

# Snek Lesson #3: The Bumper Car

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## Acknowledgments

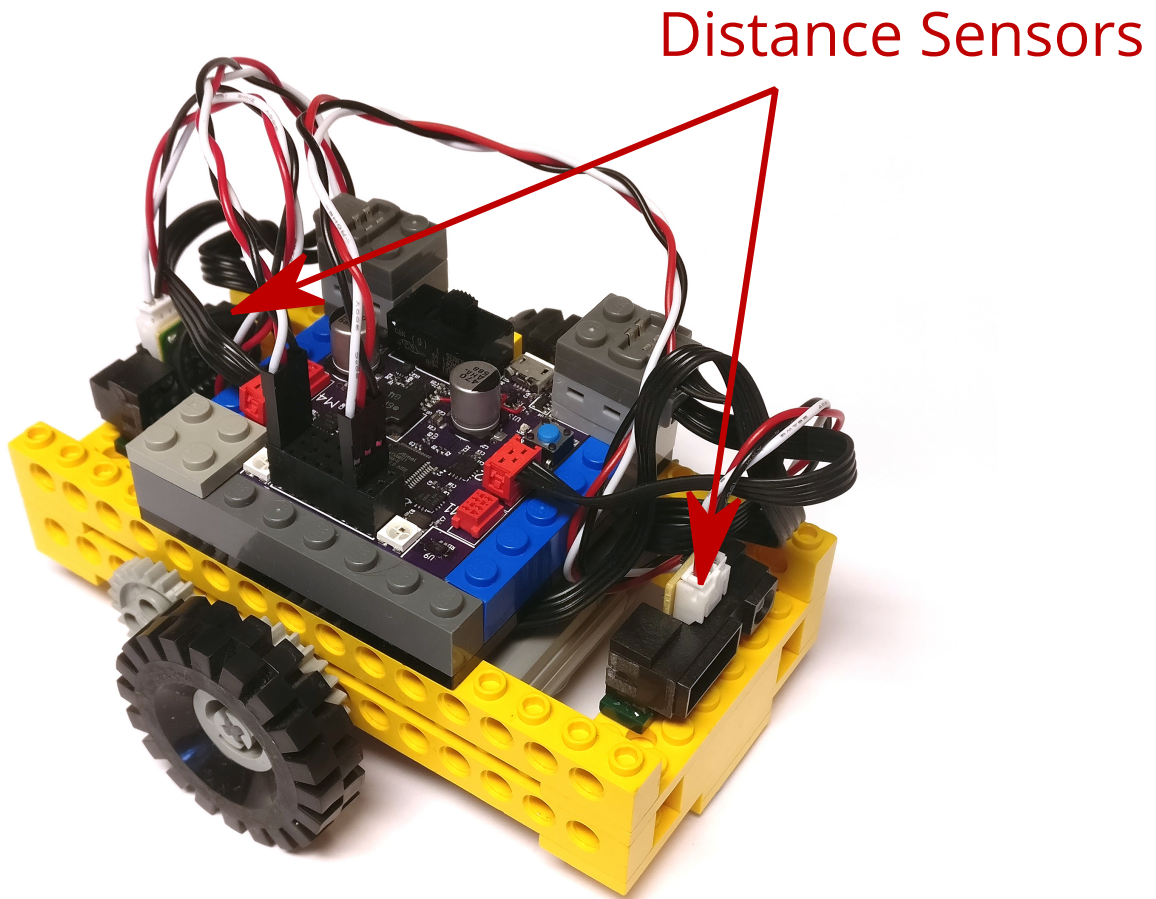
Thanks to Michael Ward for helping create this little robot.

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## 1. The Bumper Car

This lesson contains instructions for building and programming a “Bumper Car”, a little mobile robot that navigates around the room while trying to avoid bumping into things. This lesson builds on the “Line Bug” lesson, so it might be a good idea to explore that one before getting started here.

The bumper car is much like the line bug, in that it moves a car based on sensor input. However, it replaces the light sensor and LED with two analog IR distance sensors, and replaces attraction with avoidance.



*Figure 1. Bumper Car*

Important features:

- Two motors to move the bug, one for each wheel.
- Two distance sensors. These look for objects and tell you how far away they are.
- Skid plates on the bottom mean the surface must be flat!

