Moanalua High School Robotics

The Cockroach








Team Members: Nick Ing, Reese Shiroma, Sean Amorozo, Michael Amorozo, Corey Yonemura, Leighton Lum, Jason Yeo, Warren Garperio, Reese Rosco, Carina Surface, Byrn Okamura, Jason Gima, Lynsey Uyeno, Anthony Diep, Will McCallister, Kevin Yu, Steven Sedenio
Advisor: David Izumi

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Abstract

Each member of the Moanalua High School Underwater Robotics Team compiles this report, as they articulated their findings to their group leaders. The name of our ROV is the Cockroach, for its somewhat resemblance.

Remotely Operated Vehicles (ROV) is typically used where danger is extremely high and hostile environments are the common workplace for humans. It enables human operators to avoid explosives, radioactive material, biological specimens, severe deep ocean temperatures and pressure.

HERCULES, a large ROV, was used for archaeological excavation of ancient shipwrecks in the Mediterranean and Black Seas from Wood Hole Marine Systems Inc. Other examples include examining plate tectonics, ocean floor mapping, collecting & observing reef, biological samples, and deep-sea marine life, exploring the Titanic, Alligator, and other shipwrecks.

For this competition we will be completing three tasks, which will simulate the uses of the ROV. These missions will be highlighted further into the report.

The Missions

Written by Jason Gima, Anthony Diep, Cory Yonemura

Mission 1

In mission one the ROV must shut off a valve. The ball valve is at a 90-degree angle, and the ROV must turn the ball valve to the shut position. The ball valve is made of brass and has a one-meter, ½-inch diameter PVC pipe attached to simulate the "leaking oil-well" shutoff lever in the Gulf of Mexico. One of the main obstacles to overcome will be dealing with the underwater current. For this mission we plan to attach a shovel like piece made from plastic to the front end of the ROV. We hope this will enable us to push the lever arm to the shut position.

Mission 2

Gearing is important in our missions. It is connected to a separate power line, which runs to a waterproof "Otterbox" which holds the gears and the motor to operate the gearing. The eight gears, housed in the Otterbox, are controlled by a motor which is wired to the tether line that is connected to the control box. Since the smallest gear, the pinion gear (6 teeth) is moving too fast to be practical; we slowed down the rotation of the gearing by adding another larger gear (36 teeth). This will give a gear ratio of 6:1, which will in turn increase the amount of torque.

The use of gears in our mission two and three, are necessary, but is emphasized on the second mission. Mission two requires the simulation of reinserting of a communications probe, with wire attached, into the open port of a fiber optics cable connection using the ROV. We will be using a cylindrical piece; this will grab the ring and simply drop it in the open port. The gears will run and wind the wire creating tension and opening the piece to grab and release the communications probe.
the exact placement of the probe.

The Missions

Continued

Mission 3

For mission 3 we will need to push a ½-inch PVC pipe, which has a Velcro pad on one end, onto a marked section on the wall of the arena. When the mission is successfully completed, a light will go on to show we have placed the pipe in the correct spot. If the light does not go on, we must rip the Velcro pad off the wall with the ROV and try again. This mission simulates the connection of a port used on the Hubble space telescope. There will be a one-inch PVC pipe which fits over the ½-inch PVC pipe. We are expecting this mission to be the most challenging because of the exact placement of the probe.

Note: Velcro strips may take a force of 0.025 Newtons per hook (information was based on Van der Waals force). The amount of force needed to pull the Velcro apart depends on how may hooks there are on the pad

Frame and Structure

Written By Carina Surface, Dominique Wijaya, Nickolas Ing, Allison Ako, and Steven Sardenio with assistance from Warren Garperio

Using two old aluminum seat brackets, previously used in an automobile, created the frame for the ROV. We decided to use the seat brackets mainly because of the overall durability and the light amount of weight due to the aluminum. The increased surface area would hopefully not hinder the movement but increase stability underwater. To help insure this, we separated the two brackets by 5 cm to allow water to flow through the ROV as we surface or submerge. Last year's ROV weighed 20.9 kg as compared to this year's 13.2 kg. We learned this conservation on weight does not affect the buoyancy, only the amount of floatation devices needed to achieve neutral buoyancy. By limiting the amount of floatation devices we would cut down on friction as we travel, thus assuring a sleeker more mobile robot.

