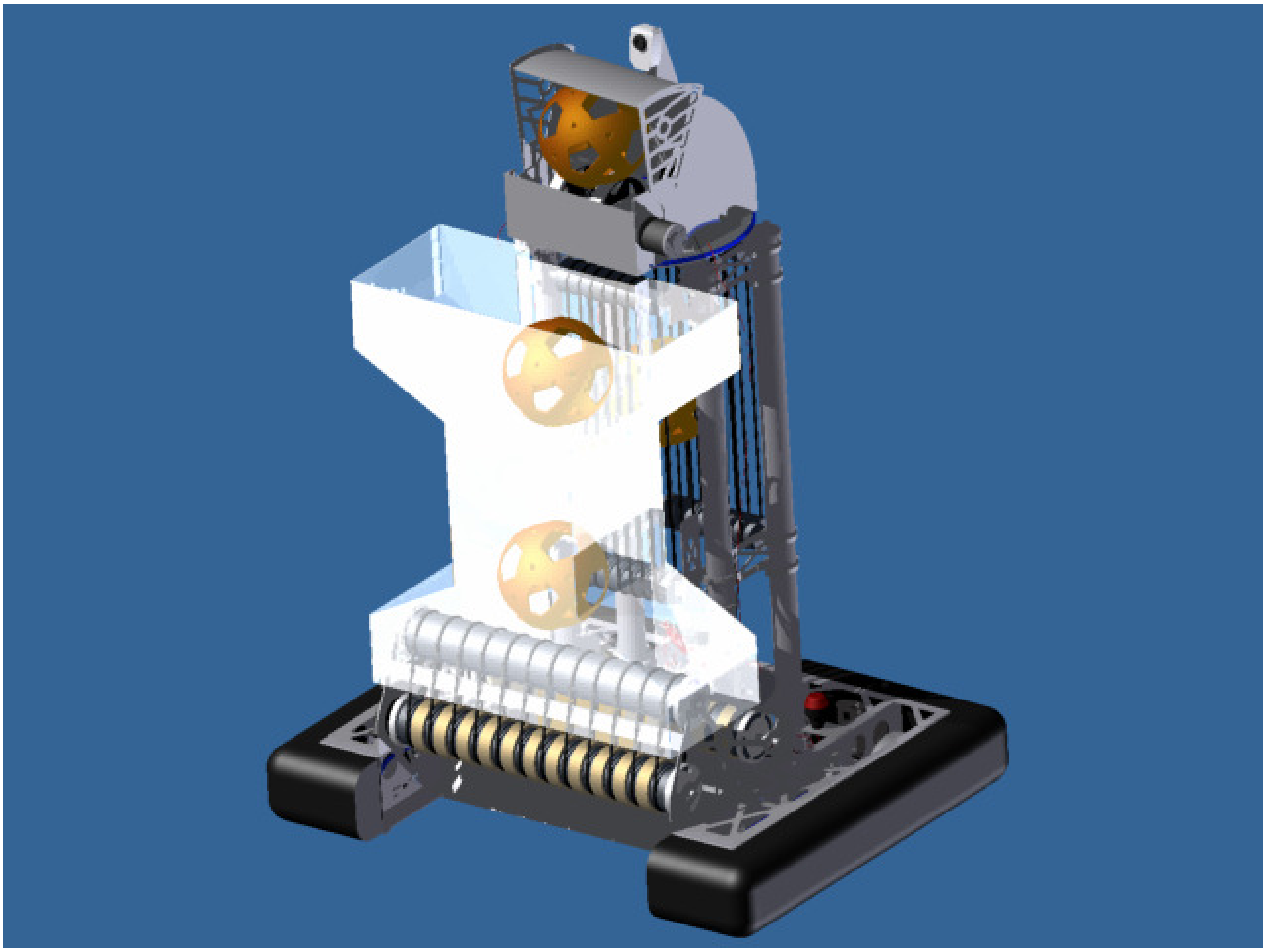
2009 "Lunacy"
First Robotics Competition
"Hot Team 67"



AutoDesk Design Competition

Submission February 25, 2009

Brainstorming:

The HOT Team has always started the season off with a bang. As it has in years past, the team gathered at Novi High School to watch the NASA Webcast from Manchester, New Hampshire. As soon as "Lunacy" was unveiled ideas started flowing and we all came up with our own ways to master this new playing experience. The low friction surface of the playing field and the introduction of human players into the game colored our brainstorming session as we considered;