The basic ideas are:

- The car should move in one direction (the direction of one of the sensors) until something gets too close.
- When something gets too close, the car should change directions (to the direction of the the other sensor).
- Now apply these rules over and over.

## 1.1. Planning the Bumper Car Program

It is always a good idea to identify (and write out) what it is you want a program to do. This helps us identify and think about key actions and behaviors. Some of the components that result from this here are:

- Moving the car in one direction. (Commands to set the motors for direction 1.)
- Changing the direction. (Commands to set the motors for the other direction, direction 2.)
- Determining when something gets too close. This requires some refinement! What if something gets close behind the car? Should the car change direction and run into it? Of course not. Therefore, the refinement is: Determining when something gets too close in the direction of motion.

## 1.2. Moving in One Direction

Once we enter interactive commands to try running the motors (turning them on and off, setting direction and power) we figure out that rotating them in opposite directions moves in the direction of a sensor. We can write two functions to move in opposite directions. For now, let's do this at ½ speed:

```
def MoveOneDir():
    talkto(M2)
    setpower(0.5)
    setleft()
    on()
    talkto(M3)
    setpower(0.5)
    setright()
    on()

def MoveOtherDir():
    talkto(M2)
    setpower(0.5)
    setright()
    on()
    talkto(M3)
    setpower(0.5)
    setleft()
    on()
```

The difference between these two functions is that `MoveOneDir` calls `setleft` for M2 and `setright` for M3 while

### 1.3. The Distance Sensor

We can test the sensor with the interpreter, using our hand for distance:

```
> while True:
+   print(read(A8))
+   time.sleep(1)
+
0.162149
0.1758242
0.197558
0.1965812
0.1726496
0.7111111
0.7103785
0.7115995
0.4957265
0.1880342
0.1777778
kbd:[Ctrl+C]
```

### 1.4. Wait Until We're Close

We figure out that A8 is sensing in this direction, and 0.4 works as a threshold between close and far. Let's write a couple of functions that wait until we're closer than that

```
def WaitUntilCloseOneDir():
    while read(A8) < 0.4:
        pass

def WaitUntilCloseOtherDir():
    while read(A7) < 0.4:
        pass
```

The rest of the program might then look like this:

```
def BumperCar():  
    while True:  
        MoveOneDir()  
        WaitUntilCloseOneDir()  
        MoveOtherDir()  
        WaitUntilCloseOtherDir()  
  
BumperCar()
```

## 1.5. Turning Around

Now that we have the bumper car avoiding objects, let's give it the ability to explore its environment a bit by having it turn, instead of always moving in a straight line. To keep from hitting things while we do this, we'll spin in place.

To make our robot less predictable, let's have it spin a random amount. Random numbers are like the roll of a die; you can't predict the value. Snek can generate random numbers using the `random.randrange` function. `random.randrange` takes one value, and will generate a random number from zero to one less than this value. So, if you want a random number from the set `{ 0, 1, 2, 3, 4, 5 }`, you'd use `random.randrange(6)`. We can do arithmetic on the number to adjust the range further.

Let's explore that:

```

> random.randrange(6)
3
> random.randrange(6)
1
> for i in range(5):
+     print(random.randrange(6))
+
5
1
4
0
3
> for i in range(5):
+     print(random.randrange(6) + 1)
+
6
5
1
1
5
>

```

Next, we can write a function that waits for a random amount of time, say between 1 and 6 seconds:

```

def WaitRandom():
    wait = random.randrange(6) + 1
    time.sleep(wait)

```

Let's figure out how to get the bumper car to spin. To go straight, we use `setleft` with one motor while we use `setright` with the other. Let's make it spin by having the wheels turn in opposite directions by setting both motors with either `setleft` or `setright`:

```
def Spin():
    talkto(M2)
    setpower(0.5)
    setright()
    on()
    talkto(M3)
    setpower(0.5)
    setright()
    on()
```

Now we can hook those together to spin for a random amount of time:

```
def SpinRandom():
    Spin()
    WaitRandom()
```

Add some code to BumperCar to back up from the obstacle a bit, spin randomly and then go straight again:

```
def BumperCar():
    while True:

        # Back up a bit and spin around
        MoveOneDir()
        time.sleep(1)
        SpinRandom()

        MoveOneDir()
        WaitUntilCloseOneDir()

        # Back up a bit and spin around
        MoveOtherDir()
        time.sleep(1)
        SpinRandom()

        MoveOtherDir()
        WaitUntilCloseOtherDir()
```



Here are some further ideas on how you might extend this program:

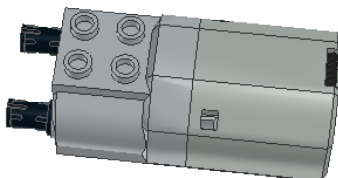
- 
- Wait for closeness before starting the bumper car.
  - Stop all motion when things get close on both sensors.
  - Adjusting the speed of motors.
  - Adjusting the closeness before changing.
  - Try changing directions with a fixed or random turn.

