Mintlaw Academy
Young Engineers
Aberdeenshire
Scotland

Technical Report
Featuring 'Perseus'

Our Team

Joanne McDonald – ***CEO***
Entering 4th Year at school
Ben Mellin – ***Chief Mechanical Engineer, Pilot***
Leaving school for University
Roddy Robertson – ***Mechanical Engineer, Co-Pilot***
Leaving school for Electrical Engineering Apprenticeship
Robert MacNeil – ***Electrical***
Returning for 6th year at school
Erin Kindness – ***Finance and Marketing***
Entering 4th Year at school
Stephanie Buchan – ***Tether and Tooling***
Entering 4th Year at school

Mentors
Ali Hynd – ***Teacher***
Neil Stagg – ***BP Mentor***

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Contents

The 2016 entry for the ROV MATE competition would not have been possible without the help pof the following people and companies.

Our Teacher - Ali Hynd

Our Mentor - Neil Stagg

Regional and International Co-ordinators

Graeme Dunbar & Jill Zande

ROV MATE - All officials and Tech support

Robert Gordon University

Aberdeenshire Council for pool time and access

Craig Reid - Hydro Group - Aberdeen

Abstract

Subsea Technical Services (STS) is a cutting edge company, with 4 years experience in designing and manufacturing underwater ROV's, which are made bespoke to meet the customer's needs. Introducing new technology every year, we aim to provide the best services for our clients.

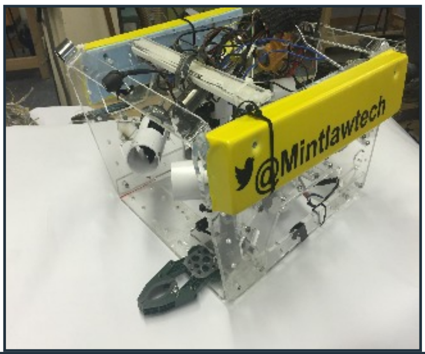


Fig 1: The ROV-Perseus

Credit: Joanne McDonald

Our latest project -Perseus- (Fig 1) is an ROV which is principally suited to delving into the depths of both the Gulf of Mexico and Europa (Jupiter's moon.)

The Perseus project has taken the team a total of 18 months to complete, after vast re-designing and testing-including 40 hours of pool testing and introducing industry standard joining and buoyancy development-all of which have been tested in our workshop. This year's ROV is total rebuild of previous concepts and has undergone many modifications to help improve its performance. Perseus also features many cutting-edge tools which have been carefully designed to carry out the tasks set by the client.

It features a:

- A detachable Temperature Sensing Probe
- Ice and Water Depth Measuring Device (IWDMD).
- Fully Functioning Manipulator, (Fig 2)
- 20 metre of tether to reach all aspects of the project.
- 8 directions of movement to allow for full manipulation.

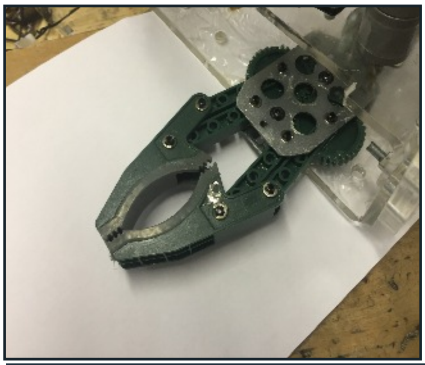


Fig 2: The Manipulator

Credit: Joanne McDonald

To use the detachable tools, together, with six precisely positioned underwater cameras, these features allow Perseus to:

- Explore, document and assess coral samples in the Gulf of Mexico.
- Retrieve a cable connector and transport it to a communications hub.
- Measure the depth of the ice crust and compare it to the sea level.

Planning Schedule

The planning schedule was put in place early in the session 2016 -17. It was amended after the Regional event success.

Mintlaw Tech Planning Schedule 2015 - 16 Competiton

	Aug	Sept	Nov	Dec	Jan	Feb	Mar	Apr
Planning	■							
Design	■	■						
CAD Drawings		■						
Prototyping		■	■					
Frame Construction			■					
Wiring		■	■	■				■
SID				■				

BudgetInitial plans were to include a joystick control so budegtting was allowed to include the required electronic parts.

Costing Information

Parts	Description	Cost - USD	Donated / Recycled
Frame	5x sheets Acrylic @ 10mm	$ 183.35	New
Thrusters	4x 4 3.2A 450 LPH Pumps	$ 140.00	New
Thrusters	4 x 3A 450 LPH Pumos	$ -	recycled
manipulator	1 x Vex manip	$ 44.00	New
Cameras	8 x reversing camera	$ 105.00	New
Camera Cable	4 x camera AV cable	$ 46.00	
Control Box	1 x Peli Case	$ -	Donated
Wiring	200m 4 A cable	$ -	Donated
Cable Connectors	2 Hydro Group Connectors	$ -	Donated
Electrical consumables	various	$ 100.00	New

Joanne McDonald - Age 15

Career path - Role in the Offshore Industry

Company Chief Executive Officer

Joanne is currently studying her national examination courses in S4, this is her 1st year of competing in the ROV Mate competition. Main designer of all things plastic including the frame and tooling.

