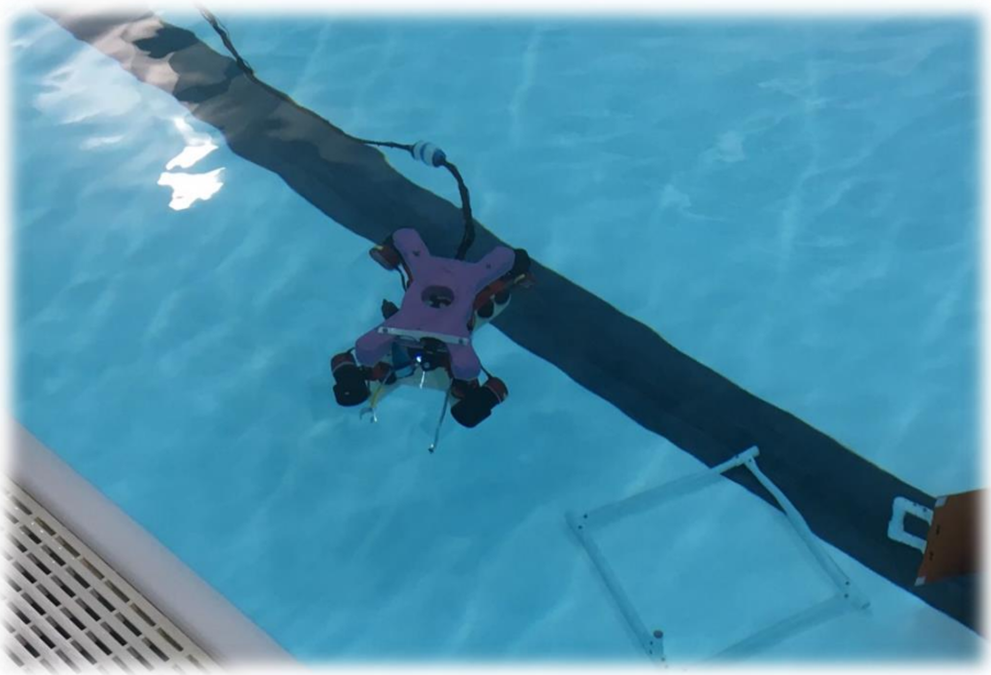
GrovER exploration

GROVE ACADEMY

ROV Report



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Company Mission

Grover Explorations is a new company that plans to provide the finest in marine ROV systems. Although this is our first year entering the competition, our skilled team of engineers have built a great ROV that meets MATE standards. Grover's first creation, Nessie, has been manufactured with incredible attention to detail. We firmly believe Nessie is best suited to the tasks given to us.

Abstract

Grover Exploration's' latest product 'Nessie' is an ROV designed to complete a series of tasks as effectively and efficiently as possible. To do this we followed a series of steps during the process of building 'Nessie', analyse the problem, design solutions to the problem, build our solutions and test them, if the solution fails, repeat the process. 'Nessie' is equipped with two tools to help complete the 'Jet City' themed tasks, a hook and a grabber. The hook is a multipurpose tool used in all three tasks as it was a simple yet effective way of carrying and interacting with the props in the water. The hook was made using an aluminium bar that was bent and shaped appropriately in a vice. The grabber was made specifically for task 3 as the tidal turbine had trouble staying on the hook so the grabber was made as it can wrap around the stem of the turbine to give it a secure method of transport. The grabber was made from an aluminium bar with an aluminium sheet screwed on to the end. The aluminium sheet was used because it is malleable meaning it can be shaped around the stem of the turbine. The set tasks at this year's MATE competition revolves around two real world applications. The first application is to correctly position items such as an OBS or a tidal turbine and the second application is the use of ROV's in the renewable energy industry.

Company Effort

Team Member	Roles
Gregor Rhind	Thruster Design, Thruster Assembly Monitor box, Construction of task 3, Report
Isaac Bews-Ivins	Frame Design, Buoyancy Design, Camera installation, Construction of task 2, Report
Sam Alexander	Frame Design, Construction of task 3, Monitor box, Structural integrity
Stephen Hanna	Frame Design, Buoyancy Design, Camera mount design, Camera installation, Structural integrity, Report
Ryan Stokoe	Thruster Assembly, Ballast design, Ballast installation, Construction of task 1
Jasmine Gray	Circuit design / Control system, Tether lining, Lead of task 2, Done all soldering
Kieran McDowell	Thruster Assembly, Lead of task 1, Thruster design, Ballast design, Ballast installation
Finlay Ellis	Circuit design / Control system, Control interface, Lead of task 3
Owen Fordyce	Circuit design / Control system, Control interface, Construction of task 3
Renz Llasus	Thruster Assembly, Construction of task 1, Thruster design, Buoyancy coating, Ballast installation
Kayleigh Gall	Circuit design / Control system, Control interface, Construction of task 2

Project Management

Our project leader, Captain Jack, gave our whole team time sheets so we finish our assigned task as soon as possible so we could make sure it works and move on to the next task and also so Captain Jack could keep up to date with what's been completed.

