Deriving Consistency from LEGOs

What we have learned in 6 years of FLL

by

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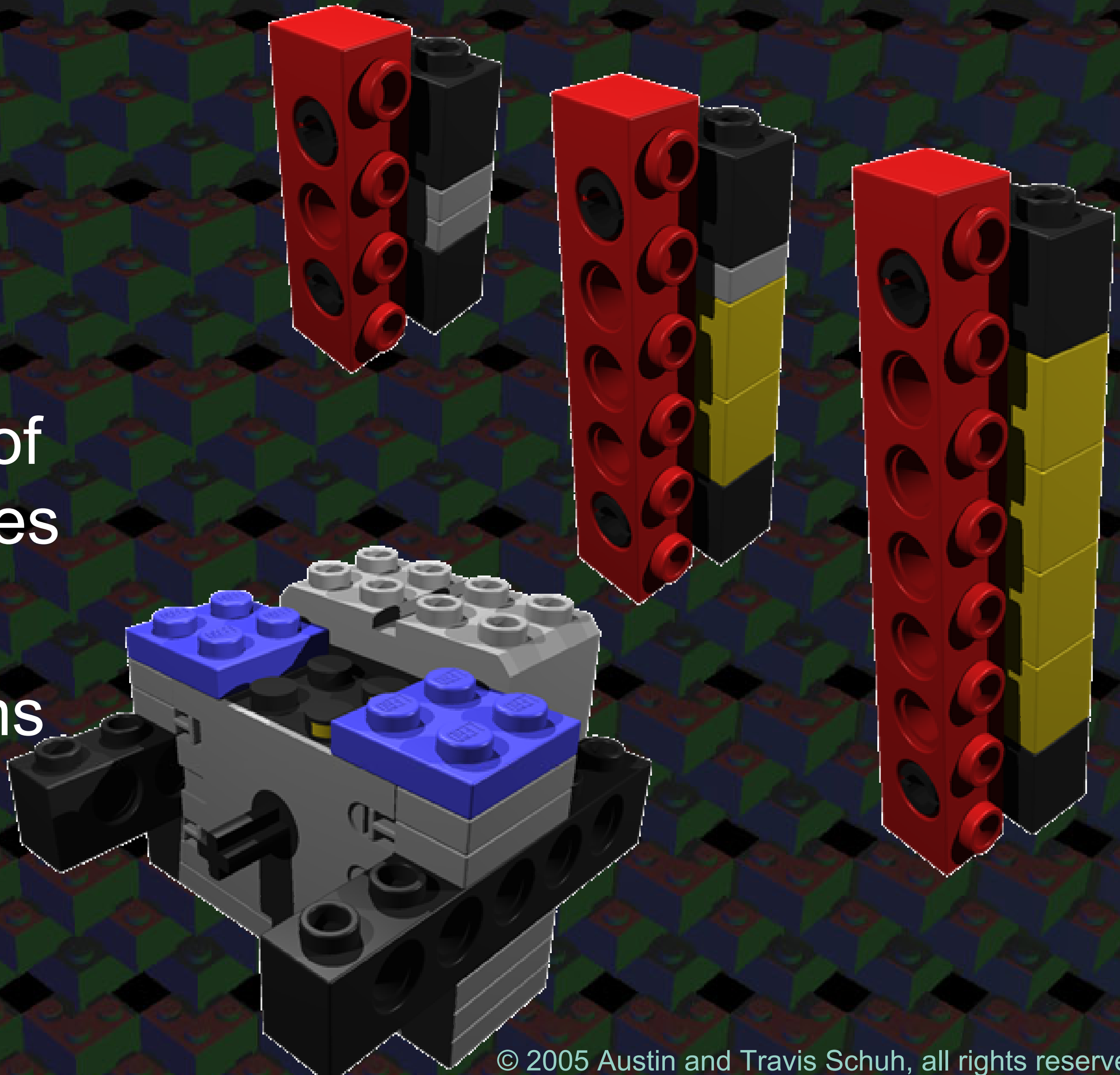
Objectives

