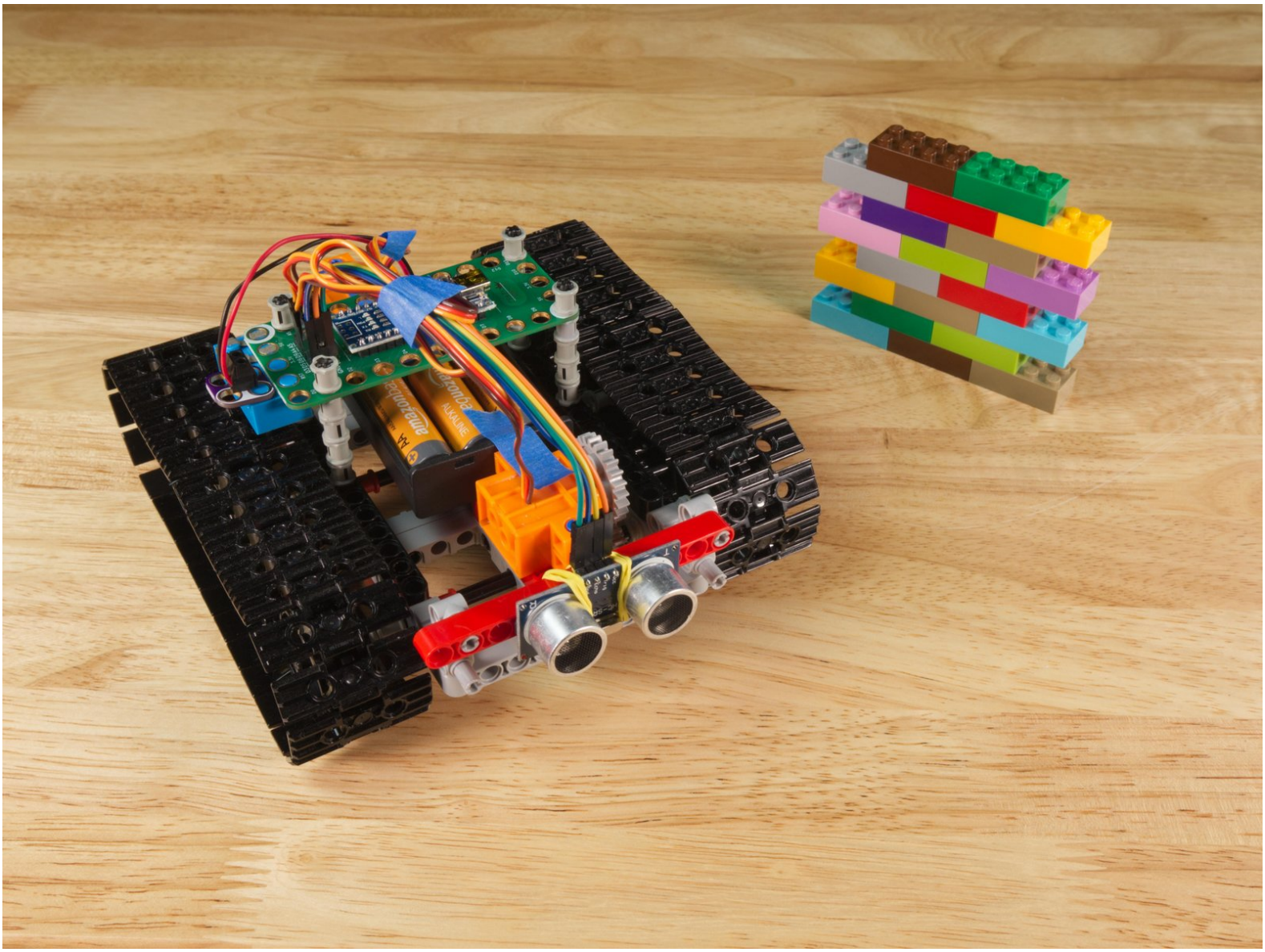
LEGO Avoidance Tank (Prototype)

Build a LEGO Tank that doesn't crash into walls thanks to an Ultrasonic Distance Sensor.

Written By: Pete Prodoehl



INTRODUCTION

Note: This is a project that predates our Rover Tank. This is a complex project requiring many components. We recommend you look at the simplified Rover Tank Body guide instead.

This project was built to work with our LEGO Tank (Prototype).

TOOLS:

- Computer (1)
- Small Slotted Screwdriver (Flat Head) (1)
- Scissors (1)

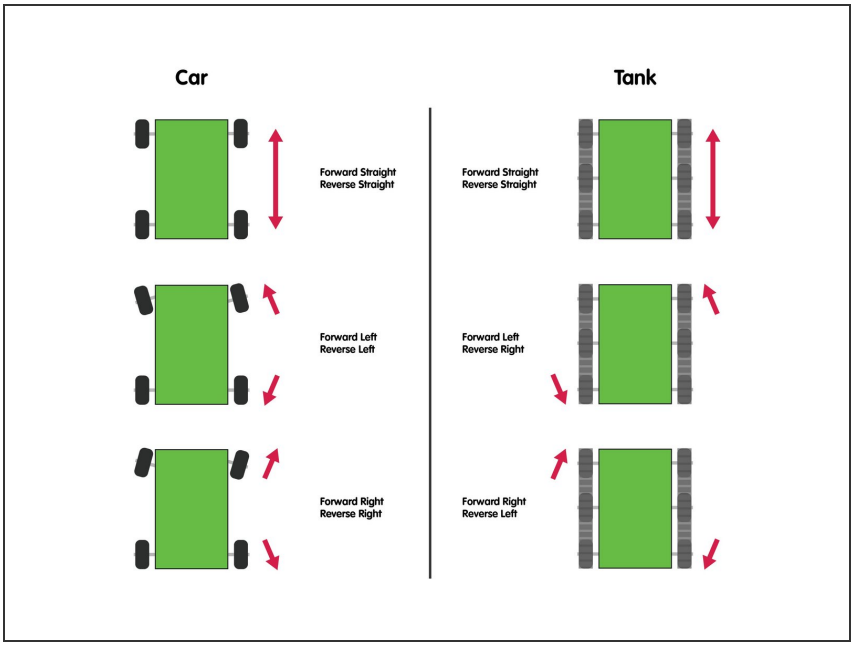
PARTS:

- Crazy Circuits Robotics Board (1)
- Brick Compatible 360 Degree Servo (2)
- Distance Sensor (1)
- 3 AA Battery Holder (1)
- Crazy Circuits Screw Terminal Chip (1)
- Maker Tape (1)

1/8" Wide

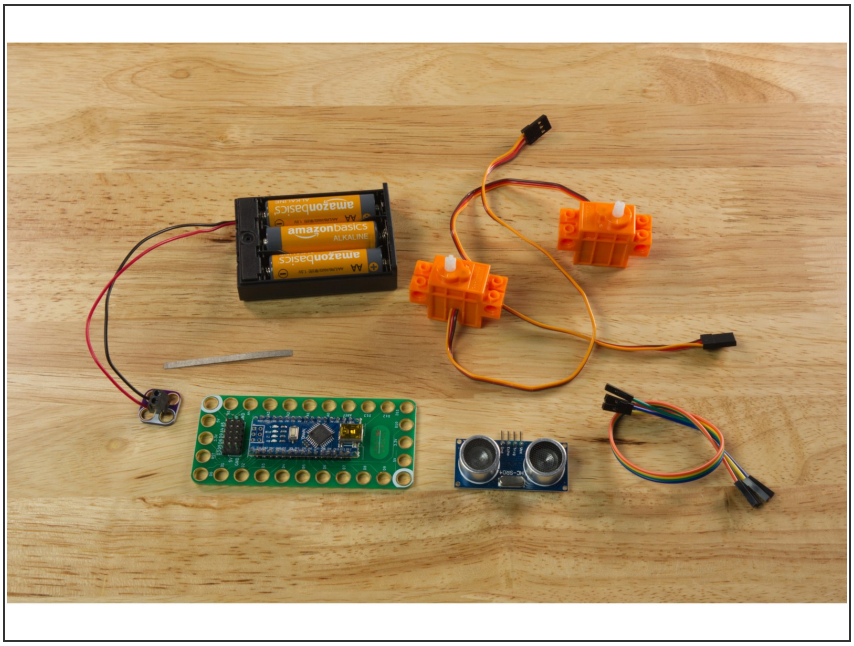
- LEGO Brick 2 x 4 (3001 / 15589) (1)
- LEGO Beam Frame 5 x 7 (64179) (6)
- LEGO Large Tread Link (57518 / 88323) (58)
- LEGO Technic Sprocket Wheel 40.4 (57519) (6)
- LEGO Beam 15 (32278 / 64871) (4)
- LEGO Beam 7 (16615 / 32524) (4)
- LEGO Technic Pin with Friction Ridges and Slots (2780 / 61332) (26)
- LEGO Long Pin with Friction (6558 / 42924) (4)
- LEGO Bushing (6590 / 42798) (32)
- LEGO Half Bushing (32123 / 42136) (2)
- LEGO Axle 8 (3707) (10)
- LEGO Gear with 16 Teeth Unreinforced (4019) (2)
- LEGO Gear with 24 Teeth (3648 / 24505) (2)

Step 1 — How does a Tank Work?



