROV, and is knowledgeable on each aspect and design purpose of PIPPY 2.0. Over a time period of 7 months, PIPPY 2.0 started from a few PVC pipes salvaged from a previous ROV and a cubical drawing. Now, it has transformed into a fully operational underwater ROV with numerous attachments for the many obstacles that could potentially arise while underwater.

Pippy 2.0



PIPPY 2.0 taking new pictures for Michigan



Lauryn designing *PIPPY 2.0's* claw



Everyone puts their input in



CEO hands-on help designing *PIPPY 2.0*

Budget/Parts List

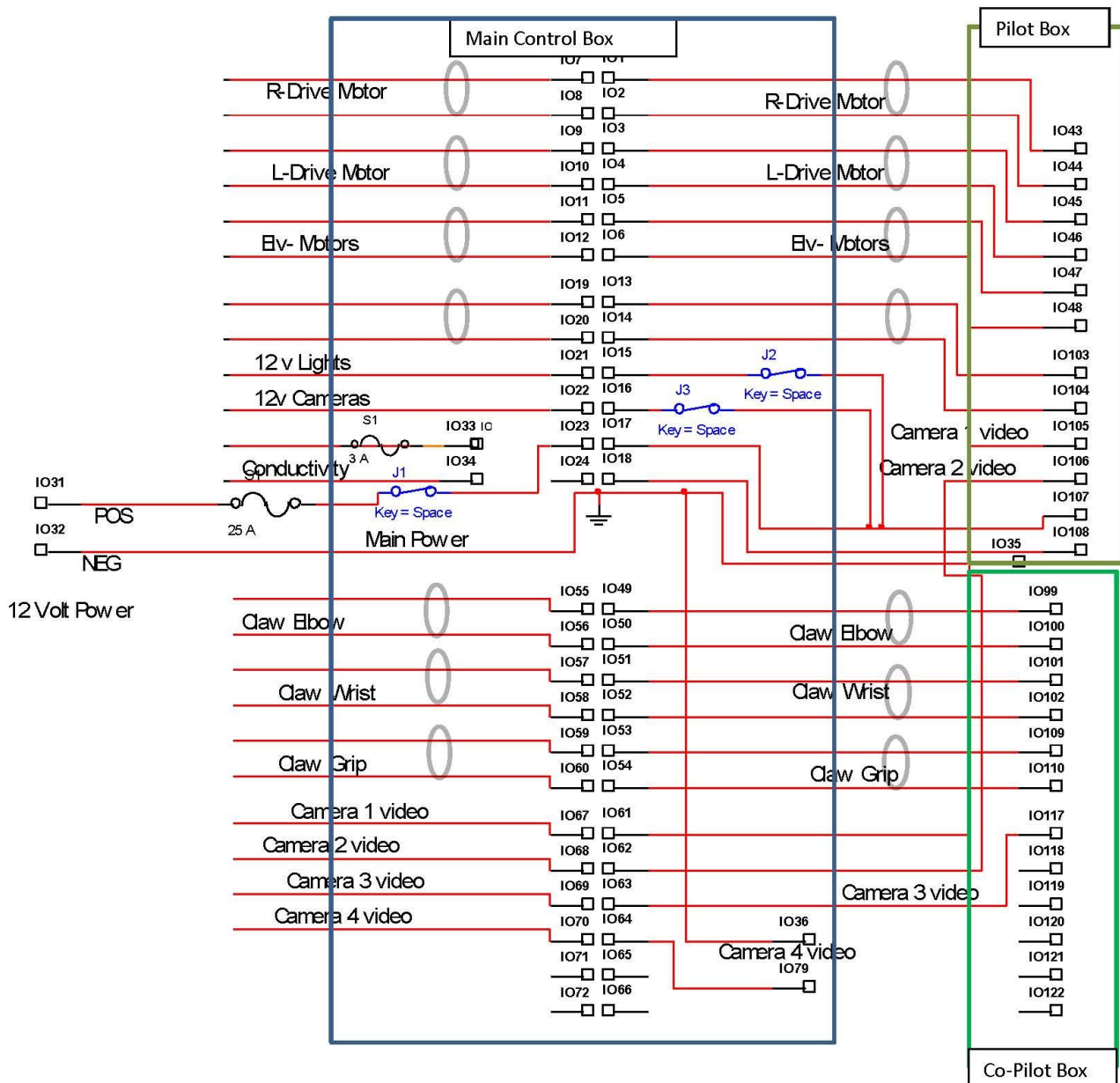
Qty	Item	Part#	Source	U/I	Qty	Unit Cost	Ext. Cost	Notes
	Hull							
	1/2" PVC Pipe		Home Depot or Lowes	10 FT	10	1.81	\$18.10	
	1/2" PVC Elbow		Home Depot or Lowes	EA	30	0.46	\$13.80	
	1/2" PVC Tee		Home Depot or Lowes	EA	15	0.66	\$9.90	
	2" PVC Pipe		Home Depot or Lowes	2 Ft	4	5.24	\$20.96	
	2" PVC End Cap		Home Depot or Lowes	EA	8	11.56	\$92.48	
	PVC Glue	SKU # 187100	Home Depot or Lowes	8oz CN	3	4.44	\$13.32	Model 310131
	1.5" Conduit Clamps		Home Depot or Lowes	EA	16	2.30	\$36.80	
	#10 1.5" Machine Screws		Home Depot or Lowes	5/pk	6	1.18	\$7.08	
	#10 Nuts		Home Depot or Lowes	12/pk	4	1.18	\$4.72	
	#10 Washers		Home Depot or Lowes	50/pk	1	2.36	\$2.36	
	Machine Screw	32-8	The Home Depot	100	1	6.21	\$6.21	
	Round Cupped Slider		The Home Depot	4	1	5.49	\$5.49	
	PVC Cutting Tool		The Home Depot	ea	1	11.98	\$11.98	
	Machine Screw		The Home Depot	100	1	6.21	\$6.21	
	Machine Screw Nut	32-8	The Home Depot	pl	100%	392%	392%	
	Alum Downspout Strnr		The Home Depot	ea	400%	268%	1072%	
	Propulsion						\$0.00	
	Marine Motor	IK-011153	Cabelas.com	EA	8	27.99	\$223.92	http://www.cabelas.com/product/Johnson-Pump-Replacement-Motor-Cartridges/700045.uts