As learned from members last year, we needed to waterproof the floatation devices because although they are made of foam, it takes on water thus changing the buoyancy of the ROV from neutral to negative. During the regional competition we had to add more floatation devices because we suddenly couldn't maneuver the robot or make it surface. We knew that we had achieved neutral buoyancy but yet somehow during the course we were dead in the water. Pulling the robot up we discovered the floaters took on water which led to our rock like imitation. In order to achieve neutral buoyancy we made use of an old body board. We shaped it so it would assist the flow of water as we travel underwater to complete our missions. To keep it waterproof, we coated it with a rubberized coating, Grip Guard.

We did use PVC in the fabrication of our protective shrouds to create a "Kort Nozzle" effect. Placing the propellers close to the wall of the shroud, and having a tapered PVC pipe, which is cut to allow the water to be literally sucked into the propeller as it travels through the PVC, creates this. The speed of the water increases as it exits the smaller back end of the shroud. This is made to react, as sort of an underwater jet engine.

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Propulsion-How a Propeller Works

Written by Warren Garperio, Bryn Okamura, Lynsey Uyeno

1) Thrust

-As Newton stated, "actio est reactio": This means a device accelerating air or water in one direction, feels a force in the opposite direction.

-A propeller accelerates incoming air particles, or water molecules, "throwing them towards the rear, and thus feels a force on itself—this force is called thrust."

-The Thrust of a propeller depends on the volume of air (or water)accelerated per time unit, on the amount of the acceleration, and on the density of the medium.

Thrust Formula

T thrust [N]

D propeller diameter [m]

V velocity of incoming flow [m/s]

Additional velocity, acceleration by propeller [m/s]

Density of fluid [kg/m3]

(air; = 1.225 kg/m3, water; = 100 kg/m3)

Propulsion-How a Propeller Works

Continued

2) Pitch:
-The linear distance that the propeller would move in one complete revolution through a solid medium not allowing for slip.
Different types of pitch:
1. Constant (fixed) pitch - pitch is equal for each radius.
2. Progressive pitch – pitch increases along the radial line from leading edge to trailing edge.
3. Regressive pitch – pitch decreases along the radial line from leading edge to trailing edge.
4. Variable pitch - pitch is different at selected radii
5. Controllable pitch – blade angle is mechanically varied.

3) Cup:
Small radius or curvature located at the trailing edge of blade.
Cupping, helps to reduce or delay cavitations.
Helps to reduce slip, thus increasing actual pitch and usable thrust.

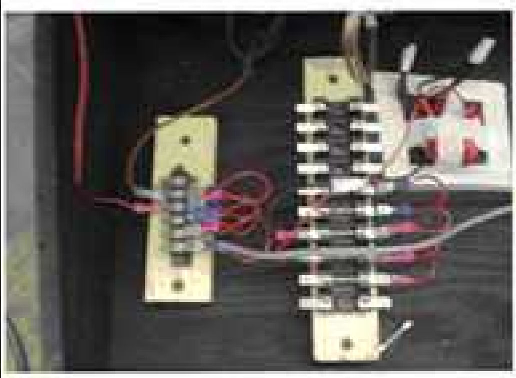
4) Rake:
Propeller blade will slant forward or aft from the Blade Centre Axis (BCA).
Positive rake – blade slants towards aft end of the hub.
Negative rake – blade slants towards forward end of the hub.
Can be specified in inches at the tip or in degrees.

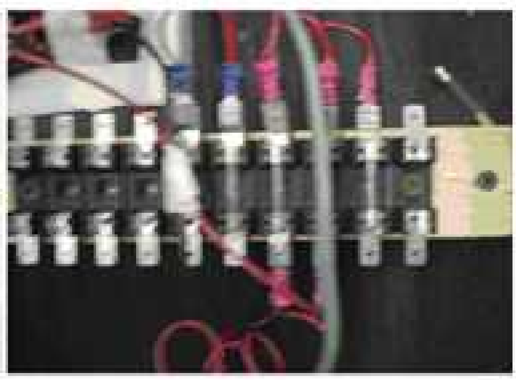
5) Skew:
Blade Centre Line (BCL) is curvilinear sweeping back from the direction of rotation. Contour of the blade is not radially symmetrical about blade centre axis.