- Tank Steering works differently than steering for a car. Most cars have rear wheels that are fixed and **cannot** turn/pivot left or right, and front wheels that **can** turn/pivot left or right. The turning/pivoting of the front wheels allows the car to make left and right turns (while moving) in addition to just going forward and backward.
- For a tank the wheels do not turn/pivot left or right, but by spinning the "wheels" (which typically have a set of tracks attached to them) a tank can drive left or right, or even spin around clockwise or anticlockwise depending on if the wheels on opposite sides of the vehicle are turning the **same** direction or **opposite** directions.
- Tank steering is similar to how a wheelchair works. If both wheels spin the same direction one of them rotating faster will allow for turning of the vehicle. If they are spinning opposite directions the vehicle will spin around.
- Our Obstacle Avoiding Robot (Robotics Board) and WALL-E projects both use a form of tank steering.

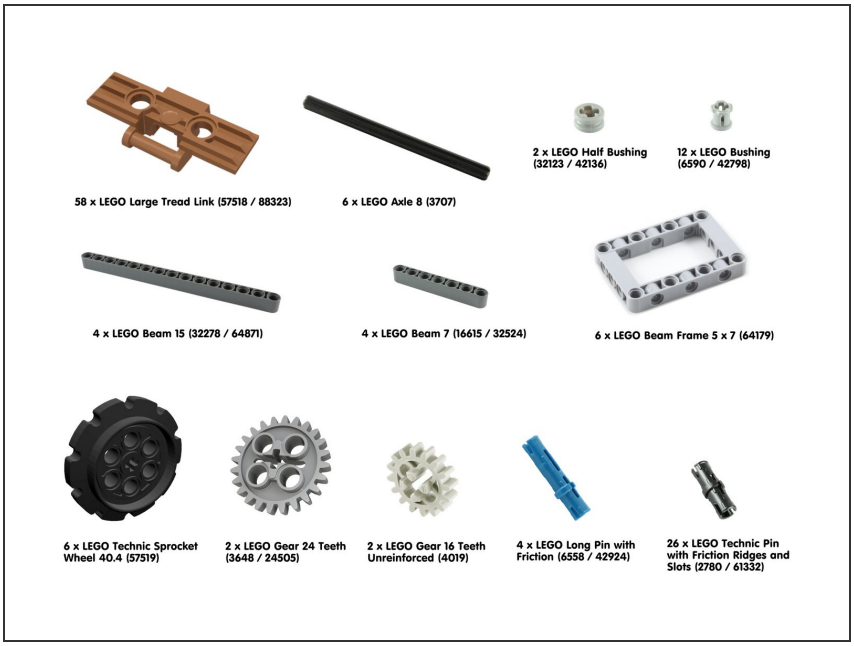
Step 2 — Gather Electronic Parts



- We're going to use a Crazy Circuits Robotics Board along with two LEGO Compatible 360 Degree Servos and an Ultrasonic Distance Sensor. (We'll power it all with a 3 AA Battery Pack.)

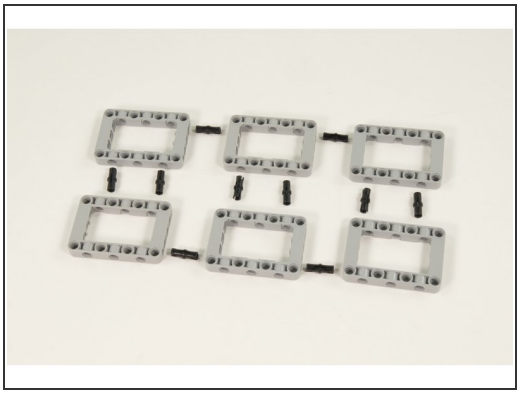
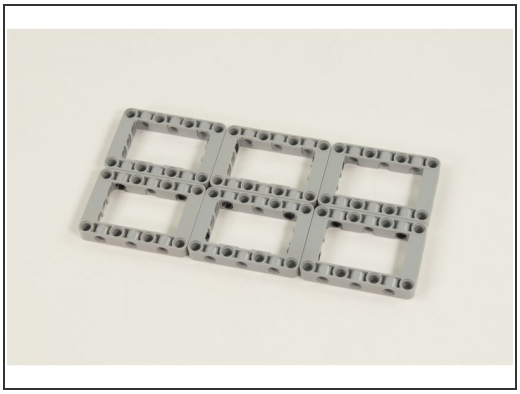
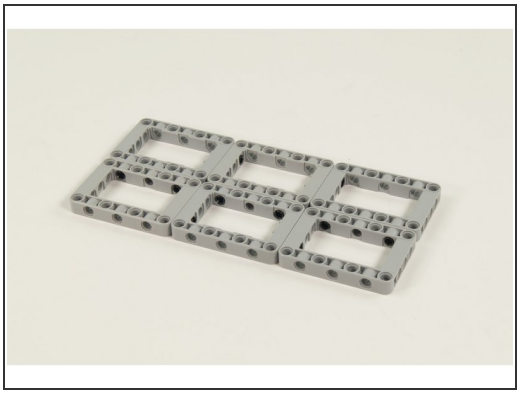
ⓘ The electronics portion of this project will be fairly easy since we just need to plug the two servos and the sensor into the Robotics Board and then add the battery pack with a Screw Terminal Chip and a bit of Maker Tape.

Step 3 — Gather LEGO Parts



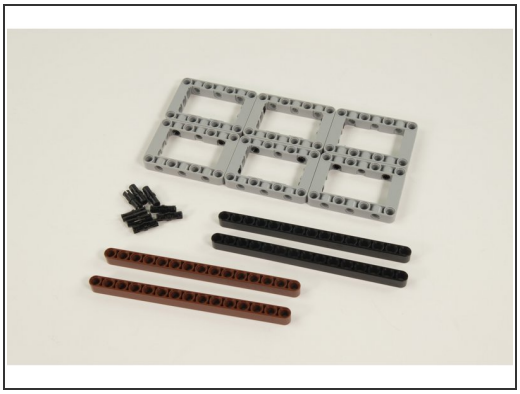
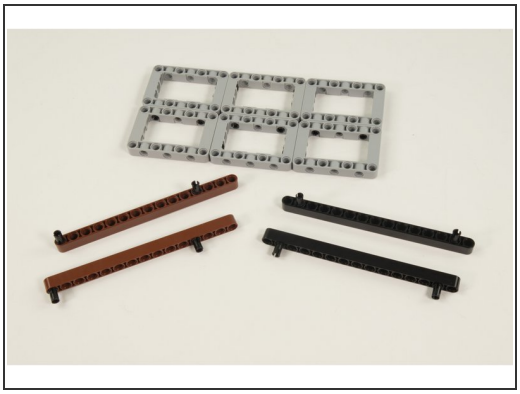
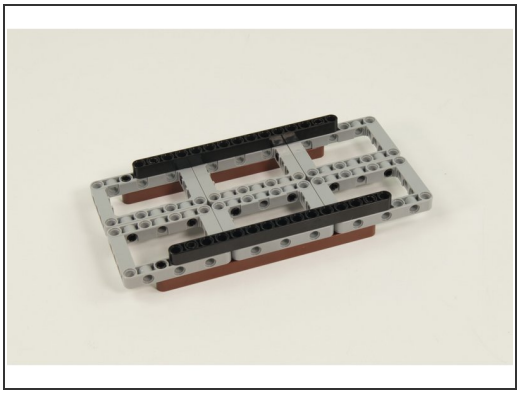
- Gather all of the LEGO parts needed to build the tank chassis.
- If you don't have these exact parts you can often make substitutions. For instance, if you have longer axles they can still work, or if you have half bushings instead of regular bushings they should work fine.
- LEGO is about building what *you* want to build! Consider our guide a suggestion for your own build which should be based on the parts you have available.