Fig 4: Joanne

Credit A Hynd

Erin Kindness - Age 15

Career path - Environmental Issues Lawyer

Marketing and Finance Officer.

Erin is also studying for her National Examinations in may 2017, currently in S4 this is her 1st year in the competition. She has been in charge of the marketing, liasing with companies, designing poster and keeping track of finances.

Fig 5: Erin

Credit A Hynd

Stephanie (Steph) Buchan. - Age 15

Career Path - Graphic Designer

Health and Safety officer and Tether manager

Steph is currently in S4 and is studying her National Examinations in May 2017, this is her 1st year competing in the competition. Steph has taken control of the scheduling of this years entry, taking control of all the Health and Safety measures, and has the role of managing the tether on the pool deck.

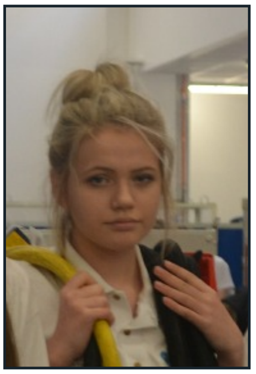


Fig 6: Steph

Credit A Hynd

Ben Mellin - Age 17

Fig 7: Ben

Credit A Hynd

Career Path - Electrical Engineer

Electrical Engineer and Pilot

Ben has just finished hi Higher Examinations in S5 and is hopeful of gaining entry into University this autumn. Genuine interest in all Engineering projects from drones to working on his car. Ben has been the lead engineer on the project, rewiring all the controls ensuring everything meets our standards.

Roddy Robertson - Age 16

Fig 8: Roddy

Credit A Hynd

Career Path - Electrical Engineer

Mechanical Engineer & Co-pilot

Roddy has just completed his National and Higher Examinations and is preparing to work as an Electrical Engineer apprentice. On this project Roddy has been thorough in designing and checking the motors and tooling to ensure they are operating and maintained. He is the co-pilot in the team and ensure all tooling and calculations are manoeuvred and carried out correctly.

Robert (Bob) MacNeil - Age 17

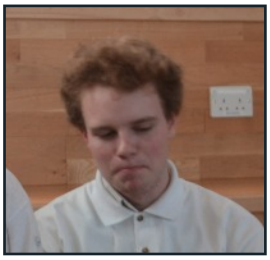


Fig 8: Robert

Credit A Hynd

Career Path - Mechanical Engineer.

Electrical and Camera specialist.

Bob has just finished his Higher Examinations in S5 and is staying on at school to gain more higher qualifications. Genuine interest in all Engineering projects has a particular interest in blacksmith and electrical work. Hopes to go to university or employment after leaving school. Bob is in charge of all tooling on the pool deck and ensuring all cameras are fully operational.