The Control Box

Connected to the plug and fuse box are several wires; four sets of which are the ones that connect the switches on the "Ultimate Joystick", to the positive fuse box and the negative plugs. There are eight of these single pole double throw switches, and each is attached to the underside of the two joysticks (four on each joystick). Unlike actual joysticks, which can control the speed of the motors' rotation, these joysticks merely activate the desired switch, allowing for vertical and horizontal movements of the ROV. One single pole double throw switch has three brass electrical ports on it. Two are reserved for the negative and positive power source, but the third is the wire that will connect to the motors. These eight motor wires run out a hole in the front of the box and gather together in a plastic plug. The tips of these wires in the plug have male plug parts fused onto the wire. This will then attach to the female parts fused onto the tether line wire that leads to the motors. The voltage passing through the circuit that powers each individual motor is about 12.1 volts, and each individual circuit between the switch and the motor is 4.4 ohms of resistance.

Other important wires that are connected to the negative plug and the positive fuse box inside the control box are the power lines that go to the infrared cameras and the gear box on the ROV. The camera video wires are also connected to a switch inside the control box. From this switch, a different set of video wires lead out of the box, and connect to a monitor or television. Since there are two cameras on the ROV, the switch allows the pilot to change views between cameras with greater ease and efficiency.





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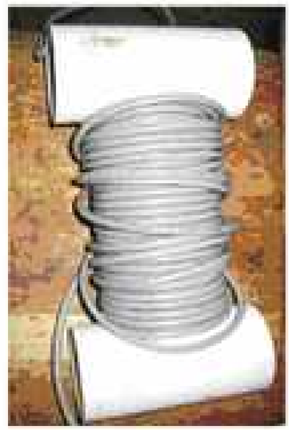
POWER CLARICATION
(Taken from Competition Handbook)



Electrical power traveling through the tether must meet specifications, 25 amps for Ranger.
The following auxiliary DC electrical power is also permitted:
- Batteries to run topside computers used as control panels/monitors.
- Batteries to run onboard lights (Explorer teams must include these batteries as part of their onboard 13-volt, 25 amp limit)

Note that auxiliary DC systems must be fused.
The following non-electrical sources of power are also permitted, provided that they meet safety guidelines:
- Hydraulic, such as oil or other liquids up to 150psi
- Pneumatic, such as compressed, inert gases up to 60psi

These non-electrical sources of power can be:
- Run by hand or foot (e.g., manual bicycle tire pump)
- Run by DC. Note that DC systems must be fused.
- Run by 110 volts, GFI-protected AC (e.g., AC-powered air compressor)
- Generated from approved, tested, and inspected pre-pressurized containers. These containers must have a safety relief device.

Teams with questions about their planned power scheme should contact the competition coordinator (better to clear up any concerns now rather than the day of the competition).

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Infrared Camera System

Our ROV supports two CCI Water Proof cameras. Each camera is equipped with ten infrared LED lights. An LED is a light emitting diode. These LED's emit infrared light, the lowest frequency of light. Infrared IR radiation is electromagnetic radiation of a wavelength longer than visible light, but shorter than microwave radiation. The name means "below red" (from the Latin infra, "below"), red being the lowest color of visible light of longest wavelength. This basically means with the naked eye it is virtually invisible, but with our ROV being tethered to a monitor, it enables us to see the effects of the IR lights. Infrared radiation spans three orders of magnitude and has wavelengths between 700nm and 1mm.

Since the cameras are waterproofed, it saved us time and the hassle of waterproofing a camera system. The manufactures spec sheet states the waterproofing has a maximum depth of 90 ft., yet recommends an operation depth of 50 feet. 120 feet of waterproof wire provides the signal to be transported up to the monitor, and the power for the system.