Step 4 — Build the Frame

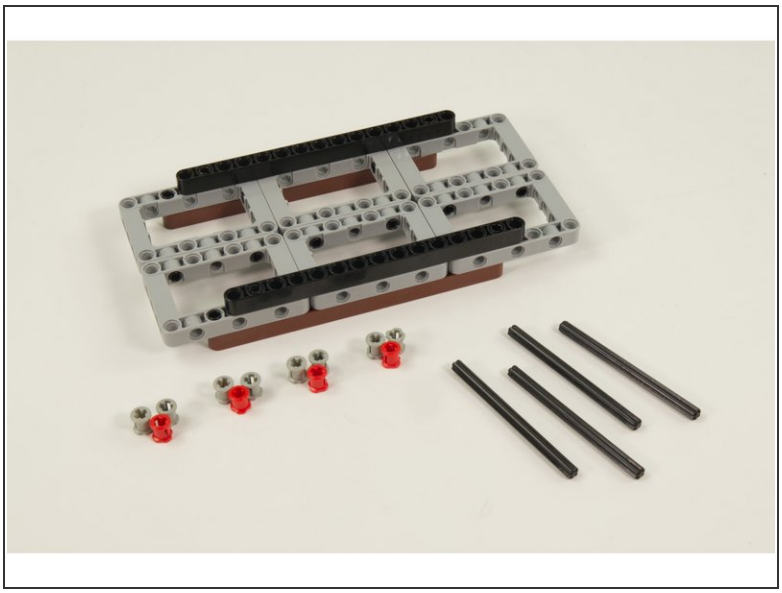
- The frame will be built using 6 LEGO Beam Frame 5 x 7 parts.
- Connect them as shown using 10 LEGO Technic Pin with Friction Ridges and Slots

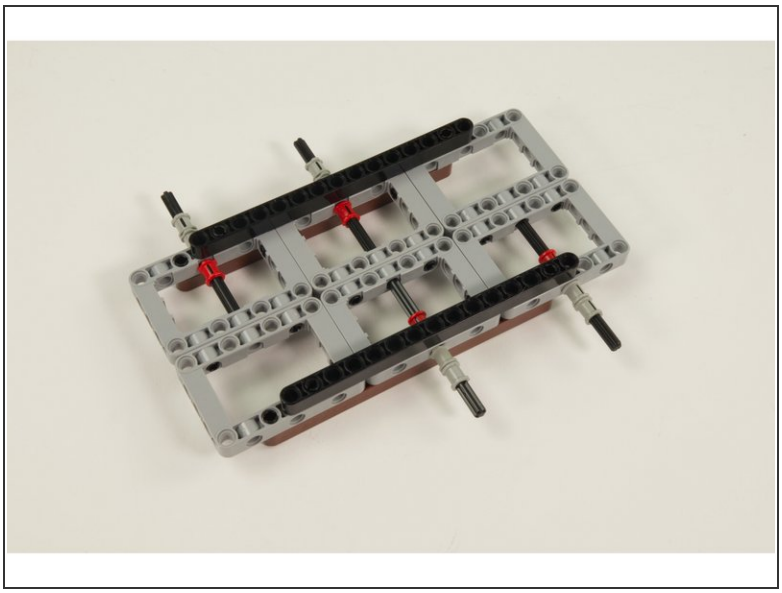
Step 5 — Reinforce the Frame

- Once your frame is complete you'll want to reinforce it using 4 LEGO Beam 15 parts.
- On the top we placed them centered between the front and rear of the vehicle.
- On the bottom we offset the beams by one hole on the LEGO frame, putting them closer to the rear of the vehicle.
- You'll need to make sure you leave the center hole on the side of each frame piece open for the axles to go through,

Step 6 — Add Four of the Axles

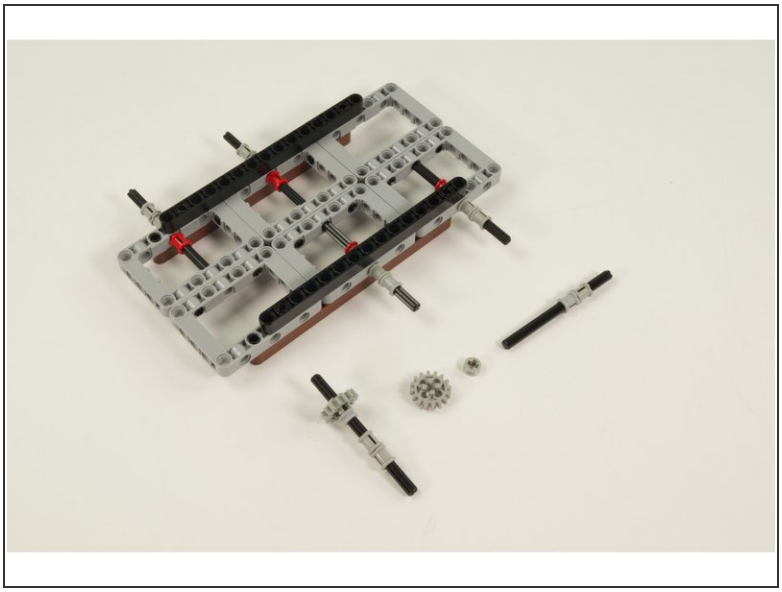


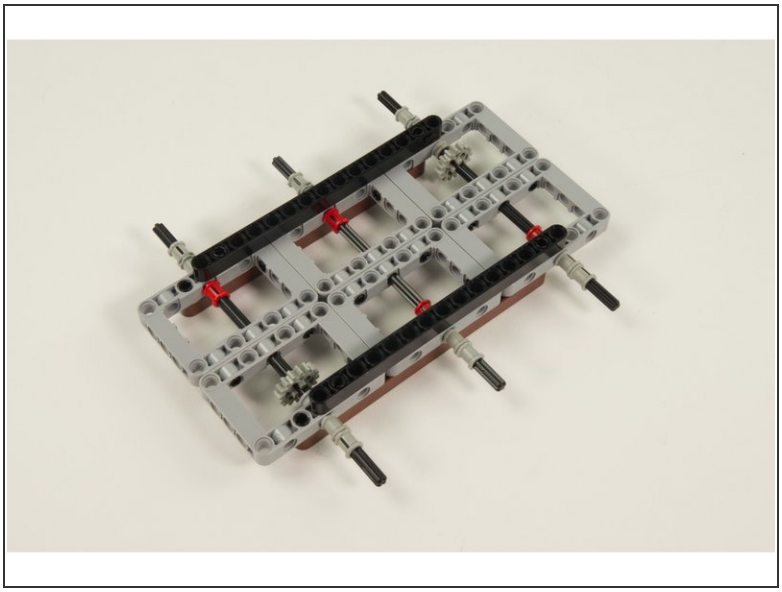


- Next we'll add 4 of the LEGO Axle 8 pieces.
- Use 12 LEGO Bushing to hold the axles in place.
- Each axle gets three bushings. Two on the outside, and one on the inside.

☒ We need to use two separate axles for each "pair" of wheels because they need to spin independently of each other. One long axle won't work.

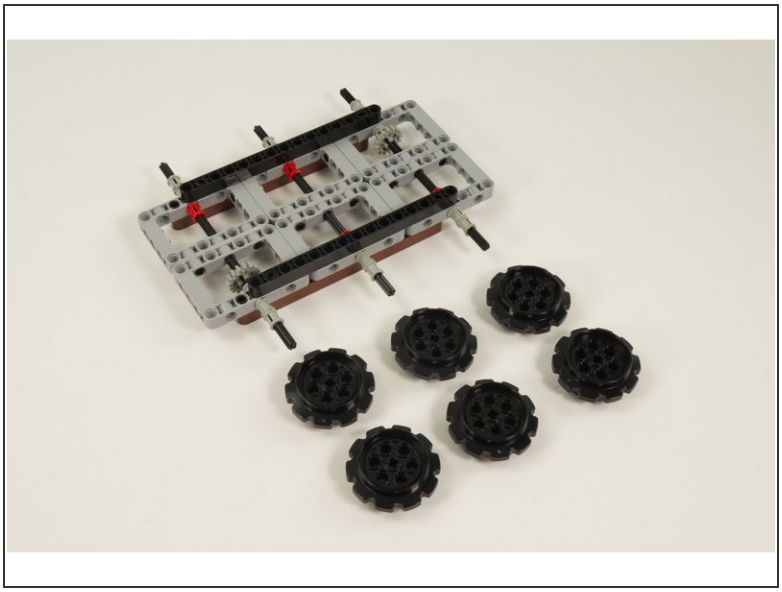
Step 7 — Add the Axles with Gears

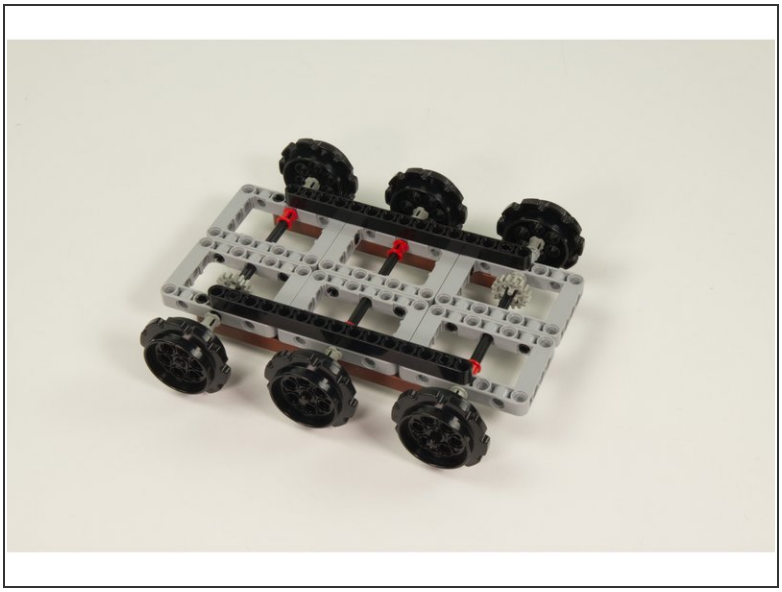




- The last two axles will be used to drive the vehicle, so we need to add a LEGO Gear with 16 Teeth Unreinforced along with a LEGO Half Bushing.
- Like the first four axles, there are two bushings on the outside, and then the gear and the half bushing go on the inside of the frame.