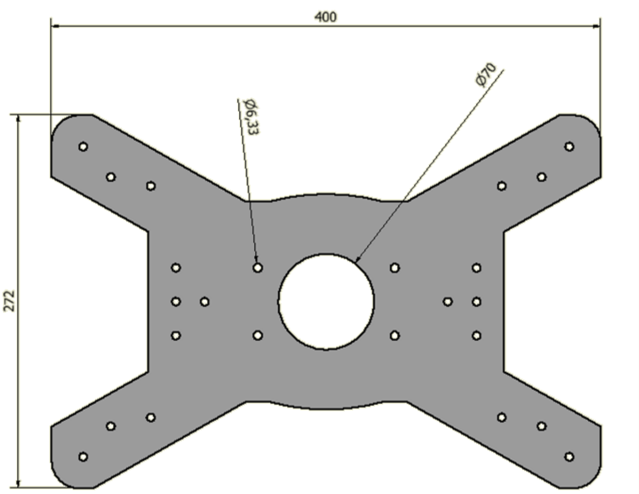
We were also set target dates to finish our main goals, such as making the ROV ready for water. Our deadline for our main goals was the start of November and we met the deadline due to us pushing ourselves to get it into the water for testing.

Problem solving- Whenever a problem occurred during production of the ROV, a team member was appointed on making sure that its fixed, if it was a larger problem a team consisting of 2-4 people would be assigned to making sure it was solved as quickly as possible. If parts were needing to be ordered, the members assigned to a different task until the parts arrive.

Team roles played a big part in the production of our vehicle, our team leader gave everyone lead on at least one thing so that they all had a chance to take lead in a specific task.

Design Rationale

The layered frame was designed to allow sufficient space for tooling and to have little water resistance. The x-shape frame was changed from the original design which had a square frame around it, to the one used now. The removal of the square frame was completed to reduce the weight and the square element, which did not provide sufficient extra structural support. The frame was altered further after initial pool-testing to incorporate holes to allow more water to flow through to the vertical thrusters.



The design for the thruster cowl had to both allow a sufficient flow of water through the thrusters and provide a safe durable housing so users won't get injured if handling the ROV. The very first design was a simple housing that did not facilitate for attachment to the frame, as at the time the frame had not been completed. The final cowls for horizontal movement was completed with the addition of a bracket for attachment. The cowls were 3d printed solid. The initial vertical thruster cowl did not provide sufficient water flow, to help with this the vents were extended. This did not have the desired effect so the vertical cowls were removed, but the frame design provides enough protection to users.

The ballast system has remained the same as its initial design. Many small weights can be easily added or removed from the frames supporting structure. To prevent the weights from rusting they were blued.

The buoyancy was dense polystyrene coated in varnish and paint, then a further coat of spray paint to prevent intake of water.

After initial test the ROV was positively buoyant. The introduction of the adjustable ballast system allowed us to achieve neutral buoyancy.

The Control System for the control of the ROV was written in P basic and coded onto a Pickaxe board. The majority of the control is transistor based. The system operates from an Xbox 360 controller. The problems encountered in the control system was that the initial program did not have both vertical thrusters working in tandem.

This was quickly improved so that both vertical thrusters work together. After this change it was found the current passing through was too great and fuses were blowing. Fuses of a greater value were then put in place to fix this issue.

Two of the Cameras used on the ROV were reused from a previous ROV and the third was provided new from mate. The cameras are connected to an external supply and 3 monitors. There is one camera that is fixed in place parallel with the middle plate of the frame so that its line of sight is directly forward, another fixed camera is angled looking directly at the tooling on the front of the ROV, and the third camera is able to be adjusted to a desired angle for whatever task is needed to be completed for the best view on what the ROV is operating on, this camera in located at the top of the front of the ROV.

The equipped tooling is specialised for the tasks required. There is an aluminium grabber which holds the T-piece for task 3 and is malleable enough to be released by reversing. There is also a hook that is sufficient tooling for all other aspects of all other tasks.

