Image available in James Jeffrey Trobaugh book Winning Design!: LEGO MINDSTORMS NXT Design Patterns for Fun and Competition

Robot Chassis Design Requirements

What type of robot do you want to build?

○ Two-Wheeled

○ Three-Wheeled

○ Four-Wheeled

○ Tracked (Avoid)

○ Walking (Very Complex)

Why did you choose this type of robot?

What type of wheel?

Speed

The larger the wheel, the faster it will go.

Traction

The more wheel contact surface, the more traction for pushing objects.

Wheel Speed Experiment

Line up the wheels of different sizes on a starting line. Roll each wheel one rotation.

Which wheel traveled the farthest?

Wheel Traction Experiment

Gather different types of wheels and drag each wheel across a hard surface.

Which wheel was the hardest to drag?

Speed and Traction

The double-wheel configuration gives both speed and traction.

Which wheel did you select and why?

How do you want to support your wheels?

- Good Axle Support
  - Some Friction
  - Some Axle Bend

- Double Axle Support
  - Less Friction
  - Limited Axle Bend

Will use sensors for navigation?

- Straight Line Following

- Curved Line Following

- Dual Sensors

Why use sensors for navigation?

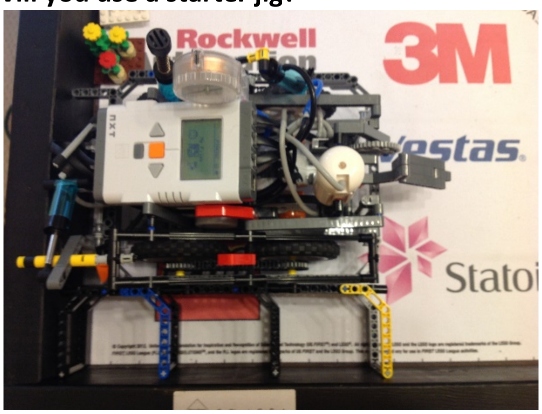
What sensors do you think you will use?

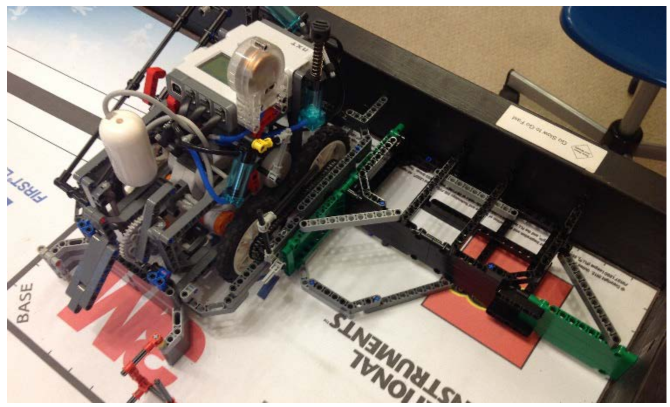
- **Color Sensor**
- **Light Sensor**
- **Rotation Sensor (Motor)**
- **Touch Sensor**
- **Ultrasonic Sensor**

Will you use wall squaring, following or a starter jig?

Why would you use a wall squaring?

Will you use a starter jig?





Why would you use a starter jig?

How you attach attachment?

○ Non-snapping Pins

○ Snapping Pins

○ Magnets

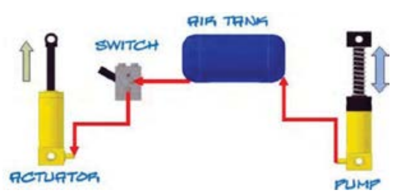
Why did you select the attachment method?

How will you power attachments?

○ Front-Mount Motor

○ Top-Mount Motor

○ Gears to distribute power



○ Pneumatics

Gears

Will you use gear to distribute power?