- Basic Building Techniques
- How to Build Arms and Drive Trains
- Using Sensors
- How to Choose a Programming Language
- What to do Before and During the Season

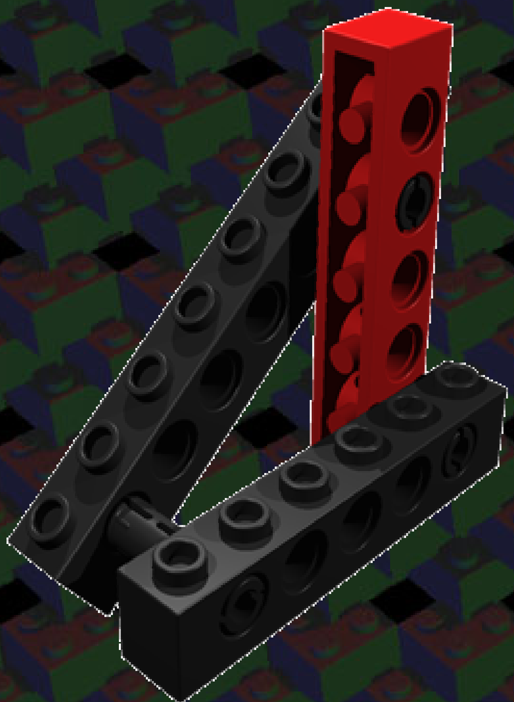
Basic Building Techniques

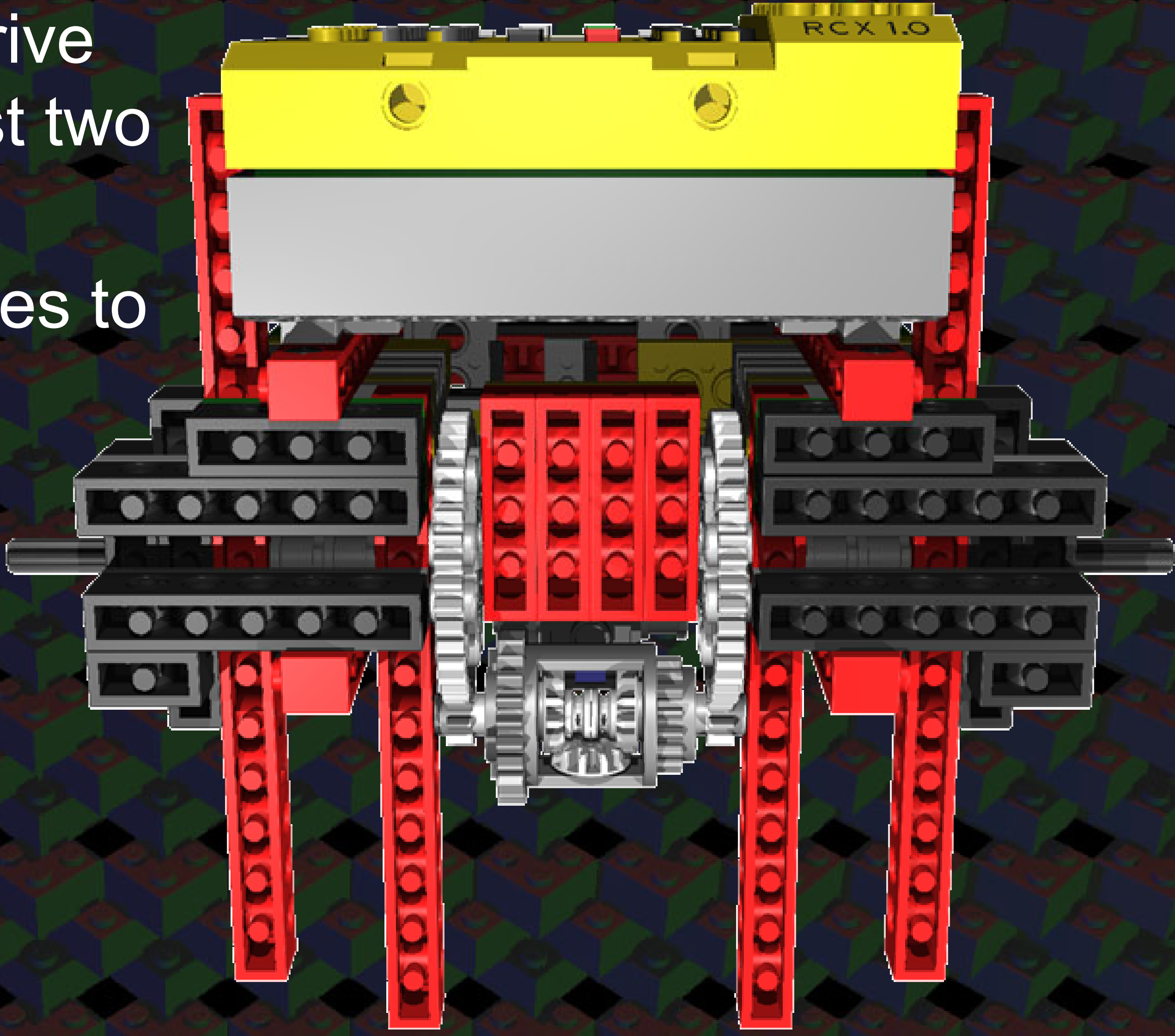


- Pinning
- Pros and cons of Beams and Axles
- Attaching Beams to Motors

Advanced Building Techniques

- Support each drive axle with at least two beams.
