Technical Report

Submitted by team **N.O.R.T.H**
To the **M.A.T.E** Centre
Ranger Class

"The Sednatron"

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Nunavut's **O**nly **R**obotics **T**eam in **H**ouston

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Table of Contents

Abstract

The following technical report describes the Remotely Operated Vehicle (ROV), *Sednatron*. It was designed and produced by a group of 10 students from Inuksuk High School, in Iqaluit, Nunavut, Canada. Throughout the process of building the ROV the students exhibited strong problem-solving skills while working as a cohesive team.

The ROV was designed to meet the mission specifications of the 2006 Marine Advance Technology Education (MATE) competition. This year's 5th annual competition is hosted by the Johnson Space Center in Houston, Texas. The mission outlined for the Ranger class is composed of two tasks which are demanding in both the performance of the ROV, and the dexterity of the pilot. The ROV was designed to perform the following tasks as precisely and efficiently as possible. A specified amount of 20 minutes is given to complete both tasks.

1. Complete the central node:

Transport an electronics module from the surface to the trawl-resistant frame, install the module in the frame, open the frame door, and insert a cable connector into one of the open ports on the electronics module.

2. Trigger a malfunctioned acoustic release transponder to release an instrument package:

Manually trigger a release to free an instrument package. Once released, the instrument package will float to the surface.

The team's community of Iqaluit largely supported construction and completion of the ROV, as well as the team's traveling expenses. This report includes descriptions and detailed diagrams of the ROV's components, challenges faced by the team as well as possible improvements for next year.

Design Rationale

Frame

Top view of Sednatron

1.25 cm PVC pipe was used as the main building material for the structure of our ROV. It was chosen because it was simple to manipulate into the shapes and sizes we needed for our designs. It is easy to cut, and connect together using T's and elbows. Another useful aspect of using PVC is that it is strong, lightweight and easy to attach to other parts of the ROV. It was ultimately decided upon because there was plenty of PVC pipe available in Iqaluit.

Control System

The control system we used is a control box. As this is our first competition, we went with simplicity. The control box is relatively easy to construct, and to use. It consists of a rectangular box that houses wires and

Wires inside control box

momentary switches. Each switch is connected to one thruster, and can give it full power forward or reverse. The control box also fit within our budget.

Video Camera

DSP Underwater Camera

The ROV uses one DSP Underwater Camera with a 3.6 mm lens. This camera was chosen because of its underwater capabilities. The camera retains a suitable field of view when submerged, is small, lightweight, and durable. Another useful advantage of this camera is that is can be easily attached to our ROV with PVC brackets. The camera also fit in our budget and was recommended by Clarence Button, an external mentor in Newfoundland.

Tether

The tether used for our ROV was selected because it meets the needs of our motors. It contains nine 18 gauge wires which fits the general needs of our ROV, because its diameter is not too large. We determined that 15 metes of tether would be sufficient and not interfere with the completion of any tasks during its missions. The tether remains visible in water, which is much more convenient when maneuvering the ROV underwater.

Tether

Thrusters

Thruster

The team agreed on four Mayfair Marine 1250 GPH bilge pumps motors for our thrusters. These 12 V motors drew less than 1 amp out of water and about 5 amps underwater. We attached a four blade plastic propeller with a 70 mm diameter to each motor. Using a simple pull test, each motor was rated with a maximum thrust of 30 N. The motors are small and can be placed in the most efficient locations on the ROV.

Tasks and Tools

Task 1

"Hook"

The first task requires an electronics module to be transported from the surface to a trawl resistant frame. At this point, the door of the frame must be opened and a cable connector must be picked up and inserted into the correct port on the electronics module.

We chose to transport the electronics module with a hook that will carry the module by the centre U-bolt, as this is where the centre of gravity lies. The hook is made of 1.25 cm PVC pipe and steel wire, and is designed so that it can release the module quickly and efficiently.

The door on the frame will be opened with an arm made of 1.25 cm PVC pipe that extends from the front of the ROV. The arm will fit easily into the door handle and pull it open with minimal effort, as the door requires less than 1 N of force to open.

