



Mustang Robotics

McFadden School of Excellence
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TEAM 129

Table of Contents

Research Paper	p. 3
Client Requirements	p. 7
Team Organization	p. 7
Mustang Robotics Organization	p. 8
Implementation	p. 8
Brainstorming Approaches	p. 9
Analytical Evaluation	p. 12
Offensive and Defensive Evaluation	p. 14
Design Creativity	p. 15
Building the Robot	p. 20
Testing the Robot	p. 23
Conclusion	p. 27
Changes since Game Day	p. 27
Change Order Redesign Process	p. 28
Appendix	p. 30

Research Paper

The future of easy energy for earth is not guaranteed. If we continue at the pace we are on, all of earth's fossil fuels will be used up within our lifetime. We owe it to future generations to make sure this does not occur. Reducing the overall use of fossil fuels is possible, but it will take a global commitment to truly make a difference. Currently, the United States leads every other country in the world in the use of fossil fuels. We need to make a change today and fuel cells may be the answer.

To begin, a fuel cell is a conversion device. It changes hydrogen and oxygen into water. In order to do this an electric current is run through the elements. As long as these two elements are flowing into the fuel cell it will not lose power. Fuel cells produce energy in the form of electricity and heat.

Two British scientists, Anthony Carlisle and William Nicholson, developed the idea that they could use an electric current to turn water into hydrogen and oxygen. This however is the opposite of what a fuel cell is supposed to do. The idea for the fuel cell was invented by a scientist in Germany named Christian Schonbein. This idea that he came up with in 1838 allowed for a Welsh scientist named Sir William Grove to create the first fuel cell in 1839. He discovered that if he could continuously supply the device with hydrogen and oxygen he would

essentially have a battery that never needed recharging. Today we know this type of fuel cell as a Hydrogen Fuel Cell, but at the time Grove called it a “gas battery.”

In 1893 Friedrich Ostwald explained in greater detail how the whole concept of a fuel cell worked. In the 1930’s, a man named Francis Bacon began his work with fuel cells. During the Second World War he helped the British Navy by developing ways that the fuel cells could be used on ships. Eventually an American company asked him to help develop a way to use fuel cells on the NASA Apollo space projects. Around the same time, in 1955, a chemist named Thomas Grubb made even more modifications to the technology. Three years later his modified version was used in Project Gemini. That began a new and viable option to the common fossil fuels we had been using for decades.

In today’s society robots are being utilized to create, build, and analyze many different elements that occur in nature. Robots are being used in many ways to help our environment and also to make it easier on humans. One company in particular, Oceaneering International, is utilizing robots or ROV’s (remotely operated vehicles) in deep underwater exploration. One example that Oceaneering International is using ROV’s is the Hydra Magnum. This was developed with the desire to go deeper into the sea and drill at depths never drilled before for the exploration for oil. The Hydra Magnum is a fully remote controlled robot that can

perform numerous tasks at water depths to 10,000 feet. Is it possible to use similar robots to work with alternative fuels?

Fuel cells are unique because when they are combined in a certain way, they actually equal and are the same as using fossil fuels yet they provide not only clean but resourceful energy. World use of fuel cells may be the answer to the abuse of the earth's fossil fuels and may be the answer to our energy challenges. Fuel cell use is already having a huge impact in today's society. In some cases fuel cell systems are already serving as the main power source for schools, hotels, and office buildings. Sometimes, fuel cells are used for power that may be needed in case of an outage such as in a hospital where a surgery may be taking place and immediate power is needed if a power outage were to occur.

The most popular way fuel cell technology is being utilized that is most known by all is through transportation. Many of the automobile makers realize that the use of fuel cells will actually substitute the internal combustion engine in vehicles. Fuel cells are already assisting with powering trains, buses, planes, and even bicycles. Future growth of this technology is inevitable and will most certainly impact our lives in the neat future.

The use of current and future technology in finding ways to better our environment and to help our posterity will allow generations to thrive. This is only the start of what the future holds, with the continued development of the use and

application of fuel cells. Now, the world must come together and realize that we need to conserve our natural resources such as fossil fuels, so that our future generations will have the means to power their society.

Research Paper Resources

http://www.iop.org/activity/policy/Consultations/Energy_and_Environment/file_2864.doc

<http://www.oceaneering.com/>

<http://www.articlesbase.com/automotive-articles/the-destructive-consequences-of-fossil-fuels-491141.html>

http://www.kettering.edu/futurestudents/undergraduate/fuelcells_faq.jsp

http://en.wikipedia.org/wiki/Fuel_cell

http://www.princeton.edu/~chm333/2002/spring/FuelCells/fuel_cells-history.shtml

http://www.princeton.edu/~chm333/2002/spring/FuelCells/what_is_fuel_cell.shtml

2009 BEST Robotics Client Requirements

Mustang Robotics has been requested by BEST Robotics to design a robot that will be used to collect different molecules and resources to complete a series of chemical reactions. These chemical reactions will then create the important compound isooctane. Isooctane is necessary for the production of fuel cells and our client and their investors have requested our help in making this an automated procedure using a minimal budget. Our goal, as a team, along with our robot, is to collect these different molecules and resources in different amounts to form the reaction needed to synthesize isooctane and ultimately create a fuel cell.

Team Organization

Before we started planning and designing we elected two leaders, a president and a vice-president. The leaders would be responsible for making sure all team activities were completed on time. The team chose to elect leaders that had previous experience with the BEST Robotics client. Previous experience was necessary to make sure that we had everything in order for competition day. Individual team leaders were also chosen to represent the different groups that would make up our robotics team. The president and vice-president are working

with the team leaders to make sure that all groups will meet their designated deadlines.

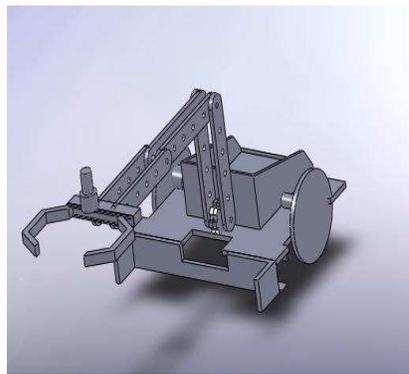
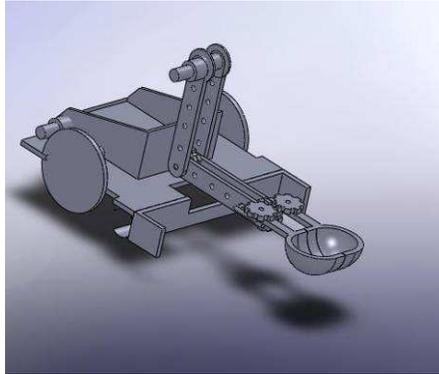
Mustang Robotics Organization

Adam Raymer	President
Ryan Eagle	Vice-President
Adam Raymer	Engineering Manager
Ryan Cripps	CAD Design Engineer
Sylvio Mayolo	Website Manager
Andrew Heim	Notebook Writer
Corbin King	Multimedia Presentations
Seth Harrell	Publicity and Promotions
Lauren Grizzard	Oral Presentation Leader
Hannah Guthrie	Spirit Team Leader

Implementation of the Engineering Design Process

On the first day after receiving our task, the team gathered together to work on ideas and to begin the engineering process. The engineering team includes not only building the robot, but creating both cardboard, KNEEX, and CAD (computer aided design) models of our robot. The CAD design program SolidWorks was used to make models of possible ideas of what the robot might look like and also

the actual robot. To make a CAD drawing, measurements are created of the various parts of the robot and then they are created as drawings of two dimensional shapes. After that, the shapes are then made three dimensional to make one of the components of the robot. When all of the components are put together using distance of one part from another part, parallels between parts, and more such things, our robot is created in CAD. We are fortunate to have an experienced CAD design member on our team.



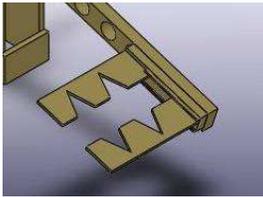
These are two early ideas for the robot. One idea uses a scoop on the front and the other use a grip to hold parts. SolidWorks was used to develop ideas on computer prior to building.

Brainstorming Approaches

During our first meeting on September 8, 2009, we started the brainstorming stage of our design process. There were 33 members in attendance at our first meeting. We met as a group and discussed the setup of the playing field and how our robot would need to be constructed to meet the challenge we were given. Team President Adam Raymer led the group in a discussion about ideas for building the robot. Most everyone had an idea. Some were good, while others were not appropriate for the task. It was helpful for all team members to be involved in this

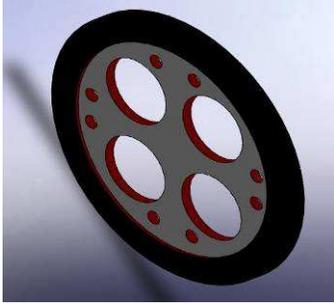
area even if they were not a part of the engineering team. We believe that using all the available resources (team members) helps our engineers design a better robot.

As we discussed and brainstormed ideas it became clear that we most definitely needed some type of claw/apparatus on our robot to pick up all of the different objects that would be on the playing field.



This is the claw design that was determined to be the best for our robot.