SYSTEMS INTEGRATION DIAGRAM

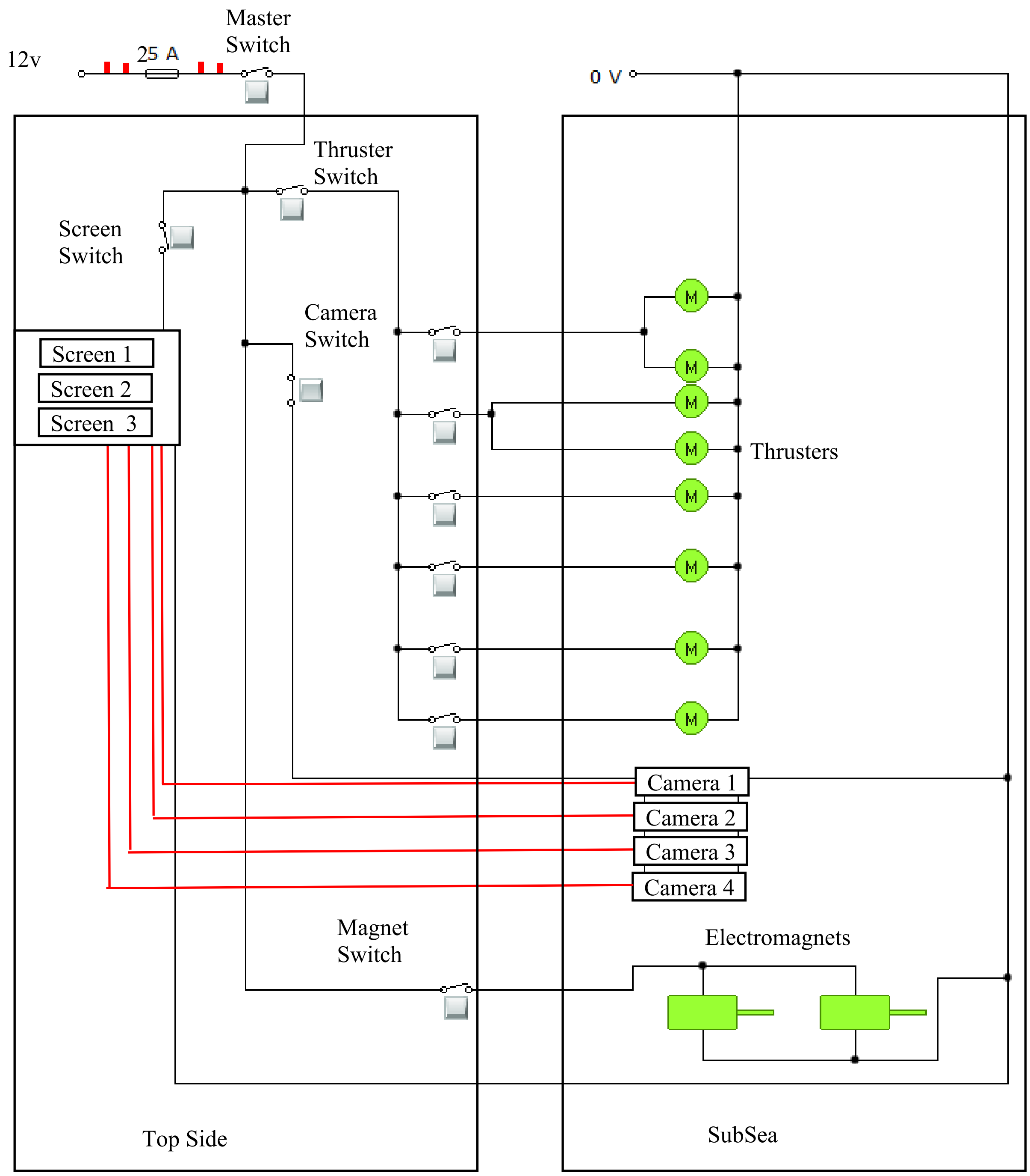


Fig 7: SID

Credit Ben Mellin

Mission Theme:

http://www.cosmosup.com/

ROVs have played a major part in development and e including assisting in the extraction of oil and gas from technology has developed the use of the vehicles has no exploration. The mission has two distinct areas of requir it was discovered Europa, one of Jupiter moons, has an ocean below its frozen crust. Further exploration of this expanse of water is required to conduct experiments to check and monitor the quality of water in preparation for it supporting living organisms.

'Jupiter's moon Europa is considered one of the most promising places in the solar system to search for signs of present-day life'

http://www.nasa.gov/press-release/all-systems-go-for-nasas-mission-to-jupiter-moon-europa

Initial missions to this remote outer space environment in 2020's will provide NASA with data to enable them to send an ROV into this new and harsh environment carrying out further exploration in the oceans of Europa. NASA will also carry out a 'piggy back' mission to retrieve small Cube Sats, small satellites that were developed in 1999, designed and built by students these small craft can carry out experiments in space, initially education based but are now used for industry and amateur research.

deepwaterhorizonsettlementclaims.com/

The second aspect of the mission is to investigate the effect that the Deepwater Horizon oil rig explosion had on the environment in the Gulf of Mexico. In 2010 an explosion occurred which caused the US's worst oil spill, the rig was drilling in water 1500m deep when a blow out of natural gas through a concrete well cap caused the rig to ignite an capsize into the Gulf of Mexico.

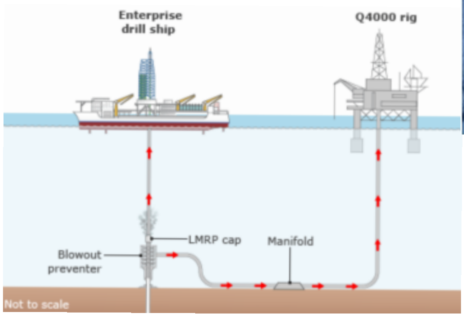
http://www.oceaneering.com/rovs/rov-systems/

Six years on studies need to be carried out to determine the environmental impact off the coast of Louisiana, carrying out work in the US based 'rigs to reefs' project. The ability to successfully cap wells and decommission rigs is a major part of the life of the ocean after the oil and gas has been extracted.

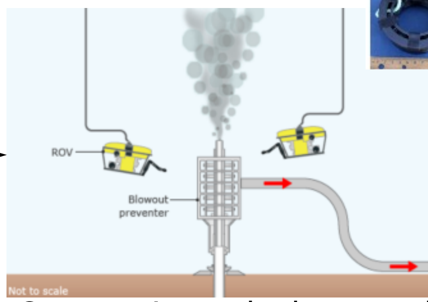
The use of an ROV operating at depths of 1500m allows companies to carry out the important tasks of checking the reef and the coral as well as the extremely difficult job of capping existing wells.

ROVs have the ability to work in extreme conditions within a varying depth of water, carrying out exploration, observation and engineering challenges are being completed all over the world 24 hours a day.

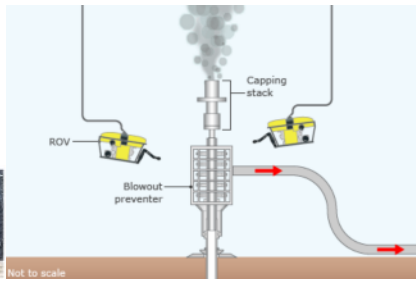
<u>Placing a new cap on a leaking oil</u>



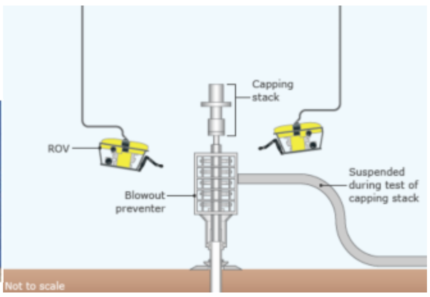
In June 2010, BP placed an LMRP cap, on top of the Deepwater Horizon well so that oil could be collected at the surface. Despite this, the well continued to leak and has since been replaced with a better fitting device.



