Brooks DeBartolo Collegiate High School
Tampa, Florida, USA

Technical Documentation

Team Member - Role

Benjamin Glow - Chief Executive Officer

Sarah Metayer - Chief Financial Officer

Paul Fernandez - Chief Operating Officer

Jake Heiny - Chief Piloting Officer

Caleb Jaramillo - Engineering Specialist

Matthew Fernandez - Tether Specialist

Marlon Edwards - Communications Specialist

Jadon Jackson - Repairman

Eryk Chazares - Tether Assistant

Mentors

Mr. Eric Fernandez
Mr. Chris Hochman

BROOKS~DEBARTOLO COLLEGIATE HIGH SCHOOL

MATE

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Abstract

This is the Phoenix Robotics Company presenting our U.S.S. Phoenix. We are a small company coming from Brooks DeBartolo Collegiate High school in Tampa, Florida, USA. The design of the frame for our machine originated from the desire to have a more hydrodynamic machine than previously. Our machine uses aluminum to have a more sturdy, solid build. Our OBS- (ocean bottom seismometer) is used to indirectly release and carry items to the surface with the means of a balloon or lift bag. Our system utilizes an electromagnet system hooked up to our power source where when the protruding magnet on the ROV makes contact, it is released, and a balloon brings the secured OBS cross to the surface, which is applicable to any situation where items on the bottom of the ocean need to be hooked up and carried to surface. We have a claw that functions with servos to both close and rotate 90 degrees. This device assists us in completing the tasks which require picking up and moving, which with a real ROV in the ocean, would enable it to manipulate its environment. The motors consist of standard functions: up, down, left, right, forwards, and backwards, controlled on a x-y axis system. Our machine utilizes 3 cameras in different angles to get the best possible view for the driver. Different views are essential to navigate correctly and avoid obstacles, as well as applying all functions of the claw to the optimal ability.

Project Management

The team's schedule for building the machine was circumstantial on specific tasks but with a critical meeting and overview on Friday to access weekly completion. The model was altered from an existing 1-hour weekly debriefing on Mondays due to loss of availability from certain members and scheduling conflicts. The planning of activities was done at the beginning of each meeting using the authority and supervision of the hierarchy chart provided in figure PM1.

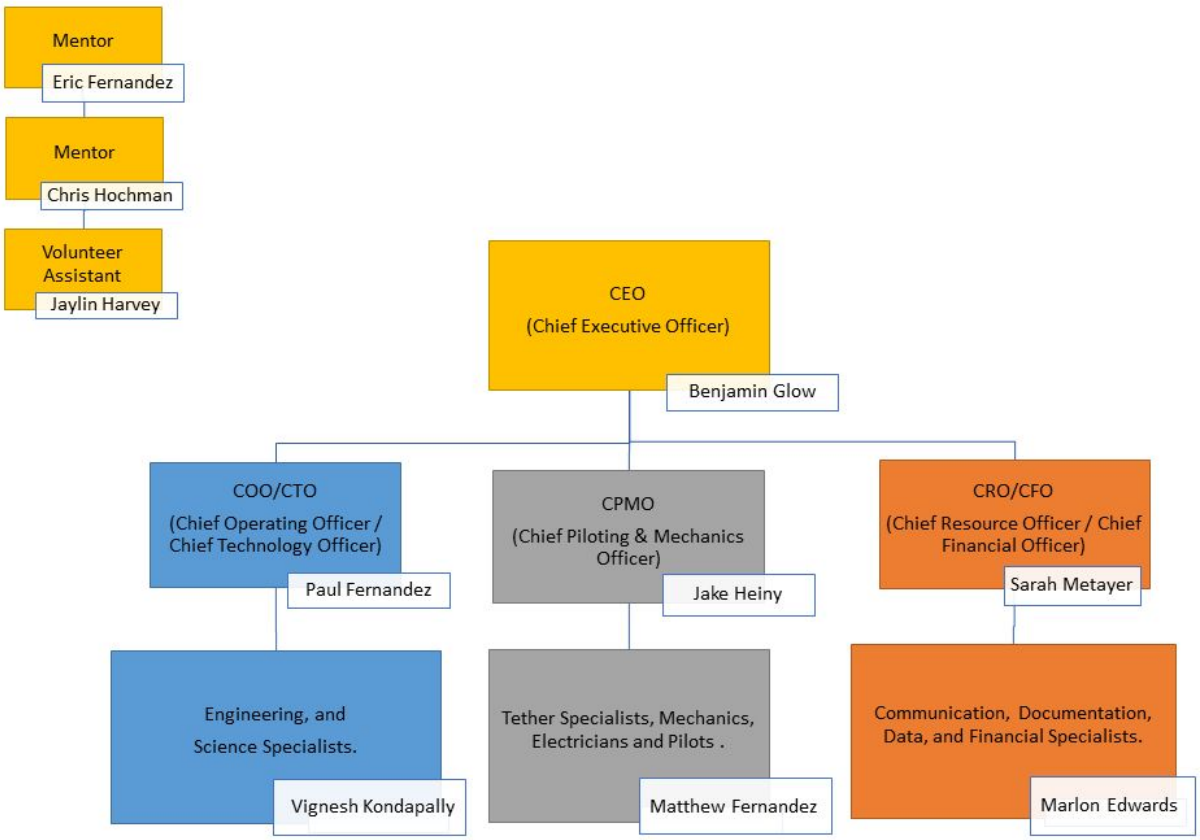


Figure: PM1

The Authority hierarchy came to after members of team became frustrated in the design stages. When 1 hour debriefings were conducted, little could be accomplished when agendas were not followed through with or created. The mentor, Mr. Eric Fernandez was asked to observe such a meeting on September 28th of 2017. By the 8th of October, before the next meeting, this hierarchy was suggested by the mentor in an effort to "reduce bureaucracy" . The members described on the chart agreed to adopt and comply.

