# Part 1

Step 1: Chassis frame

Hardware: 288mm channels (x2), flat plates (x2), 5/16" socket head cap screws (**SHCS**) (x7), kep nuts (x7)

Instructions: Position the flat plates on top of the channels and screw in place. Make sure that the screws (marked in green) align with the plates and channels exactly as shown in the photo - this is where the REV hub will mount and we don't want any interference from the screw heads.
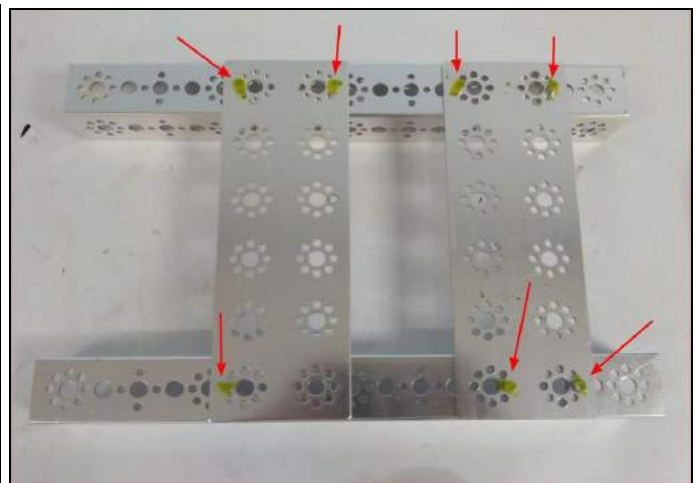
Step 2: Phone mount

Hardware: 160mm channel (x1), 1/2" SHCS (x2), 2" stand-off post (x2)

Instructions: Position the 160mm channel so that it touches both ends of the 288mm channels and the open side facing up. Screw the channel into place from the bottom, so that the posts stick up. This will hold the robot controller phone.
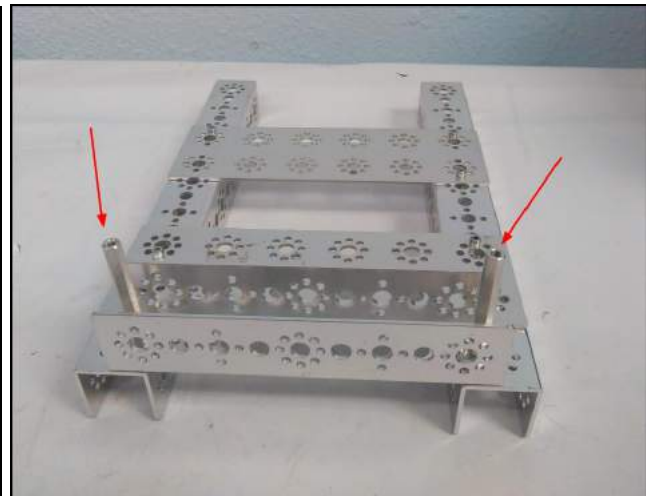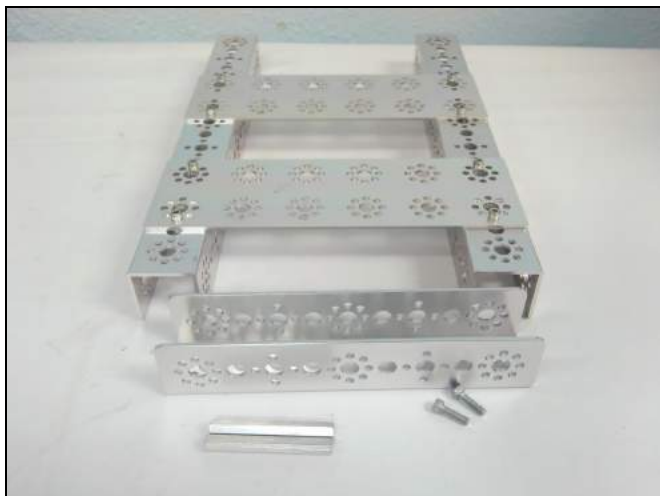
Step 3: Robot Arm Mount
Hardware: 160mm channels (x2), 5/16" SHCS (x4), kep nuts (x4)
Instructions: Screw the 160mm channels into the longer 288mm channel. These channels will be the risers used to mount the robot arm.
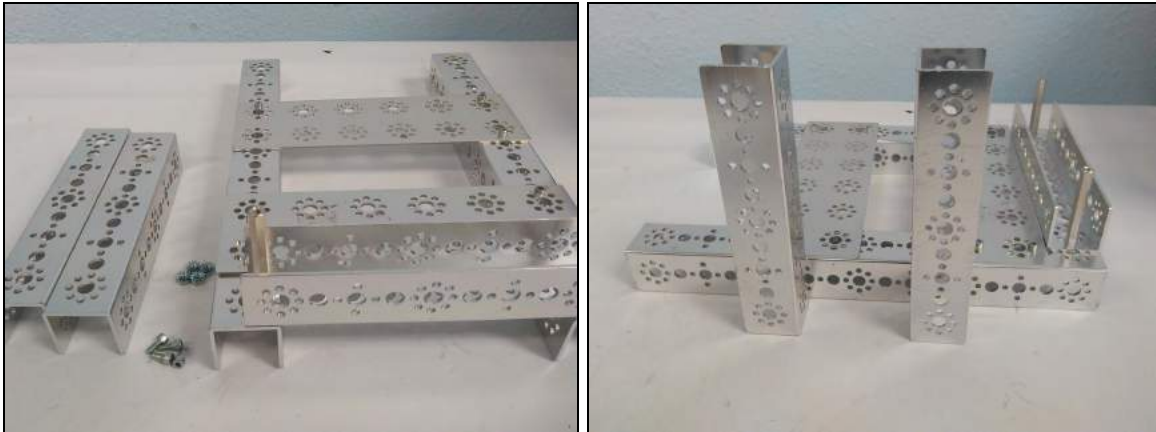
Step 4: Robot Arm Mount (cont.)
Hardware: 288mm channel, 5/16" SHCS (x2), kep nuts (x2), single servo bracket (x1)
Instructions: Add the servo bracket onto the channel at one end and screw in place. Follow screw holes indicated.

