FIRST® Tech Challenge

PushBot Build Guide

Part II: Building the Robot

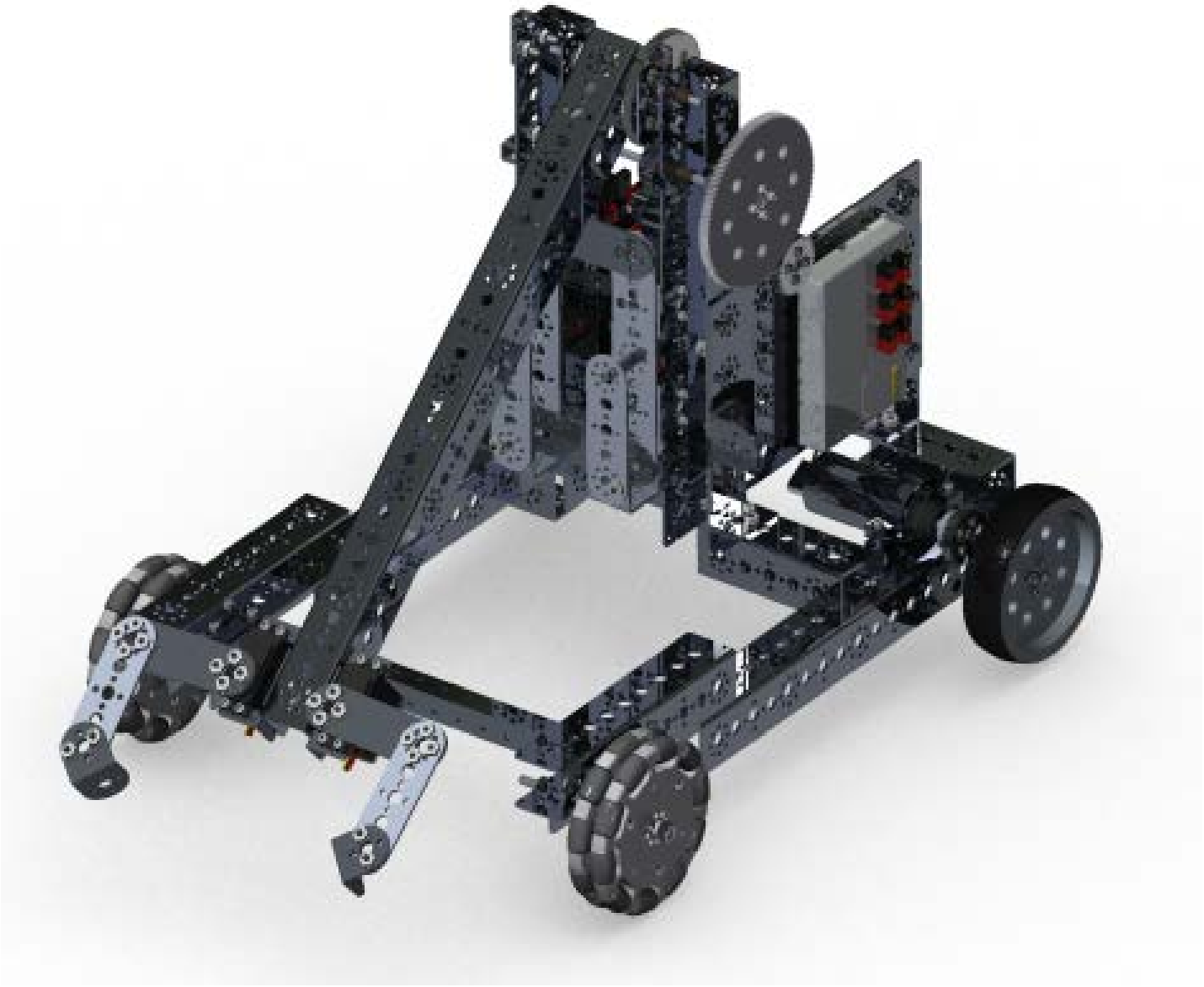
Revision History		
Revision	**Date**	**Description**
1	8/15/2014	Initial Release – by FTC Team #003 Australia, The Southport School
2	9/1/2014	Replaced MATRIX with TETRIX content by former FTC Team #2843, Under the Son
3	8/6/2015	Updated using the new kit of parts and new programming environment.

Contents

Building the Robot

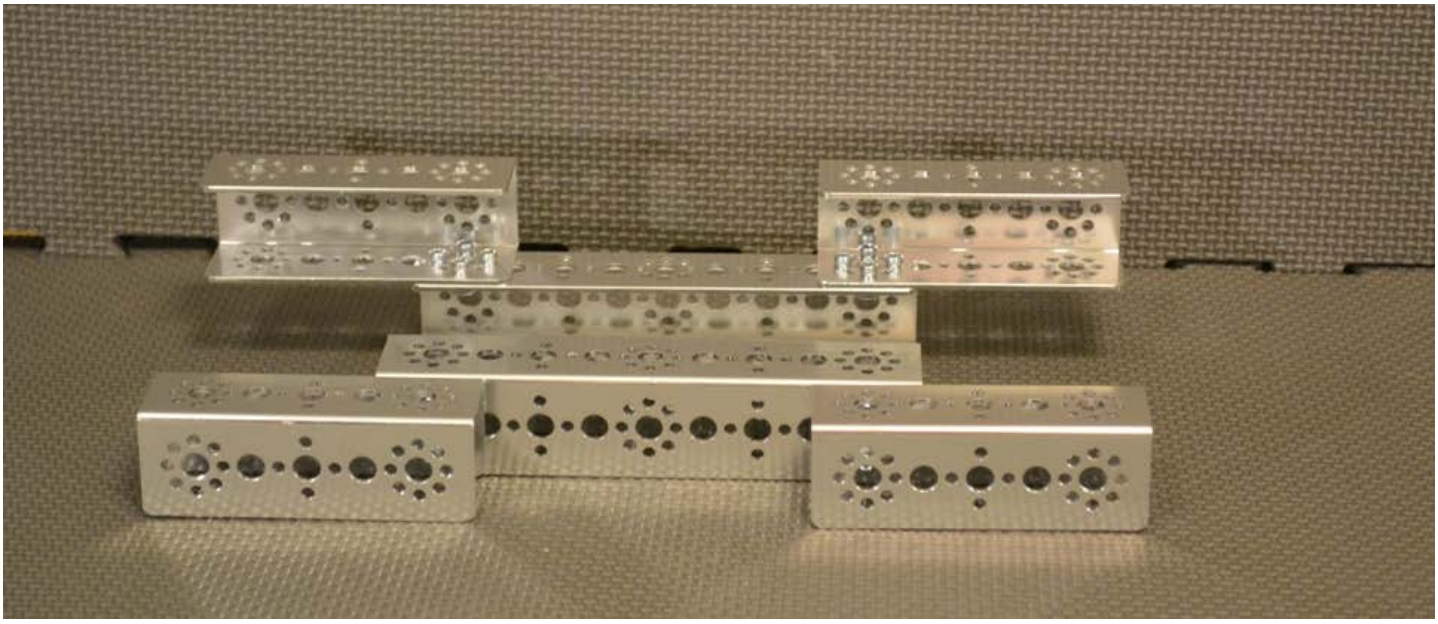
This section will outline the construction of the chassis, sensors, and electronics. The chassis is constructed using the TETRIX Kit of Parts. The standard tools included in the Kit of Parts set will be needed to build the chassis. All parts needed for the construction are listed in the instructions (most are shown below). Make sure that when using an axle hub, motor hub, or axle collar that the set screw is installed. Also, make sure that all assemblies are square. It is hard to drive a crooked Robot straight!