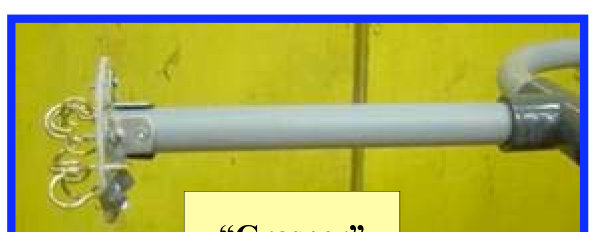
The Arm

To pick up and insert the cable connector into the electronics module, the ROV will use the same hook tool that was used to transport the module itself. Reusing the hook proved to be the simplest idea because of its positioning on the ROV, and due to its ability to easily release the object that it is attached to.

"Hook" in action

<u>Task 2</u>

This task involves the release of a pin from a malfunctioning acoustic release transponder. The tool designed for this task consists of a circular piece of



"Grasper"

Plexi-glass attached to a PVC pipe. Many screw hooks are attached to the Plexi-glass. The tool must only be positioned near the release pin for one of the screw hooks, to grasp it. From here, the ROV must only move backwards and the pin will be released.

Challenges

The main challenge that we faced was that of living in a remote community. This made it difficult to acquire the materials needed to construct our ROV and mock-up tasks. The lack of stores where we can get the materials that we needed sometimes made us unable to move forward with our designs.

Another challenge of living in a remote community was the difficulty of finding professionals that could help us with certain aspects of our robot. An example of this was our electronics. We did not know enough about wiring the robot to complete it ourselves, and could not find anyone who could help us for several weeks. This slowed our progress substantially.

The lack of facilities in Iqaluit also affected our progression. This restricted the amount of time we could spend working on the robot. We also had to share our working space with other groups, which sometimes led to conflicts. Occasionally we had meetings at awkward times that not all of us could attend.

It was hard to get time to test our robot in the pool, which left us with uncertainties of how our robot would perform underwater.

Trouble Shooting Techniques

People use trial and error in their every day lives. Every great scientist has used trial and error to attain the desired final product. Trial and error is attempting something that fails, then coming up with a new idea or improvising the original idea to try and solve the problem at hand.

We used trial and error to fix our problems too. We've had to deal with small and large problems. The creation of the tools for the mission tasks, for example. They required constant updating. We began our trial and error process by improving them. We did so by making them more efficient and easier to change.

We faced many problems with the electronic portion of the robot. One of the biggest problems was that we did not know how to properly set up a control box with 4 switches and motors. We initially had our fuses at 1 amp, but they would blow as soon as the motors were turned on. John Coogan (from Baffin Electronics) helped us test the underwater load at 5 amps. In the end, we used 6 amp fuses. We had an immense amount of problems with our wiring as well. We had a lot of miss-wired switches and crossed over switches.

Plexi-glass is a difficult building material to work with. Due to its brittleness, it was prone to crack easily when being cut. Several times, the team had to start over again due to a break in the Plexi-glass. We made a lot of adjustments as to how we cut the Plexi-glass. A couple of people were needed to hold the Plexi-glass as one person cut it. This proved to be much easier than having just one person cutting it and holding it.

Improvements For Next Time

If we were to build another ROV, the main thing that we would keep the same would be the use of the 1.25 cm PVC. The PVC has been the base of our ROV and has never caused us difficulties. PVC doesn't break easily and can be used to form the ROV 'skeleton' without much difficulty.

Next year we would begin earlier in order to have more time to work on and test our robot and write the technical report. The team became rushed at the end of the year, which impaired our thoughtfulness pertaining to the design. Time is our most valuable resource, and if not used to its full potential we may find ourselves racing against the clock and calendar to finish the ROV.

In the beginning of this endeavor we established a time management calendar that dictated our work schedule. However, the team was not as vigilante as required, and we occasionally lost track of time. Assuming we compete again, we well ratify this error.