Step 5: Robot Arm Mount (cont.)
Hardware: Arm assembly from step 4, axle hub (x1), 1/2" SHCS (x2)
Instructions: Screw the axle hub onto the channel. The flange (part that extrudes) should fit into the channel hole.
**Note:** Notice that there is a set screw on the side of the hub. We will use this later, so make sure that the set screw is in a position where it is accessible (i.e., away from the channel.)

Step 6: Robot Arm Mount (cont.)
Hardware: Arm assembly from step 5, 80-tooth gear (x1), axle hub (x1), hub gear spacer (x1), 1.25" SHCS (x2)
**Instructions:** Screw the gear onto the hub gear spacer. On the other end, place the axle hub. The holes are threaded and the screws will fit into that. Note that the flange on this hub must face outward as it conflicts with the hub gear spacer. This is a complex step so take your time.
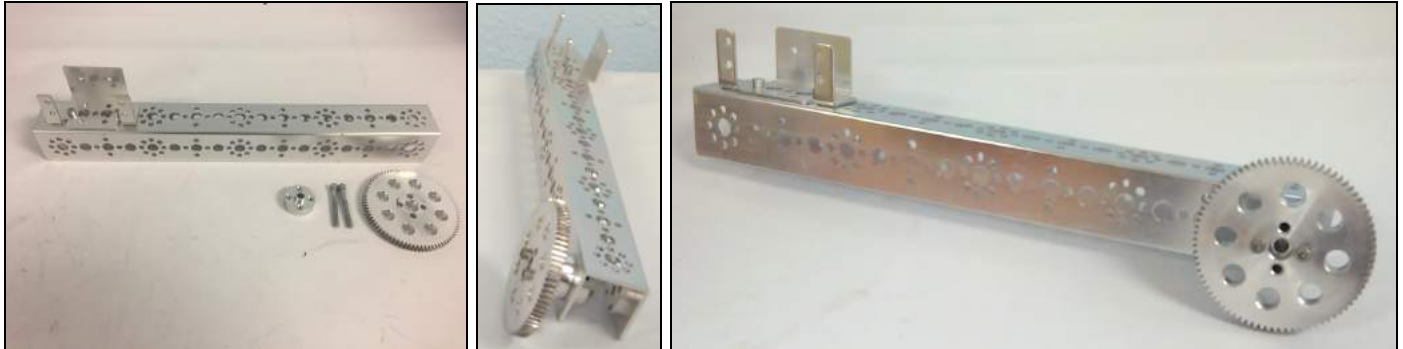

Step 7: Robot Arm Mount (cont.)
Hardware: Arm assembly from step 6, bronze bushings (x2), ⅛" nylon spacer (x2), 100mm axle
Instructions: Add bronze bushings from the outside of the channels so the long part faces outward.
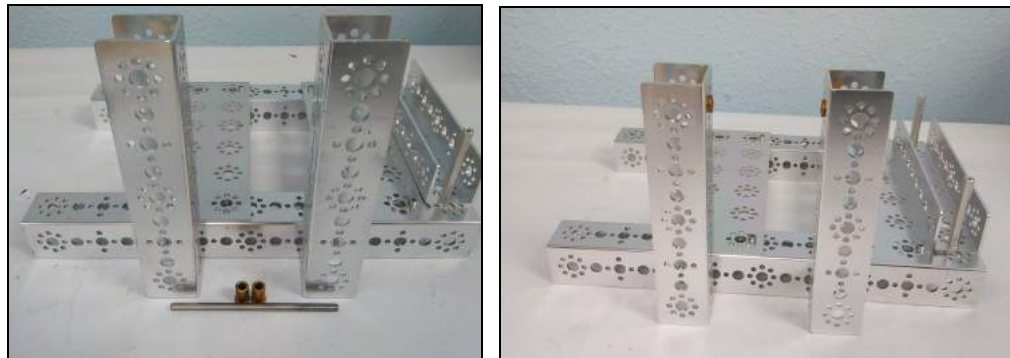
Now slide the arm assembly onto the axle. _Ensure that the hub set screws sit on the flat part of the axle (marked with green tape)_. Add a spacer on each end of the axle. Insert this whole assembly in between the channels. You may have to take out parts and add them individually in order for them to fit. This is a complex step so take your time. Tighten the hub set screws once finished.
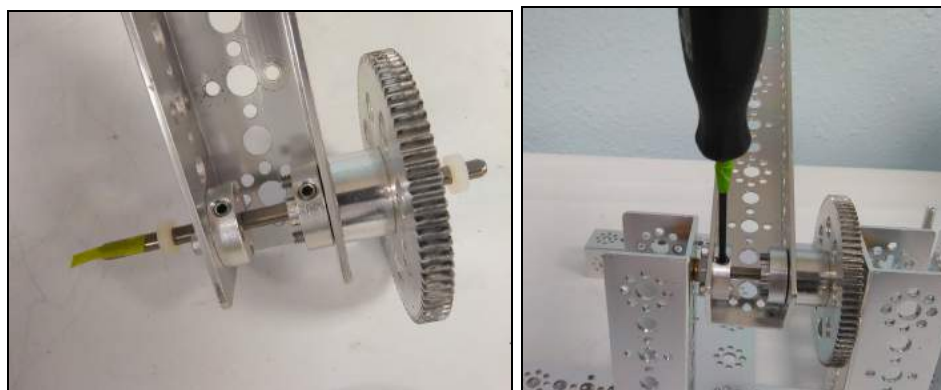
Step 8: Arm Motor Mount

Hardware: Motor mount (x1), 1.25" SHCS (x1), motor mount screws 1.5" (x1), nuts (x2)

Instructions: Position the screws as shown on the motor mount. One of the screws will be longer than the other; this is fine, because one side of the motor mount is longer than the other. So place the longer screw in the longer (clamping) side; the screws should come out even in the end. Add the motor mount in the holes indicated, clamping side facing up


Step 9: Driving Motor Mounts

Hardware: Motor mount (x2), Motor Mount screws (x4), kep nuts (x4)

Instructions: Attach the motor mounts onto the base with the screws and nuts. The motor mounts should are offset by one screw hole towards the center of the chassis, not in the center of the channel. As in **Step 8**, the longer motor screw goes into the clamping side of the mount. We suggest placing the clamping side to the back of the robot.