## 2. Building The Bumper Car



Follow the next few pages to complete the construction of your bumper car. For the wheels, you can use any that will fit on the axles and not rub on the 8-tooth gears.

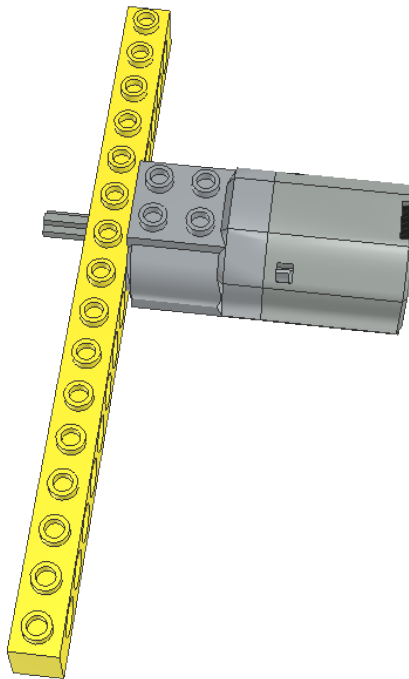
### 2.1. Step 1

Part	Description	Color	Count
	Electric Power Functions 2.0 Medium Motor	Light Grey	1
	Technic Pin with Friction	Black	2




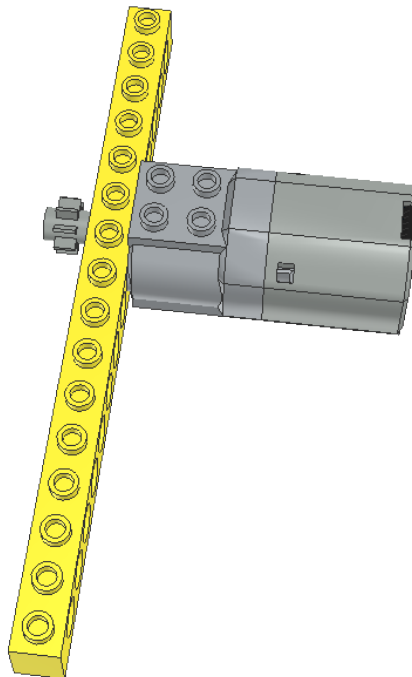
## 2.2. Step 2

Part	Description	Color	Count
	Technic Brick 1 x 16 with Holes	Bright Light Yellow	1
	Technic Axle 3	Light Grey	1