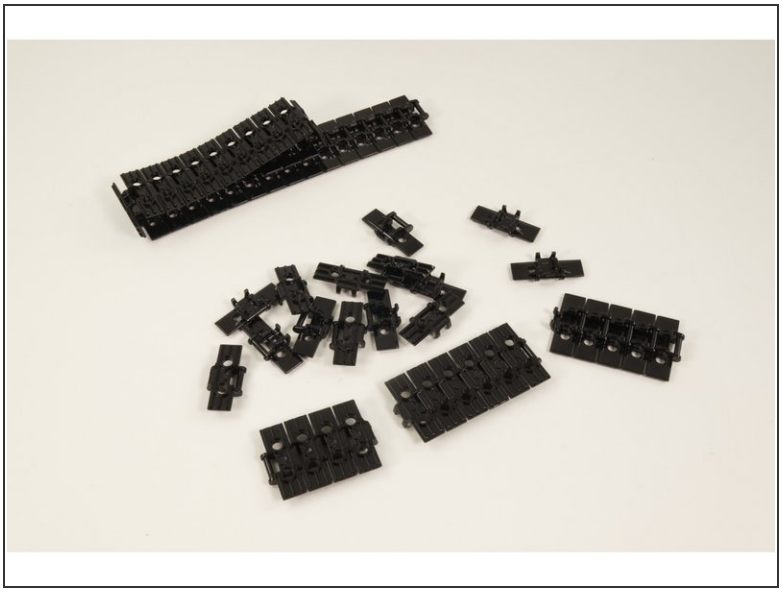
Step 8 — Add the Sprockets

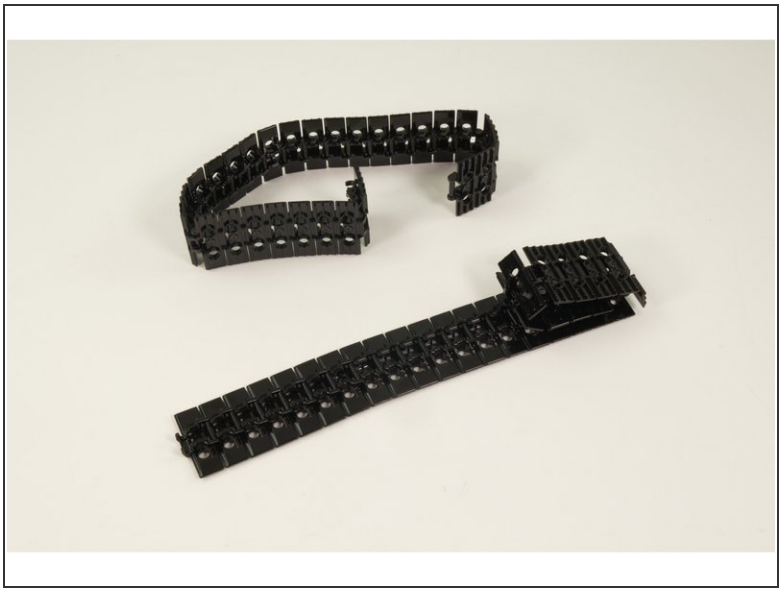




- Slide the 6 LEGO Technic Sprocket Wheel 40.4 parts onto the axles.
- At this point your vehicle could probably roll around!
- In the next step we'll add the treads so the drive sprockets can transmit motion to the other sprockets.

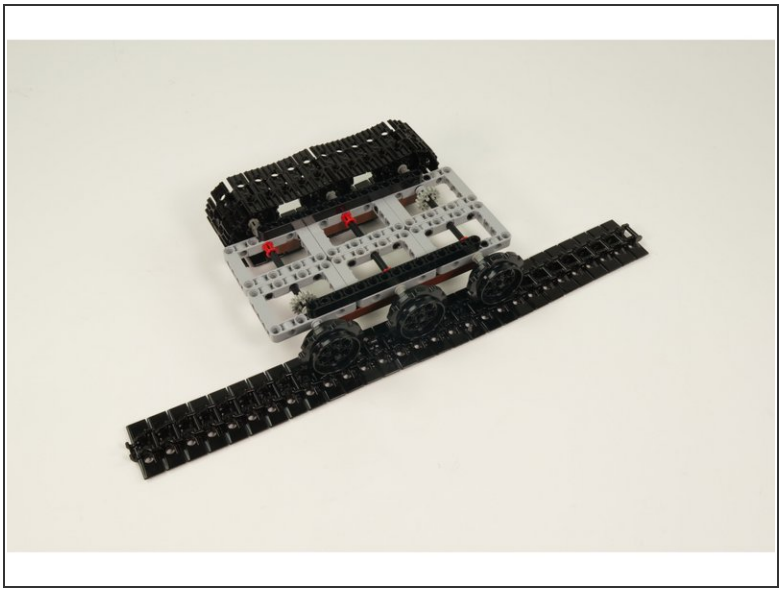
Step 9 — Build the Treads

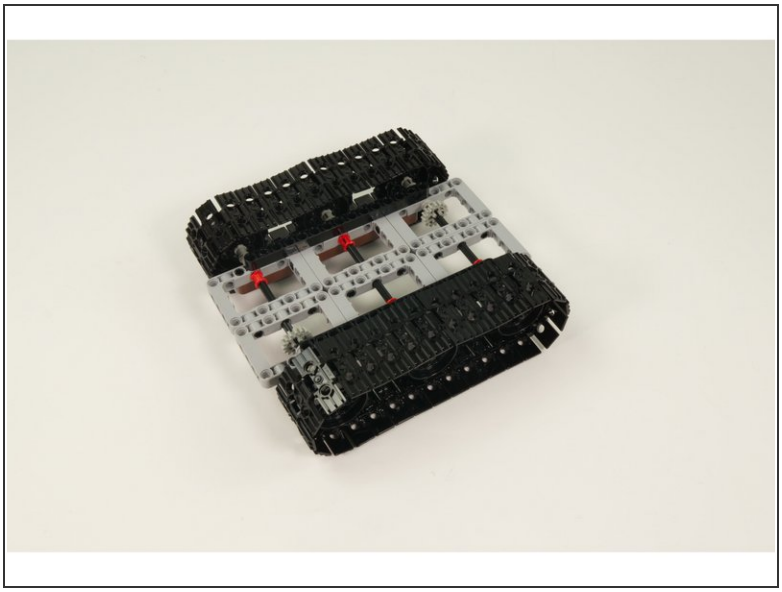




- You'll need 58 LEGO Large Tread Link to build your treads as each side uses 29 treads.
- Connect the treads together to form two sets of treads, but don't connect them into a loop yet!

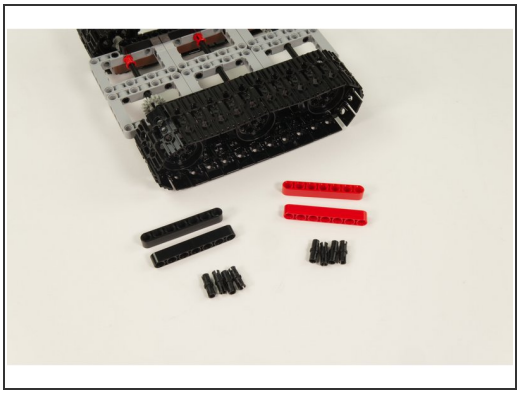
Step 10 — Add the Treads

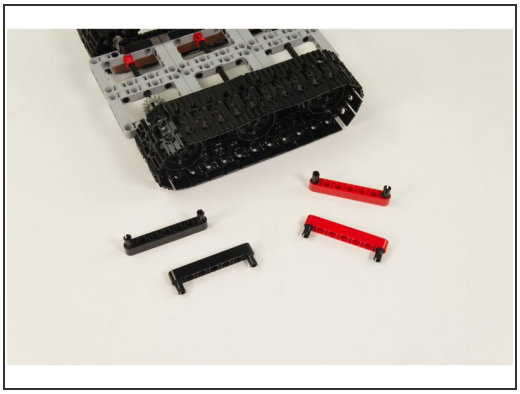


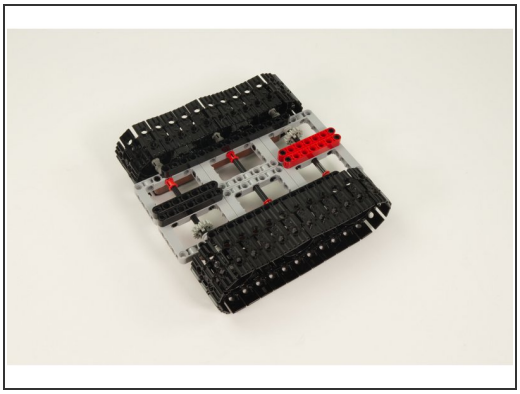


- Wrap the treads around the sprockets and attach into a loop by clicking the two end treads together on each set of treads.
- You should now have a full set of treads on each side of your tank!