Note: There are actually two motor mounts in the picture; they are not connected.
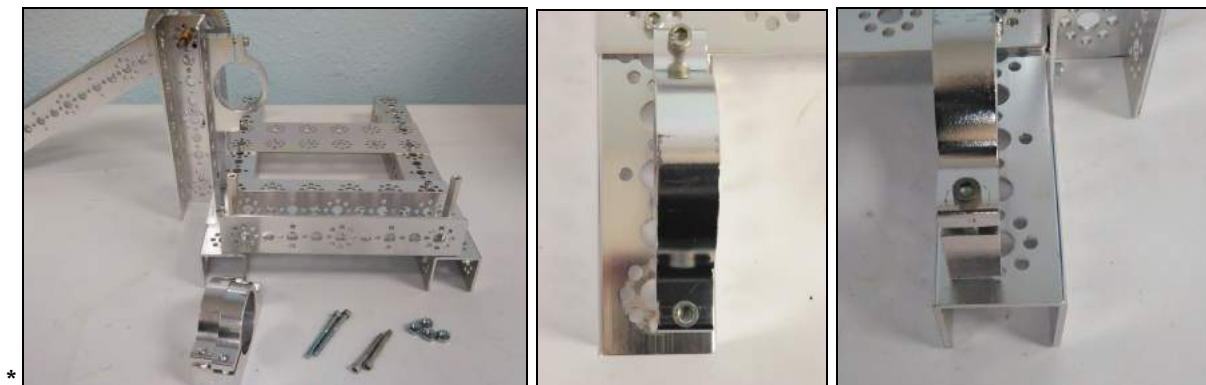
Step 10: Motor Gear Assembly (x3)
Hardware: 40-tooth gear (x3), motor shaft hub (x3), 1/2" SHCS (x6)
Instructions: Screw the hubs onto the gears, so that the flange fits into the gear.

Step 11: Arm Motor
**Hardware:** Gear assembly (1x) from step 10, NeveRest motor.
Instructions: Add the gear onto the motor shaft so that the hub faces the inside of the gear. Insert the motor and gear into the motor mount, gear first. Notice how the motor shaft is not in the center of the motor. This allows the motor to be rotated in its mount to get the right spacing for gears and sprockets. Play around with the motor and gear positioning until the two gears mesh. Then tighten the hub and the motor mount.

Step 12: Driving Motors
Hardware: DC motors (x2), gear assembly (x2) from step 10
Instructions: Add the motors into the motor mounts and adding the gear assembly onto the motor axle.
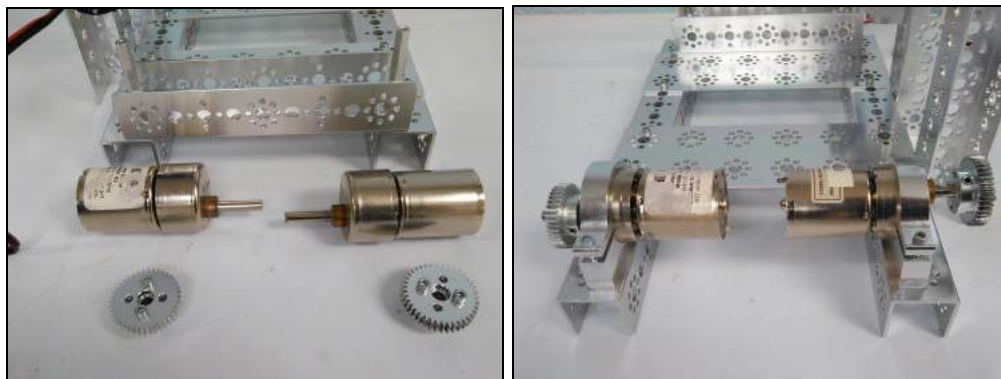
Step 13: REV Expansion Hub

**Hardware:** REV Expansion Hub, 16mm M3 screws (x2), M3 nyloc nuts (x2)

Instructions: Screw the REV Expansion Hub onto the robot plates. Note that only 2 holes will be used.

Step 14: Battery Holder

Hardware: 1/2" SCHS (x1), 1" stand-off post (this is smaller than the ones used for the phone mount)