Build Vs. Buy Justification

The majority of the ROV was constructed of new components. The Only elements that were re-used were the thrusters as they were still fully operational and undamaged from a previous ROV, the umbilical was also recycled, two of the cameras were reused. Other elements of the previous ROV were not taken as they were deemed inefficient comparatively with our new concepts, for example the previous ballast system was not adjustable. Not having to buy new cameras or thrusters saved a significant amount of money.

Non-Technical Challenge

Since all our work was in school during timetabled class time. We were fortunate enough to have plenty of allocated space and time for the design and manufacture of our ROV. Our problem lied in the testing part, getting time in our schools pool was a very difficult challenge. The problems we faced were:

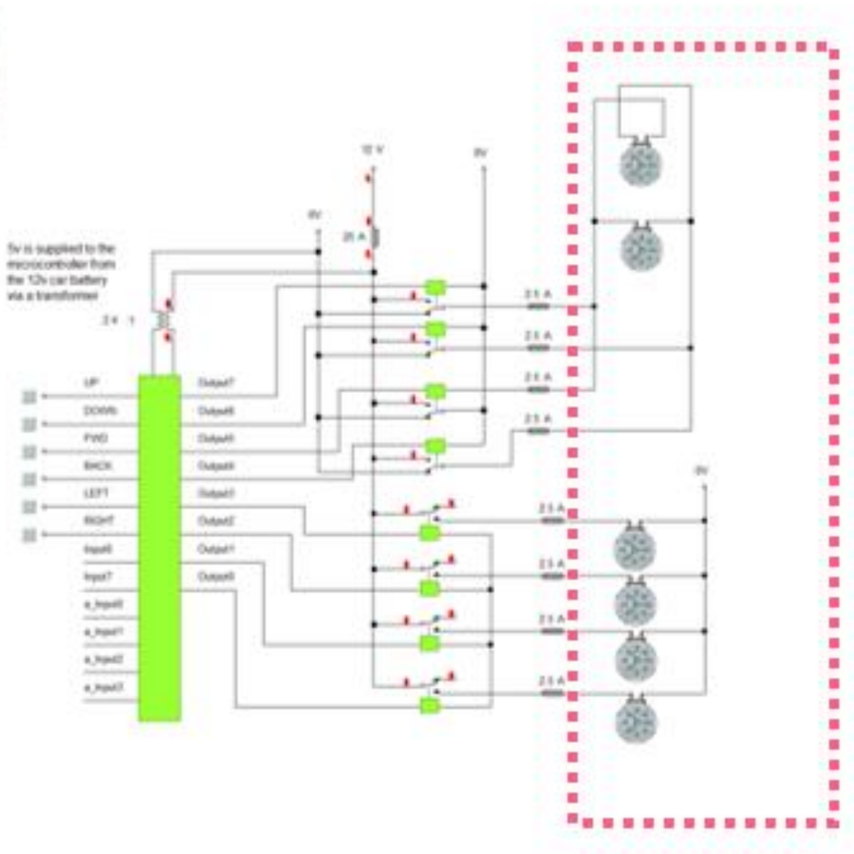
1. Safety regulations - as the schools pool is used for PE and open to the public after school hours, foreign objects were not allowed to be left in the pool.
2. Therefore, the head of the leisure department did not like the idea of our ROV being tested in the pool. But after a lot of persuading from our mentor we managed to get some rare time, but with a problem, which comes to my next point.
3. Damages – part of the deal of letting us use the pool was that any damages to the pool would have to be payed for by our mentor, which could cost up to $34,000. So when in the pool we had to be very careful not to damage the pool lining.
4. Pool time – this, was our main problem during the development of our ROV. Getting pool time in school during our timetable and not intruding anyone else's timetable was a huge struggle as many PE classes had the pool booked. And because we all had other subjects we could not settle for other times, so our pool time had to be when we were timetabled for the ROV. This caused a lot of issues as we barley had enough time to test and make adjustments and at the pool we had to fit many tasks in at once.

This was all over-come by having a plan made the day before we went to the pool, meaning when we went to the pool, as we would only have around 30 minutes, everything had to be carried out as specified the day before. We organised an order of what different tasks and testing were needing to be accomplished the day before.

Technical Challenge

One the major technical challenge that stopped us with the control system was the up and down thrusters. As we wired the control system, we wired the up and down thrusters in the same way that we wired all of the other thrusters. This means that when 'Nessie' tries to go up or down, both motors will turn in the same direction making 'Nessie' move up or down at a faster pace. To overcome this challenge, the company wired the motors up in a way that out of the four relays controlling the two motors, only two of these relays can come on at any one time. Two relays make both motors turn one way sending 'Nessie' up and the other two relays make both motors turn the other way to send 'Nessie' down. This is known as 'H Bridge'.