The robot would need to move racquetballs, tennis balls, tomato paste cans, and even grab beach balls. This made it difficult for us because we needed to design a robot that would successfully pick up each piece, but also fit within the size dimensions of 24"x24"x24". Our team decided that the robot should have some speed, but should also be able to maneuver easily. Therefore, we agreed that the wheels needed to be larger than 9 inches around, but smaller than 13 inches. We came to this conclusion by the construction of previous robots. We had an idea for moving the robot using wheels attached to the large motors. These two ideas, the claw and wheels, alone allowed us to begin the process of designing and building our robot.



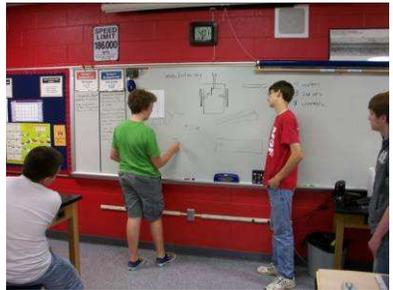
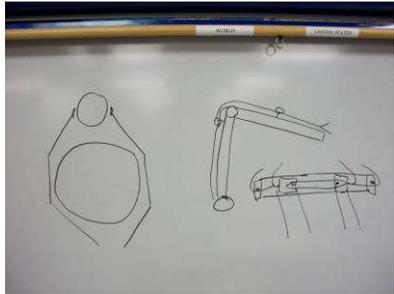
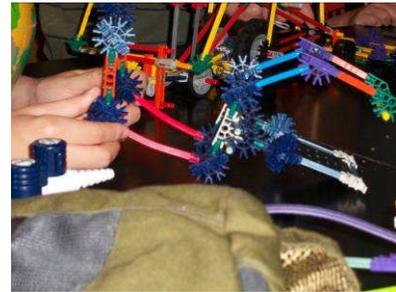
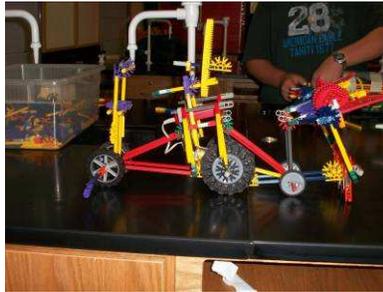
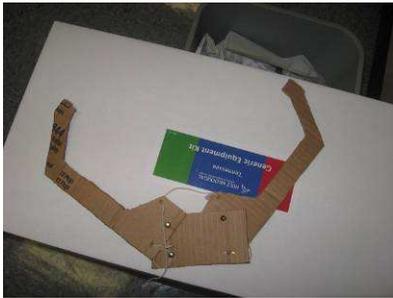
The wheel design is lightweight and provides good traction for the robot.

Other parts of the robot would be added when we knew what the limits of the claw/grabber would be and how the wheels would affect our overall speed in accomplishing the task requested of us by, our client, BEST Robotics.

On our next meeting, September 9, 2009, we began constructing cardboard and KNEX models of our robot. These materials were chosen because they are inexpensive and reusable. The KNEX pieces are made of plastic and can be bent and combined to form multiple shapes. Using these materials allowed us to design a robot without wasting our actual building materials. Cardboard and construction paper are easily bent, taped, and glued to show basic design ideas. We could also find problems with the models and change them easily with added parts or by cutting away cardboard. We did this to see what our robot might look like before we began the real construction process. Our team wanted to see whether it was possible that all of our brainstorming designs would work. The engineering team split into three groups and constructed three different designs that might work based on the required tasks.



These are brainstorming models of ideas. Construction paper, cardboard and KNEK were used to design the ideas. Each idea was analyzed for its ability to accomplish the tasks.



No designs were thrown out and each one was judged by the team based on its ability to accomplish the task assigned to us. After this process we took two of the more popular designs and built prototypes to see which one would work the best for our task. In the end, the one with the claw was the design we chose for our robot. We believed it best met our needs to pick up items and place them in the storage bins for fuel cell processing. There are more Brainstorming pictures and ideas in the Appendix.

Analytical Evaluation of Design Alternatives

When we broke into two groups, we knew we could only pick one design to use. Therefore, we went with the one that made it easier for us to collect pieces. One of the ideas that were built picked up items on the playing field by rolling over them. It was cylindrical in shape and trapped the pieces inside until they were needed to be let go. It was designed to move around the field and hold pieces in the cylinder until it reached the spotters box. We liked this idea, but it was difficult to remove pieces without spotter help and because the spotter cannot touch the robot, this idea was just not usable for this competition.



One of our engineers, Dylan Upchurch, created this roller mechanism. It was designed to pick up pieces as it rolled across the floor. The problem was its lack of reliability and it had a difficult time unloading the pieces it picked up.

The other design involved a small scoop to push pieces into the spotter zone and a claw that could pick up pieces and put them in the robots storage area. We went with the claw and scoop idea because it allowed for the most flexibility in our strategy. Our strategy is to pick up as many pieces as possible in the early rounds to allow us to concentrate on synthesizing Isooctane in the later rounds. It was also the design that we thought would be the easiest to drive by anyone on the team. Our past experience has led us to realize that the simpler the robot is in the overall

plan and operation, the easier it is to score points and perform the required task effectively.

Offensive and Defensive Evaluation

When we planned our robot, we wanted it to be a good scoring robot that could also defend our area. We built the robot with some speed so it could avoid other robots if we chose to rob them of parts, but also have the ability to turn easily and be able to move throughout the course with little problem. Our robot uses 9.5 inch wheels to move and those wheels are turned by 2 large motors. The motors are wired to run in the same direction for forward and reverse, but to turn in opposite directions for right and left. This is known as tank steering and we find that is best meets our needs for driving and turning. Maneuverability was essential and had to be smooth so that the robot could pick up items easily without dropping them. The wheel size allows us to move smoothly without jerking the robot around when we try and turn. The claw was designed to pick up multiple pieces at the same time and place them in the appropriate storage area. With our current design, we can pick up and flip over two cans, grab the beach ball, and place tennis balls where we need them. The scoop located on the front of the robot allows us makes to get elements to the spotter quickly so that he can place them in the bins or set them up to grab with the claw. Building a robot that would be quick, agile, and able to accumulate inventory is our goal. Our infrared transmitter uses three

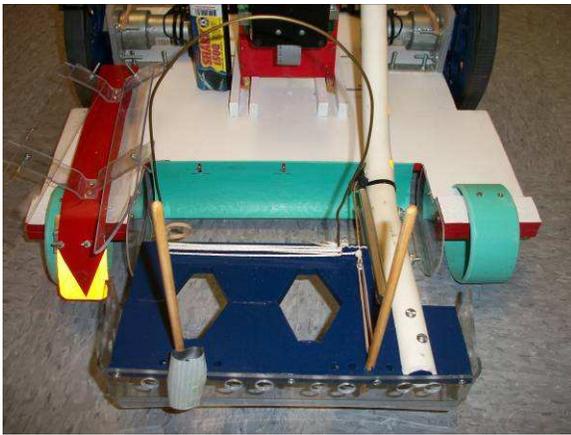
different codes. At the beginning of the match we will approach the center and shoot a 100 code. This code will protect our catalysts from being robbed. We then immediately send an 800 code to “rob our neighbor” of their catalysts. Once we know the tennis balls are releasing, we will finish with a 600 code to begin collecting energy units. With our current design, we can place five water balls, two CO2 balls, seven catalysts, and four energy cans. With this strategy, we feel that we can be very competitive at the contest.

We have mapped out a game strategy for each round. This allows us to synthesize Isooctane at the fourth round. A full round by round calculation can be seen below.

Round	Inventory	Overflow	IsoOctane C8H18	Naptha C6H14	Benzene C6H6	Ethylene C2H4	Carbon Dioxide CO2	Energy	Catalyst	Water H2O	Shorthand Results
Round 1	Collection						2	4	4	5	0 0000 2445
	Result	0	0	0	0	1	0	3	3	3	0 0001 0333
Round 2	Collection						2	4	4	4	0 0000 2444
	Result	0	0	0	0	2	1	3	3	1	0 0002 1331
Round 3	Collection						2	4	4	4	0 0000 2444
	Result	0	0	0	1	1	0	1	0	1	0 0011 0101
Round 4	Collection						2	4	4	5	0 0000 2445
	Result	0	1	0	0	1	0	3	2	0	0 1001 0320
Round 5	Collection						2	4	4	5	0 0000 2445
	Result	0	1	0	0	2	1	3	1	3	0 1002 1313
Round 6	Collection						2	4	6	2	0 0000 2462
	Result	0	1	0	1	1	0	1	0	1	0 1011 0101
Round 7	Collection						2	4	4	5	0 0000 2445
	Result	0	2	0	0	1	0	3	2	0	0 2001 0320
Round 8	Collection										0 0000 0000
	Result	0	2	0	0	1	0	3	2	0	0 2001 0320
Semi 1	Collection				1		2	2	3	5	0 0010 2235
	Result	0	3	0	0	0	3	1	0	1	0 3000 3101
Semi 2	Collection				1		2	2	3	5	0 0010 2235
	Result	0	3	1	0	1	3	1	1	0	0 3101 3110
Semi 3	Collection				1		2	2	3	5	0 0010 2235
	Result	1	0	1	0	1	1	2	3	1	1 0101 1231
Final 1	Collection				1		2	2	3	5	0 0010 2235
	Result	1	1	1	0	1	1	3	0	0	1 1101 1300
Final 2	Collection				1		2	3	4	4	0 0010 2344
	Result	1	2	1	0	1	0	1	3	0	1 2101 0130
Final 3	Collection				1		2	3	4	4	0 0010 2344
	Result	1	3	1	0	0	3	0	2	0	1 3100 3020

Design Creativity

The claw of the robot can open wide enough to grab the beach ball and can also close small enough to get the tomato paste cans and hold the racquet balls and tennis balls. We designed the claw using a saw-tooth pattern so that the cans would move into position before picking them up. The claw uses the upper lip of the can to hold it in place. The claw is attached to a pulley that allows it to open and close.