- Use right triangles to brace things.



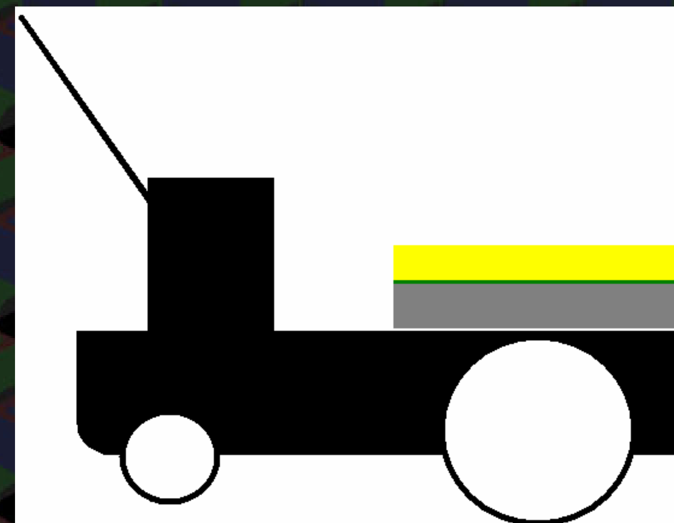


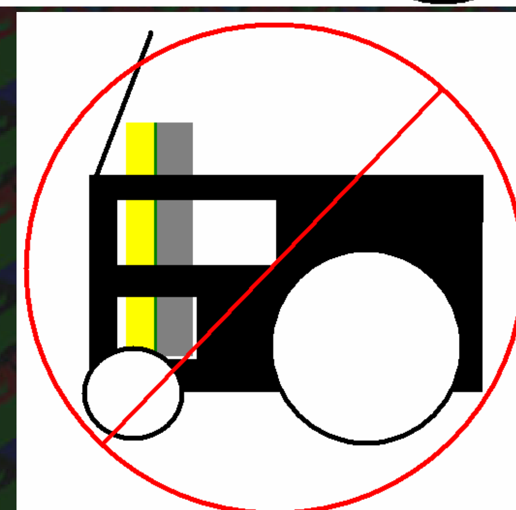
Testing Strength

- Coach Test: Have your coach pick up your robot. If they can succeed without breaking it, it passes.
- Stall Test: If you can stall all of your motors and the robot doesn't break or threaten to break, it passes.
- Drop Test: If you can drop your robot between 6" to 12", and it doesn't break, it passes.