The applied hierarchy saw an increase in productivity. Tasks in the agendas were completed and work was properly delegated. However, the process was far from seamless. Gaps in information were experienced by senior members, who could not attend all meetings. As a result, management became more difficult, as newer members would not respect authorities that were rarely present or influential.

After reflection, members of the hierarchy agree that the project this year accomplished much more than previous generations. The Metric of Success is determined by the advancement of Phoenix Robotics from Regionals to International Competition, solutions technical challenges and overall complexity of the machine. Members of the hierarchy also agree that a better internal communication system could be developed to coordinate work hours and complete tasks.

For Resource management plan, refer to figure PM2.

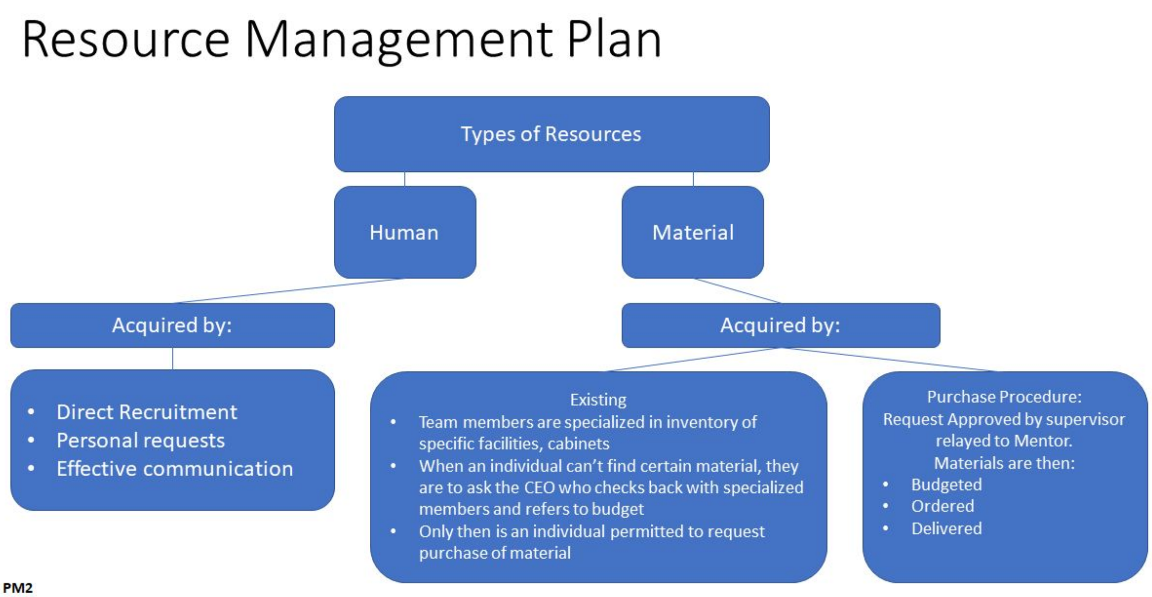


Figure: PM2

Design Process

Design and planning began in August of 2017 as a collaborative effort. Input was requested from all members. Designs were created on basis to improve the ROV from previous years Piranha, a PVC construction machine. Rigidity of this machine was to be matched but there was necessity to reduce an excessive 5kg frame weight. Weight was too valuable for additional payloads to be used on such things. Size and aesthetics were prioritized improvements as well. The theme of this year's competition moved away from space travel, so weight and size restraints were not as strict.