The finished claw is pictured here. It is created with the saw tooth design described and uses rubber bands to pull each part together. The wooden dowels and the coat hanger wire make it easy to grab a beach ball and even pick it up from off the floor. The duct tape is used to place the beach ball into the lower container.

We used rubber bands to keep the claw closed and use the pulley attached to a string to open it when needed. We wanted the claw to be strongest when it was closed so we used the rubber bands to accomplish that goal. The claw has small polycarbonate pieces attached to the front of it. These pieces allow the driver to move items from against a wall as well as turn the cans over for picking up in the field. It also keeps the balls from rolling outside the scoop area of the robot. More detail about the claw is described in the next section, The Building Process.

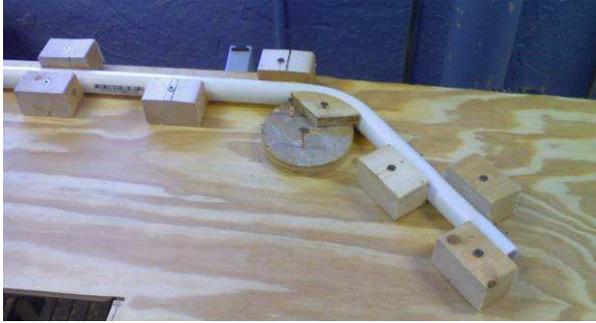
We have attached a scoop to the front section of the robot to push elements into the spotter zone. The scoop is a piece of four inch PVC that has been cut and

placed to allow the robot to act like a bull dozer and push game pieces where we need them. The scoop has pieces of polycarbonate on each side to keep the pieces in place. We realized in our practice driving that the game pieces would roll under the robot along the sides and would then be lost. These pieces of polycarbonate are designed to keep the pieces in place and to allow the robot to move the pieces as needed without them rolling under the robot.



The scoop is made of 4" PVC and is designed to roll balls or cans into the spotter area. The polycarbonate pieces on each side of the scoop keep the game pieces from rolling under the chassis.

The arm is designed to go up high and down low so that it can move items around. The arm uses a small motor attached to a pulley with a belt to make it raise up and down. The arm is located on one side of the robot to allow the claw to fit in the scoop area. The arm is made of one inch PVC that was bent into shape using a heat gun. We created a jig to make the arm fit and to allow us to create other arms in case our current arm breaks. We tried to bend the PVC without the jig, but it bent and folded which weakened the PVC arm. By using the jig, we were able to bend the PVC slowly and smoothly without the arm folding at the bend points.



The arm jig allows us to make new arms without having to bend them by hand and risk the PVC folding at the bend. It was created using plywood and scrap pieces of wood. We heated the PVC tubing and slowly bent it into place.

We had originally tested a wooden arm, but it was too heavy. When we weighed the PVC arm against the wooden arm, it was almost a half pound lighter. This made the PVC a much better choice for us and allowed us to save weight. Attached to the top of the arm is a counterweight that helps in moving the cans. The cans are heavy and need a counterweight to pick them up with the claw. The counterweight is made of an aluminum can filled with screws, washers, steel rod, and bolts. The weight of the counterweight is about two pounds. We considered using the aluminum block, but it was not heavy enough and was too large to attach to the upper part of the arm. We used lead weights to find the best counterweight and then changed the lead to the kit materials once we had found the correct weight to achieve our goal of picking up the cans.



The counterweight is an aluminum can that is filled with various pieces of metal. We used screws, bolts, nuts, washers, and steel rod from the materials kit for the counterweight. At the time of this writing, we are experimenting with a bungee cord in place of the can counterweight to save overall robot weight.

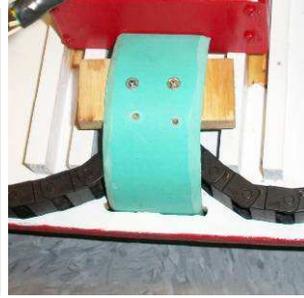
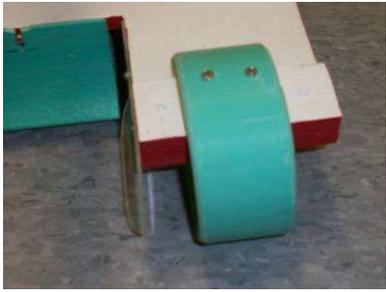
The wheels help the robot move quickly and make it easy to maneuver. The wheels are 9.5” in diameter and are constructed of 2 pieces of plywood. If we used a larger wheel, we moved too fast to be smooth with the robot operations. We tried a 12” wheel and found that it jerked the robot too quickly as we tried to turn. The turns were too fast for our needs and we were afraid that the quick turn would make the cans drop when they were in the claw. We used a router to make the wheels and keep them the same diameter. The wheels were then glued together and then sanded on the edges to smooth out any rough areas. We have tried using a jigsaw to cut them in the past, but it is not as precise as the router. We used two pieces of plywood to give the wheel a wide area to roll on and to provide additional traction for the robot. The wheel is covered with bicycle inner tube to act like a tire. This provides additional traction for the wheel and gives a little bit of shock absorbent properties to the wheel.



This is a picture of the finished wheel. The wheel consists of 2 pieces of plywood glued together and lightened with holes. The inner tube on the outside of the wheel provides traction on the course.

We used the 4” PVC to create slides on the front and rear of the robot chassis. The slides are effective in making the robot stable and move across the carpet easily.

We sanded the pieces to lessen the friction and to make them smoother.



Slides were placed on each side of the front of the robot chassis and in the middle of the back of the chassis. This makes the robot stable when weight is shifted as the arm moves up and down.

Building the Robot

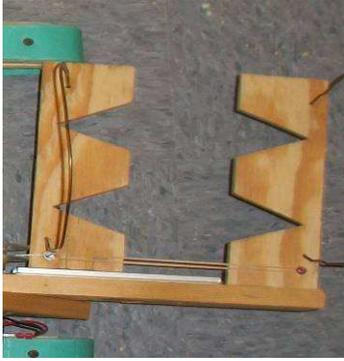
Once we had our design ideas straight, we began the construction of the robot. We cut out a new chassis based on the size we had previously that we needed and mounted the motors and wheels onto it. The chassis was designed to be longer rather than wider and had the front cut out so that we could attach the scoop to it and hold the game pieces in the area. The chassis is made of $\frac{1}{2}$ " plywood and is strong enough to mount our other pieces such as the upright supports, scoop, and wheel mounts on it.

We used a simple method for mounting the motors and wheels. The motors are mounted using the angled braces and the acrylic sheet. This has a nice clean look to it and was easy to build. In the past we have bent aluminum and attached a motor to the bent aluminum sheet. We would then have to brace it with plywood squares and make sure it was at a 90 degree angle to the chassis so the wheels would turn smoothly and not wobble. Because we had not used the angle brackets in other areas of our robot design, we used them for motor mounts. We then attached the motors to the wheel using an aluminum block.



The motors for the drive wheels are mounted to the acrylic and then the acrylic is mounted to the angle brackets. The wheel is built of two pieces of plywood and then mounted to the motor using an aluminum block. See drawing in appendix for more information about the wheel mounting block.

While one group of engineers created the wheels and attached them to the chassis, another group began construction of the claw. We weren't quite sure how exactly to make the claw so it could close small enough to pick up the tomato can, yet open wide enough to pick up the beach ball. Eventually we figured it out and came up with a claw that opens and closes sideways. If we had the claw positioned the other way, it made the robot too long to fit in the required area. The claw is made of two pieces in a saw tooth design so that it can move pieces into place as the driver tries to pick them up. The claw is made of 3/8" plywood and is mounted to the arm using the IGUS sliding system. This system allows the claw to move smoothly and keeps the two parts of the claw in line with each other. The other half of the claw is attached to the arm using bolts and is stationary. Each part of the claw is attached to the other part using rubber bands. This keeps the claw together and is only pulled apart when activated by a string attached to a pulley.



The picture shows the claw design. The saw tooth pattern keeps the cans or balls aligned within the claw. The rubber band on the side brings the halves of the claw together. A string attached on the left bottom of the claw pulls the left half apart from the right half. The left side slides along the IGUS aluminum slide.