Lessons Learned

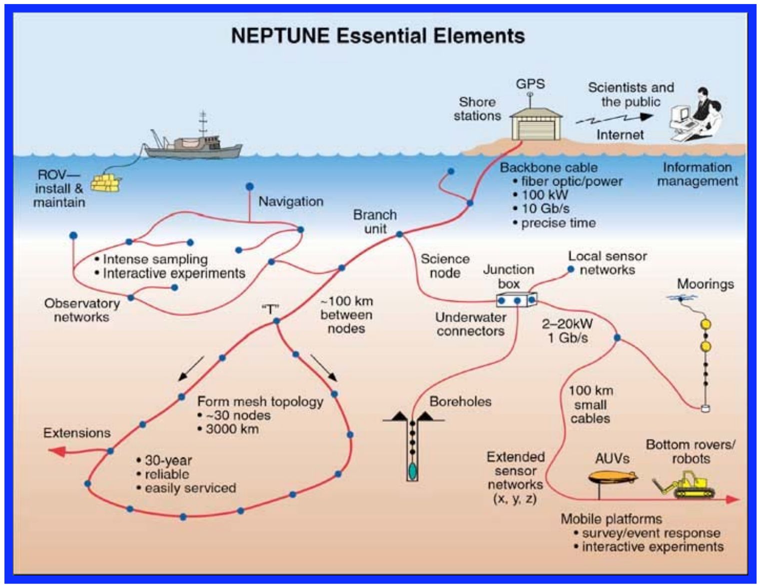
During the process of building our ROV and piecing together the poster and technical report, the team learned that an essential skill to possess is time management. Time management is particularly important because it sets a base of what must be done when, how and by whom. This ensures that the members are present on appropriate days and they do not waste time. It also ensures that work is evenly divided among the team, thus every member has an equal knowledge of the work and processes that were a part of this project.

ROV's and Underwater Observations

The main purpose of underwater observation is to understand changes occurring in our environment. These changes include ocean climate change, which affects marine life and undersea ecosystems. Sea crusts and seismic activities are also studied and observed using ROV's[1]. Technology is constantly evolving, and one such technological advancement that matters a great deal to underwater observation is the Remotely Operated Vehicle (ROV) [2].

Since initial creation of the ROV, a mere five decades ago, it has become a pervasive tool in underwater observations[3]. The reason for this is simplistic as well as essential; it can replace human divers. Many organizations and programs have been taking advantage of ROV's.

An example of a program that has been utilizing ROV's is NEPTUNE[1] (North – East Pacific Time Series Undersea Networked Experiments). This organization is a joint program with the U.S and Canada. NEPTUNE will use ROV's to become the world's largest cable-linked seafloor observatory. NEPTUNE hopes to first build two laboratories, and with funding, build four more. The funding to make this project possible will come from the Canada Foundation for Innovation, the British Columbia Knowledge Development Fund, National Science Foundation, the National Oceanographic Partnership Program, the W.M. Keck Foundation, the David and Lucile Packard Foundation, along with several other interested agencies[1].



Picture taken from www.neptunecanada.ca

Once the project is started, NEPTUNE will use ROV's to accumulate data that pertains to the ocean. These data will be instantaneously redirected to the internet[1]. In essence these data will help NEPTUNE understand ocean ecosystems and the changes that are rapidly occurring on a global scale.

As ocean observations, such as NEPTUNE, continue to flourish and play an eminent role on a global scale, so will ROV's.

1. Neptune Canada.
http://www.neptunecanada.ca
Visited May 30, 2006

2. Ocean Explorer.
http://www.oceanexplorer.noaa.gov/technology/subs/rov/rov.html
Revised February 24, 2006 by the Ocean Explorer Webmaster
Visited May 30, 2006

3.Marine Technology Society
http://www.rov.org/info.cfm
Visited May 30, 2006

Budget

Expenses

ITEM	COST
Return Airfare Iqaluit to Ottawa (5 one way, 7 return)	$7125.00
Return Airfare Ottawa to Houston (12 return)	$8304.00
Ground Transport (vehicle rental and gas)	$700.00
Accommodations Ottawa (2 nights)	$1081.00
Accommodations Houston (6 nights)	$2910.00
Materials (parts, electrical, screws, Plexi-glass etc)	$1000.00
Promotional Items (shirts etc)	$500.00
Meals (8 days 12 people)	$5280.00
	$26,900.00