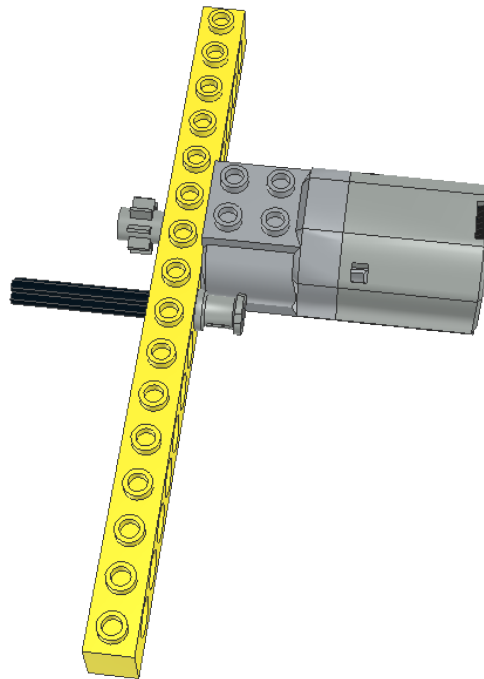
## 2.3. Step 3

Part	Description	Color	Count
	Technic Gear 8 Tooth	Light Grey	1





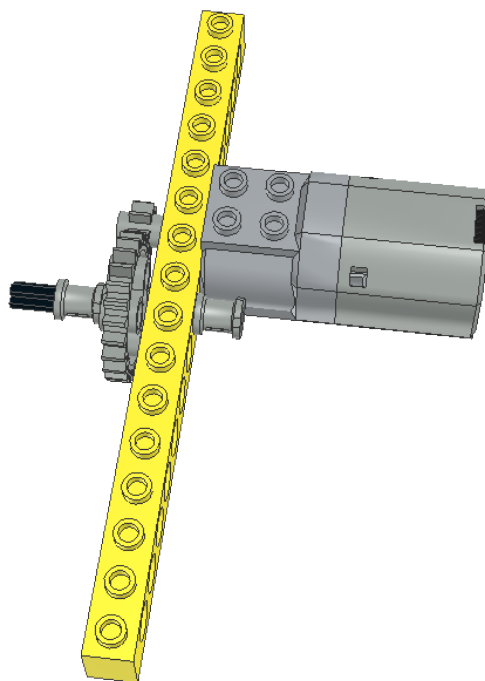
## 2.4. Step 4

Part	Description	Color	Count
	Technic Axle 5	Black	1
	Technic Bush with Two Flanges	Light Grey	1





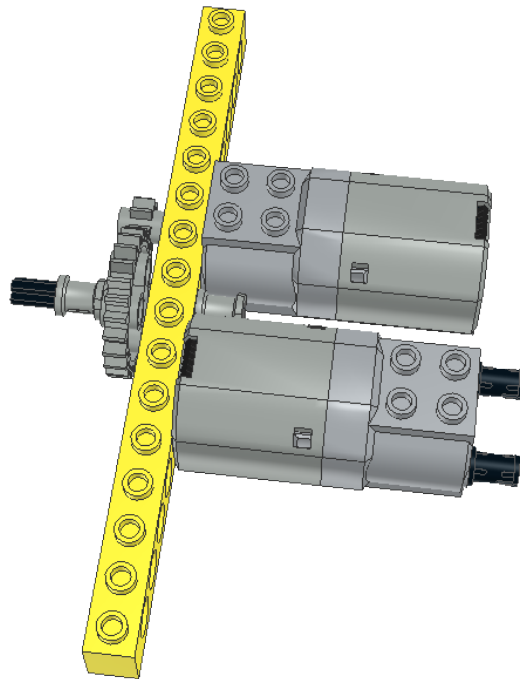
## 2.5. Step 5

Part	Description	Color	Count
	Technic Gear 24 Tooth with Single Axle Hole	Light Grey	1
	=Technic Bush with Two Flanges	Light Grey	1





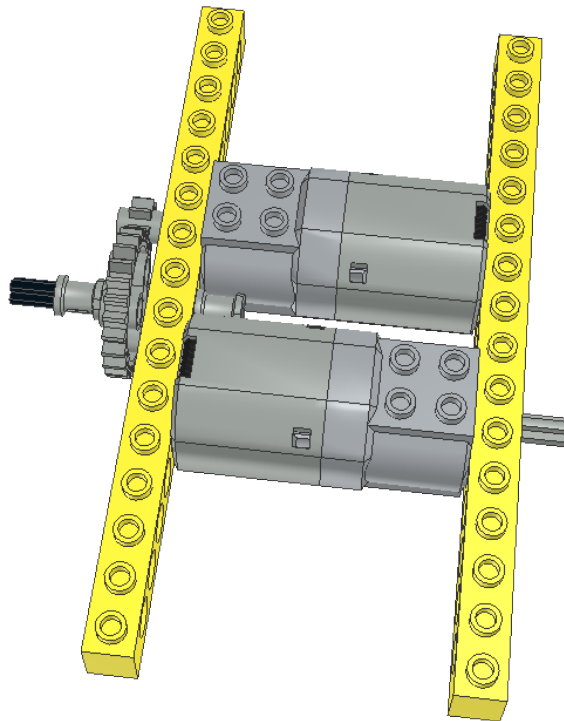
## 2.6. Step 6

Part	Description	Color	Count
	Electric Power Functions 2.0 Medium Motor	Light Grey	1
	Technic Pin with Friction	Black	2