We then built an arm that could bring the claw close to the ground but also to the height of the beach balls. This was the hardest part of the robot build. We have never built an arm before so we were trying new ideas to try and figure out which one was the best idea to fit our design needs and game strategy. The first arm was made of wood. It was a piece of whitewood that was too long. We had a scrap piece that was used as the first arm. The design was strong, but was too heavy to lift easily.



The first arm was too long and was too heavy to be effective. The lift motor had a hard time raising the arm up and down. We tried lightening it with holes, but it was still too heavy.

We decided to drill holes into the arm to lighten it up, but it was still too heavy to be used and was not a legal piece because it was too long. We considered using plywood in its place, but it is also heavy. We even considered using the

IGUS aluminum slides as an arm. When we bolted them together, it made a strong arm, but it would take all of our slide material to do this which meant that our claw would have to be redesigned. We decided to start weighing different materials and found that PVC was lighter than all the other materials. It was strong, bendable, and would support the weight of the cans. We decided on the PVC, but it took several times to bend it with a heat gun to get it at the right angle. We used a jig to get the right angle and then bent it in small steps to get the final angle.



The new arm is made of PVC. It is strong, lightweight, and is easily bent to the right angles with a heat gun. This picture shows the arm as it is attached to the outside of the upright support.

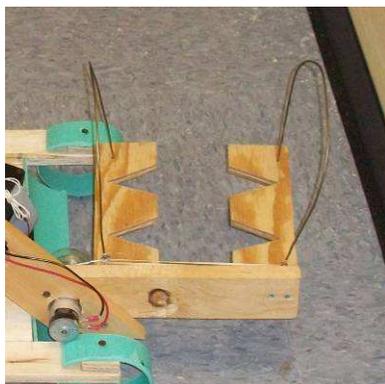
To mount the arm, we had to have a structure that would be strong enough to hold the arm in place, but not too heavy to cause the robot to be overweight. We have used plywood in the past for uprights that support large pieces and we decided to use that same idea again for the arm support and mount. The arm is mounted at the top of the upright using nylon guides and steel rod. The rod is strong and does not flex so it makes a good support. The uprights also allow us to

mount the motor and attach it to the steel rod using a pulley and belt. This method is effective and works well for our needs.



This shows how the motor is mounted to the upright supports. The uprights sit toward the middle of the chassis to even out the weight. If we put the upright support toward the back of the chassis, the robot wanted to lean back and lift the front.

Next, we mounted the arm and claw onto the robot. We also added coat hanger wires to the claw so it would be able to grip the beach ball and wouldn't drop it. After testing we have added wooded dowels on one side of the claw to allow the robot to pick up the beach ball from off the ground and to provide a firm side to the beach ball gripper.

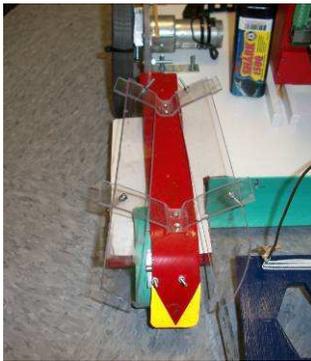
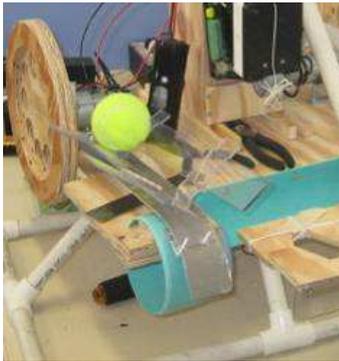


The claw moves forward and backward to grasp the globe between the coat hanger parts. This provides a reliable and firm grip for the robot.



A motor is attached to the upper arm and has a pulley attached to the motor shaft. The pulley winds string inside the PVC arm. The string is attached to the claw at the bottom of the arm.

The tennis ball holder is a simple mechanism that works very well. It is a lever that is activated by running the robot into the tennis ball drop off. It is designed out of aluminum sheet that is attached to the front slide using a hinge. The upper portion is made of polycarbonate that has been bent to hold the tennis balls. As the robot moves into position, the hinge moves upward and spills the tennis balls into the holding area. The design relies on the spotter placing the tennis balls onto the robot. We are currently working on a way to activate the tennis ball dispenser on the field and have the balls roll into the holder without the spotter being involved.



The tennis ball holder is located above the front slide and is mechanically activated. The aluminum piece and flips up and allows the tennis balls to roll off the holder and into the processing plant holder. The picture on the right shows the finished and painted piece.

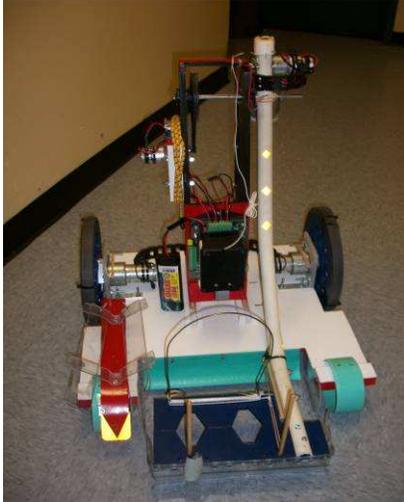
Once we began testing the robot, we found other minor problems that needed to be fixed. The robot was mostly finished and only needed a few things to make it completely ready for game day.

Testing the Robot

As we began testing the robot, we were looking for obvious problems. The first one we noticed was that the racquetballs would grab the carpet and then roll under the robot. We had not anticipated this problem. We did have to add larger polycarbonate pieces to each side of the scoop to keep the game pieces from rolling underneath the robot and to corral them in the front area. We also used Armor All on the polycarbonate pieces to make the plastic smoother and reduce the tendency to grab the racquetballs.

We also found out that the tennis ball holder released the balls too fast and that made them bounce out of the holder in the processing plant. By spreading out the pieces of plastic at the front end, the balls slowed down as they rolled along the holder and fell into the processing plant holder more slowly. This keeps the balls from bouncing out of the holder and not scoring inventory points.

At the current time, our robot performs well and we feel that we will be competitive on Game Day. We are now focusing on driving and keeping our overall scoring strategy in mind.



This is the completed robot ready for competition.

Conclusion

This year's assignment has been a challenging one. We had to make robot parts that we never had to create before and we have had to think about our design to pick up multiple pieces at one time. We used our prior experience to help in a few areas, but have had to do some extensive brainstorming in many different areas. We feel good about our efforts believe that we can be a strong team on Game Day.

Changes since Game Day

At our original Game Day, we placed second due to the fact that we had some trouble placing the CO₂ balls effectively. We synthesized Naptha too soon and failed to create an Isooctane. With that problem, we knew that we needed a more consistent robot. We made some significant changes to the robot:

Wheels – larger wheels to move faster and accumulate inventory sooner

Arm – a new arm was designed that would reach the upper CO2

Claw – a new claw was created to make placement more consistent

Scoop – we used the entire area under the chassis to contain pieces

With these changes, we had to make additional modifications to the chassis. It has remained close to size and has allowed us to keep the required dimensions.



The new robot keeps some of the original features while using larger wheels. The wheels are now 13 inches and the arm is a straight design that is expandable up to sixty inches. The center of the chassis has been removed to allow the benzene tanker to be placed there for easier transport and placement.



Change Order Redesign Process

When we received the Change Order for the BEST National Championship, we needed to redesign our robot so that it had a more multipurpose operating ability. This new design would have to place cans, racquetballs, and tennis balls effectively without spotter intervention. We have designed a slide from the one inch PVC that uses a servo activated gate to open and close as needed and allows us to place the game pieces effectively. The spotter can load the robot with the

necessary pieces and the driver can deliver them to the necessary receptacle. This new design has proven very effective in practice and allows our drivers to reach their necessary inventories during each round.



In the photos above, you can see the rear of the robot where game pieces are placed and roll down the slide into position where they are released using a servo activated flipper. The photo on the right shows additional detail of the slide. Cans, racquetballs, and tennis balls can all be placed accurately with this method.