Mounting the RCX

- It is important to mount the RCX where you can easily access the buttons and see the screen.
- Make sure it is easy to take the RCX off to change batteries, yet it is securely attached.
- Mount the RCX so that the robot will have very little weight on the front wheels.

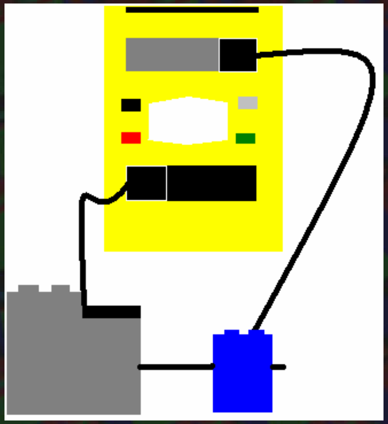




Matching Motors

Match your motors

- Each motor goes at a different RPM, which causes the robots to veer.
- This can be overcome by pairing motors of similar RPM.
- Compare the speed of motors and then choose the two motors with the closest RPM for your drive motors.



Motor Rotation sensor

Have a simple program that turns the motor on for x seconds. Use the view button to find out how many counts the motor turned and then record the number . Repeat for each motor.

Gearing

- The motors themselves go too fast, so gearing down is necessary.
- Do not use gears to change angles.
- When choosing the speed of your robot, you want to be fast enough to get around easily, but slow enough to have precise turning.

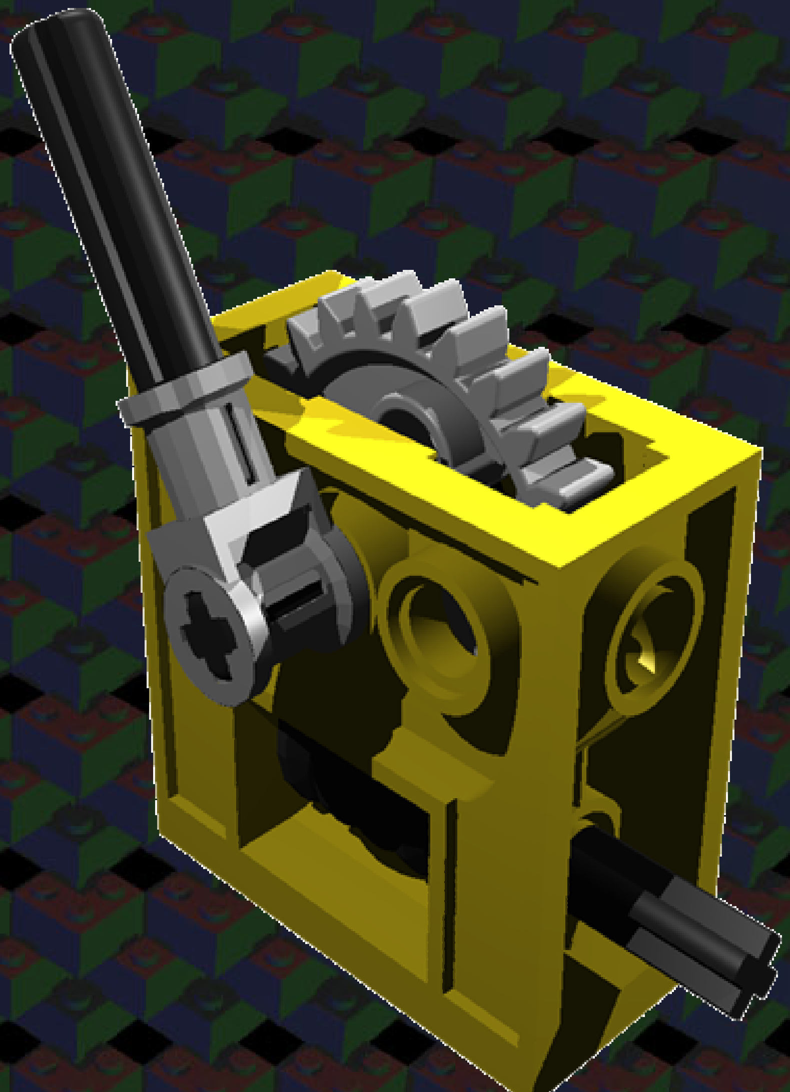
Avoid this!