Robot CAD Drawing



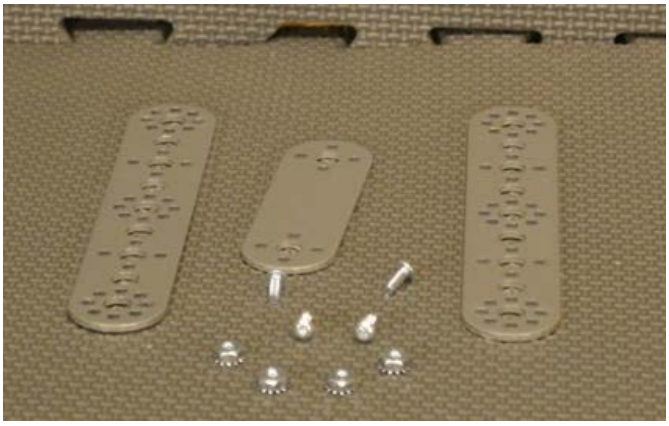
Cross Bar Assembly
Make 2 copies

Step 1: 160mm channel (1), 96mm channels (2), 5/16" socket head cap screws (8) keps nuts (8). The second picture shows BOTH completed assemblies.

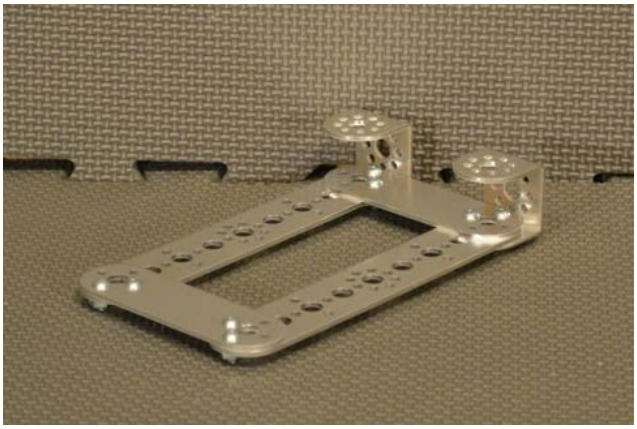


Phone Holder Assembly

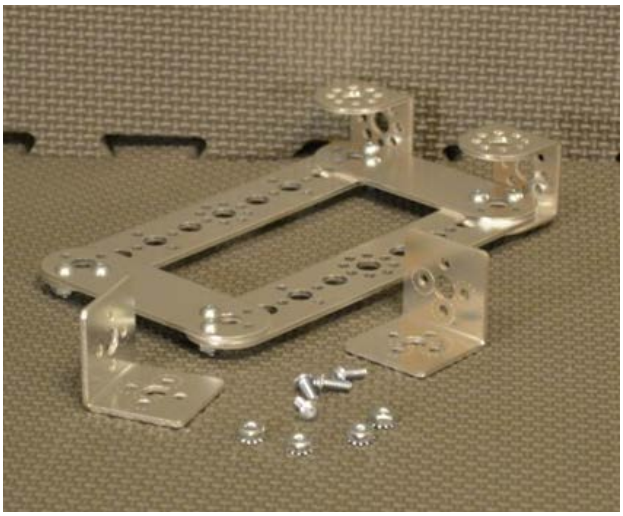
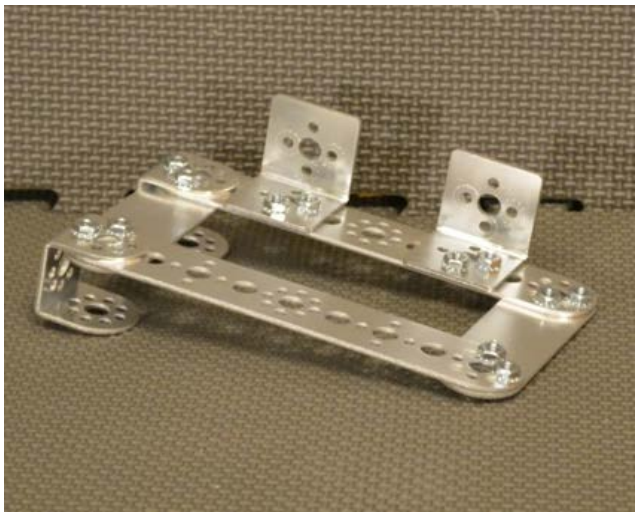
Step 1: 160mm flats (2), flat bracket (1), button head cap screws (4), keps nuts (4). The second picture shows the completed step.