Appendix

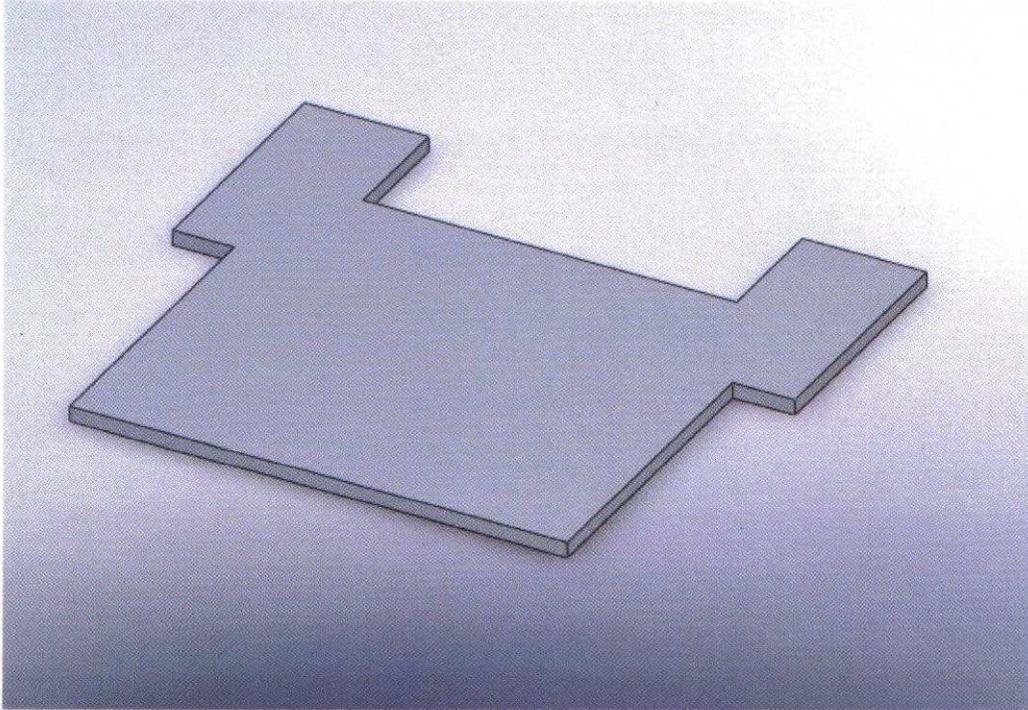
CAD Drawings – pg. 31-36

Brainstorming pictures and drawings – pg. 37-40

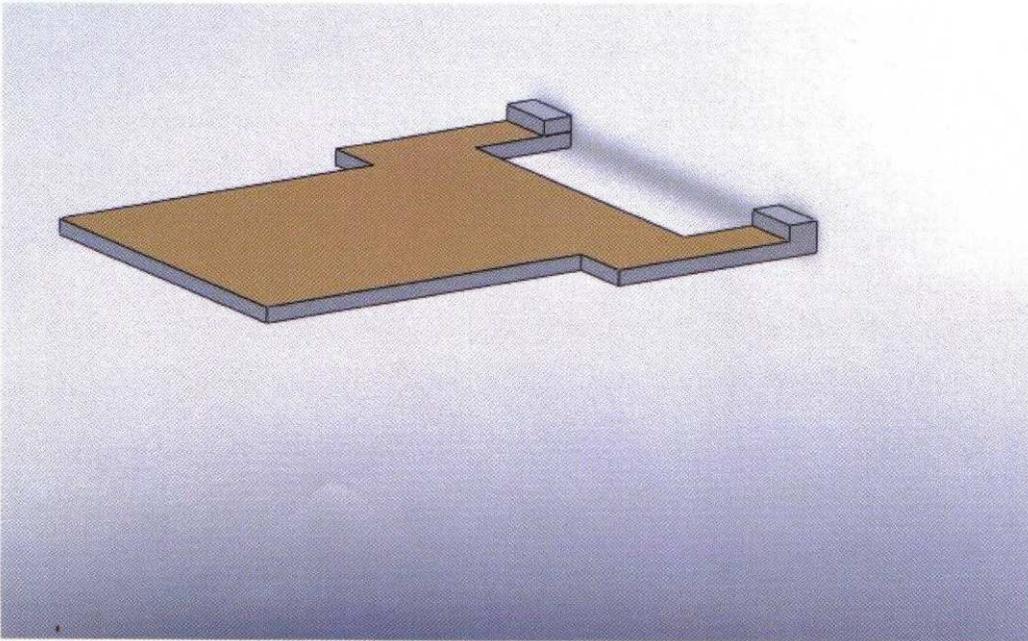
Team Notes – pg. 41-47

New Robot Pictures – pg. 48

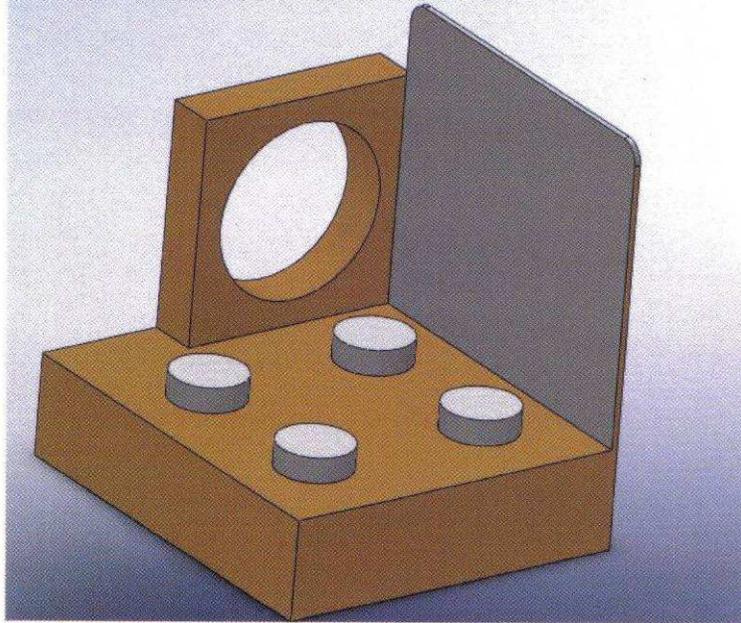
CAD Drawings



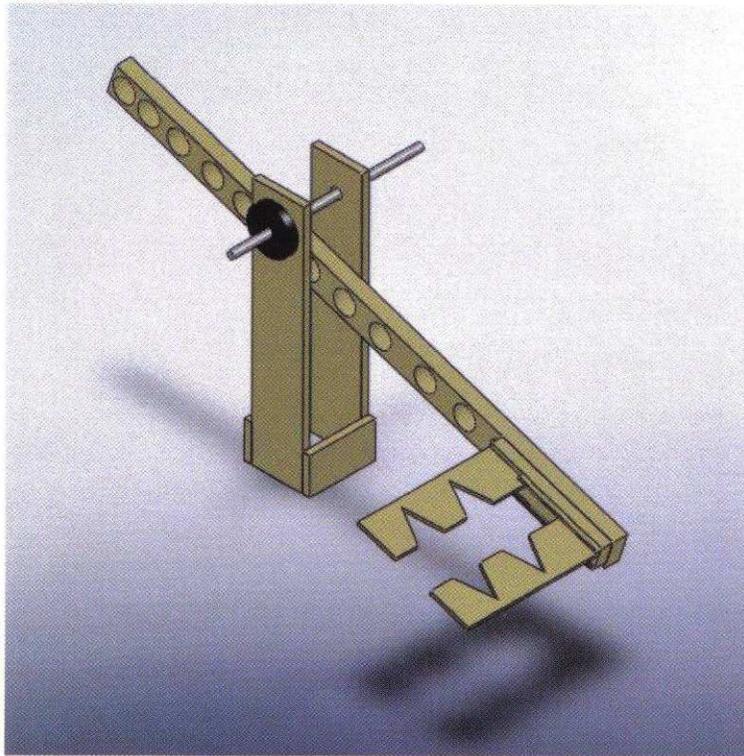
Chassis Design



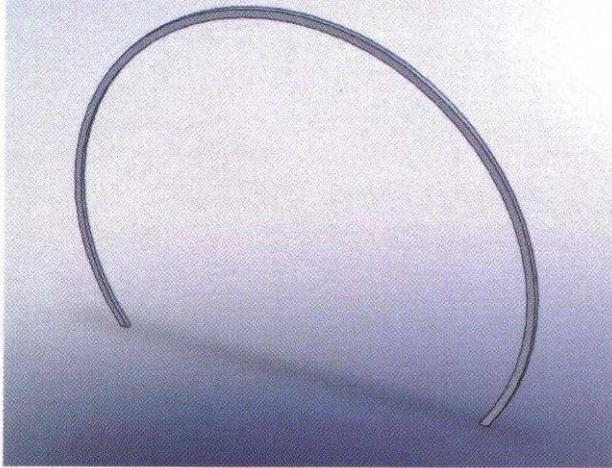
Chassis with front slide supports



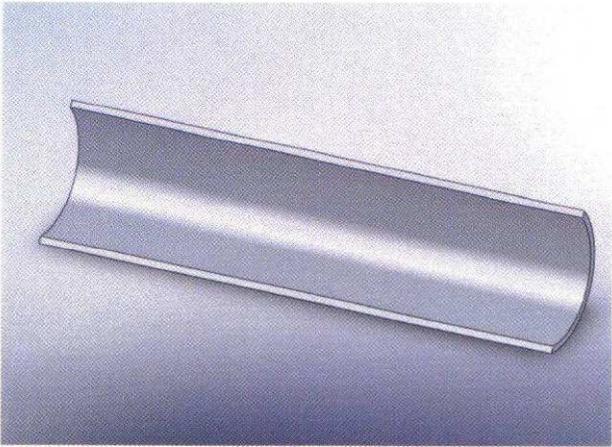