Once engineers had removed the LMRP cap on 10th July 2010, oil began to freely flow from the blowout preventer once more. However, the Q4000 containment system continued to take a little oil up to the surface.



Engineers then bolted on a new capping stack onto the blowout preventer (BOP) which allowed them to conduct a series of tests to see if the flow of oil could be stopped using the newly installed equipment.



During the test the three ram capping stack has been closed and all sub-sea containment systems collecting the oil temporarily suspended, effectively blocking the flow of oil from the well.

Safety is our Number Priority

Stef soldering wearing PPE

Photo J. Macdonald

To ourselves;

To others ;

To our equipment and the remote environment we are working in;

This included:

- Wearing safety goggles at ALL times when using power tools.
- Wearing closed toed shoes in the workshop at ALL times.
- Removing jewellery and tying up any lose clothing/hair when using machines.

When building Perseus, many solvents and chemical compounds were also used, so it was always made sure that the room was well ventilated before work commenced and all instructions and safety notices were followed.

Gloves and aprons were also worn to prevent any harm to skin from the solvents.

In addition, various safety posters were also placed around the workshop to remind us of these hazards.

Pre Dive Checklist
All moving parts clear of debris and hands.
Camera checks
Camera 1 (manipulator) on and positioned correctly
Camera 2 (front) on and positioned correctly
Camera 3(main) on and positioned correctly
Camera 4(top) on and positioned correctly
Motor checks
Up motors operating
Down motors operating
Front left motor operating
Front right motor operating
Back left motor operating
Back right motor operating
Manipulator motor operating
Electromagnets checks
Electromagnet on and functioning(metal strip test)
Manipulator checks
Claw opening and closing smoothly
Manipulator securely fixed
Temperature probe
Multi-meter reading a resistance
Final checks
Tether secured to table and laid out neatly
ROV placed in water
ROV buoyancy close to neutral
START PROCEDURE

Safety – Features of the ROV

SkotchKote & Amalgamate Tape

Photo J. Macdonald

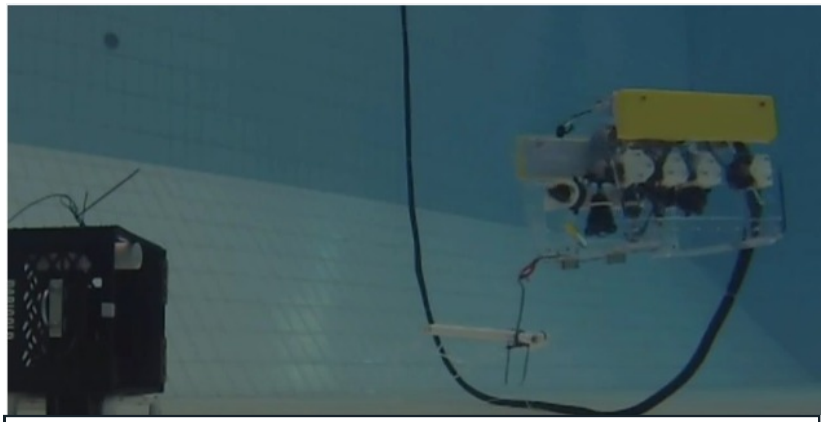
The vehicle itself has many safety features this year as well. Our most innovative safety feature this year is the heatshrink sleeves and the use of Scotch Kote and Scotch Tape to ensure the wires are all securely sealed. The heat shrink was added to the ends of the jubilee clips, where used. Each and every one has been covered this year to prevent any scratches when working inside the frame. This was particularly important this year as there is limited space to work inside the frame due to the added motors for the manipulator.

All wires for the propellers are also fixed to the frame to prevent

damage from external objects. This also helps to migrate snags and electrical hazards and improve the overall aesthetics of the vehicle as there are only a few wires which are visible. A 25A fuse has also been added to the positive lead of the main power connection to comply with the rules and also to prevent any any damage inside the control box due to excessive currents.

Testing & Troubleshooting

To prepare Perseus for Houston's neutral buoyancy lab, we have so far had Approximately 40 hours of vehicle testing. To test the vehicle, we were given regular access to our local community diving pool. The diving pool at a depth of 3.8 metres provided a means to test both the control system and to improve the performance of the vehicle. This year, we also attempted to construct all of the mission props, so we could test the ROV to ensure it can hold the capacity of all props and the pilot can control the ROV when the props are in place.



Perseus in one its first pool mission tests

Photo J. Macdonald

During our first test, we discovered that the vehicle was not diving very well as the buoyancy was unbalanced as a result, we had to do some investigating onto how we can make the vehicle as neutrally buoyant as possible which meant adding and taking away of compact polystyrene. During the Preparation period we ran into some issues concerning the cameras we used. When the cameras were in use they would start to flicker and lose signal, when investigated, we realized that there poor connections and water would slowly enter the connections into cause camera loss. Our Electrical Engineer recommended investing in Skotch Kote and Skotch Tape to seal all the connections, this proved to be the deciding factor as all our connections are now water tight and secure.