							\$0.00	
	Propeller Assy (Option 1)						\$0.00	
	Master Airscrew 05 Prop Drive Adapter	LX2897	Towerhobbies.com	EA	8	4.89	\$39.12	http://www3.towerhobbies.com/cgi-bin/wti0095p?FVPROFIL=&FVSEARCH=MA3200+&search=Go
	Dumas Plastic Prop 1/8" .19-.35	LXE472	Towerhobbies.com	EA	8	1.19	\$9.52	http://www3.towerhobbies.com/cgi-bin/wti0001p?&l=LXE472&P=ML
							\$0.00	
	Propeller Assy (Option 2)						\$0.00	
	Great Planes Collet Cone Adapter 3.175mm	LXMWK6	Towerhobbies.com	EA	8	4.49	\$35.92	http://www3.towerhobbies.com/cgi-bin/wti0095p?FVPROFIL=++&FVSEARCH=lxmwk6
	APC 4.2x4-1/2A Control Line Propeller	LXP56	Towerhobbies.com	EA	8	9.59	\$76.72	http://www3.towerhobbies.com/cgi-bin/wti0001p?&l=LXE472&P=ML
							\$0.00	
	Control Circuit (Electrical)						\$0.00	
	24-Gauge 4-Pair Category 5e Indoor/Outdoor Internet Wire (8 Conductors)	SKU # 190973	Home Depot	500 FT	1	74.00	\$74.00	Model # 270-0184J4
	18-Gauge 7 Conductor Sprinkler Wire	SKU # 881864	Home Depot	500 FT	1	98.00	\$98.00	Model # 240-1005C
	6 x 3 x 2 Project Enclosure	P/N 270-1805	Radio Shack	EA	3	3.79	\$11.37	
	SPST Main On/Off Switch	P/N 275-712	Radio Shack	EA	3	3.99	\$11.97	
	DPDT Switch, Momentary	P/N 275-709	Radio Shack	EA	8	5.99	\$47.92	
	RCA Plug	P/N 274-319	Radio Shack	2/PK	4	2.99	\$11.96	Phono Plug (4-Pack)
	16-AWG Primary Wire Black	SKU # 710914	Home Depot	24 FT	2	4.96	\$9.92	Model # 55666621
	16-AWG Primary Wire White	SKU # 710797	Home Depot	24 FT	2	4.96	\$9.92	Model # 55668021
	16-AWG Primary Wire Red	SKU # 710802	Home Depot	24 FT	2	4.96	\$9.92	Model # 55667921
	20 AMP Heavy Duty Inline Fuse Holder for 1.25 x .25 fuses	270-1217	Radio Shack	EA	4	2.99	\$11.96	