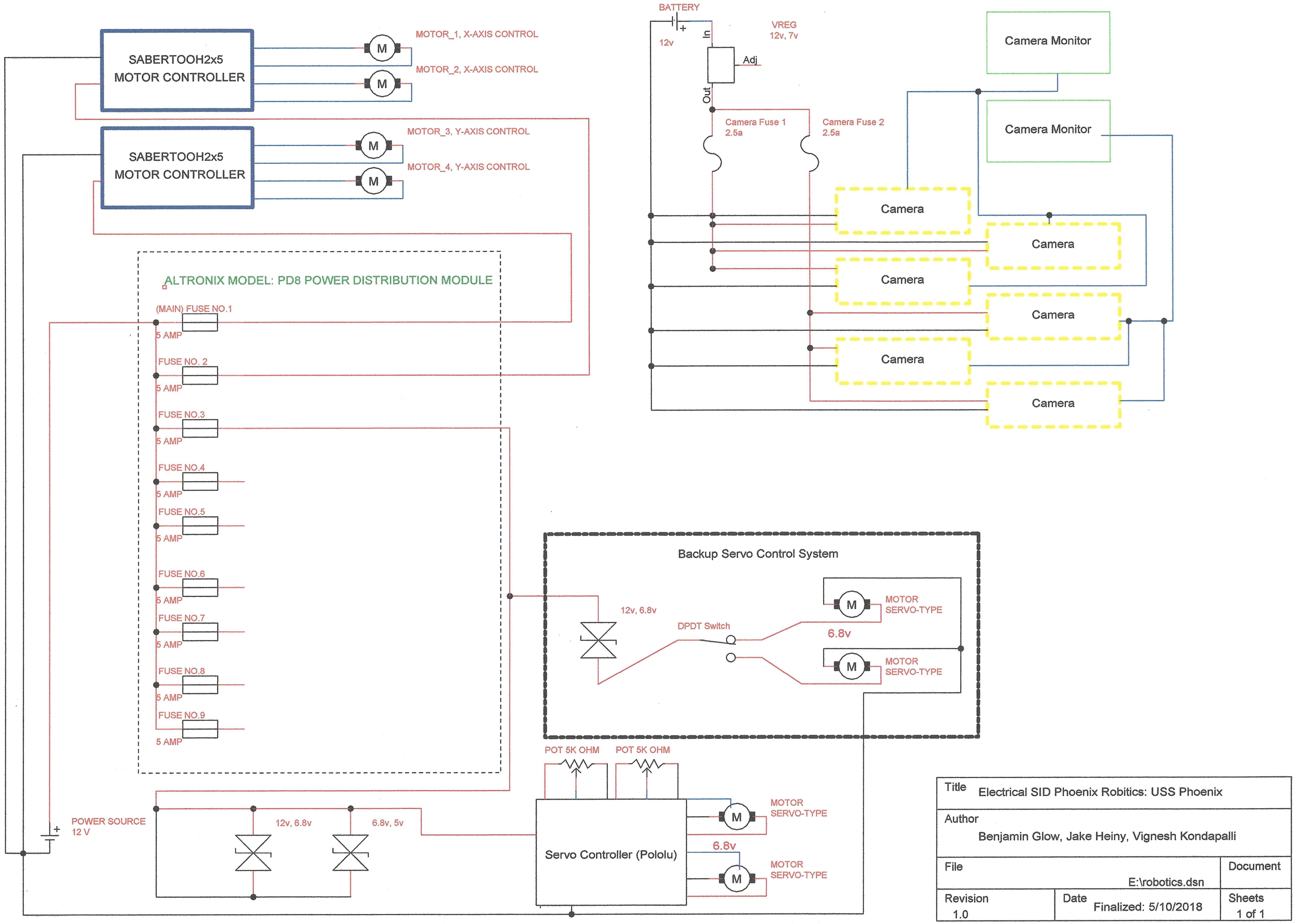
The usage of a non-PVC material was a highly desirable factor because of the armature presence PVC has at international competitions. Design inspiration was sourced from photographs taken at the 2015 MATE international Competition in St. John's, Newfoundland, Canada by a Senior Team Member. A consensus was made to use Aluminum for a structural frame.

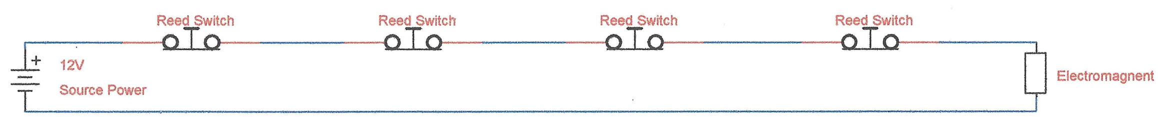
Other desired improvements were for modularity. Our system had to be adaptable in case USS Phoenix had to be reconfigured for new tasks. This approach also crossed paths of interest with the philosophy for sustainable design mentioned previously in the "new vs. used" section of this document. This machine is intended to be used for the next 5 competitions if possible. Its inaugural year will test this expectation.

Controls of the machine needed upgrades as well. Piranha had several issues of maneuverability. It was important that our machine could turn as easily as sink and rise from the water. A hydrodynamic design was selected. The machine has three main fins, the two lower downward pointed ones allow the machine to have elevation from the bottom of its environment. The space created also allowed for a claw to be tucked under the machine, giving it protection and conceal-ability. The main dorsal fin cuts the water and has minimal resistance due to its lower surface area.

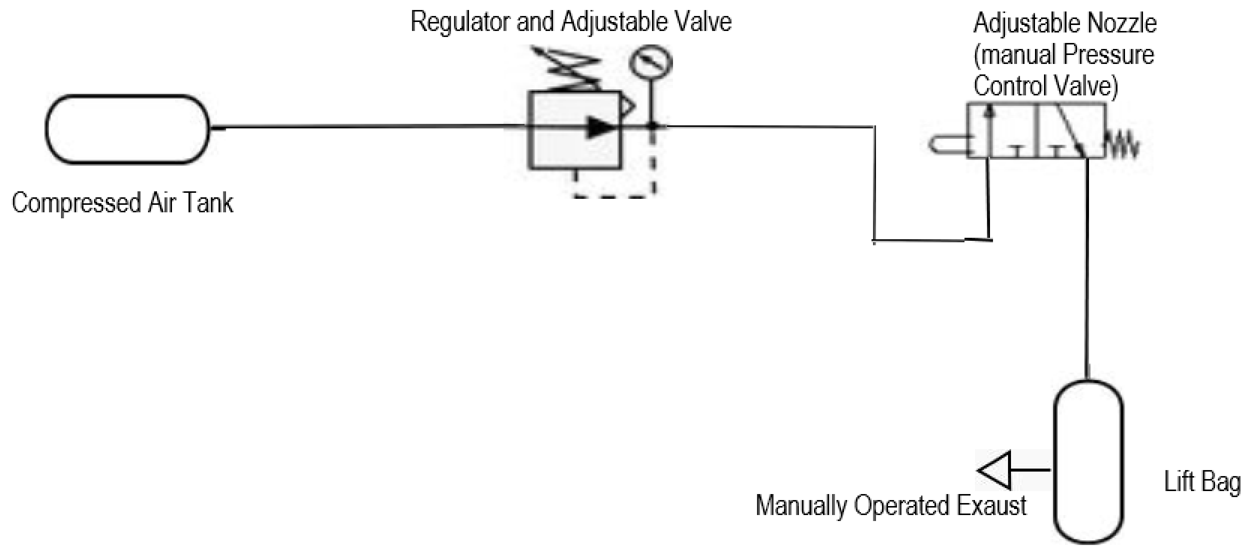
The precise machine also was forced to retire a 2-year-old controller that had been reduced an unusable state after years of modification. A new controller was purchased and fitted with new motor wire set. The team saw the attractiveness of ethernet-style cables to be used in the application of motor control as they carry signal very well while being low in weight and typically have multi-color wires. This allowed for ease of troubleshooting as well.