Hydro Group Connector

Photo J. Macdonald

We ran a new cable as the existing tether was 4 years old and was showing signs of fatigue, the new cables also have plug fit connections on the underwater side which has eliminated a major problem with the camera connections.

Manipulator

Photo J. Macdonald

This meant we had to rewire into a new connector which was manufactured by Hydro Group, member of the team visited Hydro Group and discussed the best options for the connector and held a meeting about the design of it.

After wining the regional heats in Aberdeen, we fitted a Manipulator, this was fitted using a geared motor with a ratio of 1:100, this meant designing and cutting plastic motor mounts which. Testing of the manipulator discovered that the Motor was stopping and the jaws were not closing upon investigation we found the bolts mounting the motors were hitting the internal gearing. The team had to strip the motor back to the gears and clean and refurbish them when this action was taken there was no change and after a few times of this job the motor began to become functional once again.

New Cameras for 2016

Photo J. Macdonald

Fitting the manipulator brought further problems with the camera positions, the pilot found it challenging to position the manipulator in the correct place so a new camera was fitted on top of the manipulator which meant he had a full 160 degree angle of vision over the top of it.

Electronics & Control System

Perseus' control system has been carefully and expertly designed to make the ROV easy to fly and maximise its manoeuvrability. Our control box was also carefully planned out to

Design Rationale

Buoyancy

Hydro Group Connector

Photo J. Macdonald

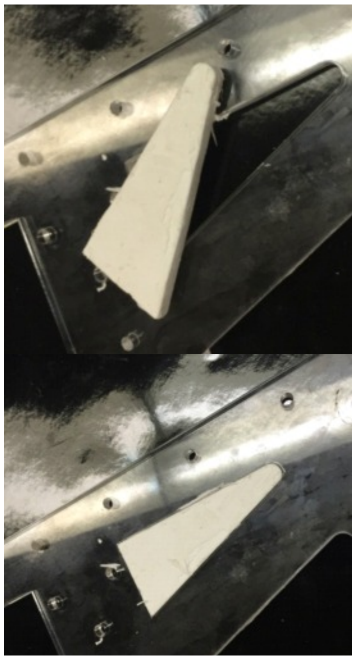
Perseus' buoyancy was made of compressed polystyrene with a Thermo plastic coating over the top which made the ROV neutrally buoyant. We ran into some troubles with this form of buoyancy as when there was weight added or taken away we had to alter the buoyancy or add weights to the frame. This meant every time we had pool mission test, time was taken to ensure the vehicle was neutrally buoyant before diving.

Buoyancy Fitted to ROV

Photo J. Macdonald

During Team design reviews we came up with the idea of some liquid buoyancy, to fill areas of the frame which were not being used and to reduce the size of the overall vehicle. This is an experimental material which is not as dense but does utilise all spaces on the vehicle.

To make Persues as close to neutral as possible in water, we used our 1000 litre test tank in school which meant we were able to be more efficient with our time when we went to the pool.



Experimental Liquid Buoyancy

Photo J. Macdonald

The liquid buoyancy that will be used is used in two parts, part 1 is a very think compound paste which is then mixed with an activator which will make the substance thin then the liquid can be poured into a mould and will solidify after 20 mins and will have the same chemical similarities.

This is still in the testing phase but we are hopeful this will reduce our size an make it easier to make the vehicle neutrally buoyant optimise user dexterity, with each button and switch positioned for ease of piloting, allowing the pilot and co-pilot to work together.

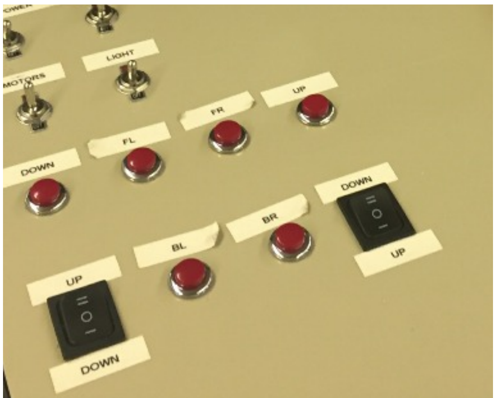
Camera with LED Lights

Photo J. Macdonald

All of the screens and controls are neatly fitted into one case with laser cut acrylic backgrounds for a more professional look and precision fit. Having all the screens and switches in one case saves storage and makes for faster mobilisation to the site.
Inside the box, there are three TFT colour monitors which display the outputs from the cameras. The bottom and top right screens are both wired to two different cameras so that the pilot gets the best view he can for each task. To change which camera he can see on the screens the co-pilot can easily switch the feed by pressing the AV1/AV2 button. The rear camera has an LED light which also provides light to the rest of the cameras allowing for easier navigation in low light environments.

For safety reasons a 1 amp fuse is wired in series with each camera to prevent damage in the event of a short circuit.