Wheels

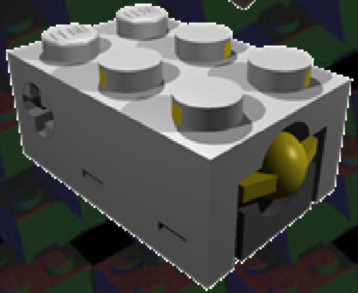
- Wheels are like gears, the bigger the wheel, the faster the robot moves; the smaller the wheel, the slower the robot moves.
- Look for a wheel that has lots of traction.
- Check if the challenge has something requiring big wheels (climbing up something).
- Tank Treads are not the most practical form of wheels, lots of energy is lost in trying to spin the treads and they can not go as fast.
- Do not put treads on the front wheels, because treads make turning hard.

Arms

- The arm's job is to help a team manipulate the field pieces.
- The yellow gear box makes a simple arm, but there is lots of friction involved.
- It is not necessary to have a motorized arm.
- It is good to be able to quickly change arm attachments, because it is common to have a different arm for each mission.



Sensors



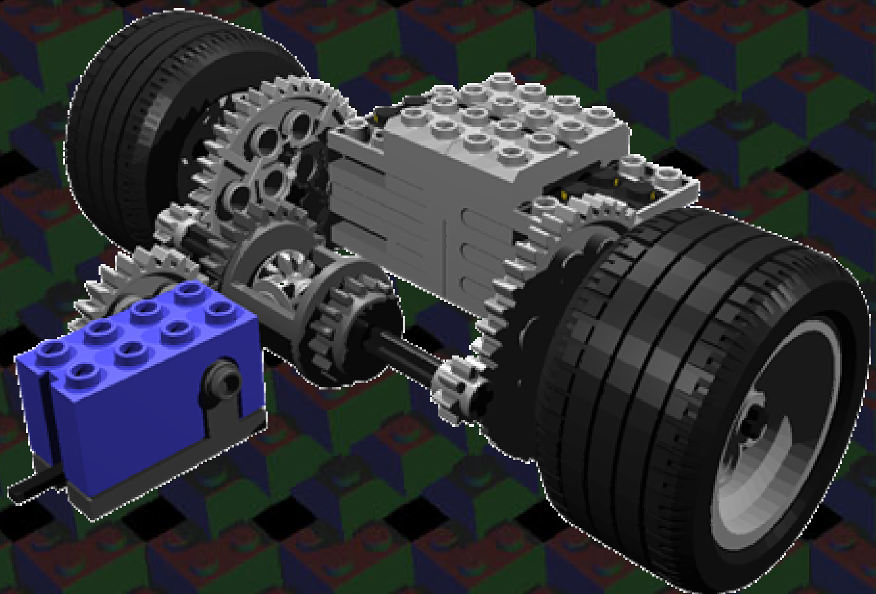
- A rotation sensor counts how many times an axle rotates. A rotation sensor starts skipping counts at around 500 rpm, and the motor operates at 375 rpm, so gear the rotation sensor so that it goes at the same speed as the motor.
- A light sensor measures how reflective a surface is, and returns 100 as the brightest and 0 as the darkest.
- A touch sensor tells the robot when it is pressed or depressed.