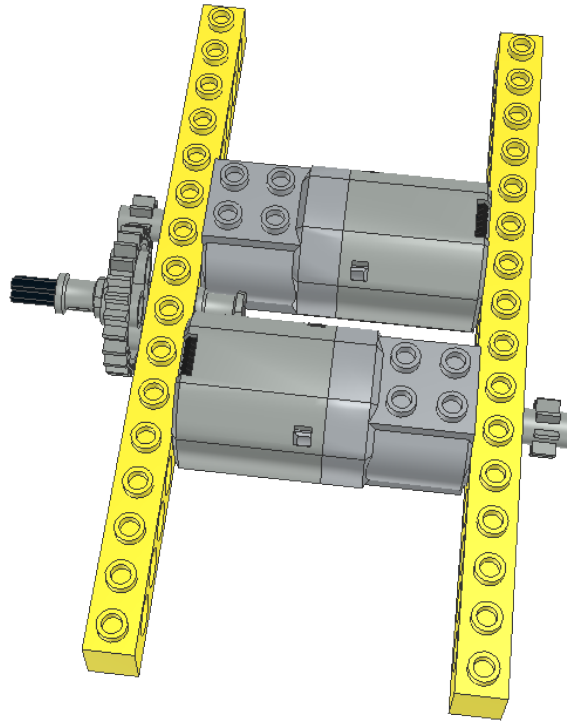
## 2.7. Step 7

Part	Description	Color	Count
	Technic Brick 1 x 16 with Holes	Bright Light Yellow	1
	Technic Axle 3	Light Grey	1





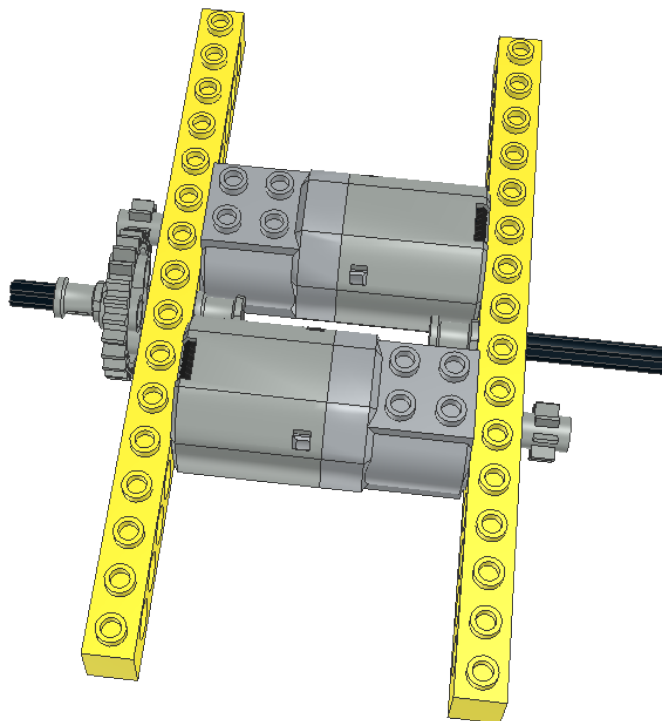
## 2.8. Step 8

Part	Description	Color	Count
	Technic Gear 8 Tooth	Light Grey	1





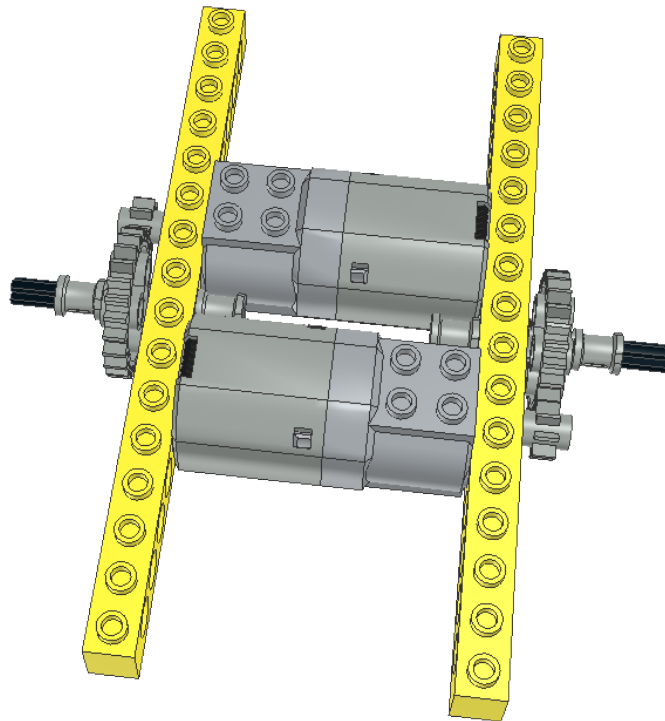
## 2.9. Step 9

Part	Description	Color	Count
	Technic Axle 5	Black	1
	Technic Bush with Two Flanges	Light Grey	1