Systems Integration Diagram



GROVE ACADEMY

SYSTEMS INTEGRATION DIAGRAM (SID)

Safety

The ROV was designed so that there wasn't any sharp edges so that when operating in the pool there wasn't anything that could damage the pool lining or any of the props that were being worked on. The Cowls were designed to allow water flow but also to cover the rotating props, if anything got caught in the props they would either get damaged by the prop or would break the prop. When tooling the ROV we decided not to have any tool that was sharp, this was because if the tool was sharp it could damage anything that it interacted with.

Safety Procedures

When handling the ROV and working on the thrusters it was important to not have your hands near the props and to not touch the control system, as this could cut your fingers when the props are spinning.

When soldering the wires of the thrusters to the umbilical cord, since we were using a hot solder we needed to make sure not to place it randomly as someone may pick it up not thinking that it was warm, resulting in an unwanted injury. If the solder was placed randomly and unsupervised it may burn or set fire to nearby objects and could cause serious damage and become a health risk.

When creating our ballast system the weights were needed to be blued as they would rust if not coated. So when they were getting blued they needed to get heated up with a blow torch, so as you can tell there needed to be strong safety procedures when handling a blow torch. So when heating up the weights the blow torch needed to be only directed towards the weights as if something else was touched by the flames it would catch on fire or someone would get seriously burned. After the weights were heated up, when handling with them it was important to not touch them straight away as they would still be hot, so the weights were picked up with metal clamps and placed securely into the coating oil.

Testing and Troubleshooting

The ROV was tested in the pool every Tuesday and Thursday. At the start of the project the ROV was tested to gain a neutral buoyancy, to make the testing easier our ballast system was created to make an efficient way to alter the weight of the ROV so that the ballast and buoyancy were balanced which resulted in a neutrally buoyant ROV. This had taken a couple of pool tests to perfect the buoyancy of the ROV. When piloting the ROV there was a few complications that we ran into with the ROV. The ROV had difficulty ascending in the pool, this was due to the middle plate blocking the flow of water from the vertical thrusters so when in class we altered the 2D computer sketch of the middle plate so that there was holes cut into it to allow water from the vertical thrusters to flow easier making the ROV ascend quicker and smoother. Another reason why the ROV had trouble ascending was due to the vertical cowl vents not having enough room to allow sufficient water flow due to the buoyancy blocking it. The cowl was altered so that the vents of the vertical cowl were extended down so that the water wasn't blocked. The ROV still didn't have the capability to ascend so the vertical cowls were just scrapped, this allowed the ROV to raise quicker. The horizontal thruster cowls needed to be professionally made by NCR as our 3D printed cowls weren't a high enough quality so when in the water the cowls gained water changing the overall ROV buoyancy. So after changing the cowls to the higher quality cowls from NCR, they didn't gain water, made the ROV fly through water more elegantly as the overall buoyancy was neutral.

So now it was onto trying out the three tasks that were needed to be perfected for the competition. The props for all three tasks were created and placed in the pool when it was their allocated pool time, the pilot was tasked to do and repeat each task in the pool until the pilot knew how to do each task in the quickest and most efficient way possible for the most amount of points to be awarded. These pool tests were repeated within school hours and was tested each week up to the competition to gain the most amount of time to perfect each task. When in the pool doing each task, we would record what needed to be altered to make each task easier, then we would work on the props next period of class to change the props that were difficult to use. The tooling was also modified so that is was tailored to the tasks at hand so that our performance of each task was at its easiest.

Lessons Learned

Since this whole experience was the first time for our whole team, we were all new to everything. As a team we have developed skills that have made us a strong, cooperative team as we all worked closely with each other and branched off with other teams as their input would help our task that we were working on.

Individually we have all leaned new skills throughout the project, our control system team (Owen, Finlay and Kayleigh) had never programmed a real circuit only created simulated circuits on the computer.

From working hard they learned how to create a very efficient working control system that works extremely well and makes the ROV fly in the water easy, quickly and elegantly.

We found out that not every idea will be the best and that we should think about many, then test them out to find the best idea for what needed to be created. From trying ideas out instead of overthinking if it would work, we learned that to just try things out would be a more efficient use of our time.