Some members of the team additionally acquired the skill of water-proofing cameras. Because cameras could be waterproofed in-house, the focus of Camera quality and size could have greater effect on choices to purchase new systems. Peripheral Systems stand as the highest quality to date in the History of Phoenix Robotics.


SABERTOOH2x5
MOTOR CONTROLLER
SABERTOOH2x5
MOTOR CONTROLLER
M
MOTOR_1, X-AXIS CONTROL
MOTOR_2, X-AXIS CONTROL
MOTOR_3, Y-AXIS CONTROL
MOTOR_4, Y-AXIS CONTROL
ALTRONIX MODEL: PD8 POWER DISTRIBUTION MODULE
(MAIN) FUSE NO.1
5 AMP
FUSE NO. 2
5 AMP
FUSE NO.3
5 AMP
FUSE NO.4
5 AMP
FUSE NO.5
5 AMP
FUSE NO.6
5 AMP
FUSE NO.7
5 AMP
FUSE NO.8
5 AMP
FUSE NO.9
5 AMP
BATTERY
12v
In
Out
Adj
VREG
12v, 7v
Camera Fuse 1
2.5a
Camera Fuse 2
2.5a
Camera Monitor
Camera Monitor
Camera
Camera
Camera
Camera
Camera
Camera
Backup Servo Control System
12v, 6.8v
DPDT Switch
6.8v
MOTOR
SERVO-TYPE
MOTOR
SERVO-TYPE
POT 5K OHM
POT 5K OHM
POWER SOURCE
12 V
12v, 6.8v
6.8v, 5v
Servo Controller (Pololu)
MOTOR
SERVO-TYPE
6.8v
MOTOR
SERVO-TYPE
Title
Electrical SID Phoenix Robitics: USS Phoenix
Author
Benjamin Glow, Jake Heiny, Vignesh Kondapalli
File
E:\robotics.dsn
Document
Revision
1.0
Date
Finalized: 5/10/2018
Sheets
1 of 1



Title Phoenix Robotics: OBS Wiring Schematic		
Author Jake Heiny, Benjamin Glow		
File E:\OBS Schematic (1).dsn		Document
Revision 1.0	Date	Sheets 1 of 1



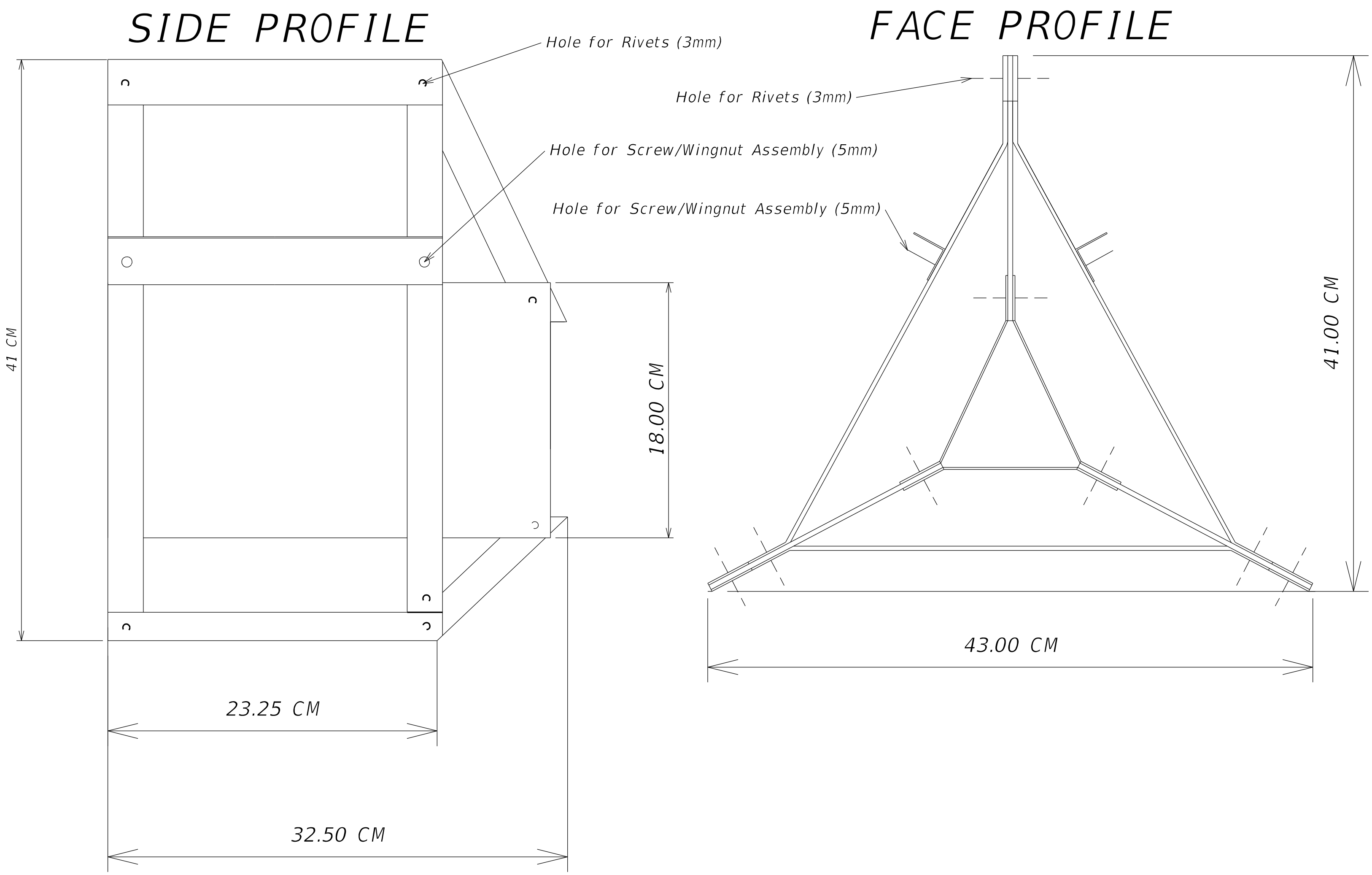
Title Phoenix Robotics Fluid Power SID		
Author Jake Heiny		
File		Document
Revision 1.0	Date	Sheets 1 of 1