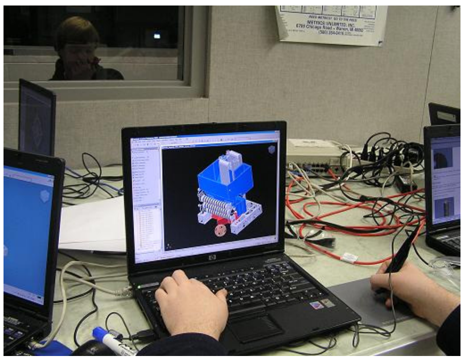
- How to get score pieces
- How many wheels
- Scoring strategy
- Drive strategy
- How to Fit within Size and Weight limits

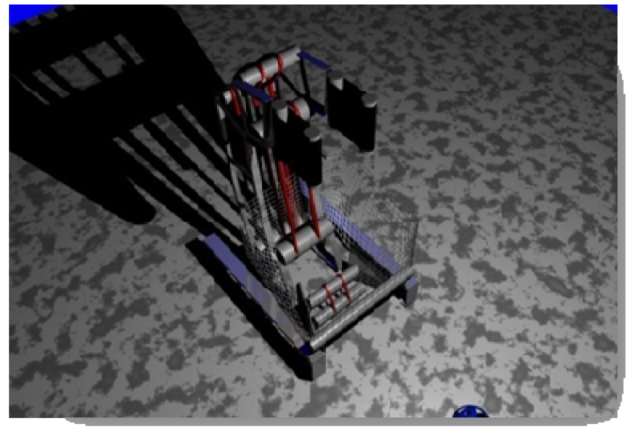
Every student and mentor who proposed a design or strategy idea presented it to the team, explaining key points and highlighting the benefits. Everyone agreed their ideas would do well at the competitions. So we called for a vote. Some of the key design features considered were:

- Ball pick-up from ground
  - \+ Won't run out
  - \+ Carrying possession
  - \- Complicated mechanics
- Ability to throw in the top
  - \+ Chance of getting extra balls
  - \- Container must have a large enough opening for thrown balls
- 4-Wheel Drive
  - \+ Easier mechanical
  - \- Less Traction
- 6-Wheel Drive
  - \+ More Stable
  - \+ More Traction
  - \- Harder mechanical aspect
- Shooter
  - \+ Expanded Range of scoring – near and far
  - \+ Allows scoring when pinned
  - \- Complex controls and motors
- Dumper
  - \+ Simple controls
  - \- No flexibility

Our final robot is a combination of these ideas. We wanted to be able to score when we were pinned but we also wanted the ability to drop a ball into a nearby trailer if we could. So we chose to design a shooter. Being able to control the shooter speed would allow us to drop a ball out or shoot it over the robot in front of us and into their trailer.

Our choice in drive train was also key. A skid steer drive would allow us the most control on this low friction surface without giving up the ability to turn and avoid being pinned.