Step 11 — Add the Servo Beams

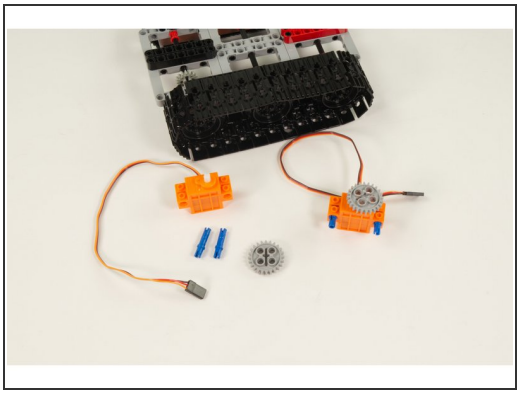
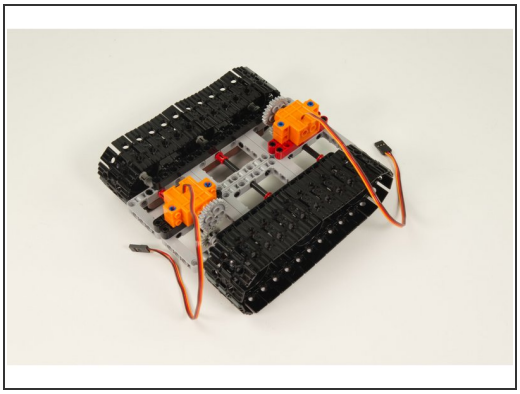
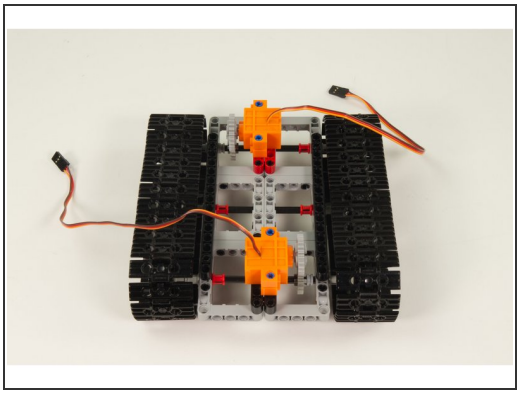






- We'll use the 4 LEGO Beam 7 parts to raise and mount the servos to the proper position.
- Use 2 LEGO Technic Pin with Friction Ridges and Slots for each beam and connect them to the frames as shown.

Step 12 — Add the Servos

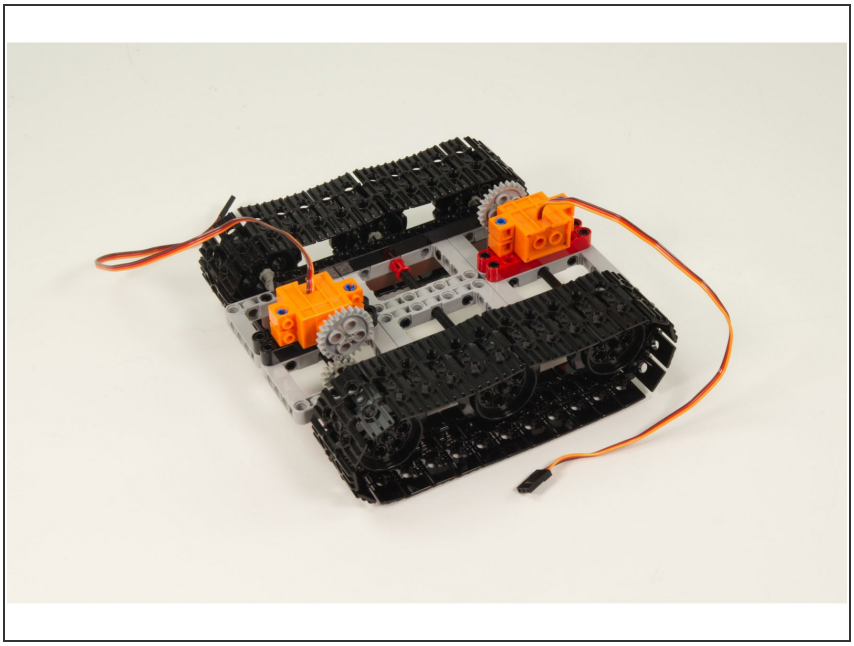




- For each servo press a LEGO Gear with 24 Teeth into place on the servo shaft.
- For each servo use 2 LEGO Long Pin with Friction parts to attach the servo as shown,

Make sure the servo wires are facing upward.

Make sure the gears line up when putting the servos in place.

Step 13 — Tank Chassis Complete!



- You should now have a complete tank chassis!

Fun fact: In vehicle building this is what would be referred to as a **rolling chassis**.

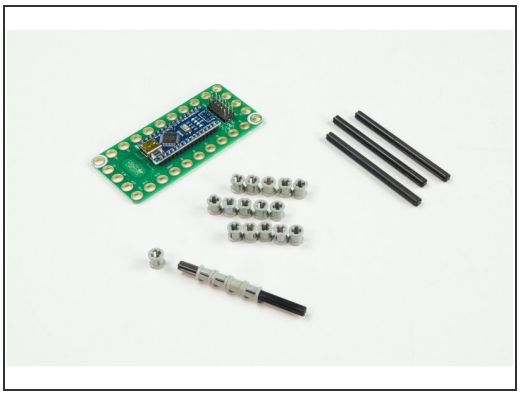
We still need to add power & control. Also known as batteries and a micro:bit

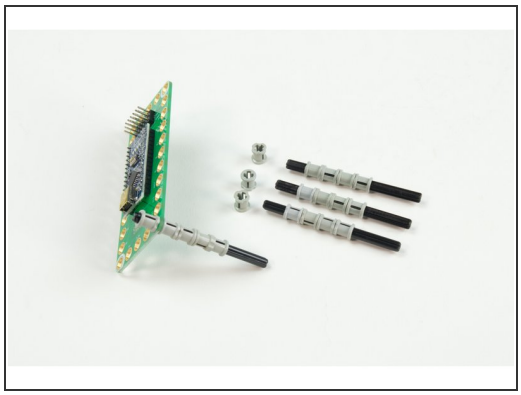
Step 14 — Gather More LEGO Parts

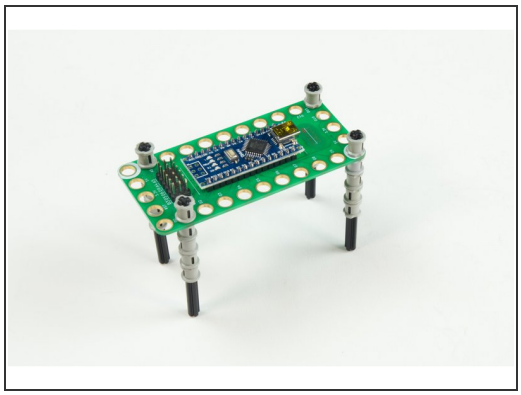


- Gather the LEGO parts shown so we can attach our Robotics Board to the tank chassis.
- We're basically making 4 "legs" for the Robotics Board so it can be fit into the frame pieces of the chassis.
- As always, if you don't have these specific parts, others can work. Longer axles? No problem! Less bushings? You can probably still make it work.