Perseus' controls are similar to our Companies previous ROV Poseidon, but with two double pull double throw switches which allows us to switch between using all 4 motors going either down or up and using only 2 of the motors for more precise movements and more vertical thrust. Each of the horizontal motors can be operated individually using one of 4 push buttons. Each combination of buttons being pushed will manoeuvre the ROV in a different way. For example, if the pilot wanted to move forward he would operate the button for the back left motor and the back right motor and for more accurate manoeuvres the pilot can operate one motor at a time.



Control box and button

Photo J. Macdonald

The manipulator controls work similar to the up and down motors. We have used a double pull double throw switch to reverse the high torque motor which is how we open and close the manipulator, we have also used a toggle switch in series with this so that we can leave the motor on which will give a tighter grip. There is also a double pull double throw switch wired in series to a push button for rotating the manipulator if we ever decide that we may need to rotate the manipulator.

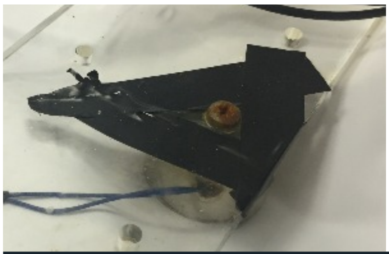

Electro Magnet

Photo J. Macdonald

To activate the electromagnet, a simple toggle switch is used to turn it on and off. Four other toggle switches have also been added in addition. For safety, a main power switch has been added to cut off power to the whole control box as well as a switch for all of the motors, the light and the TFT monitors so that when each part is not being used they can be turned off to save battery.

Propulsion

Perseus is equipped with 8x 450 litres per hour Johnson bilge pumps which give the vehicle 8 degrees of movement; forward, backward, crab left, crab right, rotate left, rotate right, up and down. Each pump has been stripped down to the motor with a plastic 3 blade propeller which we have changed for a 2 blade propeller. This change was made as we felt we were able to gain more thrust with a two prop arrangement.


Thrusters

Photo J. Macdonald

Each propeller is screwed onto a threaded bar which is secured to a brass coupling by a split pin. A small grub screw is then tightened until the brass fitting is secured to the shaft of the motor.

Initially we had used white 3mm thick acrylic plastic laser cut to the shape of our motor mounts which was later bent to a 45 degree angle using a line bender and a template at an angle of 45 degrees. Although early on we found that the white acrylic wasn't the best choice and that we was better going with the clear acrylic to help the pilot see more of the tooling. Also some of the angles were bent slightly off of 45 degrees which effected the direction of movement so we had to re-bend these and take extra time for a more precise bend. 4 of these mounts also had to be bent at 90 degrees for the vertical motors. These mounts are all held onto the frame with three 5 mm bolts.

Old Motor Shrouds

Photo J. Macdonald

Originally we reused the motor shrouds from the previous ROV, Poseidon. These shrouds were made from mild steel spot welded together. Although after testing the vehicle with these on we decided they were too heavy so we redesigned them using PVC piping with sections cut out of it to let the water flow through the back of the propeller and out of the front which we jubilee clipped onto the motor.

This means that we now have a complete cylindrical section around the prop which has increased the flow rate of water through the props.

New Motor Shrouds

Photo J. Macdonald

Cameras & Lighting

Perseus is fitted with five underwater cameras. Each camera has been carefully positioned to maximise its use and help the pilot fly the vehicle. As only 3 monitors are permitted in the control box, we have to switch between camera 3, 4, and 1, 5 on two of the monitors, depending on which one is more useful for the task in hand.

Camera 1

Camera 1, is positioned on the front top bar of the ROV , facing down on the

Manipulator, Venting Liquid Temperature Probe, measuring device and aids the pilot with navigation . This view allows the pilot to see the manipulator from above and help judge when to close it when grabbing an object. The

camera is also used attach the Venting Liquid Temperature Probe to the venting pipe, this allows delicate work to be carried out. In addition, this camera can be used to position the props over the recovery basket ensuring all artefacts are retrieved successfully.

Camera 2

Camera 2, is positioned centrally on the top middle bar of the ROV, and is used as our main navigating camera. This is a real ROV camera, which was kindly donated by Teledyne Systems, and gives us a much sharper image in comparison to the other three on our vehicle. Camera 2 is the most used camera on Perseus, as it can be used or many different tasks. These include determining the identification number on the project tasks, attaching objects to the manipulator and obtaining the vertical ice measuring device.

Camera 3

Camera 3, is positioned on the top middle bar of the ROV, just next to the main camera. This one is used for orientation and focusing on the tooling when performing task. Working in partnership with cameras 2 and 5, as all three cameras give the pilot three different views of the manipulator, this is good for the pilot since they can execute task more efficiently with more ease.

Camera 4

Camera 4, is positioned centrally on the top rear bar of the frame facing down towards the central electromagnet. This camera angle is used primarily to ensure all areas are clear at the rear and also for placing tooling on the electromagnet, guiding them over their specific areas.

Camera 5

Camera 5, is positioned on the of the Manipulator to look directly down the jaws on the manipulator to give a better view for operating to make it easier to control for retrieving specifics objects that can be quite difficult to pick up or to set down, added to this you can have a better view of what is below the ROV and some what gauge how close the bottom is of the pool is from the ROV.