Concepts considered included variations on ball handling and storage in a hopper

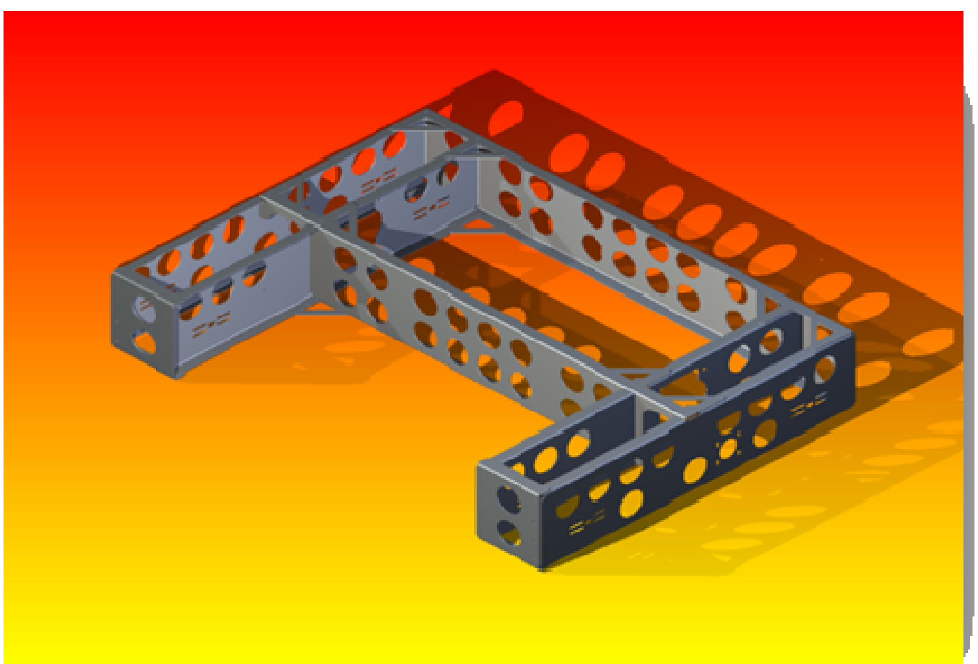
Base

The base is one of the many key components of our robot. It must protect all of the electronics that run our robot. It must house and shield the drive train from oncoming rams and be tough enough to keep moving after we are slammed into the wall. This idea seems simple enough to accomplish but there are restrictions.

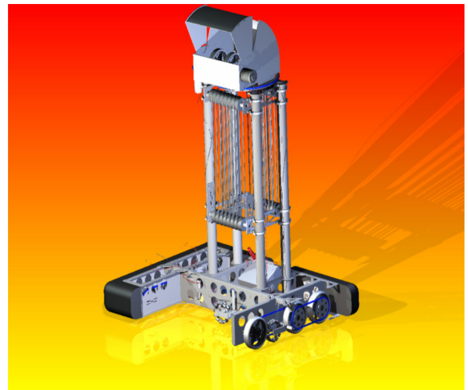
We must design a chassis that can support the weight of the shooter and conveyer, be small enough to fit inside the initial box, be durable enough to withstand impacts from all sides, contain the electronics and drive train all while being light weight.

We chose to go with a pure sheet metal chassis; this would allow us to make any shape needed to fit the components of the robot. Using a water jet we were able to lighten most of the parts used, allowing us to keep the weight down but keep the frame completely stable.

An open front design was used so we could pick up the balls off of the ground. This was a key part of our scoring strategy. We used a hopper to store the acquired balls until we were able to launch them out of our shooter and into the opponent's trailer. We found that with the open front design, we could fit the electronics in the base while keeping the drive train forward and to the sides. This would maximized the available space for the needed electronics to be placed and configured.



Drive Train



Drive Train

- 2 CIMs
- Jaguars speed controllers
- Quarter-Inch chain
- 2 Gear boxes
- Special Wheels

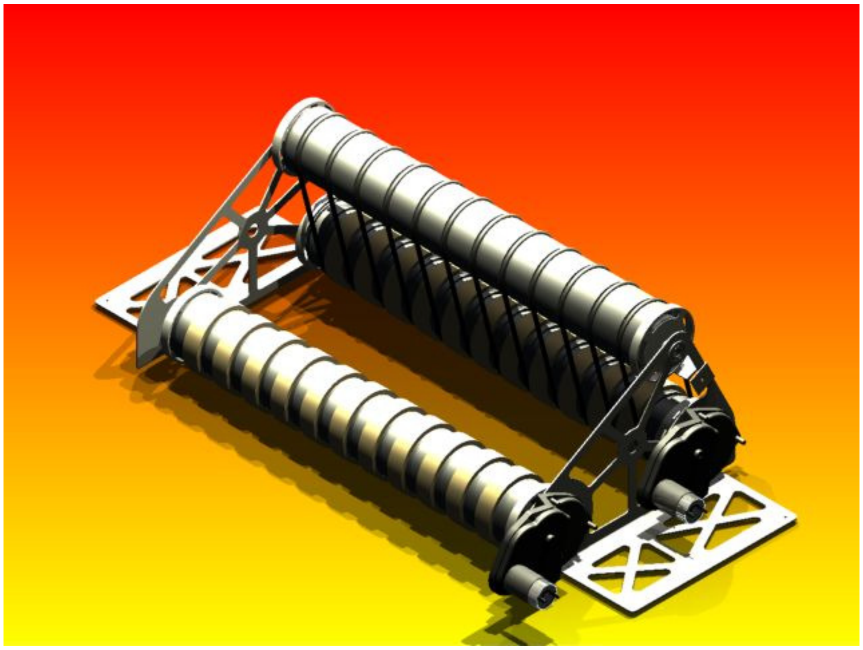
In years past, we have tried many different drivetrain combinations. We have had success with the control that comes with a six wheel drive. The ability to change which wheels are steerable and which wheels to put motors on gives an endless possibility of control options. This year, after almost a week of discussing different drive trains, we settled on the idea to stick with tradition and use a six wheel drive. But instead of using steerable wheels we chose a skid steer.