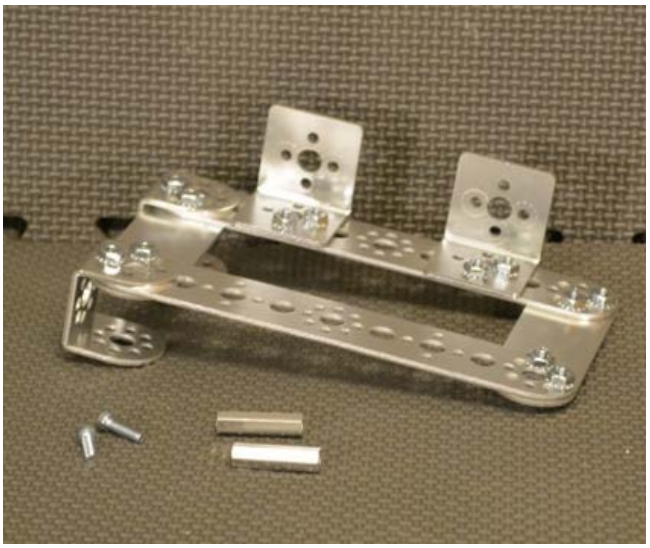
Step 2: assembly from step 1, flat bracket (1), inside C connector (2), button head cap screws (4), and keps nuts (4). The second picture shows the completed step. Note: the inside C connector is below the flat.



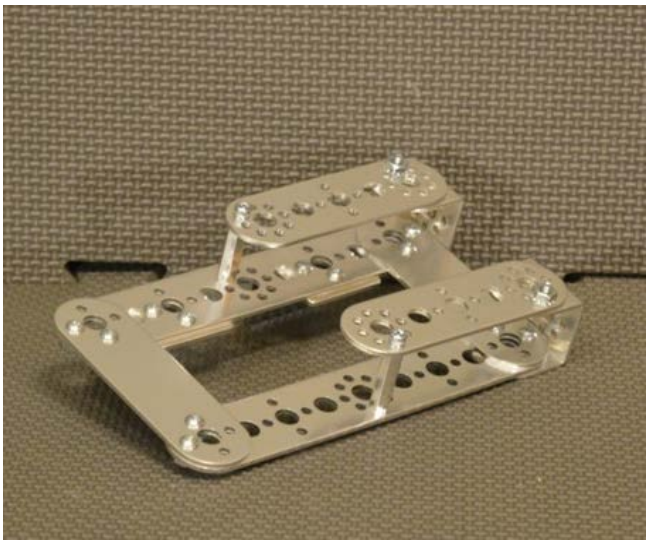
Step 3: assembly from step 2, inside corner bracket (2), button head cap screws (4), and keps nuts (4). The second picture shows the completed step.

Step 4: assembly from step 3, 1" stand-off posts (2), 1/2" socket head cap screws (4). The second picture shows the completed step. Note: the stand-off posts are not placed symmetrically.

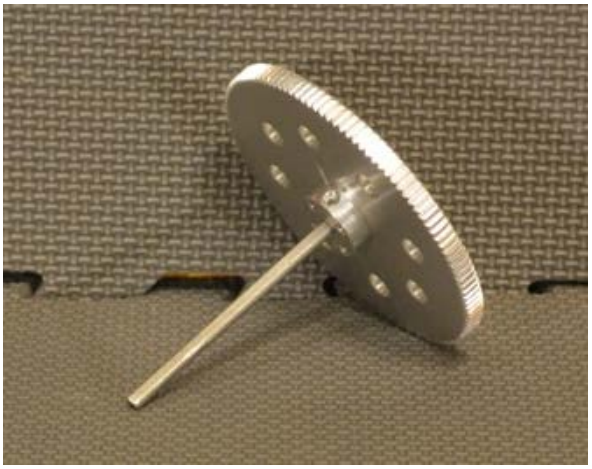



Step 5: assembly from step 4, 96mm flats (2), 5/16" socket head cap screws (2), button head cap screws (2), and keps nuts (2). The second picture shows the completed phone holder assembly.