original large motor mount idea



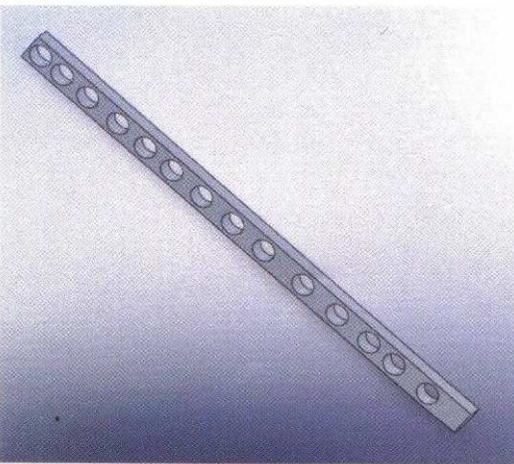
original wooden arm with claw attached



wire hoop for holding the beach ball

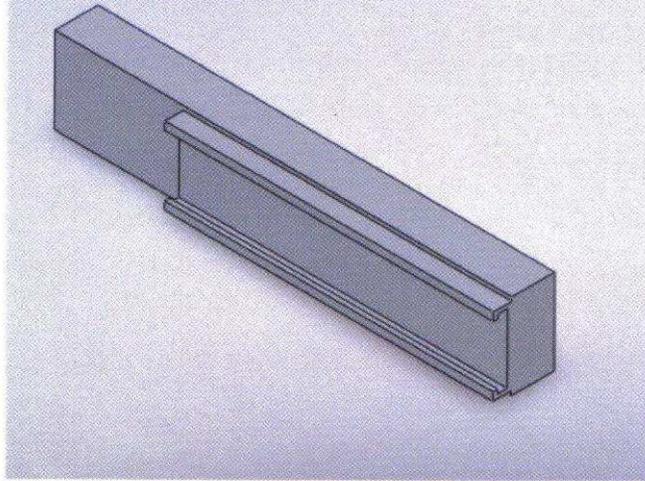


front scoop made from PVC

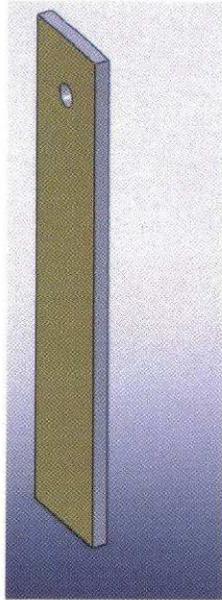


wooden arm with holes drilled

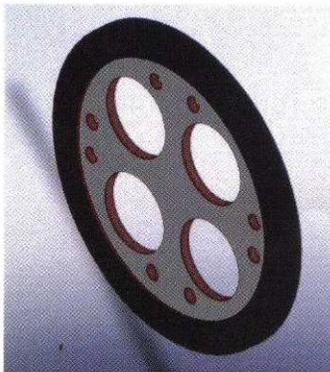
2



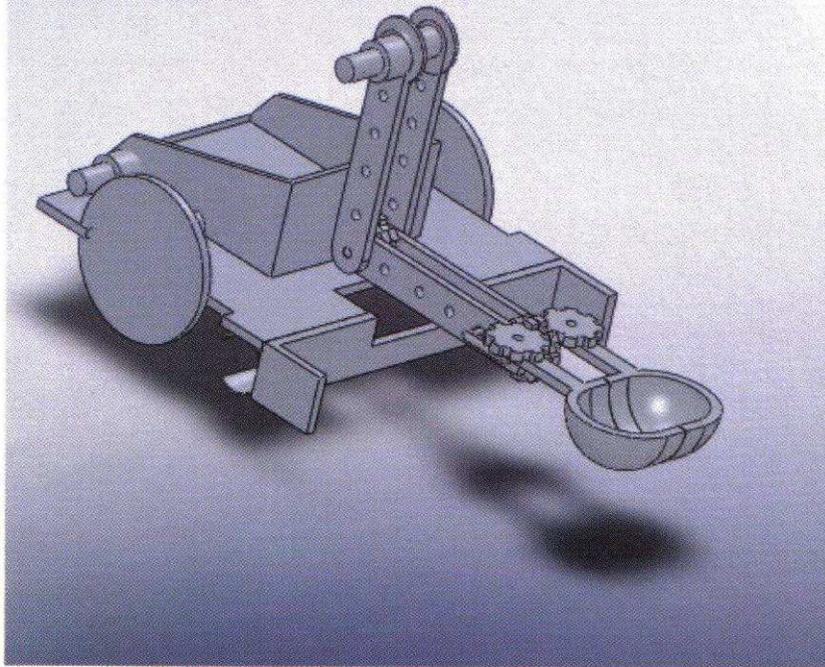
aluminum IGUS slide attached to wood for claw to move