This year's low friction playing surface is completely different than anything in years past. Using a skid steer drive, we are able to use the playing field's surface to our advantage and keep a relatively large amount of control on the robot while we race around avoiding the other teams.

One of the key features of this robot is Traction Control. This is enabled by the use of encoders on both driven wheels and on unpowered omni-wheels. The driven-wheel-encoders measure drive wheel speed, while the omni-wheel encoders measure actual robot speed. The computer, by comparing drive wheel and actual robot speed, can compensate for drive wheel slippage by adjusting input to the drive system so that the drive wheel and omni-wheel speeds are the same. In this way the robot drive system can achieve higher traction than if the drive wheels were allowed to slip.

Ball Pick-up description

Our ball pick up design is ergonomically designed to pick up the playing balls over a large horizontal area. The funnel shape of our hopper supplements the roller system to easily transfer the balls into the hopper and then back out of the hopper and into our conveyor/shooter system. The front part of our roller system is NOT separated; there is a belt wrapped around them so balls do not get stuck in the front gaps of the robot. The rear roller works as both an intake into the hopper and as a means to export the balls into the conveyor system. The rollers are wrapped with strips of tread to increase the traction between the balls and rollers to increase our robot's ability to grab more quickly and more effectively. Our rollers are powered by two Fischer-Price motors; one for the back roller and one for the front roller (with belt attached).