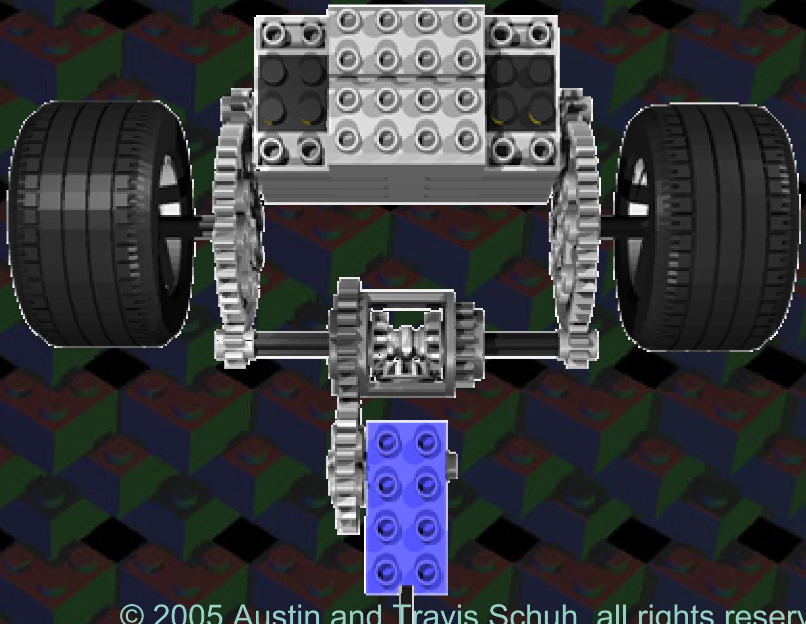
Using the Sensors with the RCX

- The RCX has three gray sensor ports.
- To maximize the use of the sensor ports, it is possible to plug a light sensor and a touch sensor into the same port. In your code, you treat the port like a light sensor, except the only difference is that when the touch sensor is pressed, the port returns 100.
- To find rotation and light values, use the view button to select a port by pushing it until the arrow points to the desired port. Then, the screen will display the value of the sensor that is defined as on that port in the code.
- If you hold down the view button while a motor is selected, you can use the Prgm and Run button to control the direction of the motor.

Differential Rotation

- A differential rotation is where one uses a differential and a rotation sensor to be able to get rotation values from both wheels.
- A differential rotation measures distance when going forward, backward, and turning with only one wheel. It does not count rotations when the motors spin in opposite directions at the same speed.





How to avoid using time

- Time is inaccurate because the distance defined by x seconds changes when the battery voltage changes. Instead, a robot can
  - Use rotation counts
  - Follow a wall
  - Square up on a wall
  - Follow a line
  - Use touch sensors
  - Drive until a line

Which Program Language to Use

- Both languages use picture programming blocks.
- MindStorms is easier to pick up because it is well documented.
- Robolab is capable of doing higher power things.
- I would recommend MindStorms for first year teams, and Robolab to more experienced teams that want more flexibility.
- In 2003, my team had the highest score at state and we programmed in MindStorms.