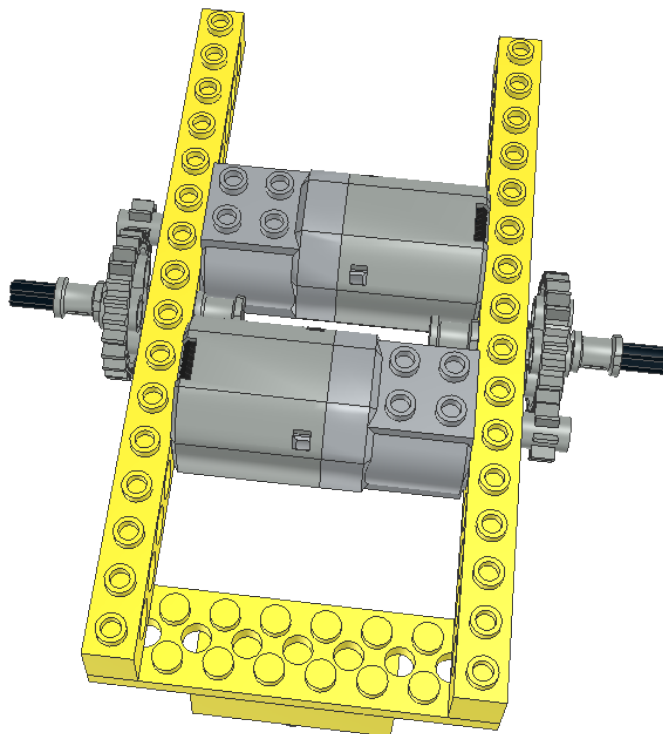
## 2.10. Step 10

Part	Description	Color	Count
	Technic Gear 24 Tooth with Single Axle Hole	Light Grey	1
	=Technic Bush with Two Flanges	Light Grey	1






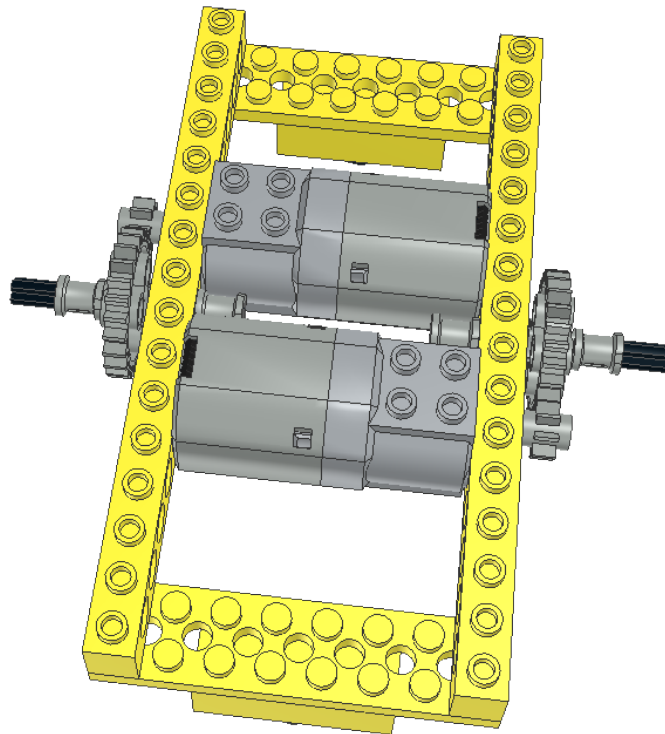
## 2.11. Step 11

Part	Description	Color	Count
	Dish 2 x 2	Black	1
	Brick 2 x 4	Bright Light Yellow	1
	Technic Plate 2 x 8 with Holes	Bright Light Yellow	1