15A 32V AGC/SFE-Type 1-1/4x1/4" Glass Fuse	270-1073	Radio Shack	4/PK	5	2.49	\$12.45	Fuse (4-Pack)
2-Wire Motor 393	0	VEX	ea	3	44.97	\$44.97	
2 Function Joystick	0	ServoCity	ea	1	59.97	\$59.97	
Bi-Directional DC Controller	0	Carl's Electronics	ea	7	24.95	\$174.65	
Blk UV Rsst Dblk Cble Tie	0	The Home Depot	100	1	5.44	\$5.44	
Natural Cable Tie	0	The Home Depot	100	1	8.27	\$8.27	
12POS EURO MINI	0	Radioshack	ea	1	3.49	\$3.49	
PK5 3.9K OHM 1/2 W	0	Radioshack	ea	2	1.49	\$2.98	
18-8 NP NS STR 100ft Reel	0	NorfolkWire Electronics	ea	1	55.00	\$55.00	
						\$0.00	
Camera and Light						\$0.00	
Car Rear View Camera	0	Amazon	ea	1	29.92	\$29.92	
Cerrowire 500 ft. 18/3 Thermostat Wire	SKU # 278319	Home Depot	50 FT	2	11.22	\$22.44	Model # 210-1003J2
CCD Camera	PC302XS	Supercircuits.com	EA	4	59.99	\$239.96	http://www.supercircuits.com/Security-Cameras/Board-Cameras/PC302XS
1.5" PVC Coupler		Home Depot	EA	4	1.47	\$5.88	
Polycarbonate Disc 1.75" Diameter x 1/4" Thick		Home Depot	EA	4	2.59	\$10.36	
J-B Weld	SKU # 112220	Home Depot	TU	2	5.67	\$11.34	Model # 8265-S
Black ABS Cap 2" Diameter		Home Depot	KIT	1	107.99	\$107.99	
Liquid Casting Resin/ Catalyst	GC0509	West Marine	QT			\$0.00	
1156-x12: 12-LED BA15S Bulb	1156-W12	SuperbrightLED.com	EA	6	6.99	\$41.94	http://www.superbrightleds.com/cgi-bin/store/index.cgi?action=DispPage&Page2Disp=%2Ftail-brake-turn.html
Waterproof Car Backup	0	Amazon	ea	3	13.15	\$39.45	
Red LED Bulb	0	O'Reilly Auto Parts	ea	1	16.99	\$16.99	
Miscellaneous Materials						\$0.00	
Cable Ties small 4 inch		Home Depot	100/PK	1	3.73	\$3.73	Double-Locking Cable Ties (100-Pack)
Cable Ties Medium 8 inch		Home Depot	500/PK	1	16.34	\$16.34	Double-Locking Cable Ties (100-Pack)
Cable Ties Large 14 inch		Home Depot	100/PK	1	13.01	\$13.01	Double-Locking Cable Ties (100-Pack)
Electrical Tape		Home Depot	6/pk	2	5.64	\$11.28	
Liquid Tape		Home Depot	ea	3	6.98	\$20.94	
High Strength Gear Kit	0	VEX	ea	1	29.99	\$29.99	
Turntable Bearing Kit	0	VEX	ea	1	19.99	\$19.99	
VSR Drill		The Home Depot	ea	1	29.97	\$29.97	
Bi-Directional DC Motor Controller	K-166	Carl's Electronics	ea	7	24.95	\$174.65	
14pc Bit Set	0	The Home Depot	ea	1	9.97	9.97	
Scotch 2 Red Duct Tape	0	The Home Depot	ea	1	6.97	\$6.97	
						\$2,176.51	

System Integration Diagrams (SID)