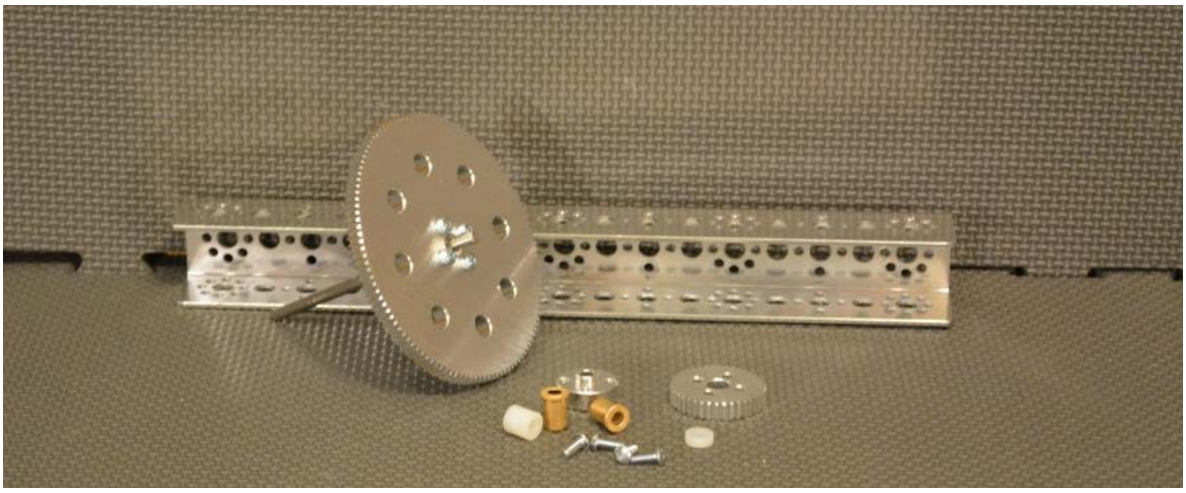


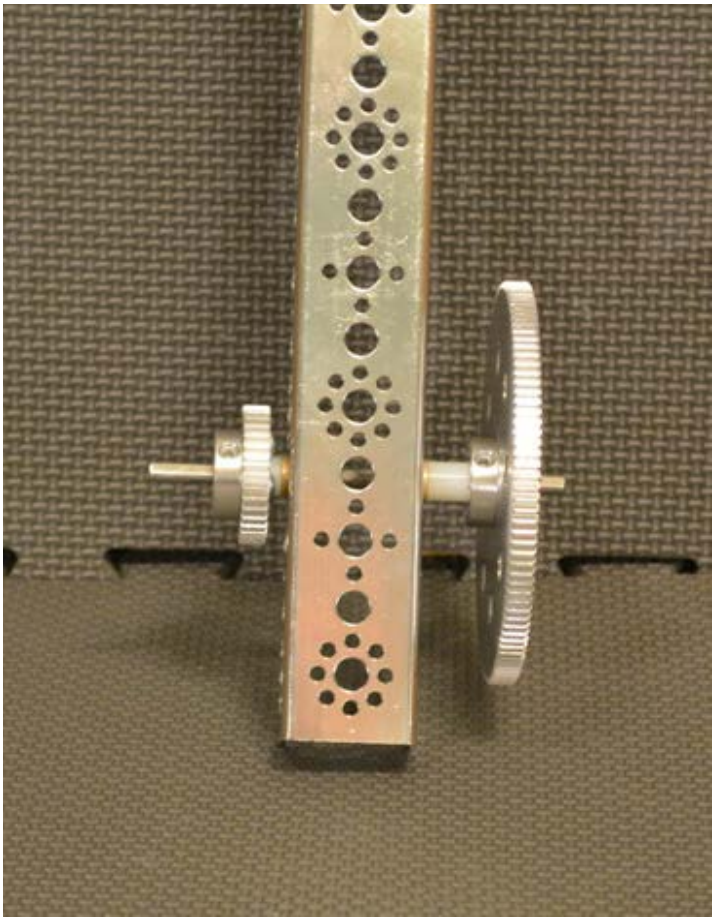
Tower Assembly

Step 1: 120-tooth gear (1), axle hub (1), 1/2" socket head cap screws (4), axle (1). The second picture shows the completed step.

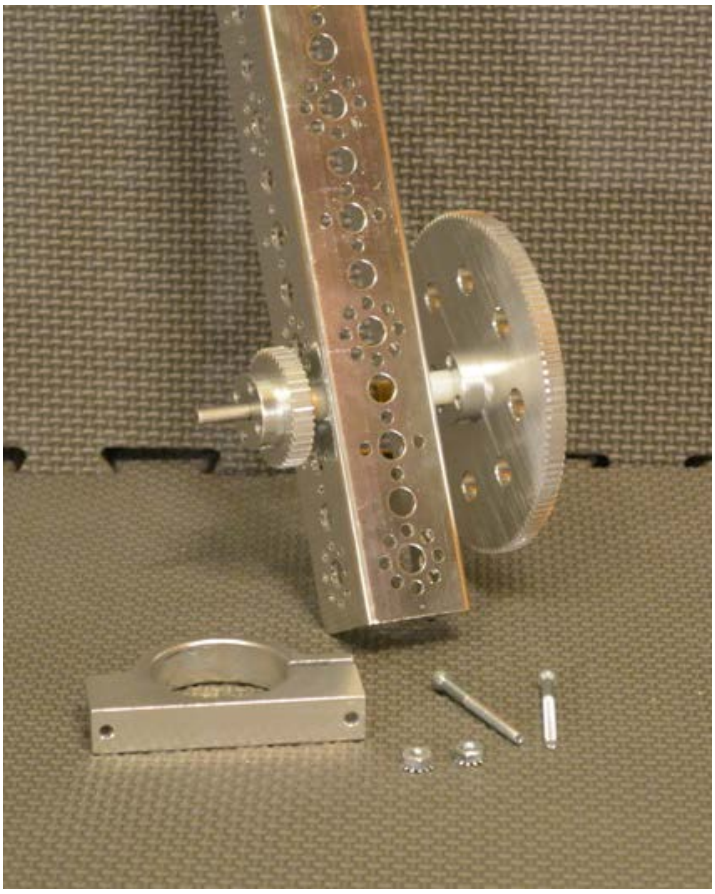


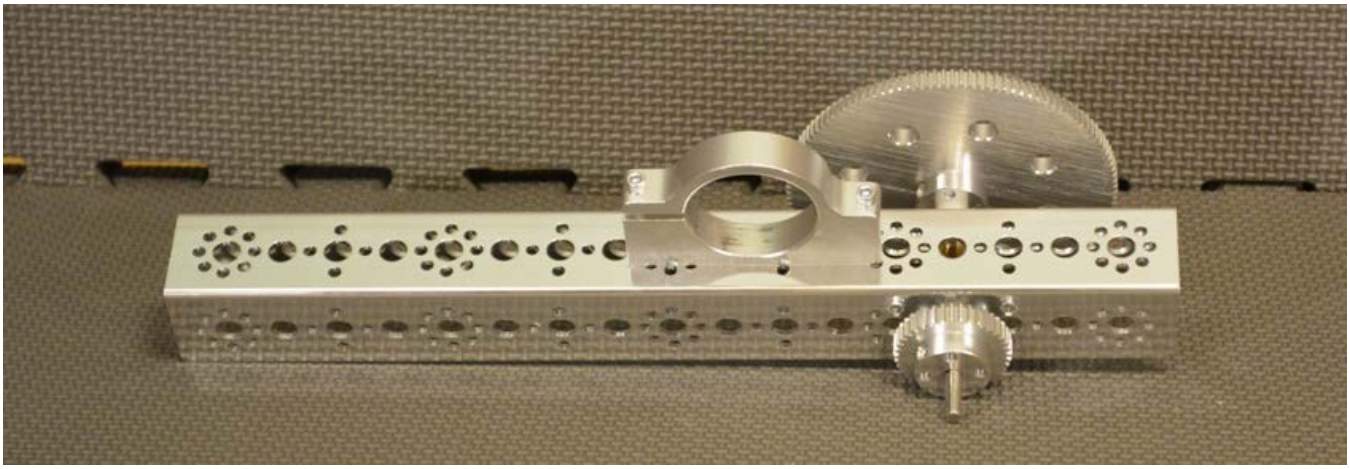
Step 2: assembly from step 1, 288mm channel, 3/8" axle spacer (1), bronze bushing (2), 1/8" ax axle el spacer (1), 40-tooth gear (1), axle hub (1), and button head cap screws (4). The second picture shows the completed step. Note the order on the axle. 120-tooth gear, axle hub, 3/8" axle spacer, bronze bushing, channel, bronze bushing, 1/8" spacer, 40-tooth gear, and axle hub.