Step 15 — Build the Robotics Board Legs

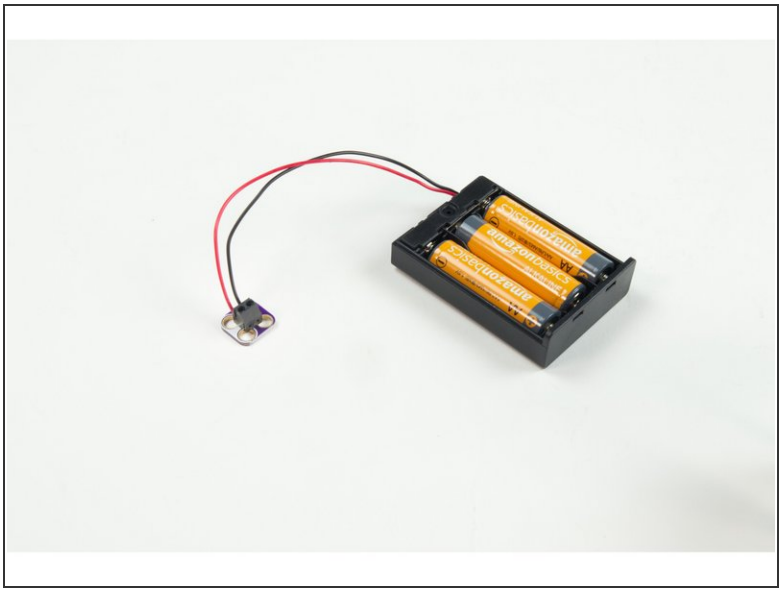


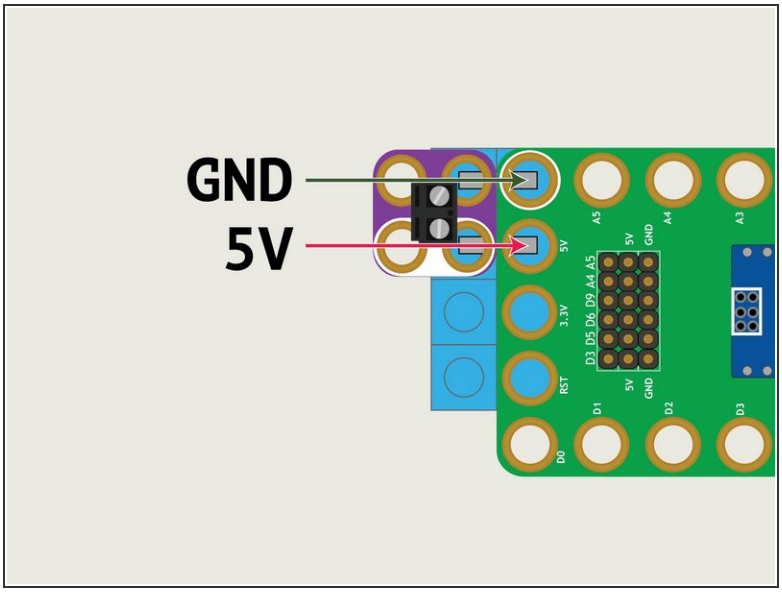




- Slide 4 of the LEGO Bushing parts onto each LEGO Axle 8.
- Place the Robotics Board onto the "legs" and add one LEGO Bushing to the top of each axle.
- You should have a Robotics Board with 4 adjustable legs ready to mount to the tank chassis.

Step 16 — Prepare the Battery Pack

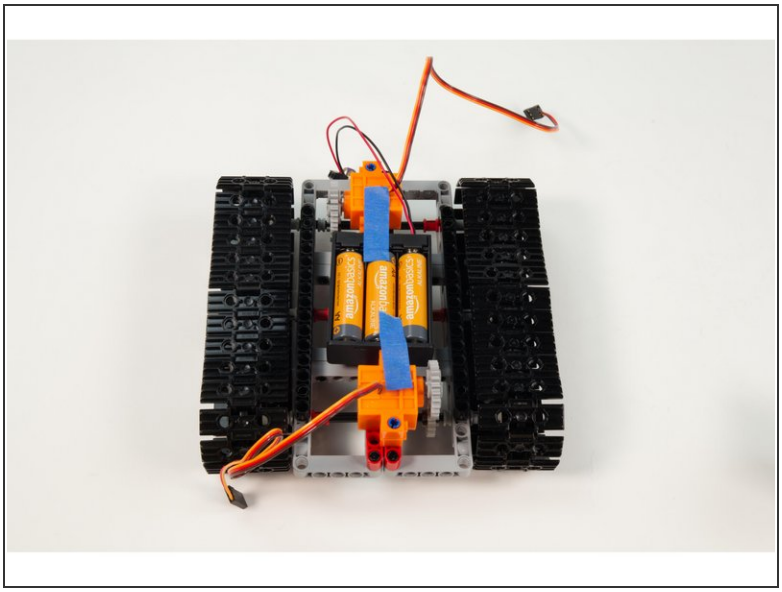


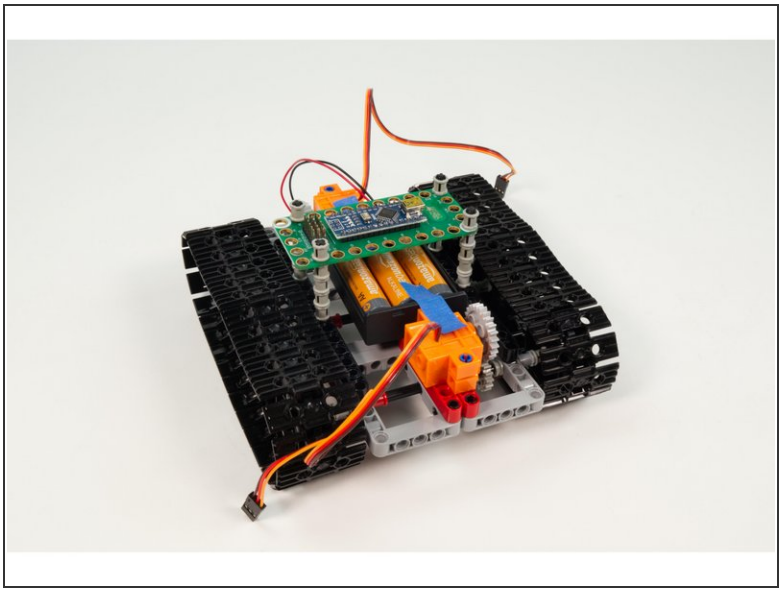


- Our Battery Pack has bare wires on the end. To connect it to our Robotics Board we'll attach a Crazy Circuits Screw Terminal Chip.
- You'll need a slotted ("flat tipped") screwdriver to tighten down the screws onto the wires.

⚠ Make sure you get the polarity correct for how the orientation of the Screw Terminal Chip will connect to the Robotics Board.

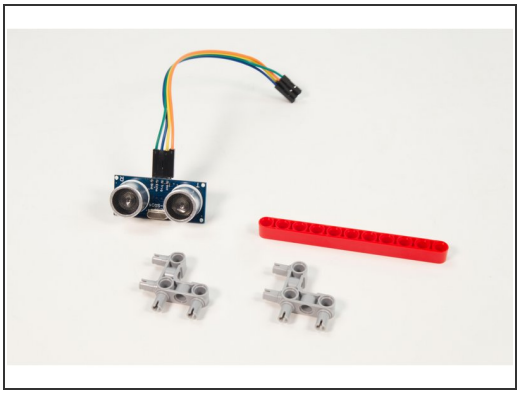
Step 17 — Mount the Robotics Board and Battery Pack

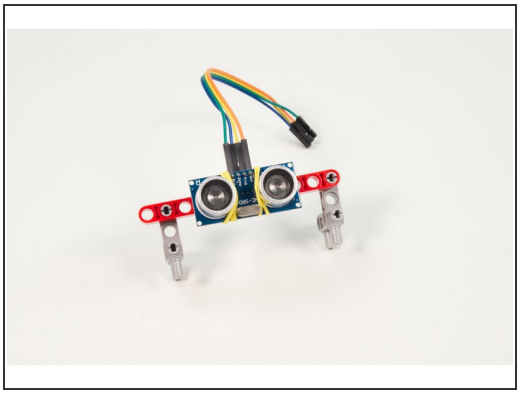


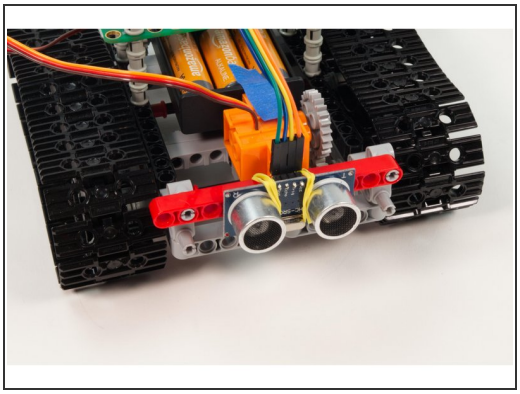


- We chose a very simple method of adding the 3 AA Battery Pack. It sits below the Robotics Board and we just taped it to the servos to keep from moving around too much. (The "legs" we added to our Robotics Board will also help keep it in place.)
- Alternately, you can find a way to mount it to the tank chassis beneath the Robotics Board using LEGO parts, but we thought this method was simple.
- Once the battery pack is in place you can slide the Robotics Board "legs" into holes of the frame.