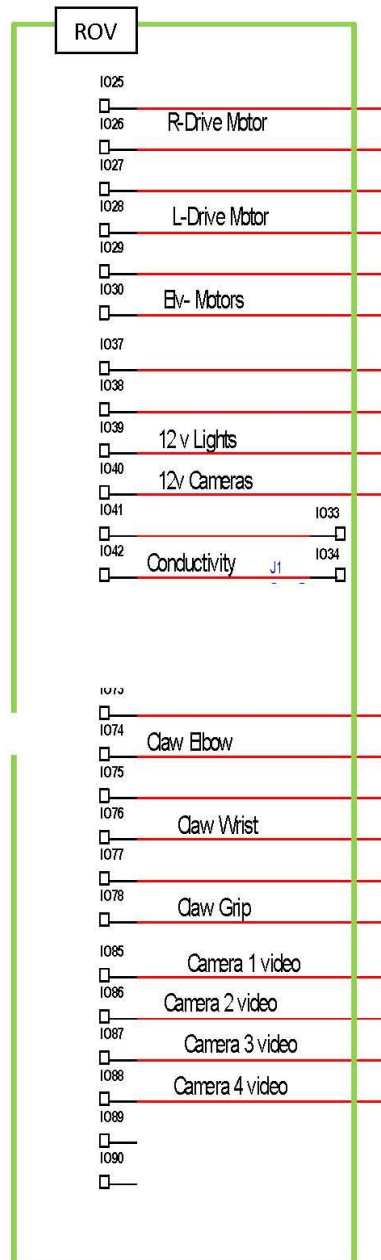
Interconnection Schematic Granby ROV

Above Water Wiring



Interconnection Schematic
Granby ROV

Underwater Connections to ROV



Rationale

Marketable Features/Vehicle Safety Features:

- Claw
- Conductivity Probes
- 4 HD Cameras
- 4 LED Lights
- 7 Underwater Motors
- Tether Line

Why we chose the design?:

The design in which the ROV was constructed is for greater mobility and balance. With the rectangular prism shape we are able to evenly assemble the gadgets on the ROV so that one side of the robot does not outweigh the other, hence would have thrown off the balance of the robot. It was also chosen because of the size of the opening on the ship wreck. We will be able to maneuver swiftly in and out the opening of the wreck, and carry on with the tasks without getting trapped inside or damaging the ROV.

Functions of the features:

- Claw: Has an arm with joints that allow it to move north and south, with 360 degree rotation
- Conductivity Probes: Test the conductivity of the microbial matter
- HD Cameras: Used to see the path underwater, the eyes of the machine.
- LED Lights: Used to enhance the vision in order to see the way in the dark water
- Underwater Motors: To maneuver the ROV through the water
- Tether Line: Used to safely remove the ROV out of the water as not to damage wiring or other functions.

Troubleshooting Techniques

As a team, we troubleshot our issues with the ROV by taking her to the Norfolk Fitness and Wellness Center to test her buoyancy and weight in the water. We then took her back with our statistics and made reasonable adjustments to her framework and weight placement.

After adjustments, we took her to the Old Dominion University pool to put her through more trials to prepare her for the Mid-Atlantic Regional Competition.

After the competition, we found problems with the claw. The gears were not tight enough to hold the claw and weight together. We had to tighten the gears and resolve the weight placement.

Vehicle Systems

The team/company used many of the system parts such as motors, lights, cameras and ballast tanks for the 2013 ROV.

The following items were purchased:

- lamp bulbs,
- cameras/monitors
- motors
- Bidirectional Controllers
- Joy Sticks
- Cable

We used an old robotic arm that we modified to use on our ROV.

Each of the reused items was in good condition and would save on cost.

The 2013 ROV frame was too large to fit into the opening access on the wreck. We designed a new frame that would meet the task requirements and handle the tools and equipment to complete the mission.

SAFETY

Motor: We placed coverings around our motors because the motors were on the outside of the ROV which was a safety hazard. The potential danger posed caused us to place the coverings around the motors to ensure that the wires would not become tangled between the propellers.

Heat Shrink: The heat shrink's purpose was to protect the wiring from the pressure of the water and to keep the water out of the wiring.

Multi-meter Probes: The multi-meter probes had sharp edges, so we placed a tube on the outer layer of the probe to protect people and wiring from the potentially harmful edges.

Safety Check List Team Generated

- First Aid kit is in tool box.
- Make sure ALL wires are connected and covered.
- Check motor guards to make sure they are not in the way of the motors working ability.
- Test ALL motors, cameras and lights before inserting into water.
- Make sure “Danger” signs are visible.
- Check to see if ALL bolts and screws are properly in place.
- Check pilot, co-pilot and main power control boxes to make sure all wires are connected and they are ready for use.
- Make sure the claw is working efficiently.
- Place cameras and lights at the correct angles as need.
- Untangle the umbilical cord.
- Remove conductivity tube.
- Make sure spare battery is on the scene and is charged.
- USE THIS CHECKLIST BEFORE AND AFTER PIPPY ENTERS AND EXITS THE POOL.