Instructions: Screw the post in from the bottom so that it stands up. Ensure you have the right hole spacing. The battery will be placed between this post and the wall of the 144mm phone holder channel from step 2 (feel free to check that the battery will fit).
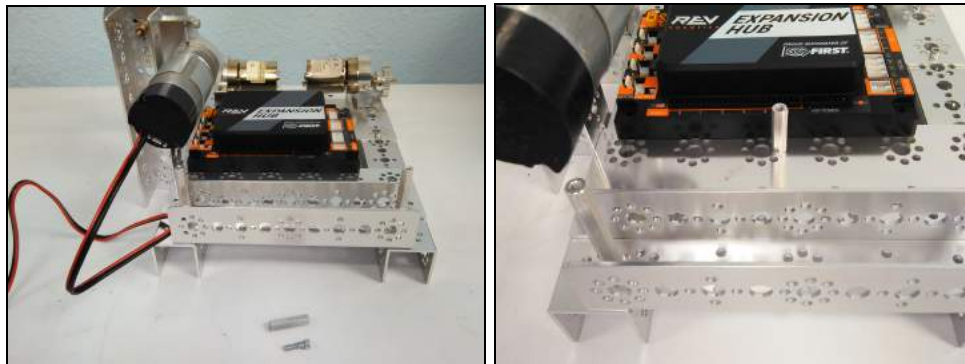
Step 15: Omni Wheels
Hardware: Omni wheels (x2), 100mm axle (x2), 1/2" SHCS (x4), axle hub (x2)
**Instructions:** Place the hub so that the flange fits into the omni wheel. Screw in place.Then add the axle; the axle should not extend past the screws on the wheel. Once on, tighten the axle hub set screw onto the flat part of the axle.
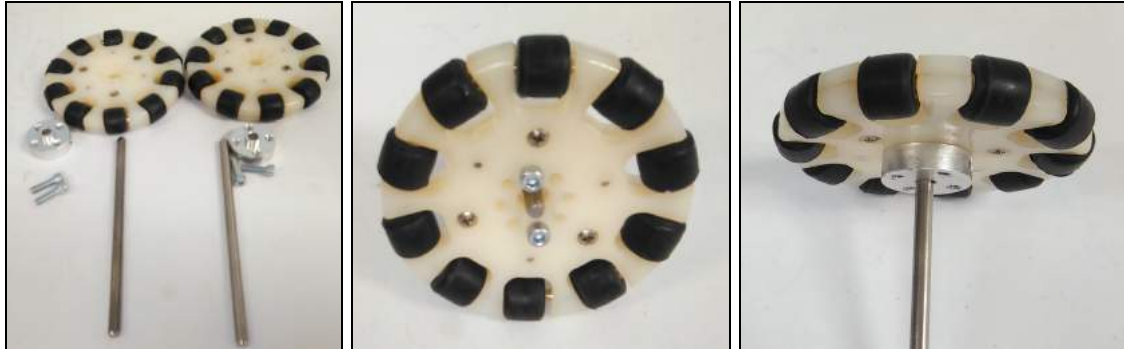
Step 16: Omni Wheels (cont.)
Hardware: Bronze bushings (x4), axle set collar (x2)
Instructions: Add the wheels as shown.. Make sure the bronze bushings are facing the right direction. Tighten the collars.
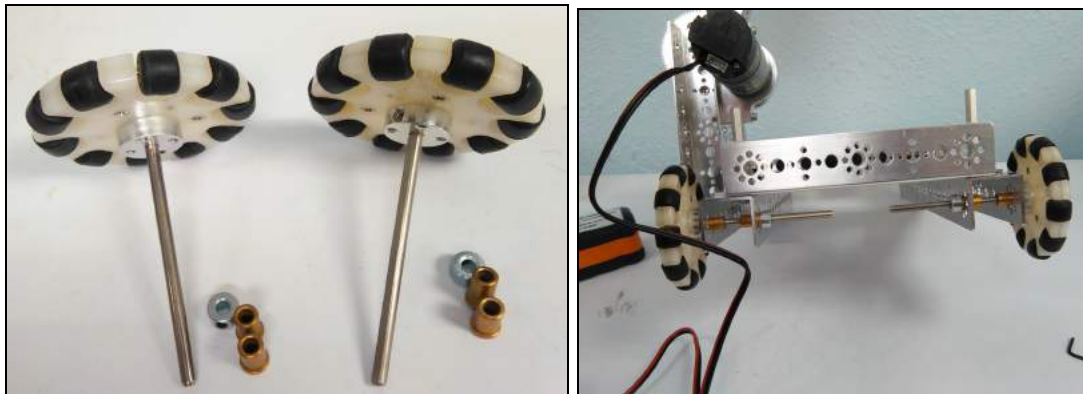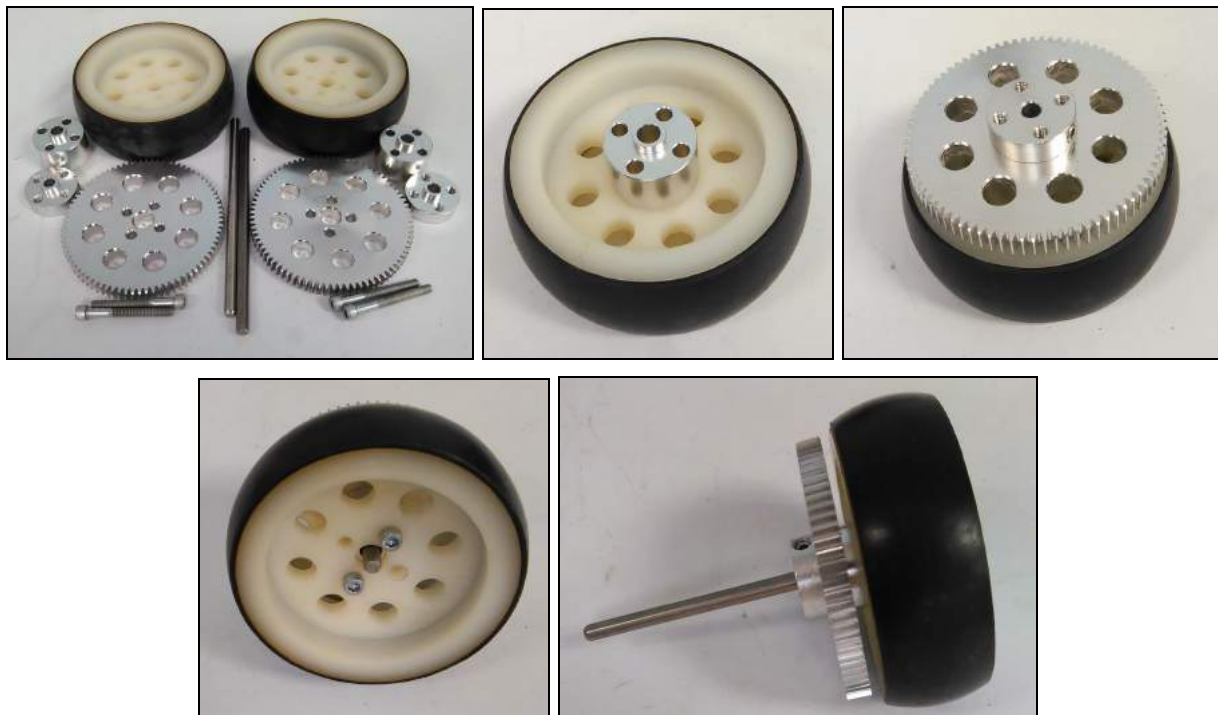
Step 17: Driving Wheels

Hardware: Traction wheel (x2), 100mm axle (x2), hub gear spacer(x2), axle hub (x2), 80-tooth gear (x2), 1.5" motor mount SHCS (x2).