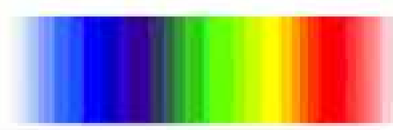
Camera Specs

Camera Mount: Bracket Included
Dimensions: 2"L x 1.5"W x 1.5"H
Electronic Shutter: auto 1/100 - 1/100,000 sec.
Housing/Color: Brass-Black Finish
Humidity: Within 95 % RH
Image Device: 1/3" B/W CCD image sensor
*IR LED: 10 IR LED
Lens: 3.6mm, Hor. 72° Vert. 53°
Minimum Illumination: 0 lux
Number of Pixels: 512 horizontal x 492 vertical
Operating Temperature: 15° F - 120° F
Outputs: Video - RCA with BNC adapter, power- DC jack
Power Consumption: 100 mA
Power Requirements: regulated 12V DC power supply included (UL and CSA listed)
Resolution: 420 lines
Scanning Frequency: horizontal 15.75 kHz vertical 60 Hz
Scanning System: EIA standard 525 TV lines 60 fields/set
Video Output Level: 1.0 Vp.p 75 ohm
Video S/N Ratio: Greater than 46 dB
Weight: 7.4 oz

Magnetic Light Spectrum

Wavelength ------------------->
<-------------------Frequency

Gamma Ray X-ray Ultraviolet Infrared Microwave Radio



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Careers

· Written by Kevin Yu

In our extensive research on the careers in the robotics, we came across many specialized fields of expertise. We manage to simplify the careers into four careers: oceanographer, marine technician, communication specialists, and environmental analysts.

· **Oceanographer**: The main job specifications are to explore the surfaces and trends of the earth's environment that will influence the future, such as continental shifts, underwater volcanic activities, and other global issues surrounding the oceans.

· **Communication Specialists**: Communication is one of the main factors to make an efficient team. People with specialty skills in this field are tasked with instigate actions to accomplish specific strategy objectives. This position will focus on planning legislative outreach activities and increasing the team's visibility by coordinating outreach activities.

· **Marine Technicians**: This field requires the person to conduct on-shore and at-sea testing. He or she would be dealing with operation, maintenance, troubleshooting and repair of the standard oceanographic instruments.

· **Environmental Analysts**: This type of career allows the person to manage and protect marine mammals. They are threatened and endangered species that are under the jurisdiction of NOAA Fisheries, that are also under careful observation. The goal of this field is to authorize protection, conservation to the populations of endangered marine wildlife species, They are also there to provide effective protection to detrimental human activities, while allowing humans to proceed in a manner that is sustainable for the species affected.

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Career Exploration

Engineering Occupations Associated to the ROV

Written by Kevin Yu

Electrical Engineering:

Electrical engineers work side by side with civil engineers to assist them with the electrical part of a project. Their main objective is to test, supervise, and manufacture electrical or electronic products. They work with power and electricity which are the elements we need to move efficiently throughout the day. Electrical engineers are very efficient in working with circuitry, electrical motors, wiring and lighting in buildings, machinery controls, navigation systems, aircraft, automobiles, radars, communications and broadcast systems. Electrical engineers are also known as designers of new products. They also write performance requirements and develop maintenance schedules. Electrical engineers can be described as a surgeon that works with the inner parts of a body and making it functional. In relation to our R.O.V. project, the electrical controls of maneuvering the R.O.V. are done as a simple parallel circuit using joy sticks with double pull-double throw switches. The joy sticks powers the motors and gives the R.O.V. the basic functions to move efficiently underwater.

Mechanical Engineering:

Like the electrical engineers, mechanical engineers work with the testing, supervision, and manufacture of tools, engines, and machines. They work power generators turbines, air conditioning system, refrigerators, and robots. They also design tools for other engineers to use. Mechanical engineers are the broadest engineering field with many opportunities with the knowledge from civil and some electrical. Its integrations make this occupation very flexible. Mechanical engineers may work in production operations in manufacturing or agriculture, maintenance, or technical sales; many of them are administrators or manager. The work between a mechanical engineer and electrical engineer on a ROV (Remotely Operated Vehicle) are very close related. They specialize in the specific functioning of the ROV. In most cases, the ROV has a device to pick up samples from the ocean surface, almost like a mechanical arm. This portion is the mechanical engineers job to plan and design a device capable of maneuvering underwater with his/her limited materials. Once the design is complete, the mechanical and electrical engineers work together to connect all necessary circuits to finalize the arm and install in on to the ROV