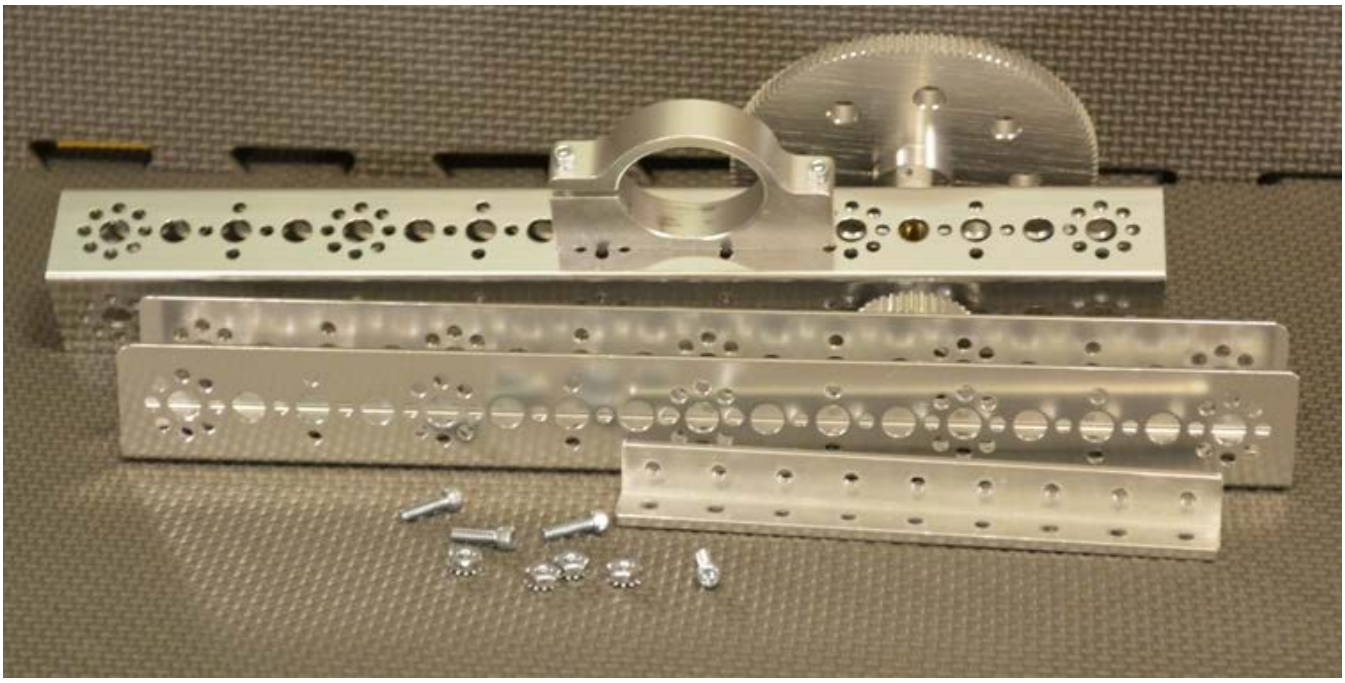


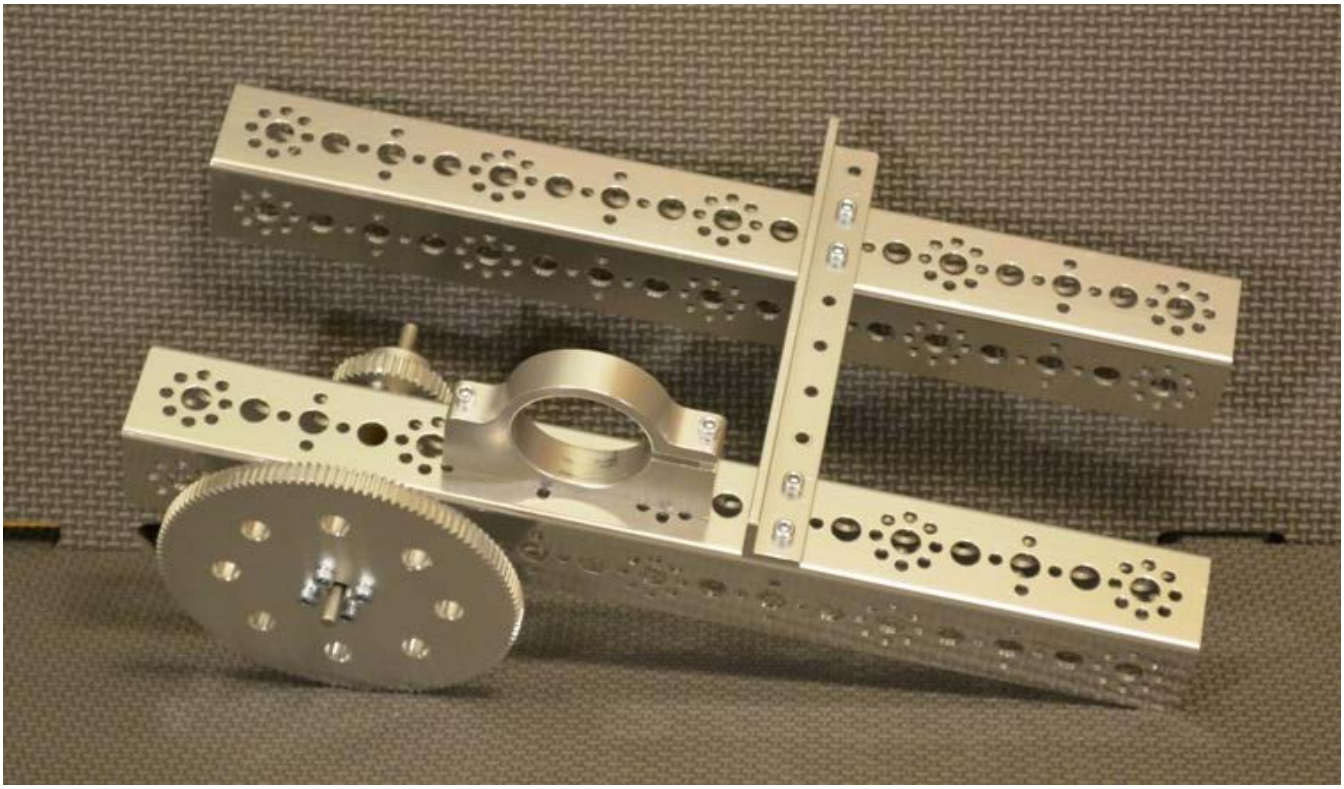
Step 3: assembly from step 2, motor mount (1) with included screws (2) and keps nuts (2). The second picture shows the completed step.