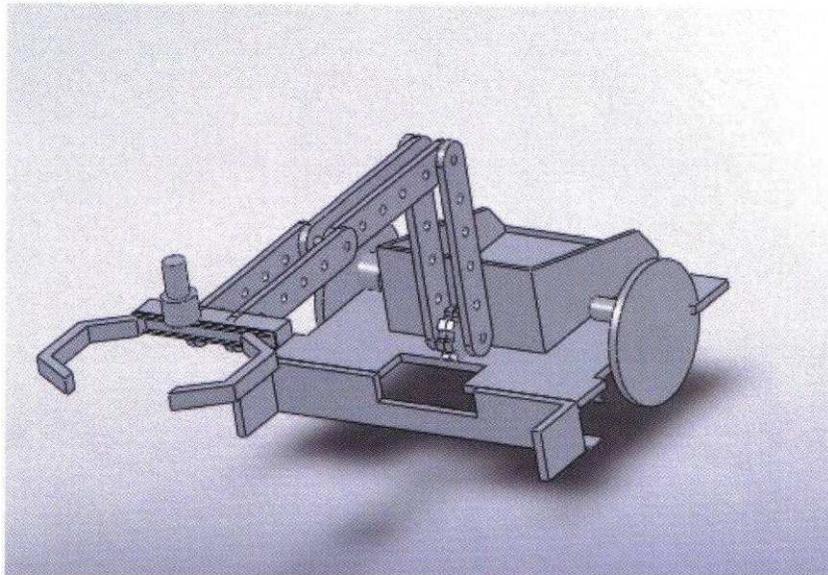
upright support for arm



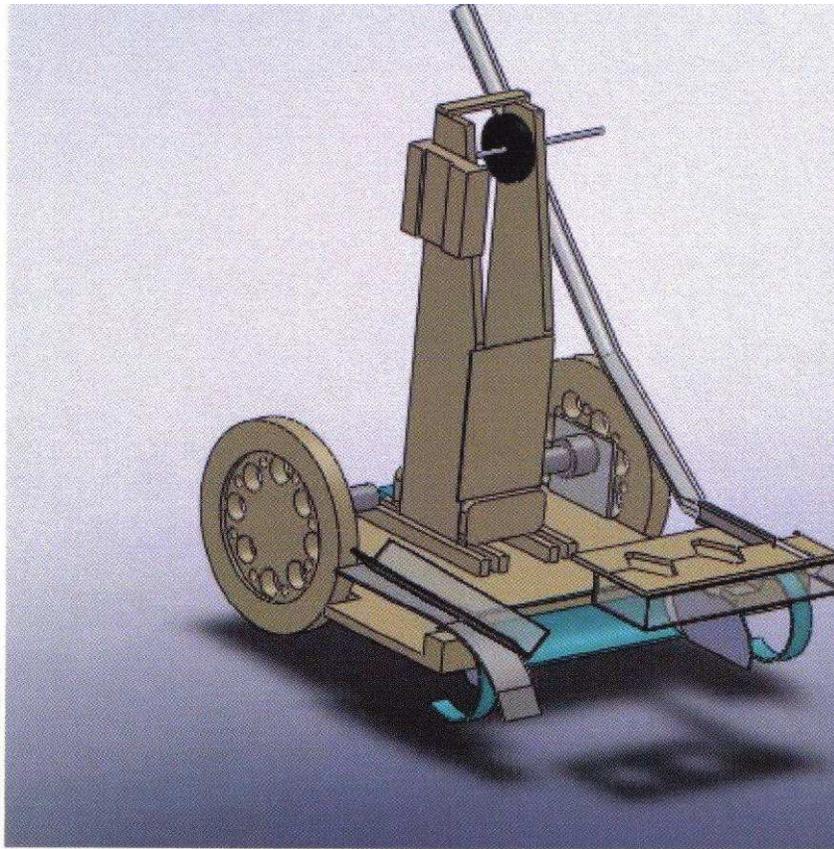
lightweight wheel with inner tube tire



first robot idea – created by Ryan Cripps

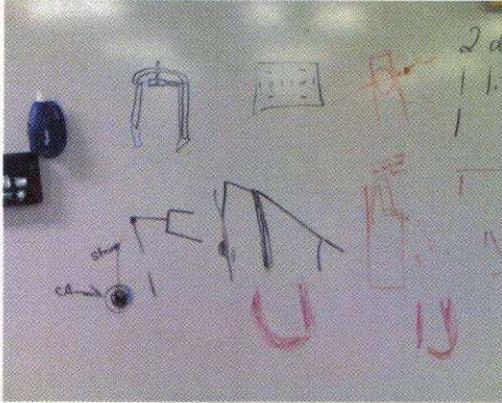


Another idea based on brainstorming session

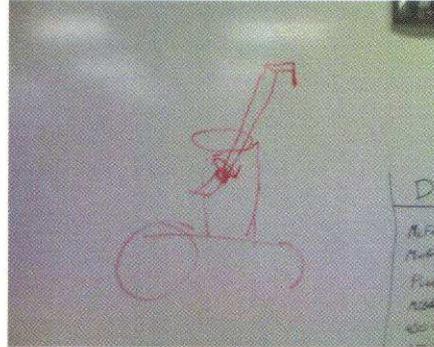


final unpainted robot with most parts attached

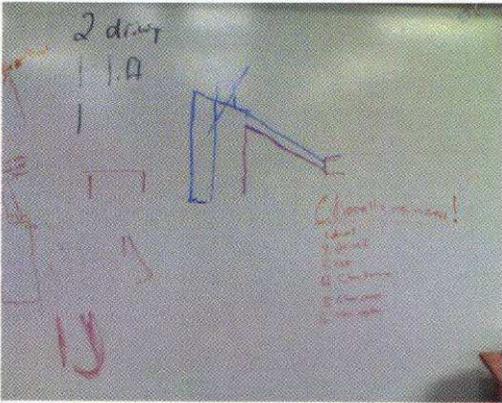
BRAINSTORMING IDEAS



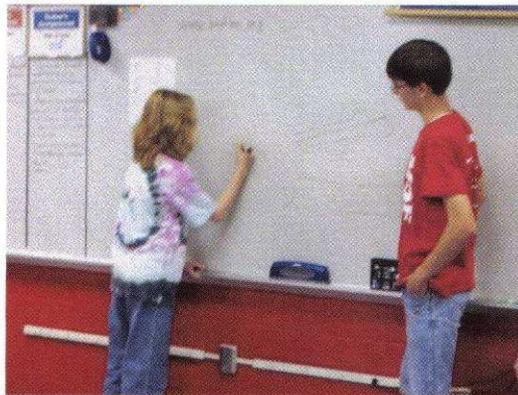
different arms and pick-up ideas



an idea using an arm the raises up and down



first arm design with channels assigned



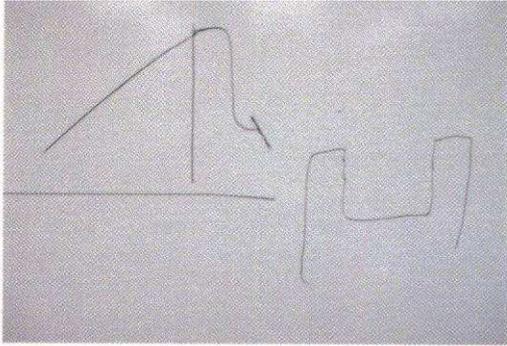
Ryan Cripps shares his idea for a gripper



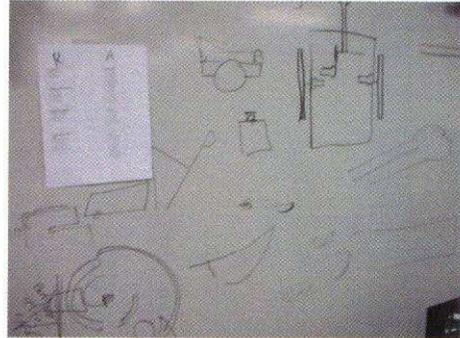
Andrew Clark shares his idea with the team



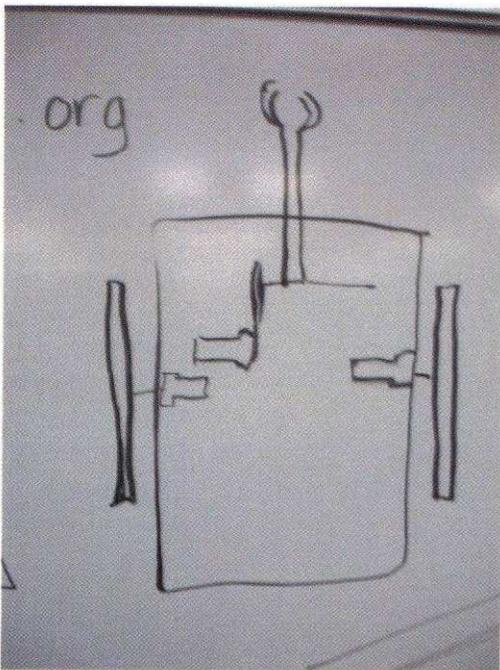
Hannah Slayton shares her ideas



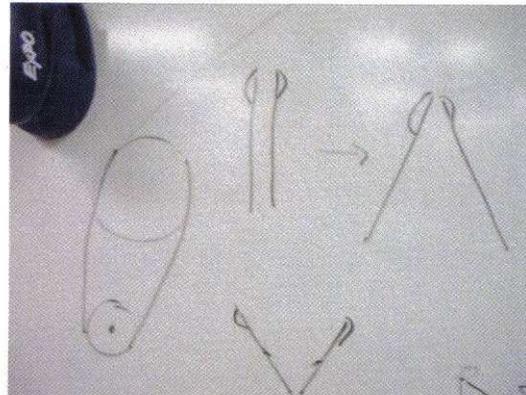
counterweight idea with cut-out chassis



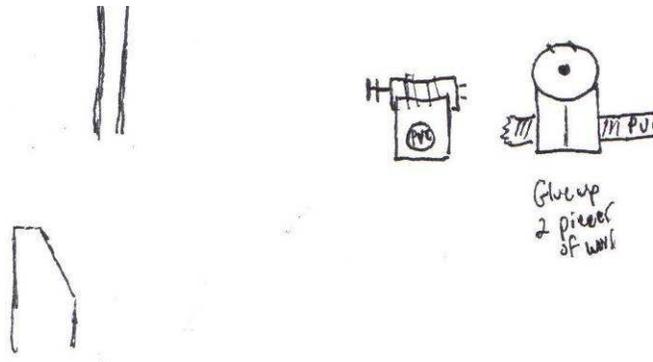
different ideas including rolling design



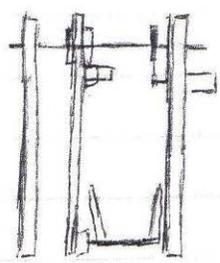
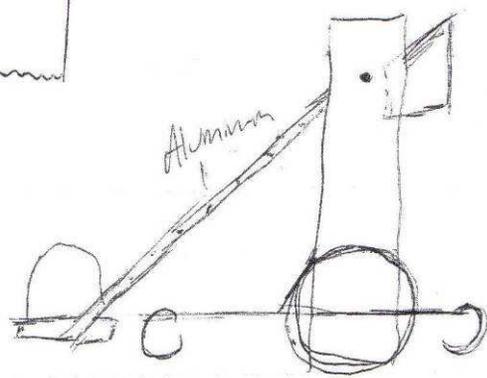
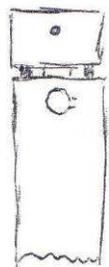
Claw design to scoop balls

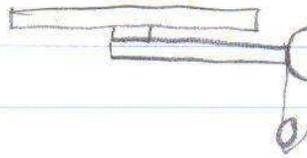
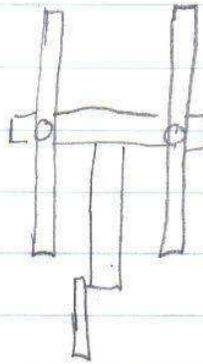
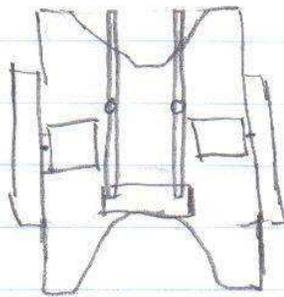
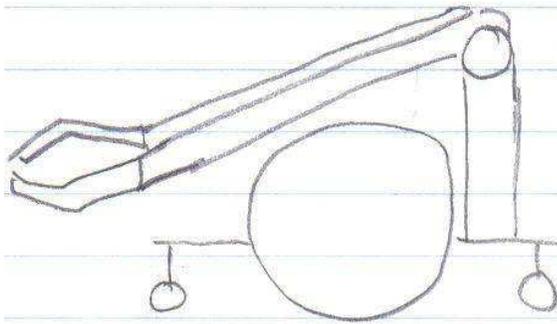