Civil Engineering:

Civil engineers deal with the supervision of construction. Their main objective is to see how the project is handled and carried out. Some other civil engineer work entirely on the field or they actually do the projects themselves. Civil engineers' work fields include structural, environmental, transportation, and geotechnical and hydro engineering. Civil engineers builds and creates many devices that helps us get through our day, such as bridges, dams, sewage systems, and even airports. These are just some things that civil engineers do, obviously there are more in-depth systems and technical instruments they have made, nevertheless engineers are known as problem solvers. They find a way to better the society and the human world. Civil engineers makes about on average $60,000 - $70,000 annually based on their work location and experience. Engineers are known to be well educated and acquire good work ethics.

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Reflections

Jason Gima

During robotics class I have gained and learned a lot about the different kinds of engineering jobs. Some of the things that I learned in robotics are learning how to test our designs. I learned about working together as a team and that is better than working alone. Our teamwork has grown from the beginning of the year and we've become so much closer as a team.

Allison Ako

My experience in Robotics has been very rewarding. I learned so many new things as well as made many new friends. It is really fun here because there is always something to do and something new to discover and learn. Whenever I am having a bad day and I come to robotic it gives me something to take my mind off things and just relax a little. What I really liked about the team is when I just joined. Everyone was so helpful and I can ask them anything. I learned how to use the tools. At first I was a little intimidated by the tools because they seemed so powerful and I didn't want to make any mistakes when I used them. After some mistakes and redoes I got the hang of it and its not as hard as I thought it would be. Another thing that I learned was how to make a balast system for the ROV. We made it by having an inflatable tire in PVC under the ROV, so when you inflate the tire it will bring the ROV to the surface. I was also working on the hydraulics and what we are doing with that is making an arm that will open and close. In order for it to do that, we had to make a tube connected to the arm filled with water. There is also a rod in side connected to the arm. When you apply pressure to the water it will then push the rod forward and open the arm and vice versa for when you close it. Being in this program is really fun and interesting. I think that it will also help me in the future since I want to sort of become an engineer. It will most definitely help me if I want to become a mechanical or electrical engineer.

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Reflections

Dominique Wijaya

Rarely does one find an after-school class comprised of such culturally diverse individuals, possessing widely differing academic classes, bound together in scientific interest and camaraderie. The Underwater robotics program is not simply a science class, but a team-focused organization, a family. We bond as we problem solve the intricacies of underwater robot mechanic, as we eat at "Dirty Lickings", our favorite buffalo wing specialty restaurant, as we fundraise our way to nationals; washing cars and selling brownies and cookies. We set aside our differences and we work- morning, noon, and night- for the good of the whole. Perhaps the smell of aluminum piping in the morning gets our adrenaline running or that we find the aromatic, earthy, scent of freshly-cut wood exhilarating. Whatever the case, we meet three days a week, after school during the school year, and morning, noon, and night during the summer. We sacrifice movies, beach, television, and we come to the "shop", our workplace, eager and hungry for knowledge, experience, and friendship.The regional and national underwater robotics competition were some of the highlights of our season, but the most enjoyable aspect of this "after-school class" were the committed, bright, friendly, individuals and the ingenious teacher and coach whose humor and enthusiasm never ceased to motivate the team, making my experience truly one of a kind.

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Reflections

Cory Yonemura

I've been in robotics for over half a year and have gained a lot from this program. I learned a lot about ROV's and how they work. I also learned about using tools and techniques of doing things. The most important things I learned from this was about teamwork and about myself. The reason I joined this program was to get experience in some engineering and because it sounded fun. Also I knew some people in it, which was a factor too. The first month or so went by slow and I did not expect it to be what it was. I was talked to a lot and became lost a lot.I didn't contribute a lot to the team at that time. I started not to like robotics and was thinking about dropping. The days before the regional competition was tough. We had to really work hard and I was not use to that. After the competition, it went by pretty fast. I started to get more involved and doing more things, which I learned a lot. Everyone was working hard and contributing. I had learned that reason I did not like robotics was probably because of my attitude. I realize how important teamwork is in this kind of program. We have to back each other up and be supportive of each other. I am glad that I stuck with the program because it has taught me not only about robotics but also about myself. I can use all that I learned from this program and apply knowledge to the real world. It's been a great and enriching experience, which taught me a lot.