Future Improvements

Based on some of the lessons we learned this year and some of the slow progress we made at time, there are some things that we would like to improve on if we were to undertake the task/ challenge again.
We had challenges in keeping to a time schedule that would allow us to do make all the improvements we wanted. While we made improvements to our scheduling/ time keeping, there is still room for improvement. If we had more time we would have made an improvement to how our ROV grabs and moves items in the water however, this did not happen quite as we planned. As we intended to have some sort of pneumatic gripper. For us to achieve and complete our goals for next time, there are improvements to be made. Such as communications between team members and project managers in order to streamline the process.
An Improvement into the ROV design would be to improve the 3rd camera's position and if it could see imaging in colour as our 3rd camera is black and white only this would helpful as it would improve the ROV's ability to manoeuvre in its surroundings.

Reflections

Throughout this whole project every member of the team has matured drastically and learned how to act and work in a workplace. It was everyone's first taste of real world hands on engineering and it taught us all so many valuable skills that will help us throughout the rest of our careers. Skills such as:

Teamwork - working with others and relying on each other.

Leadership – Taking charge in our areas and getting thing done right.

Problem solving – Facing issues and working out how to fix them

Communication – being able to communicate with other members of the team and making sure everything is on track

Time keeping – Sticking to a schedule and getting tasks done on time.

With these skills and an amazing ROV, we are all so happy with ourselves. At the start of the year, we had nothing. No ROV, no background in real engineering and no experience. But with our drive and passion we created an elegant and effective ROV which took us to victory in our national competition and will hopefully win the international as well.

Financial Report

Budget for Grove Academy					
From 30th May 2017 to 25th April 2018					
Captain: Jack Waghorn					
	Quantity	**Unit Price (£)**	**£**	**£**	**£**
Income					
Robert Gordon University	-	-			200
Design and Technology departmental budget	-	-			???
Total Income					**200+???**
Re-Used Expenses					
Bilge Pump Thrusters	6	24.99		149.94	
KKmoon HD Fish Finder Kit	2	79.99		159.98	
Mild Steel	-	11.50		11.50	
Bosch S3 Car Battery	1	51.69		51.69	
Umbilical Wiring	-	12.00		12.00	
Mantona Camera Box	1	79.08		79.08	
Output Equipment Wire	3	6.09		18.27	
Acrylic Sheets	2	9.99		19.98	
2 Inch Pipe	1	1.42		1.42	
Brick	5	0.30		1.50	
Crates	2	5.00		10.00	
				515.36	
Purchased Expenses					
Candy Pink Spray Paint	1	7.40		7.40	
7 Rolls of Electrical Tape	1	6.99		6.99	
Velcro Tape	2	12.23		24.46	
6 Foam Sheets (£45.71)	1	7.62		7.62	
Poster Printing	1	9.00		9.00	
Picaxe-28 Project Board	1	11.88		11.88	
Picaxe-28X1 Microcontroller	2	4.99		9.98	
8 Core Cable	1	4.40		4.40	
Elegoo Multicoloured wires	1	5.95		5.95	
Slow Blow Glass Fuses	6	2.75		16.50	
Chuangruifa Step Down Converter	1	3.68		3.68	
Fused Terminal Blocks	8	1.58		12.64	
1 metre PVC Pipe	12	3.12		37.44	
5 * PVC Tee Conectors	9	3.50		31.50	
5* 45 degree PVC Conectors	2	4.00		8.00	
5 * 90 degree PVC Conectors	2	4.00		8.00	
5* Coupling pipes	1	5.60		5.60	
				211.04	
Donated Expenses					
Fish Finding Camera (Donated by Robert Gordon University)	1	140.00		140.00	
Cowels (Donated by the NCR)	4	60.00		240.00	
Black XBOX 360 Controller (Donated by Team Member)	1	24.99		24.99	
Anderson Powerpole connector (Donated by Robert Gordon University Free of Charge)					
				404.99	
TOTAL EXPENSES				**1,131.39**	
Travel Income					
Hotel - 2 People per room (Provided by Robert Gordon University for 6 people)	3	761		2283	
Flights - 6 people (Provided by Robert Gordon University)	6	860		5160	
Hotel - 2 People per room (Provided by Grove Academy's Trust Fund)	2	761		1522	
Flights - 4 People (Provided by Grove Academy's Trust Fund)	4	860		3440	
				12405	
Travel Expenses					
Hotel - team (2 people per room)	5	761		3805	
Hotel - Captains (2 individual rooms)	2	761		1522	
Flights	12	860		10320	
TOTAL TRAVEL EXPENSES				**15647**	