Build vs. Buy, New vs. Used

The inclination of the team was always to recycle materials from decommissioned machines or current inventory. Recycling and incorporating “used” components is important to our company because it reduces overall machine costs, material acquisition time and environmental impact. However, the reality of used components is that materials may be inconsistent to design specifications and potentially unusable. A citable example is the recycling of PVC piping. PVC piping, when new, is a fantastic material due to its structural strength to withstand sub-surface pressures, modularity, viability and relative inexpensive cost. But, when recycled PVC piping is used it may be cut in incorrectly in undesirable ways or useless lengths. It may also have been subject to epoxy adhesives that are difficult to separate from PVC fixtures for reuse. Most times, “new” materials are preferred, their condition are in line to standards, and tolerances. While this is true, our company advocates for reduction of human waste in the environment.

The purchasing of materials or the “buy” tactic in creating an ROV also boasts of both positive and negative attributes. Buying certain components is a necessary evil. There is a general quality to ready-made motors, cameras, etc. a quality that is supported by manufacturers in warranty and technical specifications such as electrical information as well as equipment capability. In addition, some components may not be practically built, thus purchasing them is more intelligent. However, there are limitations with buying some components. Some complete systems such as complete control boxes and even entire machines cost in upwards of tens of thousands of dollars. If these expenses were decided it could double or triple the cost of the machine, making it more difficult to replicate, and making it more difficult to market to shareholders.

Building means creating from individual components/ materials. Effectively built parts are created with much planning and respect to other systems of the machine. Built parts are also created by members of the Team, if they are responsible in coordinating their plans and sharing information, such components can be serviced, troubleshooted and maintained accordingly. Unfortunately, built components take the most time create. The human condition also prevents them from being without flaw. As mentioned previously, built parts can be the most desirable, when they are properly implemented, and their information is accessible. This does not happen in most cases, designs are sometimes created with more creativity at the trade off an elementary understanding of architecture. The skill of the builder is variable.



REVISIONS			
DATE	DESCRIPTION	DATE	DESCRIPTION

BROOKS DEBARTOLO
PHOENIX ROBOTICS
10948 N Central Ave,
Tampa, FL, USA 33612

USS PHOENIX (ROV-55)

SHEET NO.
8

Safety features

The vehicles safety features include: shrouds to protect from laceration due to propeller revolution. The coloring on the shrouds matches OSHA standard *1910.44*, yellow to mark “marking physical hazards such as: Striking against, stumbling, falling, tripping, and "caught in between." The use of an external power supply. Other safety features include fuse boards, a fuse running to each component module for every pair of motors and a main line fuse running from power source. An additional switch is in place on the PD8 power distribution module to allow for analog electrical system disconnect.

Safety procedures:

- Transportation Safety:
  - Keep seatbelts on at all times.
  - Minimize distractions/movement.
  - No horseplay and control volume.
- Poolside Safety:
  - Keep all electronics (not water-proofed) a safe distance from pool/other water sources.
  - Ensure there are no shorts or any sort of electric exposure on the ROV before submerging underwater, and continually check for such.
  - Minimize the number of people in or around the pool.
  - Always keep eye protection when working with the various ROV systems that deal with electricity, soldering, drilling, etc.
  - Keep tether and other wires organized and out of the way to prevent tripping or damaging of the machine.
  - No playing around or any type of horseplay in or around the pool.
- Lab Safety:
  - Always have eye protection when dealing with electricity, soldering, drilling, or anything else that could potentially cause any type of projectile.
  - Wear cut/burn proof gloves when drilling, hot gluing, sawing, soldering, etc.
  - No horseplay in the lab and maintain a safe and proactive work environment.
  - Avoid congregations of people and keep as few people per station as possible to avoid collisions and accidents as well as keeping on topic.
- General Electric Safety:
  - Always wear eye protection when dealing with active systems/closed circuits.
  - Always wear gloves when dealing with active systems/closed circuits.
  - Be aware of and ready to use available fire extinguishing methods.
  - When not dealing with the electric systems keep them deactivated.

Testing and troubleshooting

System Redundancies were a necessity, for this year's new design implementations. A prototyping phase was a must to assess feasibility as well as the skill levels of members creating such systems. In example, multiple buoyancy systems were created and mounted to the machine. The PVC tube system was selected over high-density foam prototypes. The high-density foam would have been a costlier venture and more time would be put into optimizing mounting hardware.