Kevin Yu

Throughout this year I have been absorbing all the new knowledge that I have endured during the competitions and the working time. Such factors seriously affect the individual as well as the overall performance of the team. I believe this year the most important factor in my life and education that I have learned considering that I graduated this year was staying on task and focusing on one objective at a time. Prioritizing the workload was also crucial when dealing with time management. It helped me organize what needed to be done and what is most important.Robotics has shown me the field of problem solving, carrying out a mission, and leadership. Problem solving started at the beginning of the class; it dealt with time management, resources of the group, and the most important factor completing the mission of the ROV. After the initial challenges at hand come the secondary challenges such as questions as structure, controls, and other aspects of a functional ROV. This took our team numerous days of planning and trial and error to actually complete the ROV to our satisfaction.

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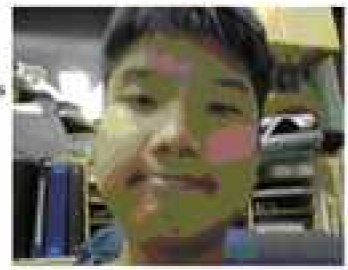
Reflections

Jason Yeo

My experience in robotics was very fun and challenging. I made new friends and learned a whole lot of things that I didn't know. The whole experience was very fun to design and completing the robotics problems is an important program. I've learned numerous things doing the program like working with the power tools. I've also learned fun things like the flat head screwdriver or a hacksaw.



Michael Amorozo

While making the two ROVS one robot for the regional competition and one for the national and the biggest thing that I learned is that failure occurs more often then success. The trials taken to make a ROV that works effectively will make most people want to quit. For us we rarely had the first prototype work and if it did adjustments had to be made anyways but each failure brought us closer to success. Each step backwards brought us two s teps forward until finally we reached our goal.

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Hindsight

There are many things we would like to have done for our ROV in this competition, but never had the chance because of time and financial constraints. For example we would have liked to explore a hydraulic or, pneumatic system but because of the lack of resources and poor time management on our part, we were limited to the final product.

Warren Garperio, Captain
The process was very excruciating. At first, it took us a while to actually start the frame of our ROV because we had to decide what we wanted our basic frame to be made of. When it was finally decided on using aluminum seat brackets, placement of the motors, and amount and shape of the floaters, almost two months had passed. And we still weren't sure on how we were going to accomplish the missions.

Having the privilege to be the captain of the 2005 Moanalua High School Robotic team is a great honor. As a senior I knew that taking on such a great responsibility would take commitment and also a lot of sacrifices. I had been fortunate enough to witness the 2004 National Underwater Robotic Challenge, which would be helpful especially for the new comers. With the knowledge and experience gained from the previous competitions, my quest for this year was not only to acquire a national recognition but to also educate my teammates.

The 2005 team consist of many underclassmen and also a lot of new faces. In the previous year, we had problems with commitment, and this year was no different. Although we had the same issues we also had dedicated people who would help keep the team on task. I believe that having new team members without any knowledge about ROVs was not a negative aspect. It is an added bonus because it gave me chance to not only educate them but to also create new friends. Overall there were recurring issues and also new faces but I believe that this year's team will gain valuable knowledge and experience from the competition.

Hindsight

Written by Warren Garperio and Carina Surface

Carina Surface, Executive Officer
Over the course of this project I not only agree with what Warren had wrote, but learned much about the many uses of tools. I gained not only leadership skills but also now Know the importance of time management but learned about teamwork and communication in a work environment. I gained a new interest in robotics and engineering and would like to consider the profession after graduating. I would have to say that after this year I have grown a lot in my first year of high school.

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All materials were on hand or donated.
No expenses were occured.

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Amount Used: 0.00
Ending Balance: 500.00

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