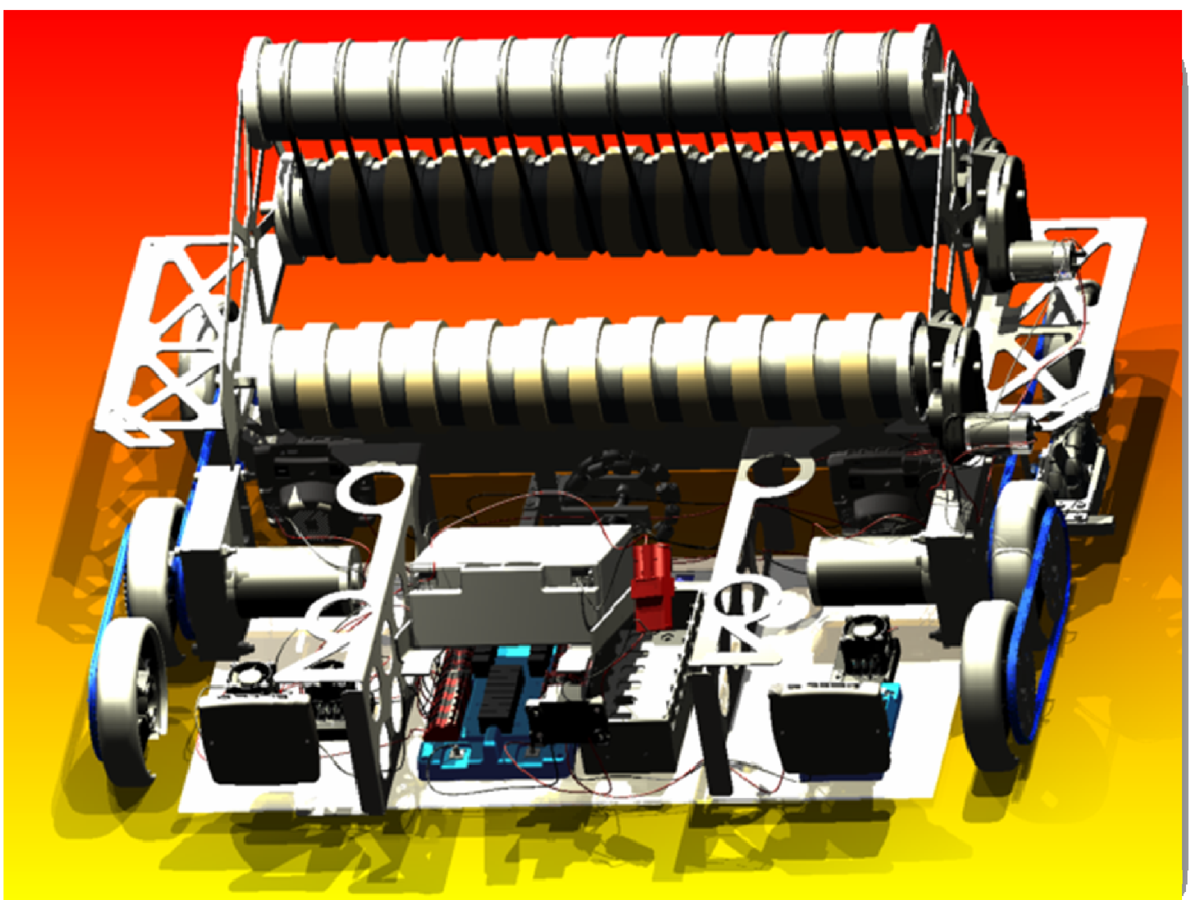


Electronics

The electrical panel contains all of the electrical components of our robot. It includes the motor speed controllers and other motor control devices, including Jaguars, Victors, and Spikes. It also houses all of the control systems, such as the Power Distribution Board, Digital Sidecar, cRIO, and the circuit breaker. This year we had to overcome new issues regarding the new control system. We also used Autodesk Inventor to design the Electrical panel to find an electrical packaging arrangement that works with the new control system.

The new electrical components are larger than previous years. Although they have superior performance, finding space in the base to package these larger pieces and still have accessibility to replace and repair them during competitions presented a challenge. We considered many approaches to solving this problem. Stacking the components was one of our original ideas. We also considered lining the inner edges of the robot with our speed controllers.

We were able to use Inventor to iterate through several packaging arrangements in the base frame. We showed each idea to the electrical group and allowed them to decide which set-up best met their needs.



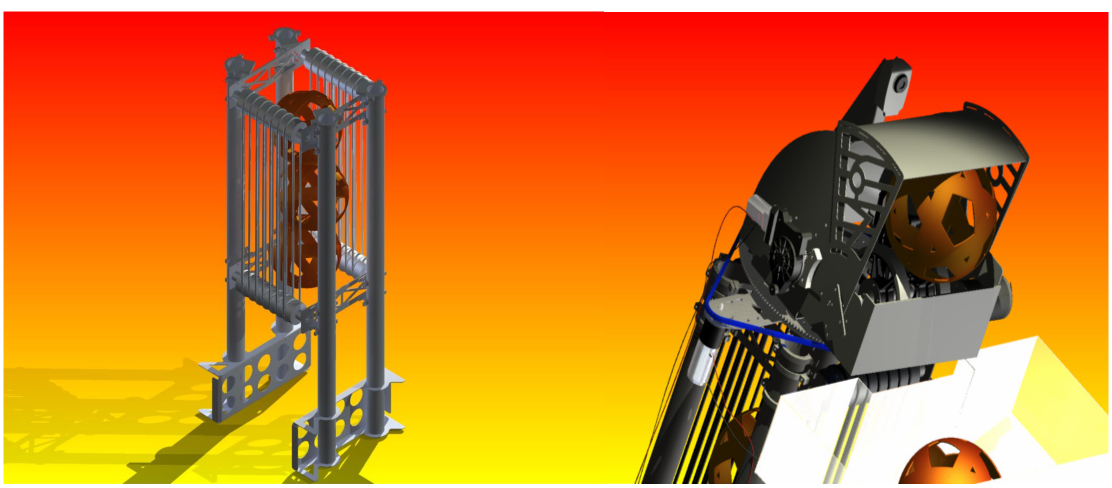
Conveyor and Shooter

- Shooter
  - Ball Shooter: 1 CIM, 1 Jaguar, Encoder Feedback
  - Turret Azimuth: 1 Globe, 1 Jaguar, Potentiometer Feedback, Lazy-Susan
  - Turret Elevation: 1 Window Motor, 1 Spike
- Conveyer
  - Ball Pickup: 1 Fisher-Price, 1 Victor
  - Ball Sorter: 1 Fisher-Price, 1 Victor
  - Ball Conveyer: 1 Globe, 1 Victor
  - .25 surgical tubing

The last key component to our robot is the Conveyer - Shooter assembly. This setup allows us to take the balls we have collected and launch them in any direction in front of the robot. The shooter is able to sweep a total of one hundred and eighty degrees side to side travel, allowing us to shoot at our opponents with great flexibility. This feature is possible due to the lazy-Susan that our team adapted to be driven by a globe motor.

We can launch the balls straight over any opponent with ease thanks to great work from the programming team. They were able to write a program that will adjust the speed of the shooter based on distance information provided by the robot's camera. They can determine the angle that the robot needs to shoot in order to land in a certain location, like an opponent's trailer.

The design of the shooter involves the use of two wheel rollers. Our conveyer allows us to store the balls just below the wheel rollers so they are ready when they need to be shot out. The conveyer uses surgical tubing on rollers to carry our stored balls straight up and park them below our shooter. With the help of rollers, the robot can take balls from the ground, then carry them through the hopper to the base where they can be carried up to score.