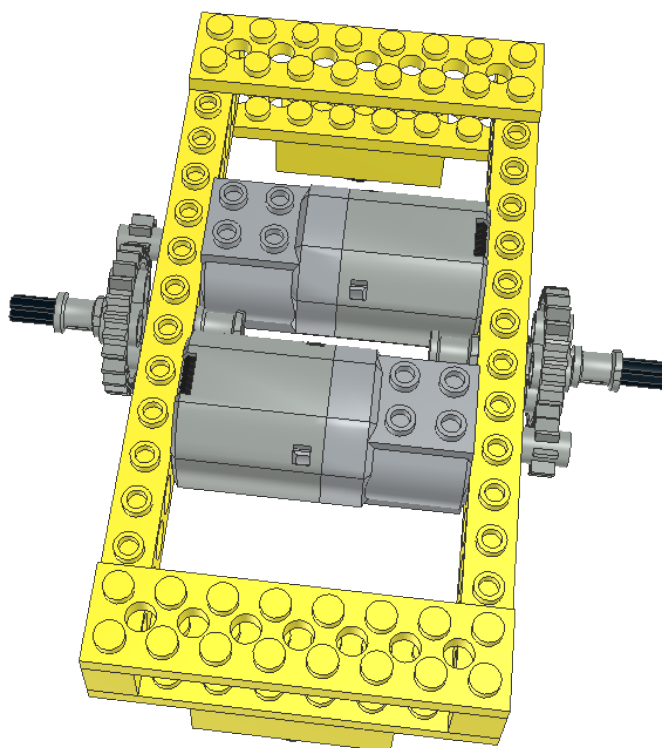
## 2.12. Step 12

Part	Description	Color	Count
	Dish 2 x 2	Black	1
	Brick 2 x 4	Bright Light Yellow	1
	Technic Plate 2 x 8 with Holes	Bright Light Yellow	1




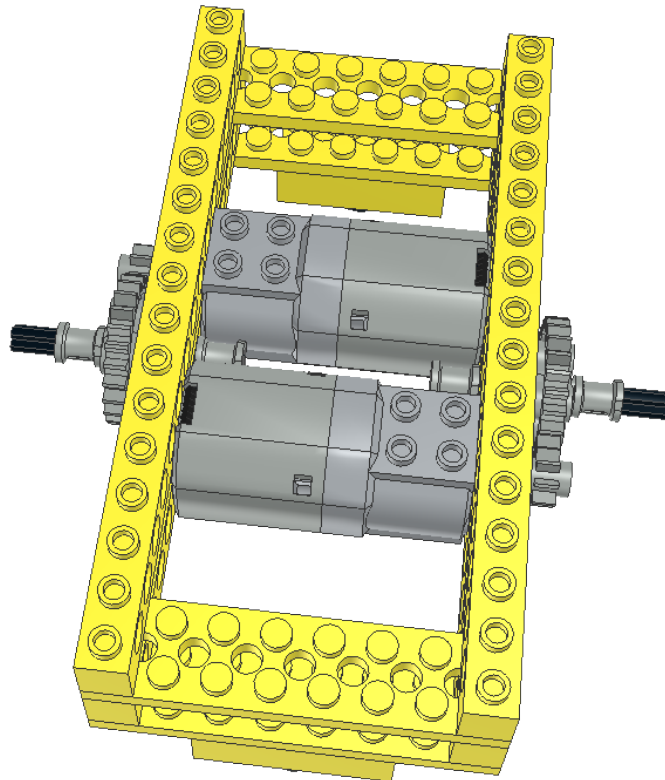
## 2.13. Step 13

Part	Description	Color	Count
	Technic Plate 2 x 8 with Holes	Bright Light Yellow	2