As the electrical systems of the USS Phoenix became regularly under use, it began to reveal its flaws. The Anderson Plug system had been in use for the 2 previous competitions. It was determined that it was unreliable in securing pin-to-pin contact for the systems integrated on such a fuse board. The Upgraded fuse board was of the manufacturer Altronix, the model PD8, power distribution module. This board passed prototyping stages and solved the issue of checking for blown fuses. Glass-tube fuses were recognized as being superior to ATO/ATC fuses. ATO/ATC fuses are difficult to verify under low-lighting conditions as was the situation experienced in the previous year of competition.

Prototyping facilities were acquired to simulate rigorous testing conditions of the created systems. The usage of breadboards gave space to test electrical components before implement into the machine. Servos and Arduino modules were tested under conditions of proposed electrical load. Additionally, the team had access to a 16-foot swimming pool. This area tested the newly devised center-tube system to access whether its electronics onboard would function to optimal capacities. Prolonged exposure to water was simulated by 55-gallon water drum in the team's lab. Newly water proofed cameras were inspected and subject to overnight exposure these conditions.

Challenges

This year, most challenges stemmed from the implementation of new technologies and structures added to the machine. The 2018 competition will be the first time the machine has had more than 5 motors between all systems. The addition of a 2-axis claw added two servo motors that are controlled with sub-surface, onboard motor controllers. These servos also came along with new coding and programming we had to figure out, which was different than anything we had previously encountered. We implemented new technologies to try and measure and manipulate the different things we had to do in the tasks, which not all work. It was a lot of trial and error to figure out all the different pros and cons these new tools had and some would end up not working out anyway, which was a big-time drainer. Along with a new year came the loss of old members, which had a particularly big impact this year because the senior members from last year had the most experience and knowledge, so we really had to work this year to catch up and to learn for ourselves things we didn't previously have to worry about.

There is also the factor that not everybody on the team had a sufficient amount of time to commit, and we really had to push for attendance and get on a grind at the end to get everything done. The number of students in the club also decreased significantly since the start due to this lack of commitment, and students realizing they weren't willing to sacrifice what this team required. This put a lot of pressure on us who remained to get all the work done in the allotted time.

The building aspect was very hands-on, and we had to take on a bunch of new types of challenges in the making of the physical ROV such as welding and figuring out how to use a variety of other tools. Waterproofing the inner brain of the ROV and locating it inside the machine was also a challenge on its own, being that if there was any water leakage whatsoever the machine would be rendered useless. The systems we were trying to use again were also very difficult to replicate, especially onto the new ROV that was different in so many ways then before and had to be approached by a whole new view versus simply carrying ideas from one ROV to the next. Servos were also a special challenge to waterproof, especially with our lack of experience with them. We had to try a few different types of waterproofing to finally get it right, and even then, they were not perfect. In this process we lost some, and that only adds to price and wasted parts.

The waterproof issue also occurred with cameras, being that we got multiple new ones. We ended up burning out 4 cameras until we finally waterproofed them correctly, without interfering with the lens at all. The voltage regulators we were using at first also didn't work anything like we needed them too, and we had to experiment and move up to more expensive ones to manage all the electronics we were taking on. Power sources seemed to be an issue on occasion due to the amount of battery power we were requiring. However, probably the most challenging thing was finding the time to put into it, as well as coordinating with everybody else on the team, while keeping moral and dedication up. With our team truly committed we managed to overcome many complications to get our result.

Reflection

The Phoenix Robotics team's vast ambition worked both with and against the creation of the most complex ROV that has come out of Brooks DeBartolo. The knowledge we have gained this year will be instrumental in the advancements of future Phoenix members. Firstly, we took on a vast amount of new and unknown technology this year. This includes our using servos for the claw, which took their own layer of coding and hooking up, plus an entirely new waterproofing process. We also built an entire new frame out of aluminum, which is not what we usually use. This took up quite a bit of time and had a learning curve to it just like anything else. Stepping out of our comfort zone however helped us figure out what new technologies we had to our disposal as well to what worked versus what didn't. There was also the challenge of taking up a more robust claw, which had its own challenge mounting and managing it correctly. With some of the new equipment we had to use unique forms of waterproofing because these types of things were never dealt with previously. We had to adjust the brain of our machine to these new types of hardware, as well we be aware of increased need on our power sources. Also, we had the problem of losing some of the experienced members from last year, so everybody had to step up to the plate and take up new jobs and positions. There is a huge variety of different aspects of this machine that changed from previous years, and that we had to be flexible with and integrate it with our previous knowledge. All of this opens a gateway to future Phoenix ROV members with new ways to make an effective ROV, as well as help us make ours. Time was a crunch all the way through, but in the end the hours we put in were worth our outcome. Overall this year was a big step for Phoenix Robotics and we will make next year even better.

Budget:

Phoenix Robotics

Tampa, FL

Expense Report- 10 Person Team, 2 Chaperones

Date	Category	Description	Notes	Amount
	Flight	$500 per person	12 Individuals	$6,000.00
	Hotel	$150 per room, per night	4 Rooms, 7 Nights	$4,200.00
	Shuttle	20 Dollars per person, shuttling to and from competition for full duration	12 Individuals	$240.00
	Equipment Shipping			$500.00
	Repairs			$500.00

$11,440.00

Accounting

Item number system

Example Item number: 01-003

The first number two numbers: XX-000 describe the category/type of material

- 01: Electronics
- 02: Materials
- 03: PVC
- 04: Mounting Hardware
- 05: Purchased Material/Other
- 06: Pneumatic
- 07: OBS Release System
- 08: Recycled/ Donated Items (Itemized, given estimated costs but don't contribute to total)

The next three numbers: 00-XXX describes the item in the chronology it was purchased. This system keeps costs organized and divisible by subject-matter so future budgets can be calculated/ projected intelligently.