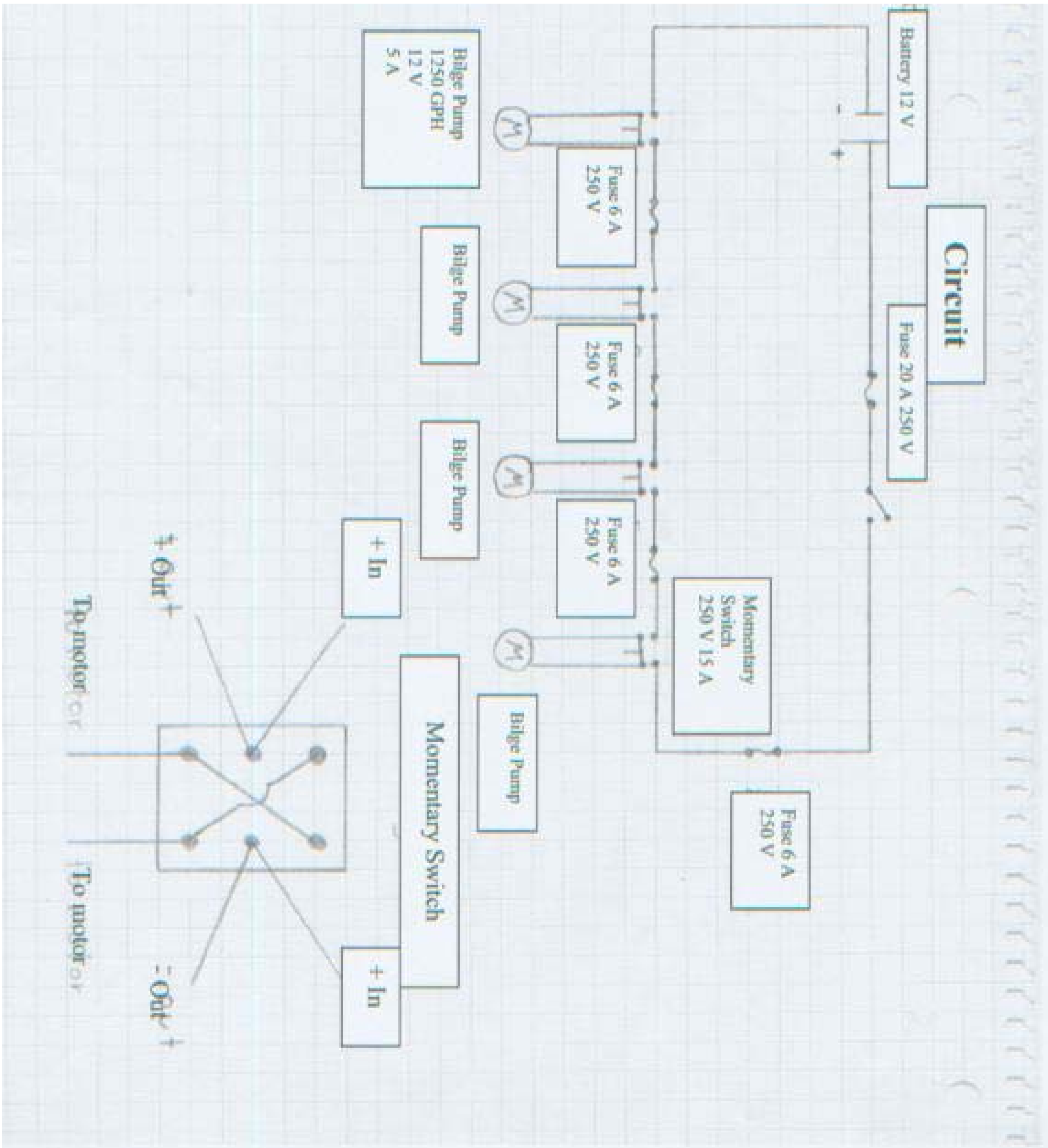
Revenues

ITEM	COST
Raffle Tickets	$6000.00
Canteen work, Catering, HS functions, Inuksuk HS donations	$4800.00
Fundraiser (silent auction)	$3800.00
Legion	$2000.00
The Royal Purple	$2000.00
Student contribution	$3000.00
MATE	$1000.00
Department of Education	$5000.00
Total	**$27,600.00**

Donations

Item	Cost	Donated by
Thrusters (6)	$150.00	Department of Education
Cameras (2)	$400.00	Department of Education
Tether	$100.00	Department of Education
PVC pipe	$350.00	KRT Electrical
Insulation	$55.00	GC North
Electrical supplies	$250.00	Baffin Electronics

Electrical Schematic



Acknowledgements

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- Elks Lodge of Iqaluit
- Royal Canadian Legion
- Royal Purple
- Department of Education

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- John Coogan (Baffin Electronics)
- Dwight Howse
- Clarence Button
- KRT Electrical LTD.
- Frobuild
- NAPA Auto-Parts Association
- BBS
- Sikitu

Appendix

Photo Gallery

Team N.O.R.T.H.

Nunavut's Only Robotics Team in Houston