ROV Light

This year's tasks doesn't require are vehicle to work in low light environments, but we can add an LED light to our ROV if needed. The light was kindly donated by Bowtech and gives out 800 Lumens. The light is switched on by a toggle switch in the control box, so the pilot can choose when to use it. The light is most commonly used to navigate in areas of low light which we may encounter on Neptune.

Mission Tooling

Manipulator:

Perseus features a multipurpose manipulator. Previously we used a range of different tooling which required a lot of time and effort to change and re-equip. So when we began to prepare for the international competition, building a manipulator was top priority, as it would allow us to complete multiple tasks using one tool.

Manipulator

Photo J. Macdonald

The manipulator can be used to-

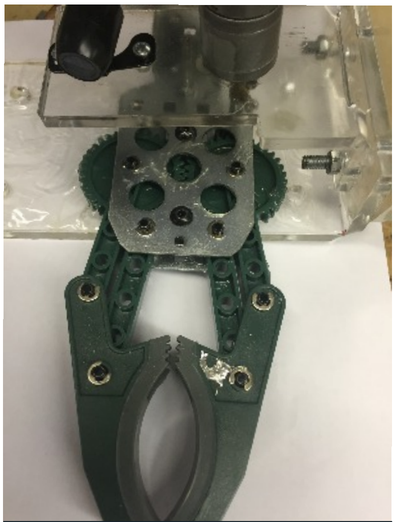
- House the temperature probe
- House the IWDMD
- Connect the ESP to the power and communications hub

  Including:-retrieving the ESP's cable and connector from the elevator

  -Laying the ESP's cable through two way points

  -Opening the door to the port on the power and communications hub

  -Inserting the cable connector into the port on the power and communication hub
- Position cube SAT's to find the four desired serial numbers
- Transport equipment and placement in the collection basket.
- Retrieve oil samples from the sea floor.
- Return the oil samples to the surface
- Return two coral samples to the surface
- Install a flange to the top of a wellhead with one bolt.
- Secure the flange to the wellhead with one bolt
- Install a wellhead cap over the flange
- Secure the cap to the flange with two bolts



Manipulator bracket and camera

Photo J. Macdonald

We first pondered about designing and making our manipulator co mpletely from scratch ,and after a numerous trials and co mplication, we decided that it would be more beneficial to obtain a manipulator from online. We then renovated it to suit our needs and to comply with the tasks at hand.

IWDMD:

In addition Perseus features the IWDMD, better known as the 'Ice and Water Depth Measuring Device'. This, as indicated, is used to determine the thickness of the ice and the depth of the ocean. It is a simple but effective measuring tool. The device is constructed from a piece of string attached to a flotation device. The string is tied to the buoyancy and then reeled out from the spool which is carried by the manipulator.

To take a measurement, the string gets released and as the floatation reaches the surface the Co-Pilot can then read the measurement from the small camera mounted on the manipulator mount. Unfortunately there is a problem when measuring horizontally as when doing so the flotation will simply just rise to the surface and move along with the vehicle.

The spool on which the device is situated, is based on a fishing reel which extends out and retracts once the measurement has been obtained. Moreover the string is based on fishing line and has markers attached to identify the dimension.

Electromagnet taped to avoid glare in camera

Photo J. Macdonald

Electromagnet

Perseus also features an electromagnet positioned at the middle of the back bottom bar. The electromagnet can lift up to 25kg in the air, so in theory is more capable of lifting objects under water. The electromagnet is used to carry an array of tooling, but only if the manipulator is having major difficulties.

Temperature Probe

Photo J. Macdonald

Temperature Probe

One of Subsea Technical Service's most innovative tools is our temperature probe. The probe is constructed from 21.5mm PVC pipe . This can accurately measure the temperature of liquid leaking from the crack on the sea bed. The device consists of an MDC thermistor. The whole probe itself was designed specifically to be used by the manipulator so it could be easily attached and removed with little effort.

To deploy the sensor, a small T-shaped pipe structure made from conduit pipe is attached at the top of the probe, this is fixed to the ROV by the manipulator gripping around the T-shaped structure. When the probe is in the desired position, the co-pilot can record the temperature after carrying out a conversion from ohms on the Multi meter to degree Celsius on our temperature calibration chart.

Temperature Probe

Photo J. Macdonald

Hook Retriever

The hook retriever is manufactured from 3mm acrylic plastic and is laser cut i nto the shape shown, a piece of wire is then threaded through the two side holes, it is situated at the front bottom bar of the ROV and is secured by two bolts. It was used to retrieve the ESP's cable connector and inserting it into the power and communications hub.

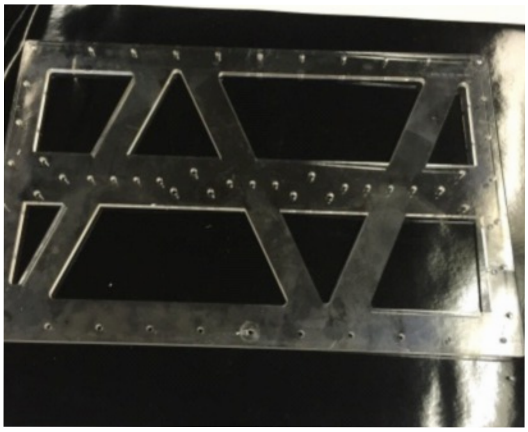
Hook retriever

Photo J. Macdonald

It was very efficient for retrieving the hook but due to the way the ROV moved through the water it made it almost impossible to keep the connector in one place. This made it difficult for the pilot to actually insert the connector into the power and communications hub so we had to persevere and figure out a solution. We did attempt to improve the device by making a prototype of a steadying extension that should have steadied the connector completely but due to prop wash and water resistance we were unable to keep the connector on the correct plane, so we had to move on and think about the manipulator doing the job instead.