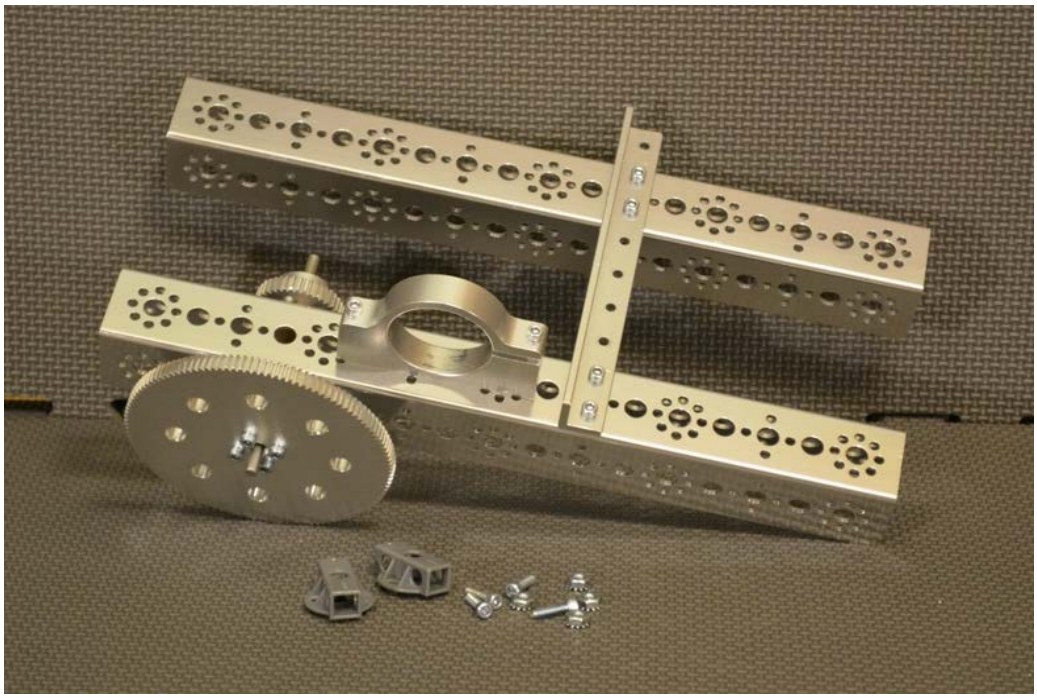


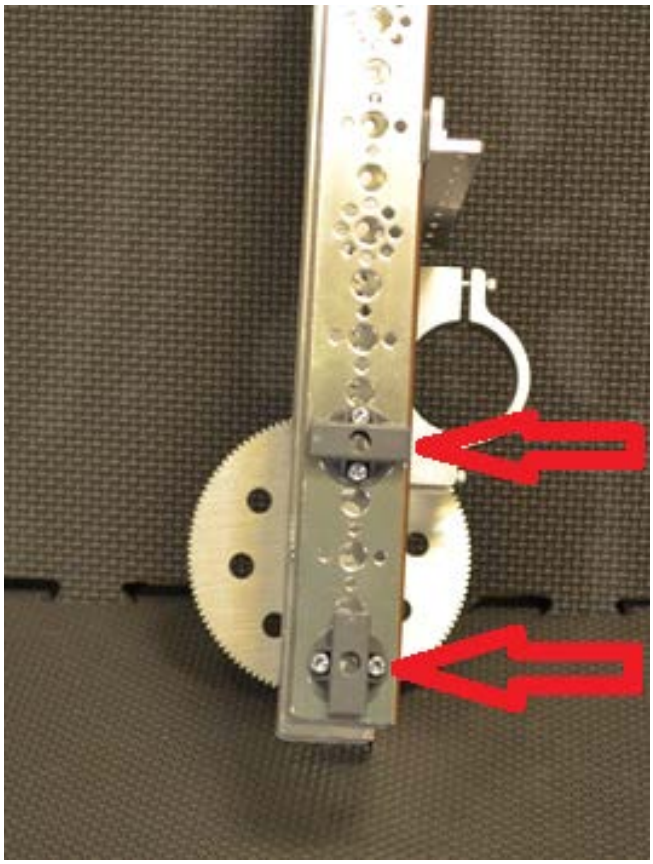
Step 4: assembly from step 3, 288mm channel (1), 144mm angle (1), 1/2" socket head cap screws (4), and keps nuts (4). The second picture shows the completed step.





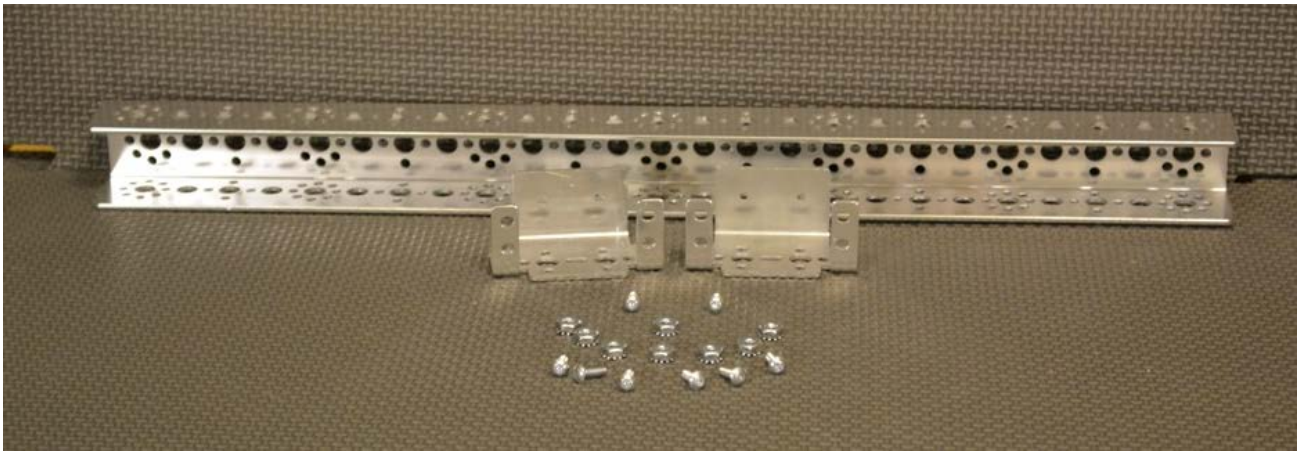
Step 5: assembly from step 4, hard point connectors (2), 1/2" socket head cap screws (4), and keps nuts (4). The second picture shows the completed tower assembly.