Instructions: Add the hub gear spacer to the tire. Then add the gear and the axle hub, and attach using 1.25" SHCS. Insert the axle into the assembly and tighten the hub set screw onto the flat part of the axle.

Step 18: Driving Wheels (cont.)

Hardware: Bronze bushings (x4), axle set collar (x2)

Instructions: Add the tires to the other side of the robot as shown. Make sure to tighten the hubs and collars. Rotate the motor within the mount until the gears mesh well. Gears mesh well when the align and sit together, so when you move the wheels, both gears turn together.
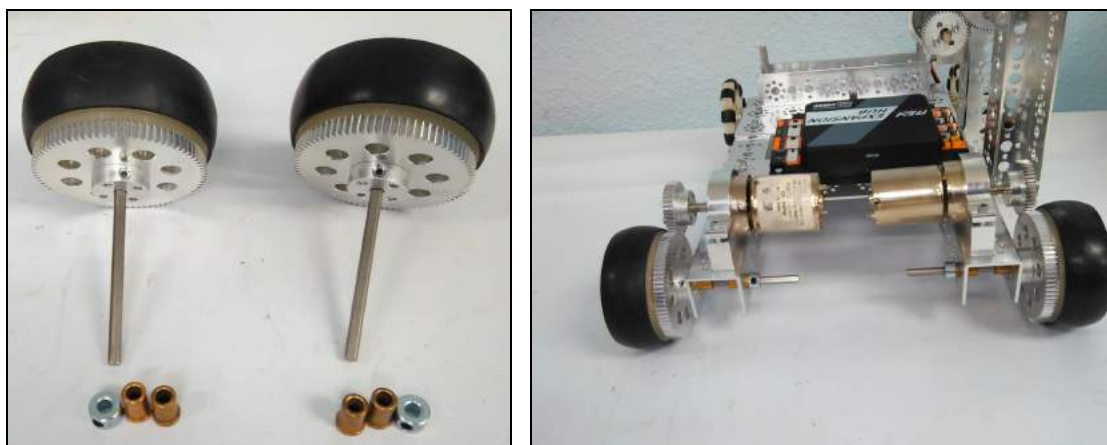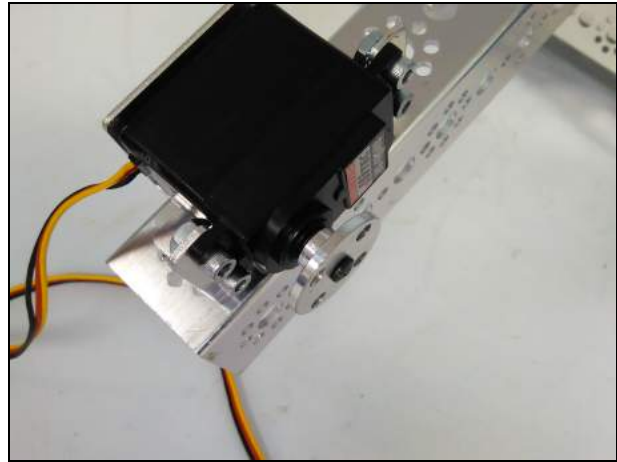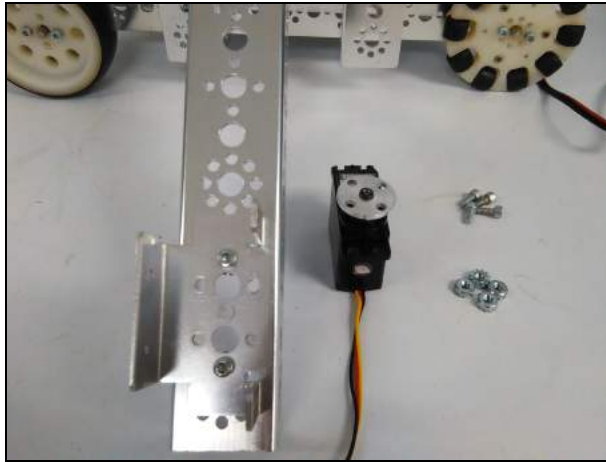
Step 19: Servo Attachment

**Hardware:** Servo (x1), 5/16 SCHS (x4), kep nuts (x4)

Instructions: Mount the servo onto the channel as shown. Place the servo so the mounting holes are on the outside of the bracket's holes.

Step 20: Power Switch

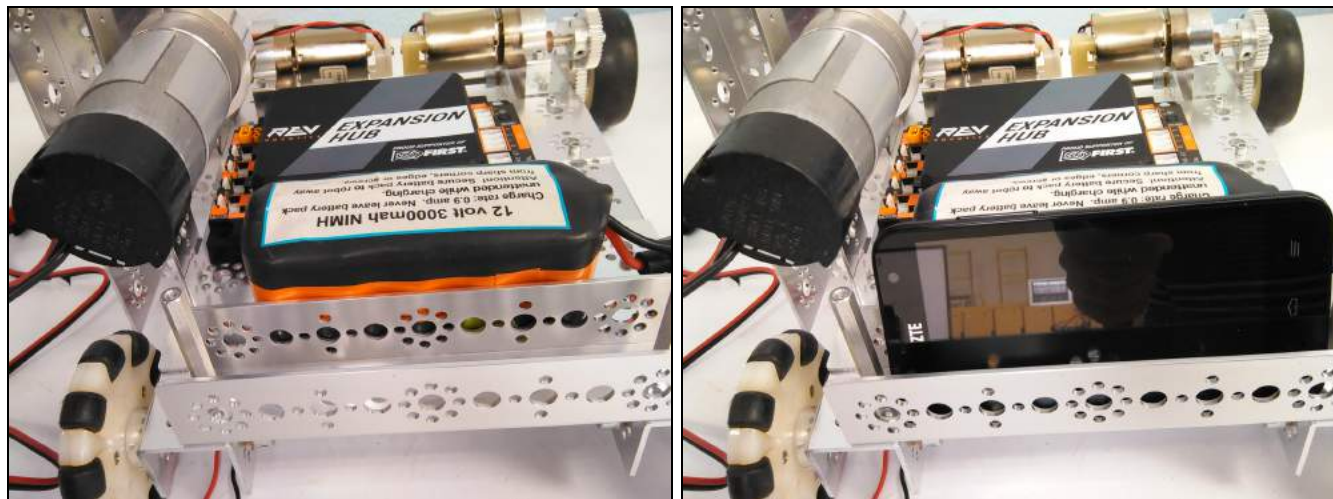**Hardware:** The power switch, power switch bracket, ½" SHCS (x2), nuts (x2)