Spur Gears

Double Bevel Gears

Pulley Gears

Bevel Gears

Worm Gears

Knob Gears

Crown Gears

Clutch Gear

Chassis Design Goals

List the goals for your robot. Examples include fast, small, strong, or sturdy.

Rank	Goal

Robot Sketch Pad

Robot Code Name:	
Number of Wheels:	
Wheel Types:	
Sensors:	

Robot Sketch Pad

Robot Code Name:	
Number of Wheels:	
Wheel Types:	
Sensors:	

Motor Matching Testing

The idea behind motor matching is to find two motors that are compatible with each other; you'd like to find two motors that run at the same pace, start evenly, and brake at the same time.

See James Jeffrey Trobaugh. Winning Design!: LEGO MINDSTORMS NXT Design Patterns for Fun and Competition for building a motor matching machine and program

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Robot Build Plan

What	Who	When
Motor Matching Test		

Robot Test Plan

What	Who	When
Center of Gravity Test		
Distance Test		
Straight Test		
Turning Test		
Drop Test		
Speed Test		
Consistency Test		

Center of Gravity Test

James Jeffrey Trobaugh. Winning Design!: LEGO MINDSTORMS NXT Design Patterns for Fun and Competition (Kindle Locations 381-385). Kindle Edition.

For your robot to perform consistently, it will need to be properly balanced; all wheels or threads need to keep in contact with the game field at all times to ensure consistency and repeatability during each mission run. A robot that tips over or wobbles will be very hard to control and program for dependable mission attempts. Balance depends on a couple of things: the center of gravity and the wheelbase of the robot. The wheelbase is any area within a region created by drawing lines between each of the wheels on your robot, as shown in figure on the right. The area with in this region is the wheelbase of your robot. For your robot to stay balanced, the center of gravity should be inside the wheelbase; the closer to the center of the wheelbase that the center of gravity is located, the more balanced the robot will become.

Test

1. Build a triangle testing block like the one below out of Legos.
2. Perform the Longitudinal Balance Plane Test and record the results.
3. Perform the Lateral Balance Plane Test and record the results.

Longitudinal Balance Plane Test

Results

Lateral Balance Plane Test

Results

Distance Test

Test: Distance Calculation

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1. What is the wheels diameter? ________

   Lay the wheel on a ruler and measure the distance at the widest outside part

2. Calculate the Circumference:

   ______________________ x 3.14 = ______________

   (Diameter from Step 1) ∏ pi Circumference

3. Calculate the distance the robot travels with 4 rotations.

   4 x ______________________ = _________________________

   Rotations Circumference (Step 2) Distance

4. Write a program that goes 4 rotations
5. Run the program and measure the distance the robot traveled

Test Results:

Did the distance you calculate equal the distance the robot traveled?

__________________ = __________________

Step 3 Distance Step 5 Distance

Test: Rotation Test

Determine how many rotations for the robot to travel 12 inches.

Rotations = distance (12) / circumference (Step 2)

1. Program the robot to rotate the calculated rotations.
2. Measure the distance the robot traveled.

Rest Results:

Did it travel 12 inches?

Straight Test

A robot that will not go straight will not run consistent.

Test: Observation

1. Program the robot go straight 4 rotations using motor power starting at 30
2. Run the robot and observe if it goes straight.
3. Increase the motor speed per the table below and test again