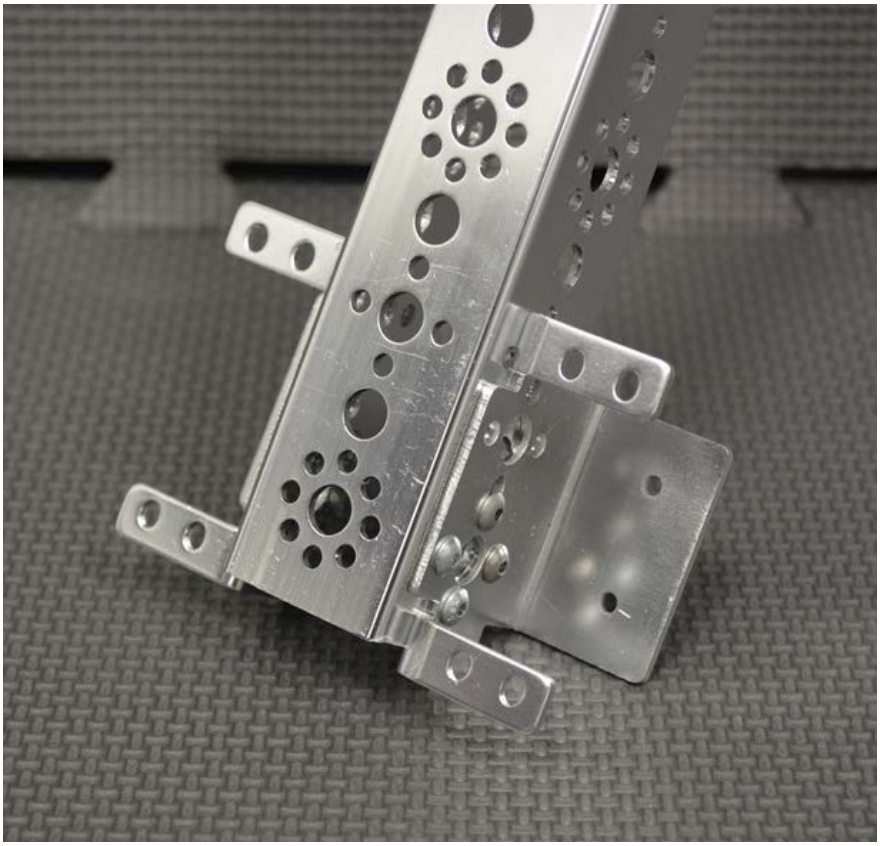




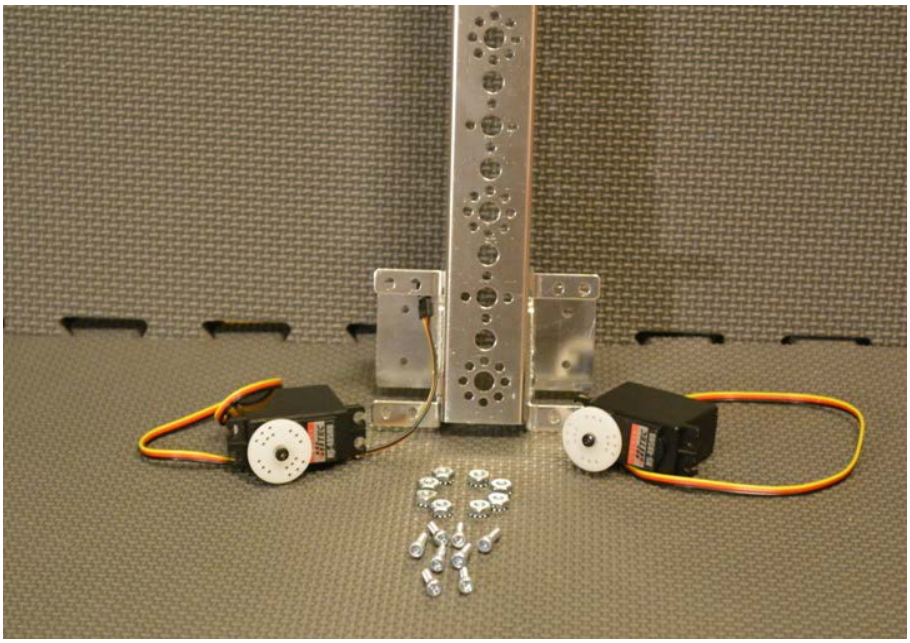
Arm Assembly

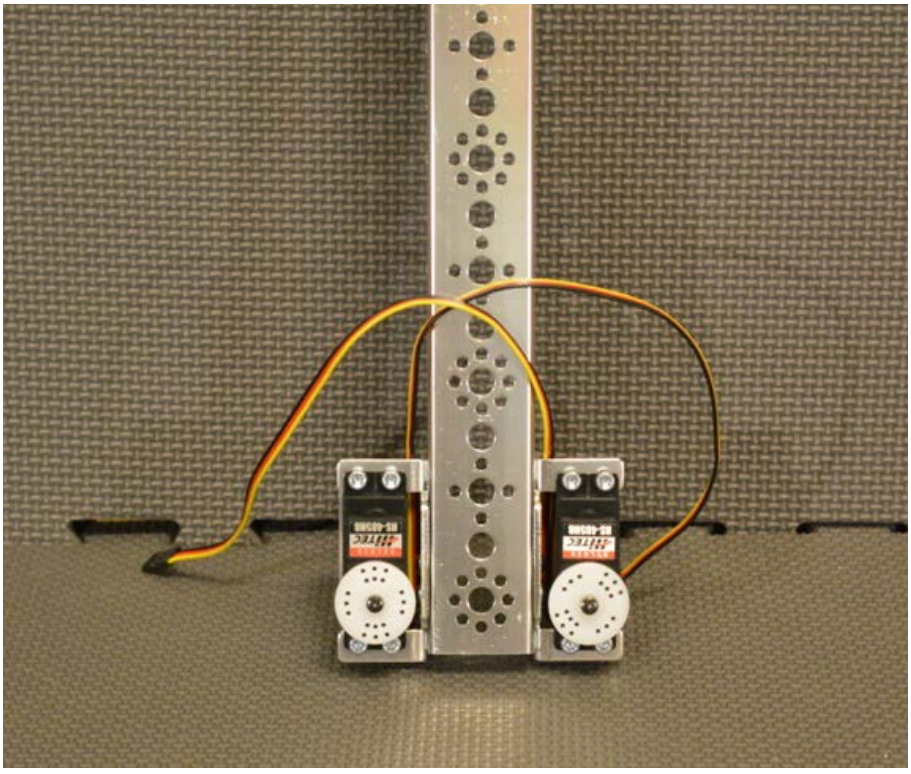
Step 1: 416mm channel (1), single standard-scale servo motor mounting bracket (2), button head cap screws (8), and keps nuts (8). The second picture shows the completed step.