This system Draws inspiration from FDOT's *Summary of Quantities, sheet* RDB17-10, RDB17-17, RDB17-18 from the *2017 Plans Preparation Manual* (PPM) for roadway and civil design.

Standard abbreviations for the Unit column are described as such:

FT – Feet

MM - Millimeter

CM – Centimeter

EA - Each

KG - Kilograms

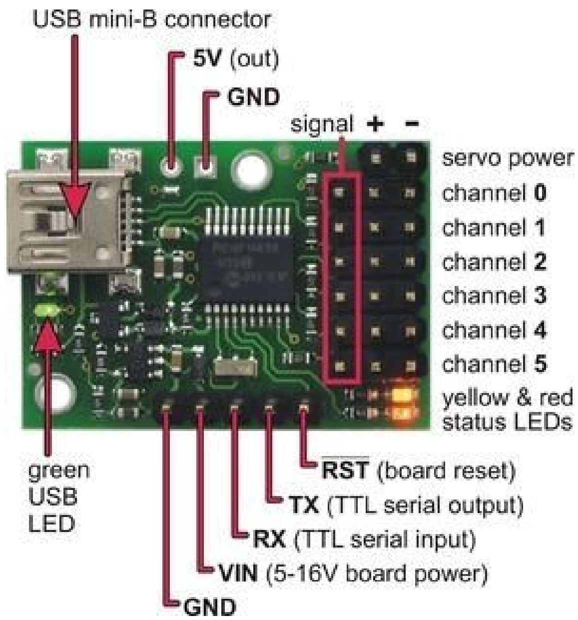
Project Costing

Item Number	Item	Cost	Unit	Quantity	Total
03-001	PVC Caps	5.49	EA	4	$ 5.49
03-002	2" Gripper	4.2	EA	1	$ 4.20
03-003	2" PVC pipe	0.85	FT	1.5	$ 1.28
04-001	Hose Clamps, 165mm type				
01-002	AGPtek 60kg 130LBs Holding Force Electric Magnetic Lock for Door Access Control System Electromagnet Fail-Safe NC Mode	23.12	EA	1	$ 23.12
01-003	1X DS3218 update servo 20KG full metal gear digital servo baja servo Waterproof servo for baja cars(Control Angle 270)	$18.11	EA	1	$ 18.11
01-005	SainSmart LM2596 Adjustable Voltage Regulator 4.0-40V to 1.25-37V DC 36V to 24V to 12V to 5V Variable Volt Power Supply Car Motor Buck Step Down Converter with Red Voltmeter Display	$8.99	EA	1	$ 8.99
01-006	LM2596 DC to DC Buck Converter 3.0-40V to 1.5-35V Power Supply Step Down Module	$11.58	EA	6	$ 11.58
01-007	SpeedDa Magnetic Reed Switch Normally Open Closed NC NO Door Alarm Window Security	$16.98	EA	6	$ 16.98
01-008	B5K 5K OHM Linear Taper Potentiometers POT w/ control knob	$6.48	EA	6	$ 6.48
02-001	RoboCore Robotic Claw - Croc V2	$9.95	EA	1	$ 9.95
06-001	PROSUB 1st Stage Regulator	$25.00	EA	1	$ 25.00
04-002	4.0" black heat shrink tubing 2:1 ratio 4"	$16.87	FT	4	$ 16.87
02-002	Power Antenna Aerial AM FM Replacement Mast for Lincoln Mark VII VIII Town Car	$12.99	EA	1	$ 12.99
01-010	US Wired waterproof mini Camera CCTV	$39.98	EA	1	$ 39.98
01-011	800TVL 1/3" Sony CCD Mini Micro Bullet Spy	$47.46	EA	1	$ 47.46
01-012	Altronics PD8 Fuse Board	$10.73	EA	1	$ 10.73
01-013	Anderson Powerpole 600v 3A Electric	$40.28	EA	40	$ 40.28

03-004	Clear Acrylic Round Tube (2.25 inch)	$14.00	FT	2.5	$ 14.00
01-014	5A 12 Position Wire Connector	$7.54	EA	10	$ 7.54
01-015	Hilitchi 12pcs Ground Circuit Terminal Blocks	$14.44	EA	12	$ 14.44
01-016	4x2 Channel Dual Relay Switch Model	$13.54	EA	1	$ 13.54
04-003	3" Black Heat Shrink 2:1 Adhesive Glue Lined Waterproof Tubing Heatshrink	$8.09	FT	3	$ 8.09
03-006	3" Clear PVC Pipe	$21.99	CM	90	$ 21.99
04-004	Fuel Tank Grommet Kit	$12.99	EA	1	$ 12.99
03-005	2" x 12" Clear PVC Pipe	$15.84	FT	1	$ 15.84
01-017	Black USB Dual Shock PC Computer Wired Gamepad Game Controller	$7.38	EA	1	$ 7.38
01-018	eBoot DC to DC Buck Converter	$11.59	EA	6	$ 11.59
01-019	Adjustable Voltage Regulator	$8.99	EA	2	$ 8.99
01-020	18mm Hole Saw Mini Macro Parking Reverse Backup CCTV	$13.50	EA	1	$ 13.50
02-003	20KG full metal gear	$18.11	EA	1	$ 18.11
01-021	Micro Maestro 6-Channel USB Servo Controller	$19.95	EA	1	$ 19.95
01-022	Sabertooth 2x5	$49.95	EA	2	$ 99.90
01-023	Johnson Pumps of America 28512 Marine Pump Cartridge for 1000 GPH Motor	$30.10	EA	4	$ 120.40
01-024	22 gauge speaker wire	$0.15	FT	75	$ 11.25
06-002	Scuba Gauge	$35.00	EA	1	$ 35.00
06-003	Pneumatic nozzle grip	$16.00	EA	1	$16.00
06-004	Scuba Tank Hose	$35.00	FT	6	$35.00
08-001	5kg of Structural Aluminum	$28	KG	5	$0
04-003	Nylon Cable Tie Assortment	$9.99	EA	1000	$9.99
Grand total					**$814.98**

