

# Differential Lab

Theme: Gears

Authors: Mark Bieberich, Brent Werness

## Purpose

---

When two wheels are turned around a corner, they cover different distances and hence rotate at different speeds. If the two wheels are unconnected and are not being used to drive the robot this doesn't cause a problem. However, if they are connected, then the two wheels need to be driven by the a single motor at those different speeds. This is the situation where the differential should be used, because it can drive the two wheels depending on how fast they need to go.

In order to investigate this property, you will construct two different sets of wheels. One set of wheels are linked by a straight link and the other set of wheels are linked by a differential. By turning these wheels around corners we can observe why a differential is useful in a robot using a steering drive system.



## Constructing the Differential Connected Device

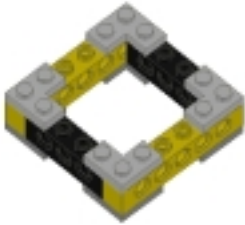
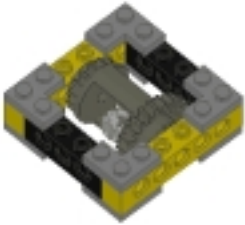
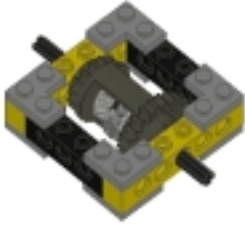
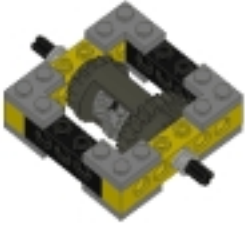

---

### Parts:

- 8 x 2 x 2 Corner Plate
- 2 x Technic Axle 4 long
- 2 x Technic Brick 1 x 4 with Holes (Black)
- 2 x Technic Brick 1 x 6 with Holes (Yellow)
- 2 x Technic 1/2 Smooth Bush
- 1 x Technic Differential
- 3 x Technic 12 Tooth Bevel Gear
- 2 x Tire 81.6 x 15 Motorcycle
- 2 x Wheel 81.6 x 15 Motorcycle

### Instructions:

<p>1</p> 	<p>2</p> 
<p>Place four 2 x 2 Corner Plates at the corners of a square 6 studs on a side</p>	<p>Place two 1 x 4 Technic Bricks with Holes on opposite sides of the square on the corner plates. Attach two 1 x 6 Technic Bricks with Holes on the remaining sides of the square on the corner plates.</p>

<p>3</p> 	<p>4</p> 
<p>Place four 2 x 2 Corner Plates at the corners on top of the base.</p>	<p>Place a differential and a 12 Tooth Bevel Gear lined up with the holes in the center of the sides.</p>
<p>5</p> 	<p>6</p> 
<p>Insert a 12 Tooth Bevel Gear into the differential and secure it with a 4 long axle. Repeat the same process on the other side.</p>	<p>Attach a 1/2 Smooth Bush to each axle to secure the axles in place.</p>
<p>7</p> 	
<p>Attach the tires to each side to complete to differential example device.</p>	





## Building the Direct Connected Device

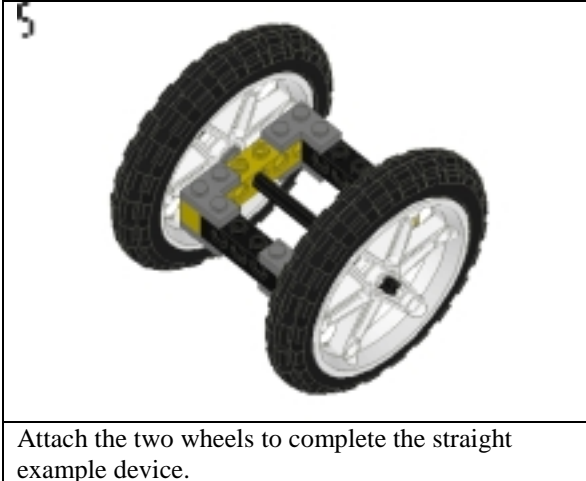
---

### Parts:

8 x 2 x 2 Corner Plate  
1 x Technic Axle 10 long  
2 x Technic Brick 1 x 4 with Holes  
2 x Technic Brick 1 x 6 with Holes  
2 x Technic 1/2 Smooth Bush  
2 x Tire 81.6 x 15 Motorcycle  
2 x Wheel 81.6 x 15 Motorcycle

### Instructions:

<p>1</p> 	<p>2</p> 
<p>Place four 2 x 2 Corner Plates at the corners of a square 6 studs on a side</p>	<p>Place two 1 x 4 Technic Bricks with Holes on opposite sides of the square on the corner plates. Attach two 1 x 6 Technic Bricks with Holes on the remaining sides of the square on the corner plates.</p>
<p>3</p> 	<p>4</p> 
<p>Place four 2 x 2 Corner Plates at the corners on top of the base.</p>	<p>Connect an axle 10 long through the base. Secure the bar in place with two 1/2 Smooth Bushes.</p>



---

### Lab

1. Move the straight axle device around several corners and note the how the tires move. Is it easy or hard to move this device around the corner?
2. Move the differential around several corners and note how the tires move. Is it easy or hard to move the differential around the corners?
3. Repeat these steps until you have a good idea of the two devices' behaviors.

---

### Questions

1. Which device moved more easily around the corner?
2. Can you tell why the differential better navigates the corner than the straight axle?
3. How could this be used in a robot design?
4. A differential rotates at the average velocity of the two wheels. Can you tell how a differential could be used with a rotation sensor and a few gears to tell how the robot is turning?