Instructions: Insert the power switch into the bracket as shown. Then mount the switch and bracket onto the robot with the screws and nuts as shown.
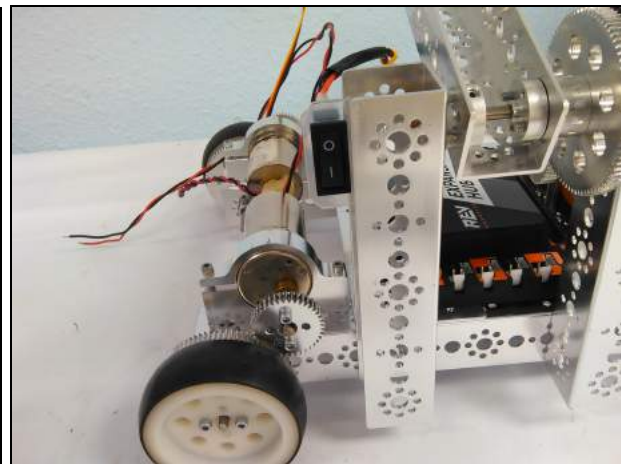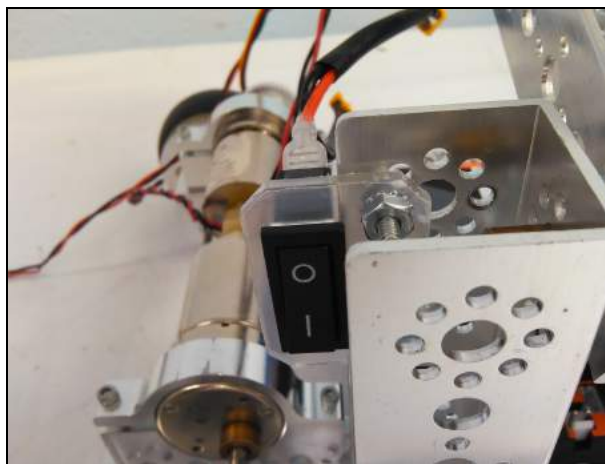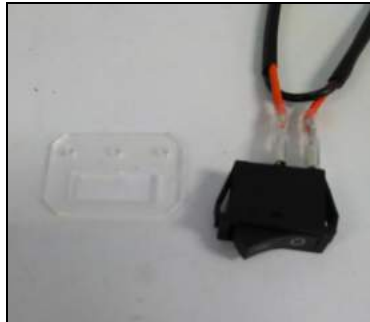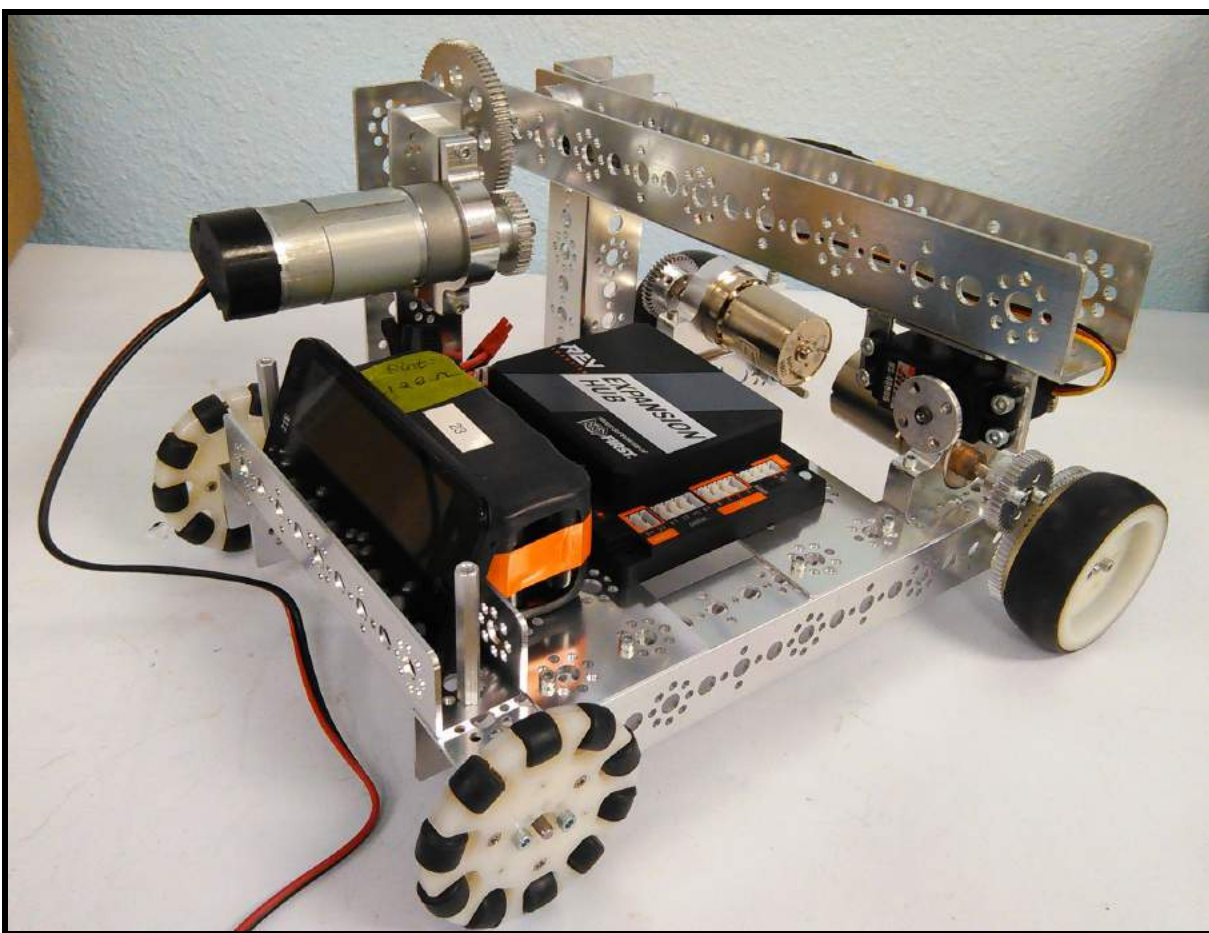
Step 21: Finishing Touches

Hardware: Phone and battery pack

Instructions: Place the phone and battery in the robot in their respective places as shown.