Test Results

Motor Power Level	Did the robot go straight?
30	
50	
70	
100	

Test: Laser Level Straight Test

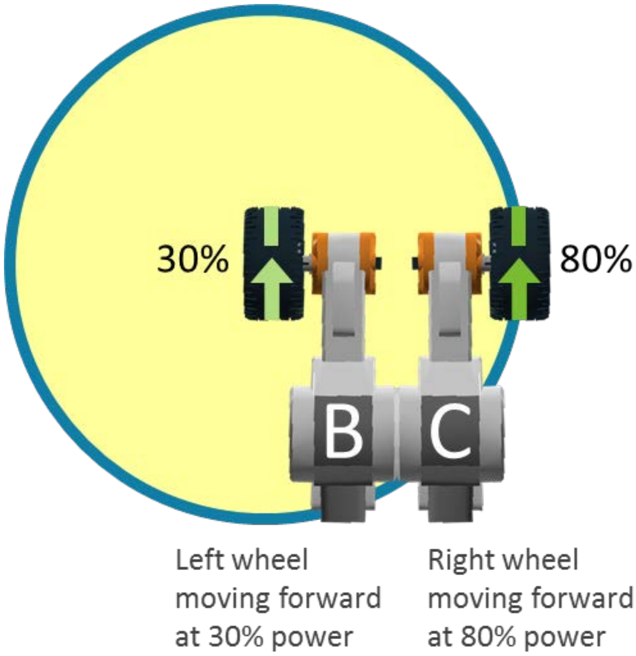
1. Use tape to mark a Spot A on the back wall of the base, left wall
2. Use a laser level to determine mark Spot B on the right wall and mark it with tape.
3. Program the robot to go straight from Spot A to Spot B
4. Start at Spot A and run the program.

Test Results

Did the robot go straight and end up at Spot B?

Turn Test

Test: Gradual Turn

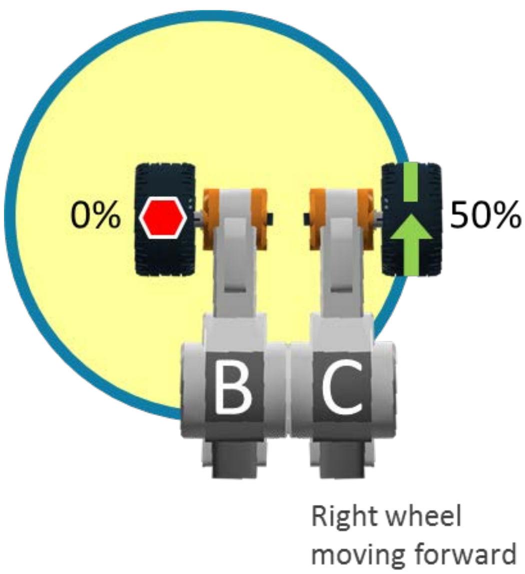


1. Program the robot to turn complete a left 90% turn using the motors speed shown.
2. Run the program 4 times

Test Results

Did the robot turn consistently?

Test: One Motor Turn

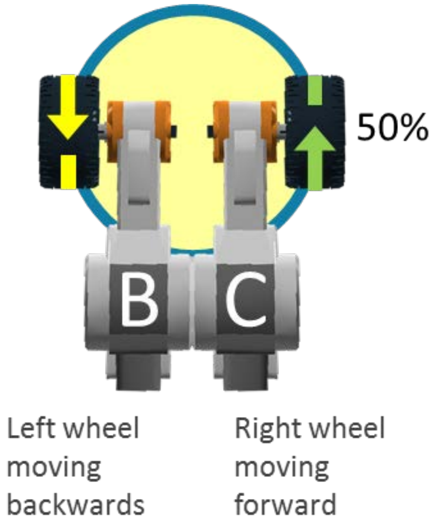


1. Program the robot to turn complete a left 90% turn using the motors speed shown.
2. Run the program 4 times

Test Results

Did the robot turn consistently?

Test: Pivot Turn



1. Program the robot to turn complete a left 90% turn using the motors speed shown.
2. Run the program 4 times

Test Results

Did the robot turn consistently?

Drop Test

Before doing the drop test, ensure the robot can be rebuilt. Take pictures of the robot design.

1. Drop the robot from 1 foot off the ground on to a carpeted surface
2. Observe and document the results
3. Repeat drop procedure but drop from 3 feet

Drop Test Results

	What happened to the robot? Did anything fall off? Did all connections stay connected?
1 Foot	
3 Feet	