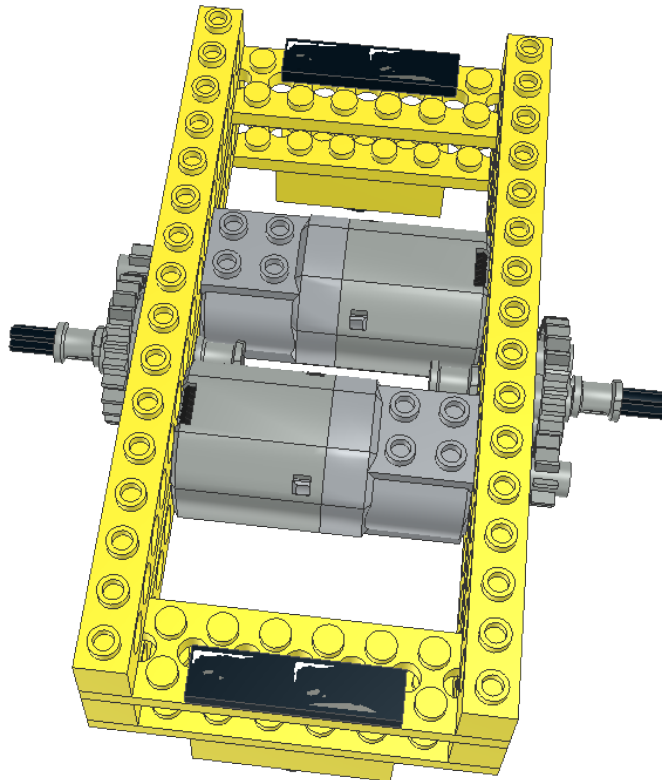
## 2.14. Step 14

Part	Description	Color	Count
	Technic Brick 1 x 16 with Holes	Bright Light Yellow	2




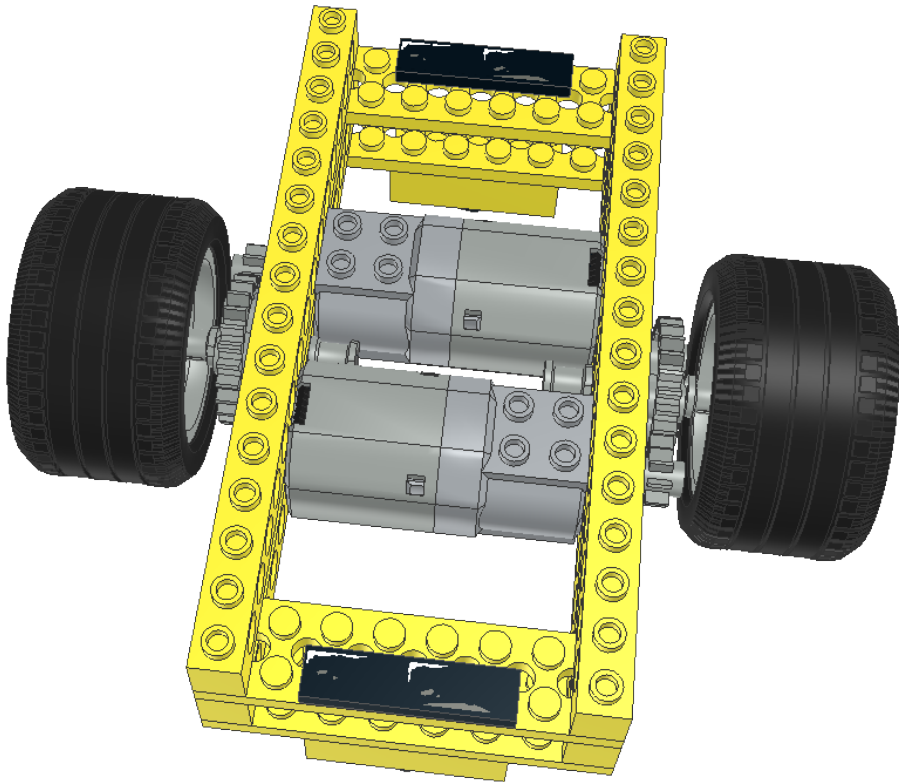
## 2.15. Step 15

Part	Description	Color	Count
	Tile 1 x 4 with Bricks and Cracks Type 6 Sticker	Black	2



2.16. Step 16

Part	Description	Color	Count
	Wheel 25 x 28 VR with 35mm Diameter Rear Rim and Complete Cross Axle Hole with Tyre 28/ 38 x 28 VR	Light Grey	2



## 2.17. Wiring The Bumper Car

Connect the motor driving the left wheel to M3 and the motor driving the right wheel to M1. If you connect things differently, you'll need to adjust the values in the program.

Connect one distance sensor to A1 and the other to A8. Make sure you insert the connectors the right way, with the black wire towards the center of the snekboard and the yellow or white wire towards the edge. Hot glue the distance sensors to 1x4 tiles and attach them at either end of the bumper car.