Finished robot build:

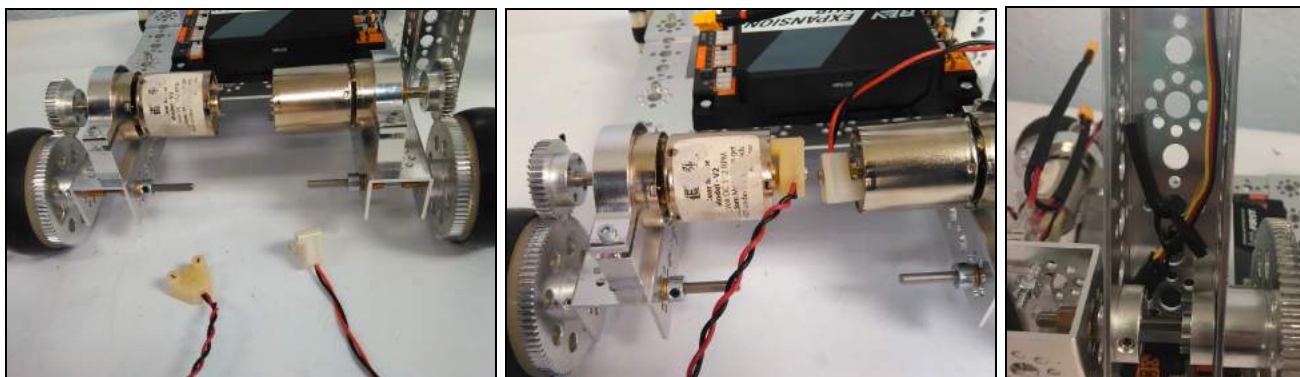**Congratulations! You have finished the robot build. Now to wire it! :)**

Part 2

Step 22: Motor wiring

Hardware: Motor power cable (x2)

Instructions: Attach the motor power cable to the motors. Make sure all wires are tucked away. Zip tie or twist-tie the wires together.
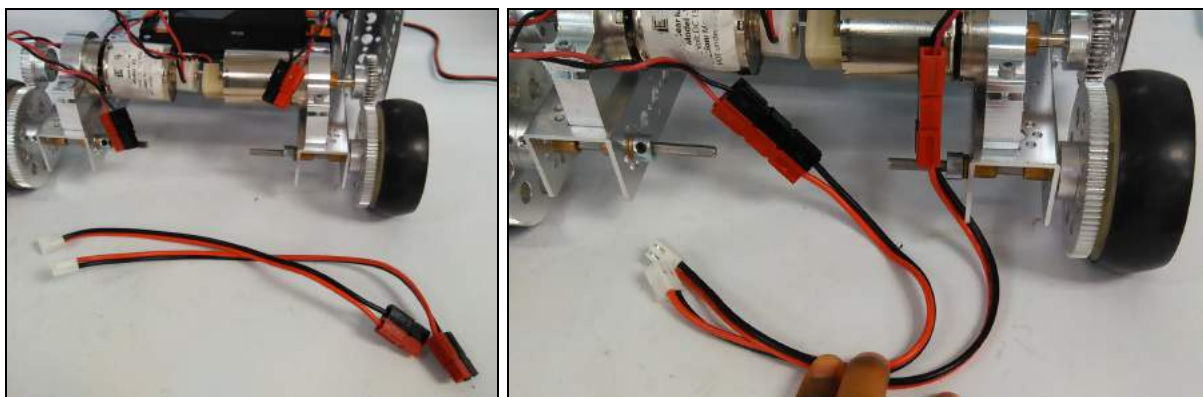

On a competition robot the connectors for the motor cables should be secured to the motors, e.g., using electrical tape. This ensures that the connectors do not fall off during competition.

Step 23: Motor wiring (cont.)

Hardware: Anderson Powerpole to JST-VH adapter cables (x3)

Instructions: Take the adapter cables and attach them to the motor cables (wheels and arm).

Step 23: Motor wiring (cont.)

Take the white ends of the motor cables and plug them into the REV Expansion Hub.

Note: The omni wheels are the front of the robot. Plug the left driving motor (the side without the arm) in port 0 and the right driving motor (the side with the arm) in port 1.

Step 24: Battery wires

**Hardware**: Anderson Powerpole to XT30 cable (x1)

Instructions: Take the cable and attach it to the battery. (Battery has been removed from the robot for clarity.) The cable should extend from the left side of the battery, as shown in the picture.