What to watch out for when Programming

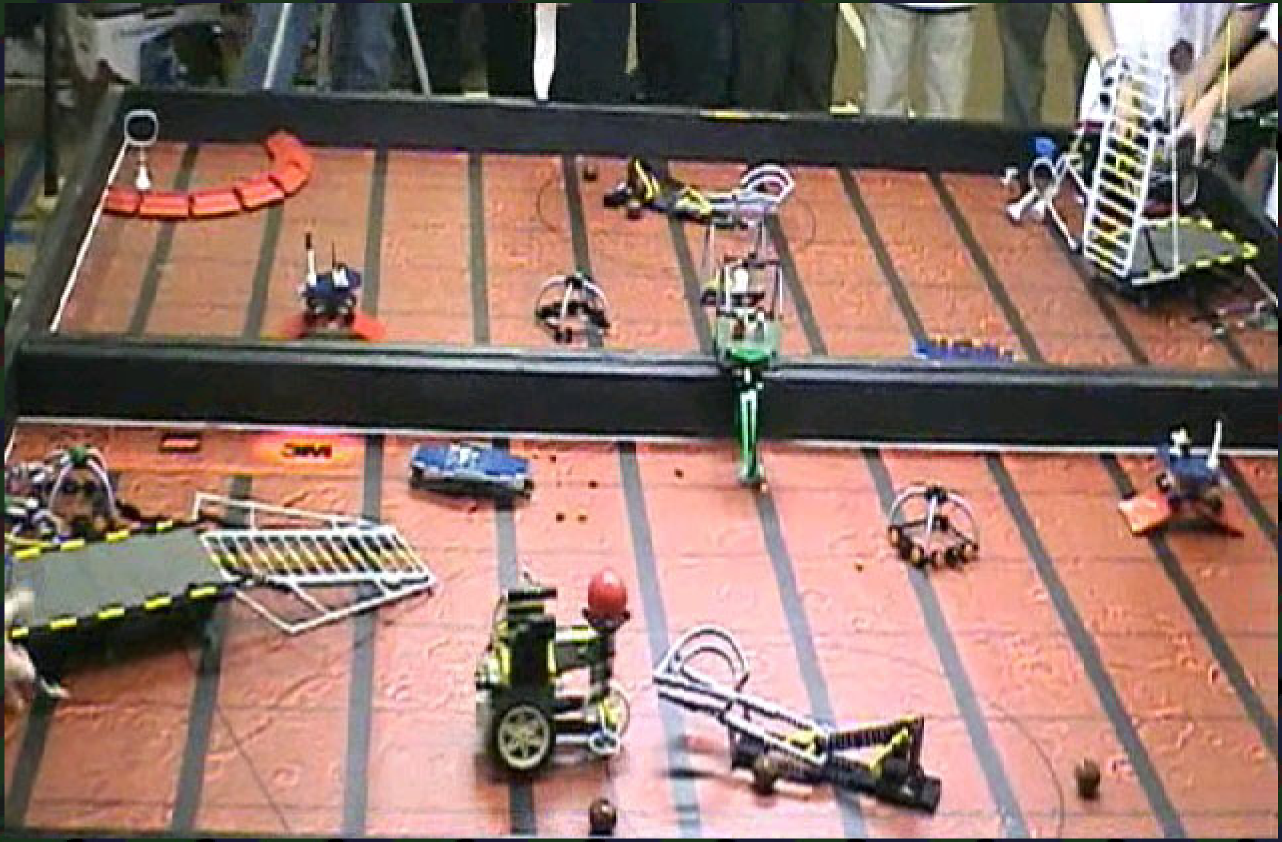
- If you tell your robot to go forward until the rotation sensor equals 24, the robot might miss seeing the number 24, so it will go forward forever.
- Instead, tell the robot to go forward until the rotation sensor is greater than or equal to 24, so that if it misses seeing 24, the robot will see 25 and then stop.
- MindStorms sometimes rounds to zero when numbers are less than 0.05, which can cause your program not to work and give you an 'Unrecognized Brick Error‘.

Things to do before and during the season

- Before the season, you should meet as a team to practice programming, building robot bases, and test your motors.
- During the season, send Scott Evans, the game designer, any questions about game rulings so that at the competitions, you can prove your strategy is legal.
- During the season, back up old versions of your code incase you make a change, save, and then decide you didn’t want that change, save under a new name after each change.
- If your team needs any extra help, you can invite us to give our talk to your team. We will try to help you out if we have time to do so.

Simplicity often wins

- Many of the best robots are robots that are simple and can do their tasks reliably.
- This is a simple robot that had the highest score at the state competition in 2003.



This is a complex robot that did quite well at the 2004 state competition.

Have a Great Season!