Step 18 — Mount the Distance Sensor





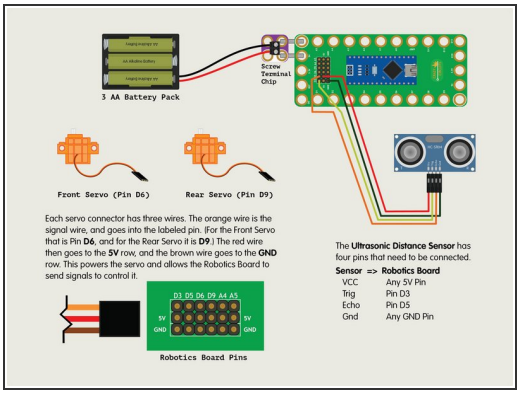


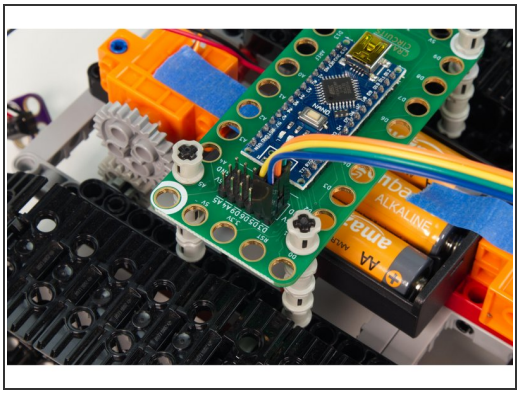
- We're going to mount the Distance Sensor to a LEGO Beam 11 and add 2 LEGO Cross Block Beam Bent 90 Degrees with 4 Pins . One at the end and one spaced one hole from the other end. (This will match the 10 hole wide frame of the Tank.)
- Once again we chose to use the most advanced mounting device we could find. A rubber band! We rubber banded the sensor to the beam with the Jumper Wires facing up.

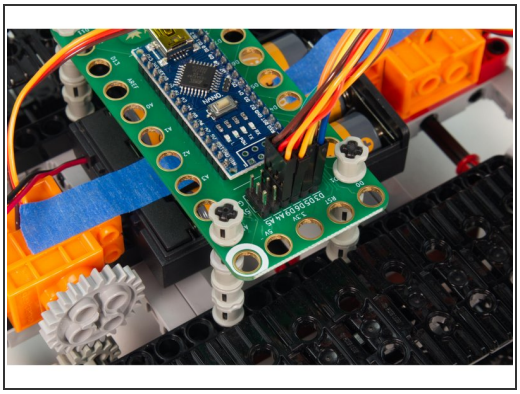
ⓘ We love to build with LEGO and we also like 3D printed parts, but sometimes tape or a rubber band is a "good enough" solution that just works.

- Once you've got the Distance Sensor assembly put together you can attach it to the front of the tank.

Step 19 — Connect the Components

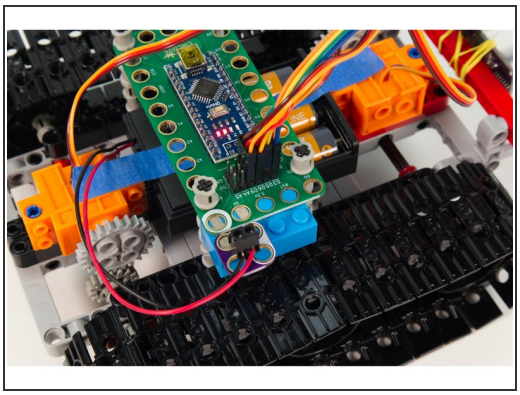


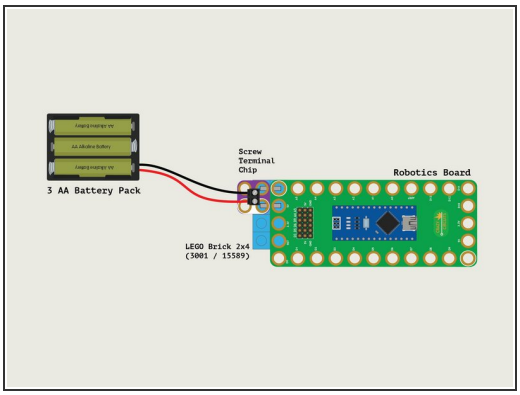


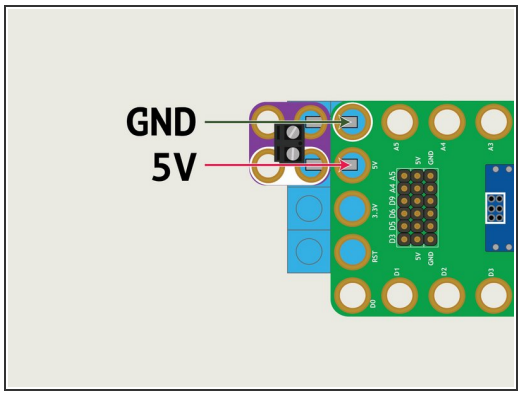


- With the Robotics Board mounted onto the tank chassis we can now connect each of the components.
- For the sensor you'll need to connect the **echo** pin to **Pin 3** on the Robotics board, then connect the **trigger** pin to **Pin 5**, then **VCC** to **5V** and **Gnd** to **GND**. This will power the sensor and allow it to talk to the Robotics Board.
- For the servo connectors the orange wire is the signal wire, and goes into the labeled pin. (For the **Front Servo** that is **Pin D6**, and for the **Rear Servo** it is **D9**.) The red wire then goes to the **5V** row, and the brown wire goes to the **GND** row.

Step 20 — Connect the Power







- To power everything we'll use a 3 AA Battery Pack along with a Crazy Circuits Screw Terminal Chip and a LEGO Brick 2 x 4 (3001 / 15589)
- The LEGO brick should stay in place under the Robotics Board once two small pieces of 1/8" Maker Tape are put in place.
- The **positive** (red) wire from the battery pack should align with the **5V Pin** on the Robotics Board. The **black** (negative) wire from the battery pack should align with the **GND Pin** on the Robotics Board.

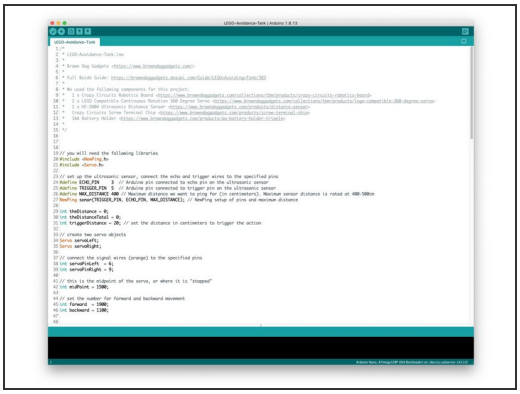
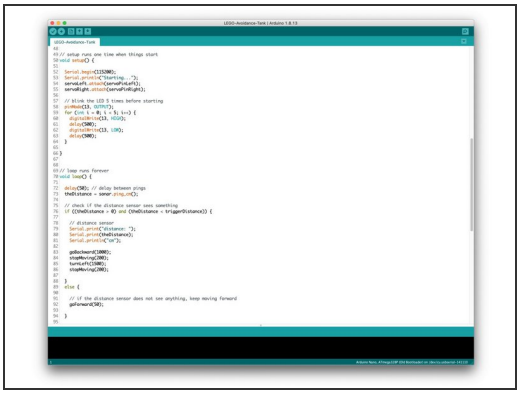
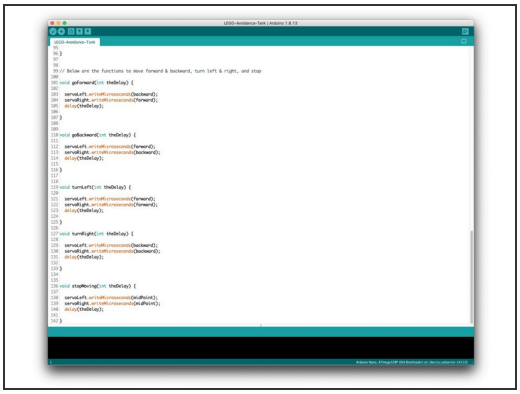
ⓘ Note that the **GND** pin on the Robotics Board has a **white circle** around it.

ⓘ **Tip!** You can use the Screw Terminal Chip as an "on/off" switch by just popping it on or off of the LEGO brick to complete or break the connection to the battery pack.

⚠ Leave the power disconnected for now. If you have no code on your Robotics Board the tank will do nothing, but if you have old code it may do something unexpected!

- In the next step we'll upload the code to the Robotics Board.