Frame

Perseus is primarily constructed from 10mm acrylic plastic, unlike any vehicle made by STS before the frame has been laser cut. The material was chosen for its strength, and is cut in a triangulated pattern to create a strong structure. The final design is similar to previous designs but is more angular towards the front of the vehicle meaning it is hydrodynamic. The frame is lined with 6mm diameter holes allowing us to constantly update and improve the vehicle; the holes allow us to attach tooling such as the manipulator (see page 9-10). In the centre of the frame there is a 15mm conduit pipe were our tether connects to the motors/thrusters and electromagnet, the first of our cameras is positioned here. There are four plastic bars on the ROV holding the two sides of the frame together, on the upper of the ROV the bars are thinner in width as they are were our camera are situated, the bars are at the upper front and back of the vehicle and can be rotated to adjust the pilots view. The bars holding the bottom of the side frames are thicker and act almost as a base for the ROV, our electro magnet is attached to the back most of the bars, whereas the manipulator and selection of other tooling can be located at the front most bar.



Original Acrylic Laser cut Frame

Photo J. Macdonald

Future Improvements

To guarantee and provide a safe and reliable service to all our customers, it is of great importance that Subsea Technical Services continue to make improvements to our existing vehicle designs. Perseus is a complex improvement from Poseidon our previous ROV, as it is now based from laser cut acrylic plastic instead of pvc pipes. Although Perseus is a massive step up from our previous ROV’s we still believe that we can develop the project further to improve Perseus’ overall performance.

The first of the improvements is the control system, we are currently working a pushbutton control system, but we believe that we would thrive with a joystick control system in place. This project was taken on in the mid of last year but when we re-evaluated, it came to light that the time frame we were working to was just not realistic and the we would leave making the joystick our primary control system till next year. We are also working to decrease the size and weight of the vehicle, achieving this would allow easier manoeuvrability and allow the vehicle to run more efficiently. Our final improvement is looking for easier more efficient ways to add buoyancy to the vehicle, so that it sits slightly positively buoyant in the water. We are currently looking at liquid buoyancy and experimenting the pros and cons-compared to foam which has been used in the past- and ways of attaching it while evenly distributing the weight over the ROV. We are currently working on adding more camera’s to the vehicle to provide the pilot with more viewing options making tasks easier.

Lessons Learned

STS will continue to reap the benefits of a development team with a strong broad skills base. We are highly committed in making future developments and improvements to our ROV. The team work involved in the making and development of Perseus has stimulated new skills and further improved skills already obtained, some of the skills are teamwork, communication and commercial communication. The safety systems that was put in place at the beginning of the project has been enforced through the course of the project ensuring no injuries to anyone during development work.

Challenges Faced

The team has worked well to overcome challenges by using skills such as problem solving and communication. We found our thrusters be delivering insufficient hydraulic effort, we came up with many ways to overcome this problem, experimenting each to find out which solutions worked and which didn't and also to figure out what our best option was. Our final conclusion to allow maximum thrust was to create shrouds which meant all the thrust was enforced in the correct direction allowing maximum manoeuvrability. During the development the team had regular design reviews to make sure the ROV was working in the way we wanted and needed it to, these meetings involved the team members pitching forth their ideas and working together to come up with reliable solutions. The team also had a deadline sheet which made sure we were completing our tasks and planning ahead so we would be ready for when the competition began, although not every deadline was reached we still managed to attain our final goal of getting the ROV in the pool by the end of January 2016.

Costing

Due to the new design and manufacturing processes the cost of manufacture was greatly reduced. Recycling of materials and contacting local and National Companies resulted in a large amount of sponsored donations.

The budget was close to our final total except for the decision not to include the joystick controls. Costs increased with the introduction of more cameras and the requirement of more acrylic for the frame.

The breakdown of the costing's are details below .

Costing Information			
Parts	Description	Cost - USD	Donated / Recycled
Frame	5x sheets Acrylic @ 10mm	$ 183.35	New
Thrusters	4x 4 3.2A 450 LPH Pumps	$ 140.00	New
Thrusters	4x 3A 450 LPH Pumos	$ -	recycled
manipulator	1x Vex manip	$ 44.00	New
Cameras	8x reversing camera	$ 105.00	New
Camera Cable	4x camera AV cable	$ 46.00	
Control Box	1x Peli Case	$ -	Donated
Wiring	200m 4 A cable	$ -	Donated
Cable Connectors	2 Hydro Group Connectors	$ -	Donated
Electrical consumables	various	$ 100.00	New
Motor Shrouds	1x length of PVC pipe	$ 10.00	New
Bouyancy	High Density Foam	$ -	Reused