Step 25: Battery wire attachment

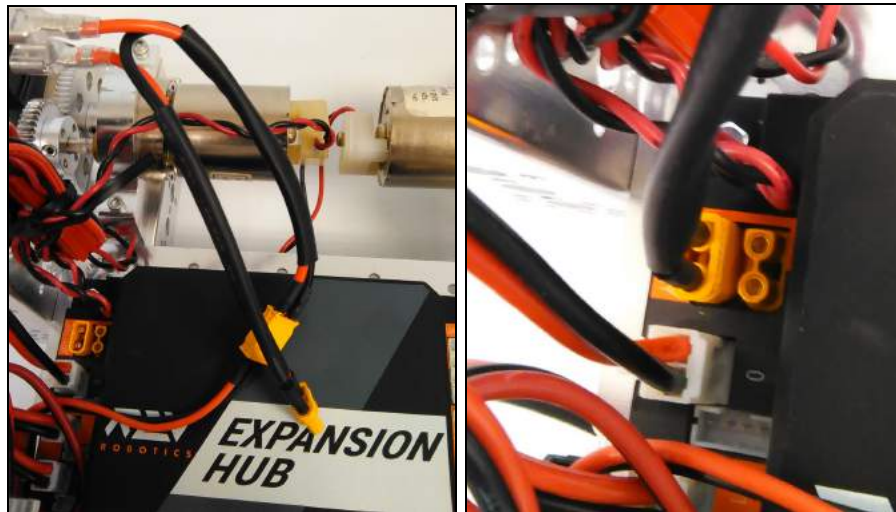**Hardware**: Battery assembly from Step 23

Instructions: Take the battery wire and attach it to the switch wire. (There are 2 switch wires; only one of them will fit.)
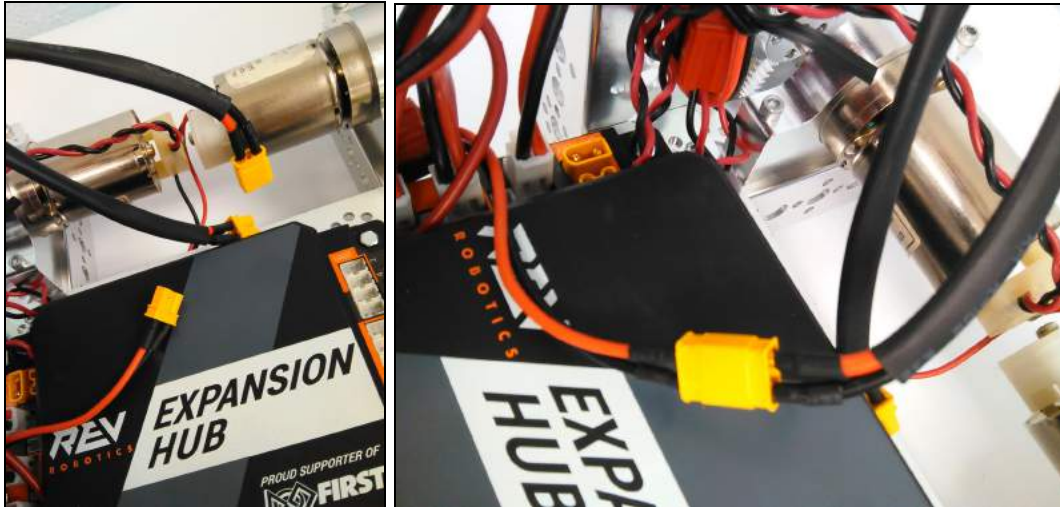
Step 26: Switch wires
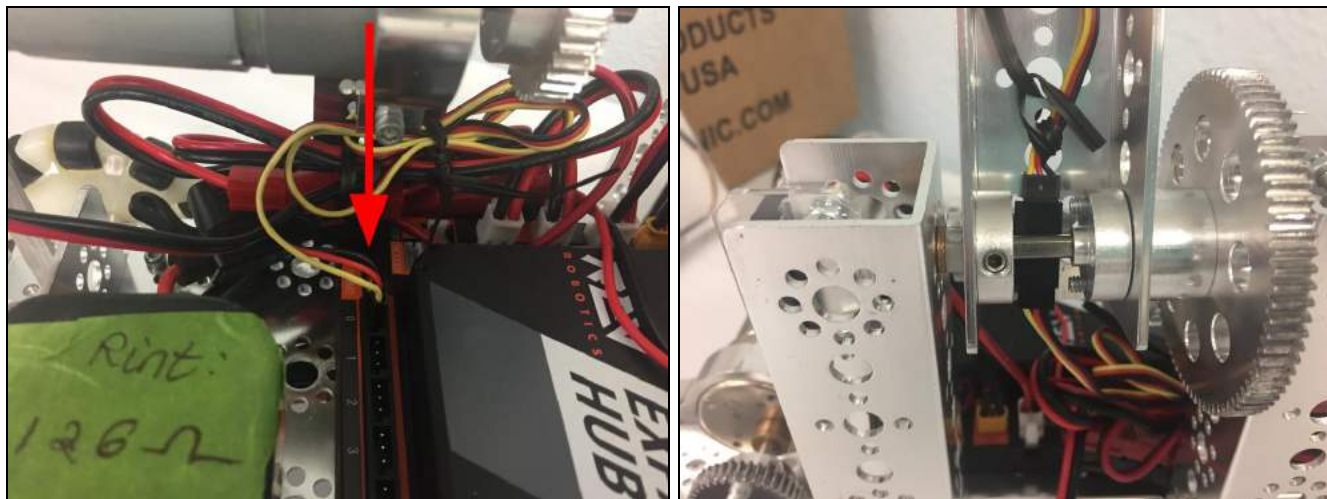
Hardware: Switch Cables (x1)

Instructions: Take the other switch wire (the one not connected to the battery) and plug it into the REV Expansion Hub. Again, there are two ports; only one will fit.

Step 26: Servo wiring

Hardware: Servo cable (x1)

Instructions: Attach a servo extension to the servo. Plug it into servo port 0 on the REV Expansion Hub.

Step 27: Phone wires

Hardware: OTG cable (x1), USB A to mini USB cable (x1)

Instructions: Attach the white USB A to mini USB cable to the hub and the black OTG cable. Follow that by attaching the black OTG cable to the robot controller phone.

Step 28: Phone wires (cont.)

Hardware: OTG cable (x1), Logitech controller

Instructions: Attach the black OTG cable to the phone and the controller by shown ports.

Step 29: Zipping 'em all up!

Hardware: Zip ties/wire ties

Instructions: Tie all loose wires into place. You can tie them up however you wish; feel free to use our robot as a guide. Just keep in mind that it is essential that there are no loose wires near gears/other moving parts because of entanglement risks. The picture you see below has the wires near the gears however all the wires are tied down and do not move upon driving the robot.