Step 21 — Load the Code

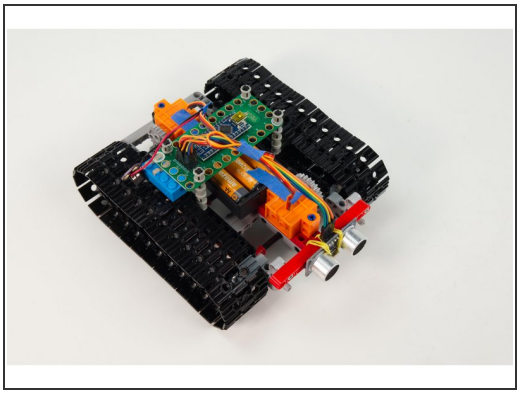
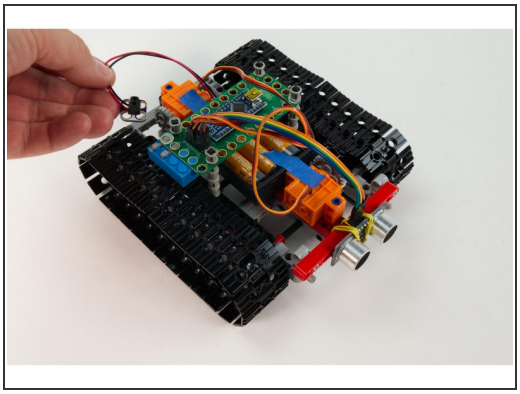
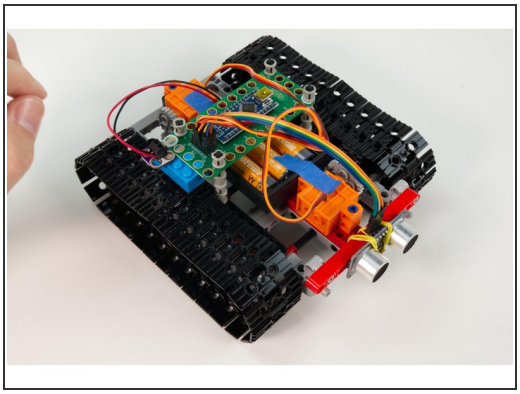
- Before our robot will work you'll need to upload code to the Robotics Board. If you've not done so already, make sure you have the latest version of the free Arduino IDE software installed on your computer.

⚠ If you've never used the Robotics Board before, start with this guide: Robotics Board Setup and Use

- Our code is found at our GitHub repo, which you can find here: https://github.com/BrownDogGadgets/Crazy...
- The code has been commented to help explain what everything does.
- You will also need the NewPing library, which can be found here: https://bitbucket.org/teckel12/arduino-n...

⚠ Once you upload the code your tank will start running! (After a five second delay.) Be prepared! It may try to run away. Remove the USB cable once the code has been uploaded.

Step 22 — Prepare for Testing

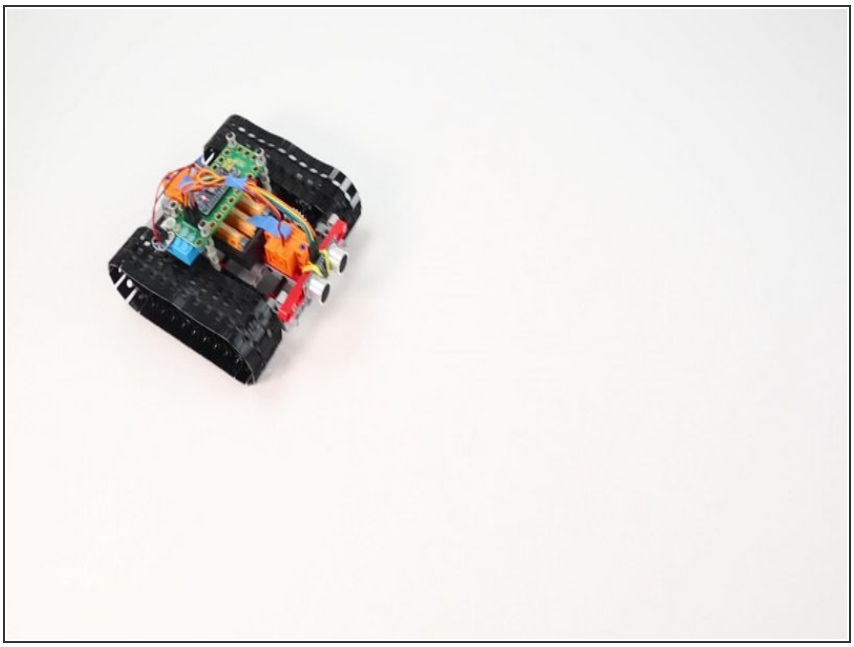




- Okay, you've got your tank assembled and the code is loaded. We're almost ready to test.
- If you've still got the USB cable connected you can remove it now.
- If the tank is on a table you might want to put it on the floor.
- You'll need to connect power by placing the Screw Terminal Chip onto the LEGO brick.

⚠ One more thing! Make sure the wires running from the servos and the battery pack are not in danger of getting hit by the treads! Secure them away from the treads using LEGO, tape, or rubber bands.

- Okay, we're ready for testing!

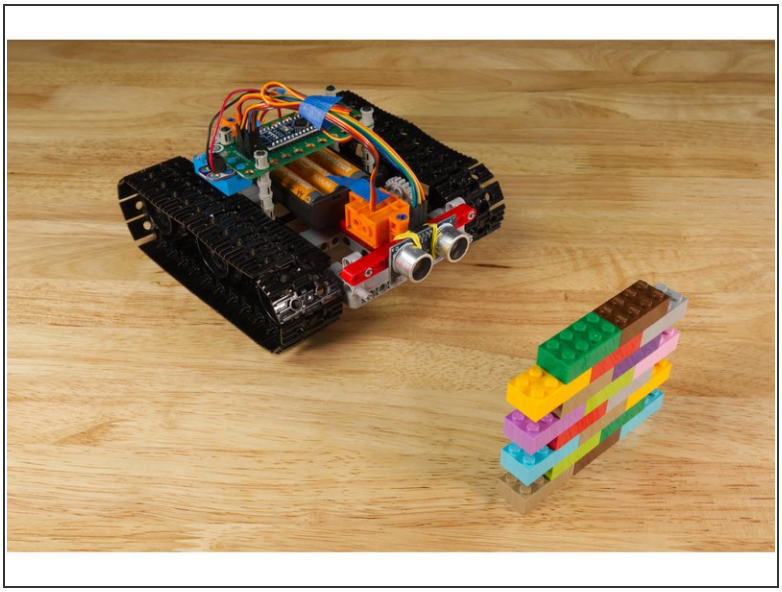
Step 23 — Test it Out!

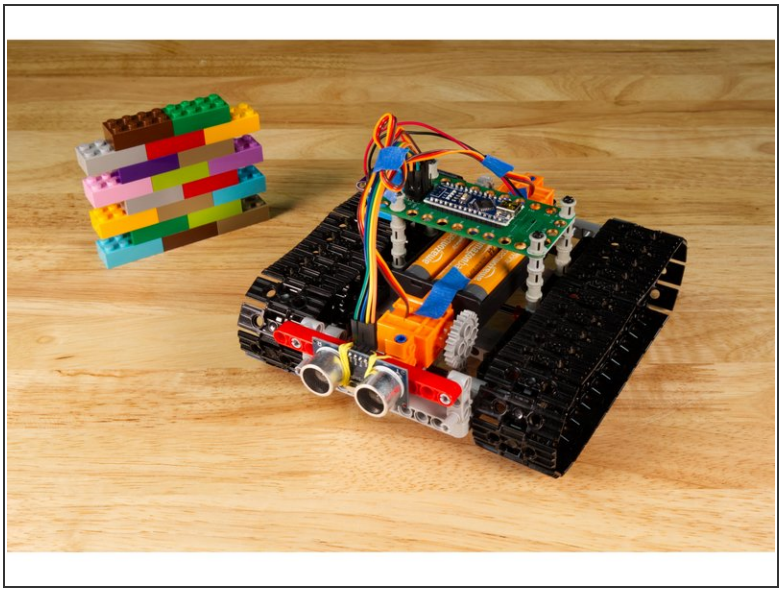


- When you put the Screw Terminal Chip in place on the LEGO with Maker Tape an LED on the Robotics Board will start to blink. It will do this for five seconds, and then your tank will start moving forward.
- Your tank should go forward until the sensor "sees" something in front of it, and then it will go in reverse, turn, and try to go forward again.
- If you need to power off your tank just remove the Screw Terminal Chip from the LEGO brick.
- Did it work? If not, re-check all the previous steps. If everything did work properly, we can keep going!

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Step 24 — Take it Further





- There's no doubt our LEGO Avoidance Tank is pretty cool... but what would make it more cool?
- You could build a bunch of LEGO obstacles! You could change the code to affect how the tank moves or how close it get to objects before reversing.
- You could make your tank (or other vehicle) completely different, and as long as you're still using two servos and a distance sensor you can use the same code.
- Whatever you do, have fun and experiment! That's how you learn new things.