Supplementing Documents

Item No. 01-021
Micro Maestro 6-Channel USB Servo Controller (Assembled)



Dimensions

Size:	0.85" x 1.20"
Weight:	4.8 g

General specifications

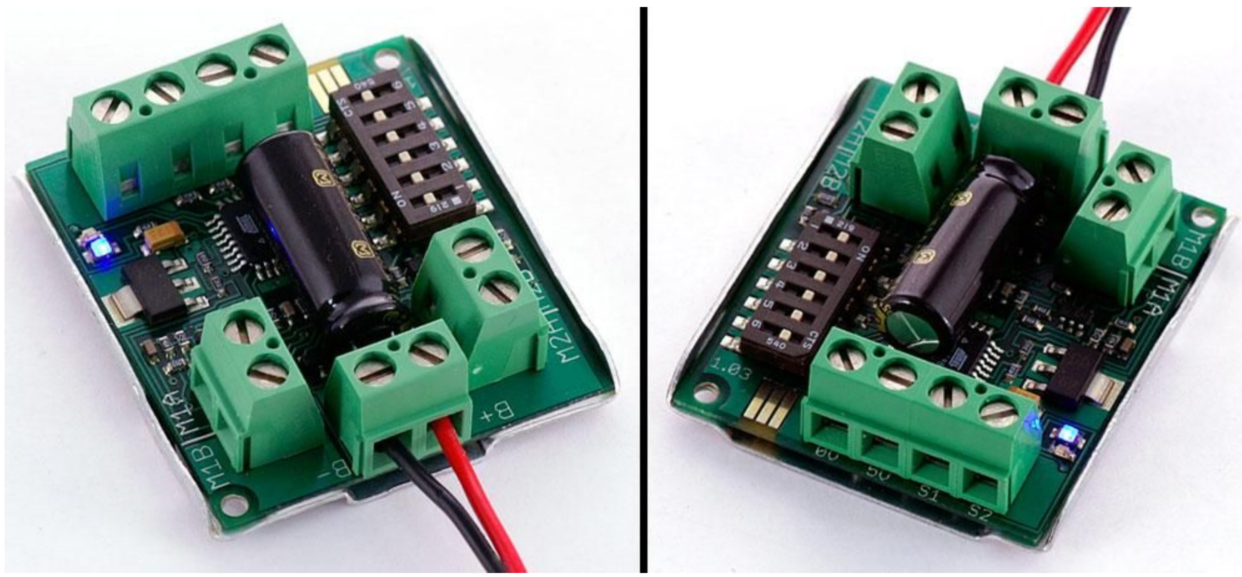
Channels:	6
Baud:	300 - 200000 bps[1]
Minimum operating voltage:	5 V
Maximum operating voltage:	16 V
Supply current:	30 mA[2]
Partial kit?:	N

Notes:

1 Autodetect works from 300 - 115200 bps.

2 With USB disconnected and all LEDs on. Connecting USB draws around 10 mA more.

Item No. 01-022
Sabertooth dual 5A motor driver



Dimensions:

19g / 0.7oz

Input Voltage: 6V to 18V,

6-12 cell NiMH or NiCd,

2s-4s LiPo,

6V or 12V lead acid (not 18+V lead acid!)

5A continuous per channel, 10A peak

Synchronous regenerative drive

Ultra-sonic switching frequency

Thermal and overcurrent protection

Lithium protection mode

Input modes: Analog, R/C, simplified serial, packetized serial

Size: 1.8” x 1.6 ” x .5”

45 x 40 x 13 mm

Item No. 01-012
Altronix PD8

Input Voltage Range:
28VAC or 28VDC max., up to 12A.
Outputs Eight (8) fuse protected outputs. 2.5A per output max.
Total output current should not exceed max current rating of power supply employed.
Fuses are rated @ 3.5A/250V.
Indicators (LED) DC Output Power LED.
Physical and Environmental Dimensions:
(L x W x H) 5.25” x 3.25” x 1”
(133.4mm x 82.6mm x 25.4mm).
Product Weight:
0.25 lbs. (0.11 kg).
Temperature Operating:
0ºC to 49ºC (32ºF to 120ºF).
Storage: -20ºC to 70ºC (-4ºF to 158ºF).
Relative Humidity: 85% +/-5%.

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Acknowledgement of Contributors

- Brooks DeBartolo Collegiate High School for providing the establishment (lab) and some of our funding for all four years
- Derrick Brooks for providing direct funding for our International Competition Experience
- DeBartolo Family Foundation for providing direct funding for our International Competition Experience
- Eric Fernandez for giving us the knowledge to create advanced machinery to perform task
- Marine Advanced Technology Education Center, our competition organizers who have challenged us to create a greater product, and for providing this wonderful opportunity for us to compete with so many different teams across the world
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