Key Programming Parts

Target detection: A camera detects the target by identifying the color on the top and bottom, either green or pink, to determine alliance. The angle is used to find the distance from an opponent's trailer.

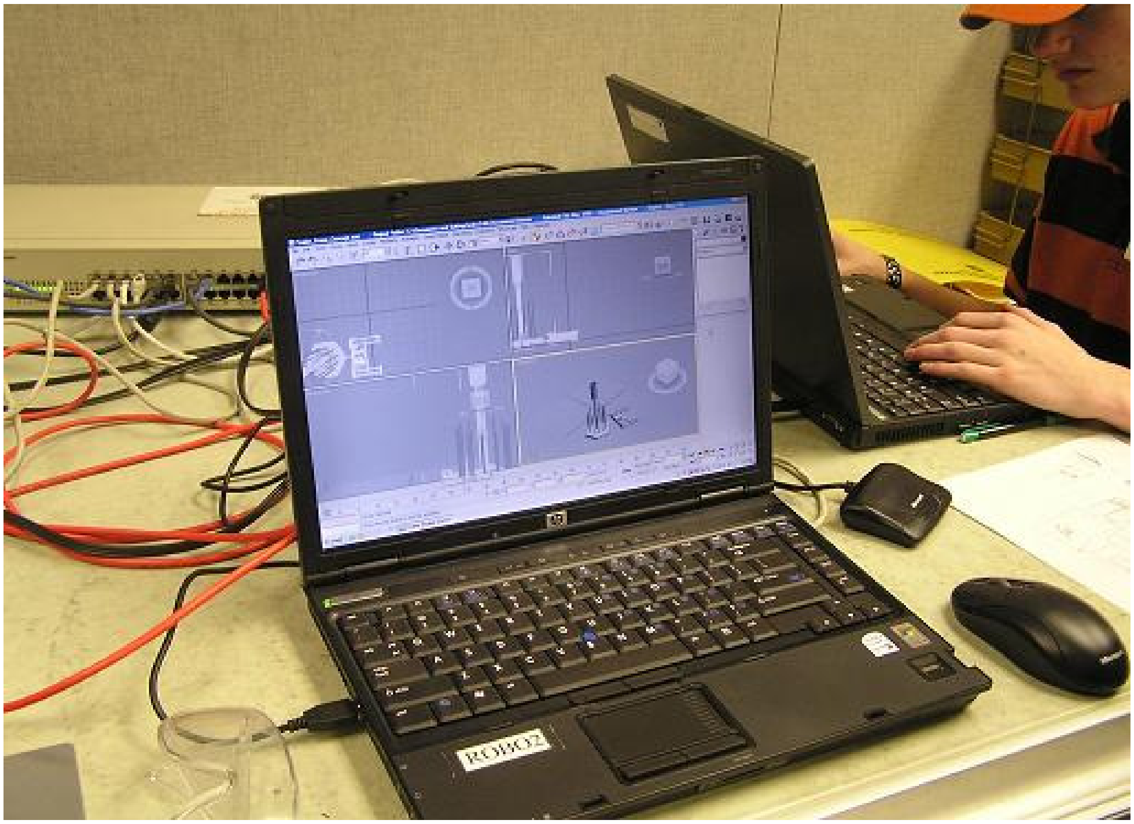
Omni wheel: Indicates the true speed of robot. The code uses traction control to find optimum speed of drive wheels and maintain maneuverability.

Driving Mode: RC mode is used for driving. In this mode the left stick controls the speed and the right stick controls the steering of the robot.

Pick Up Rollers: These rotate and allow our robot to collect balls from the floor. These rollers are controlled by the driver.

Conveyer rollers: These are used to lift balls from the hopper and into the shooter mechanism. The conveyer, shooter turret and wheel speed are controlled by the co- pilot.

Animation



Team 67 design group used Studio max 3d this year to create an animation of our robot playing the Lunacy game with another robot and a human player. Three members of the team learned and manipulated the program in a few short weeks to create our animated version of one episode on "Lunacy". The animation files are included in folder of the 2009 Autodesk submission. The viewable version is an AVI file.

The Robot


GM

The Team

From Left to right
Back Row: Sam Grebe, Mitchell Maxwell, David Armstrong, Evan Cramer, David Droulliard, Theresa Prior
Front ; Pat Brennan, Brett Billingham

Kenny Harris

Colin Hale