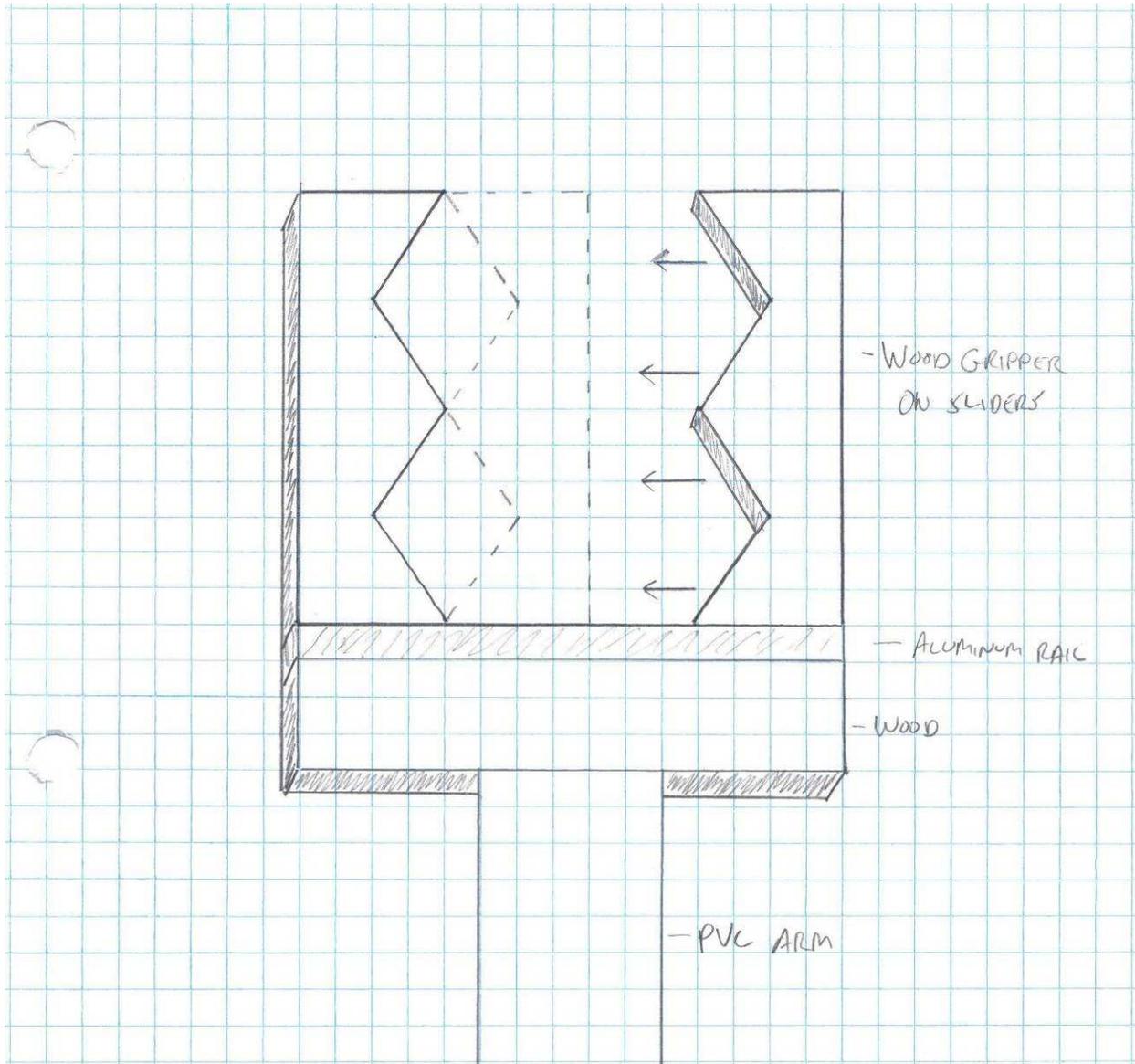
different ideas for the claw



Sept 21, 2009
Finalizing design ideas
before building



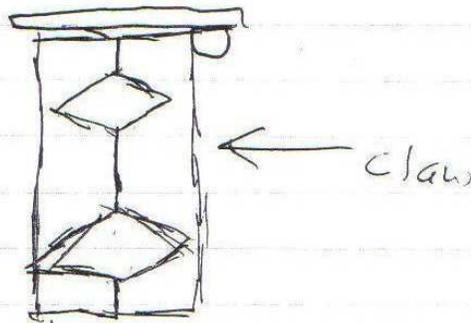
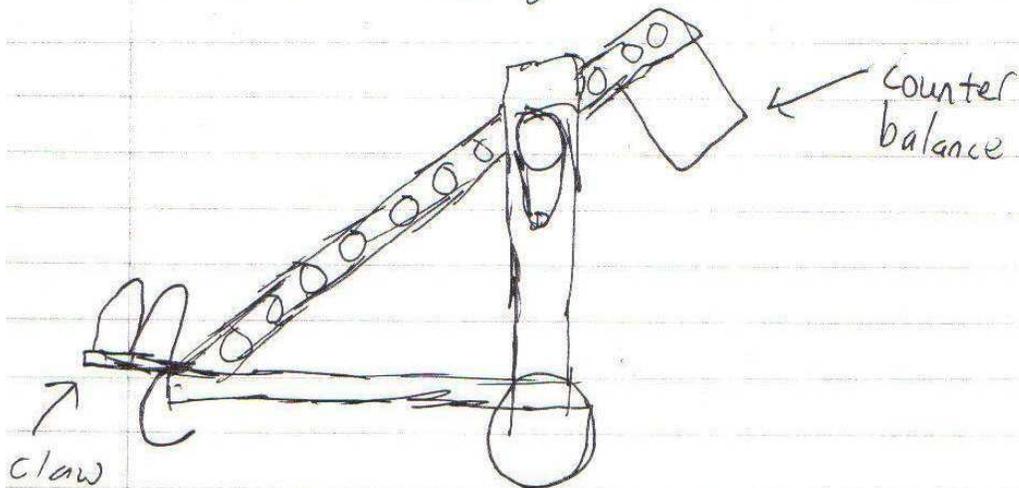




This is a detailed design of the claw we used to perform pickup and delivery tasks of the cans and balls.

9/21/04

Today we hooked up the brain to the robot. We cut holes in the arm to make it lighter. We also began to build the playing field. Here is a drawing.



We need to make some adjustments but we can pick up a tennis ball

9/8/09

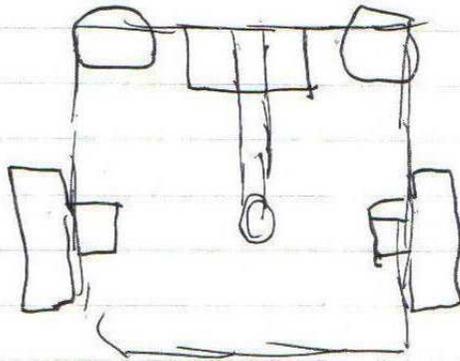
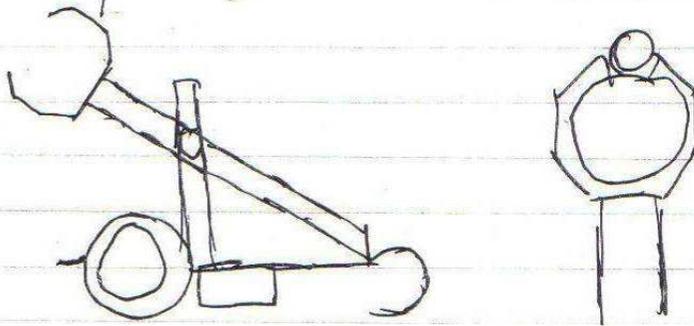
Today was our first official day we gathered everyone together and drew up many different ideas. We eventually came to the conclusion that we will need wheels larger than 9" but smaller than 13". We also decided we need a claw.

9/9/09

Today we broke up into 3 groups and began building models of our visions of the robot. 2 groups built theirs out of paper, 1 group used kinex.

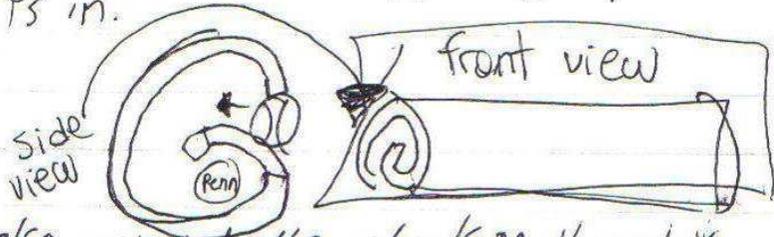
9/10/09

Today we came up with our first
sign to build it involves an arm with
claw on the end. It also has a box on the
top to put objects in:

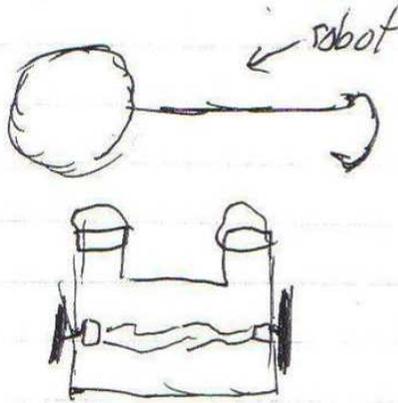


9/11/2

Today we began organizing the workshop. We also began working on the front sliders for the robot. One group began working on a PVC pipe ^{idea} ~~support system~~ to hold objects in.



We also mounted the wheels on the robot, and the sliders. We began building the arm for the robot also.



We also put the brain on the robot

9/14/06

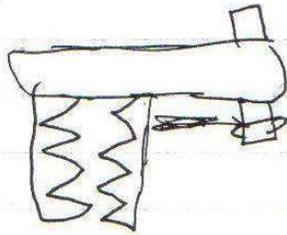
The group working on the PVC pipe idea made some adjustments to their idea. We had a problem with the channels both wheels were not going forward at the same time. We set up different courses w/ cones to practice driving techniques. We have video record of this.

9/15/06

Today we looked at many different claw designs on the internet.

11/17/06

We made a new claw design today:



We also made a few adjustments to the chassis

11/18/06

Today we mounted our new claw onto the robot. We are hoping to be driving and picking up the items by Monday. The group working on the PVC pipe idea finished. Some people cleaned out the upstairs work room

New Robot Pictures (this is the BEST Nationals Robot)