***REMINDER* ALWAYS LIFT PIPPY BY THE TETHER LINE,
NO EXCEPTIONS!!!**

Challenges

After our initial test at the pool, we came to the conclusion that our motors did not have enough power to drive our ROV forward. Afterwards, we decided that by removing the chicken wire from around the motors, we designed a new covering for the motors that would enhance the speed, maintain safety, and also, still look aesthetically pleasing. The purpose of the coverings were to shield the wiring from becoming entangled between the motors' propellers, but our test at the pool demonstrated that the initial covering design was not suitable for undersea life. For example, the animals living in Thunder Bay could have easily become caught between the propellers, which would pose a threat to endangered species and sea life, itself.

Lessons Learned

Vanessa: I learned how to drill, as well as, how decipher the color coding of the wires and pair them together.

Lauryn: I learned how to build a claw. I learned the wiring and how to add motors to mobilize the ROV for its destined purpose.

Victoria: I sharpened my skills working with workshop tools, which enabled me to lead the younger, less experienced team members. These skills will allow me to become a better leader and mentor for the next year of competition.

Tytianna: I learned how to better create technical drawings on the Inventor program. This program allowed me to enhance my team's diversity and well-roundedness.

Erika: I assisted with teaching my peers how to wire and solder different parts of the ROV, safely.

Tanisha: Although I helped in many different tasks, my main lessons were acquired through creating schematics for the ROV and improving my leadership skills so that I could set an example for the rising members of GIE.

Ashlee: While aiding my fellow team members with building our ROV, I helped them to learn the tasks at hand and the purpose of GIE, while mentoring the other members so that they could one day lead with confidence and conviction.

Future Improvements

For future clients we would like to make our product more durable, to last underwater for long periods of time without having to be taken out of water, more mobile, so that the product can be transferred and used in multiple arenas, and more accessible, so that many different companies, foundations, and groups will be able to use this product in multiple different locations and types of water.

Reflections

Overall The Girls In Engineering Company did a rather successful job getting through the obstacles given to them by the Thunder Bay National Marine Sanctuary (TBNMS). As for the design of the ROV, PIPPY 2.0, we consider the strengths to be in the form and the multiples of objectives she is built to complete. As a group we find the multiplicity of her abilities to be outstanding for one robot to achieve. PIPPY 2.0 may only need improvements in fields such as aesthetics, and maybe even properly attained gear for any other unrecognized tasks. Improving these would promote company's searching for her design to see her better and to show her off in use.

Experiences in the group were varies in the different tastes of the members. Memorable ones such as the first pool testing would be one that we were proud of yet, not feeling as accomplished as if she would have been better equipped. One of the most rewarding would be the team work and effort put into the creation of the groups ROV. If given the same challenge, next time the company would have more advanced technologies attached to the ROV to better our outcomes and have more accurate measurements. With said advancements; the ROV's, and company's', total scoring would be improved. Not to mention the knowledge from the ROV's deficiency in the previous year pointing towards the ROV's upgrading.

Teamwork

We discussed the ROV mission and operations to complete the mission. The next step was to decide who will be responsible for designing each area/system.

We determined who would be responsible for designing a system/section of the ROV.

We assigned operator task for the competition.

We reviewed your requirements for the Engineering review and choose to discuss our own areas of responsibility.

We setup a schedule to meet every Monday and Wednesday from 2:15 – 3:45 PM to work as a team on the ROV.

We had problems with snow days (days where school was canceled due to snow). To make-up we came in during our Study Hall times to work on ROV.

References

RANGER Class

IMPORTANT - SAFETY SUMMARY FOR ALL COMPETITION CLASSES

RANGER Competition Manual

Shipwrecks

Prop parts list

Safety inspection sheet and tutorial

SolidWorks files (*coming soon!*)

Mission fly-through courtesy of GRI Simulations (Vimeo versions)

<http://www.marinetech.org/ranger/>

Underwater Robotics: Science, Design & Fabrication

ISBN: 978-0-9841737-0-9

Wholesalers: Contact MATE Center

Publisher: MATE Center

Authors: Steven W. Moore, Harry Bohm, and Vickie Jensen

Acknowledgements

We would like to thank:

Susie Hill

*Regional Mid-Atlantic MATE ROV Coordinator
Education Specialist/Special Programs Manager*

Nauticus

*One Waterside Drive
Norfolk, Virginia 23510*

*Marine Advanced Technology Education (MATE) Center
Monterey, CA.*

The Norfolk Education Foundation

*The Norfolk Fitness & Wellness Center
Newport Ave*

Old Dominion University

*Granby High School
Class Of Two Thousand Twelve*

*Granby High School
Teachers and Staff*