Step 2: assembly from step 1, 180^{O} standard-scale HS-485HB servo motor (2), 1/2" socket head cap screws (8), and keps nuts (8). The second picture shows the completed step.

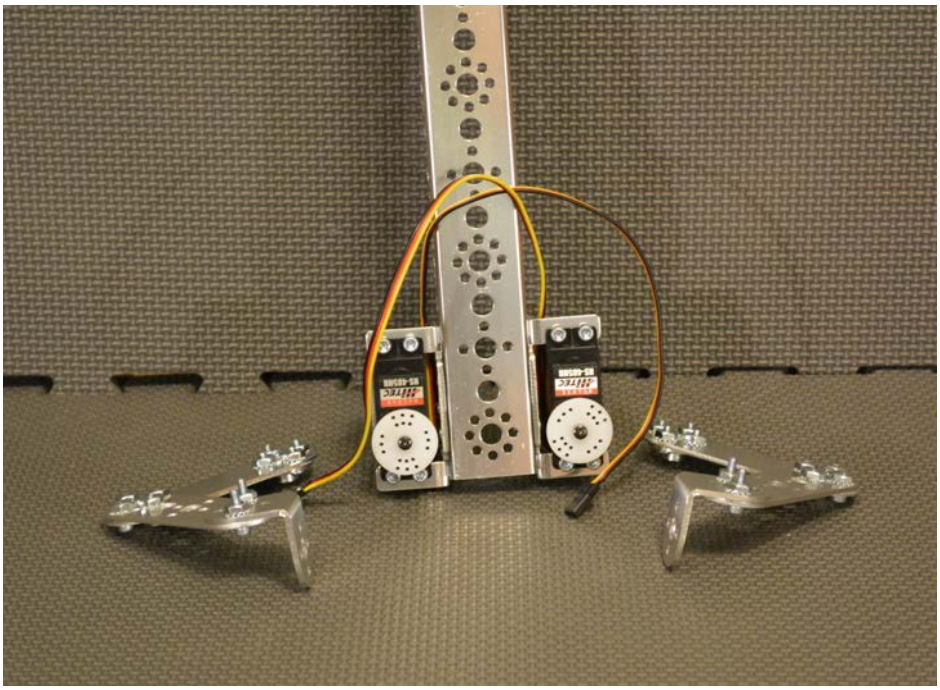


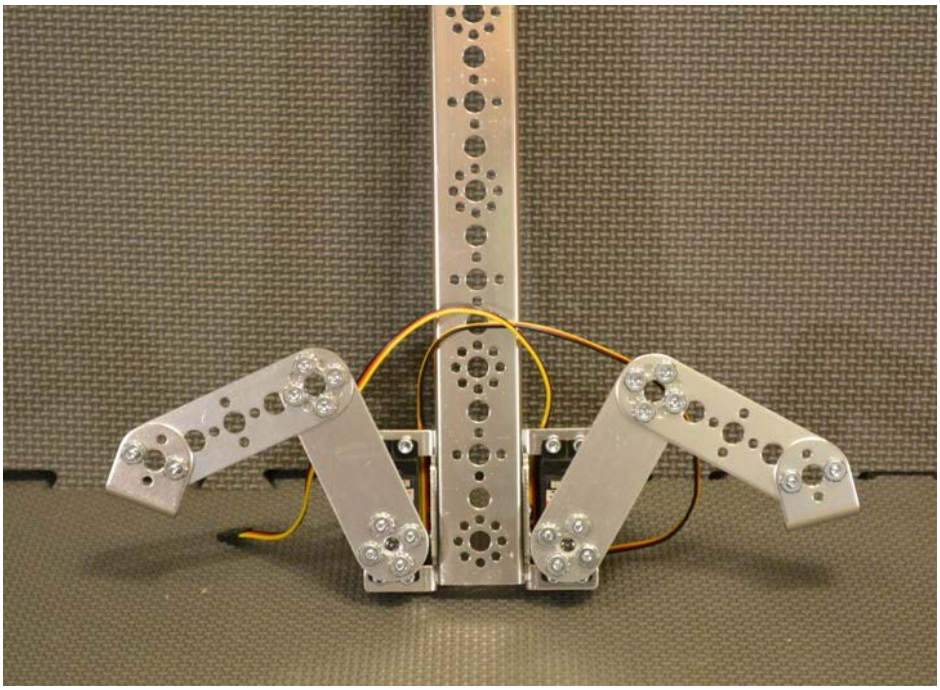


Step 3: servo horn - metal (2), flat bracket (2), button head cap screws (8), and keps nuts (8). The second picture shows the completed step.

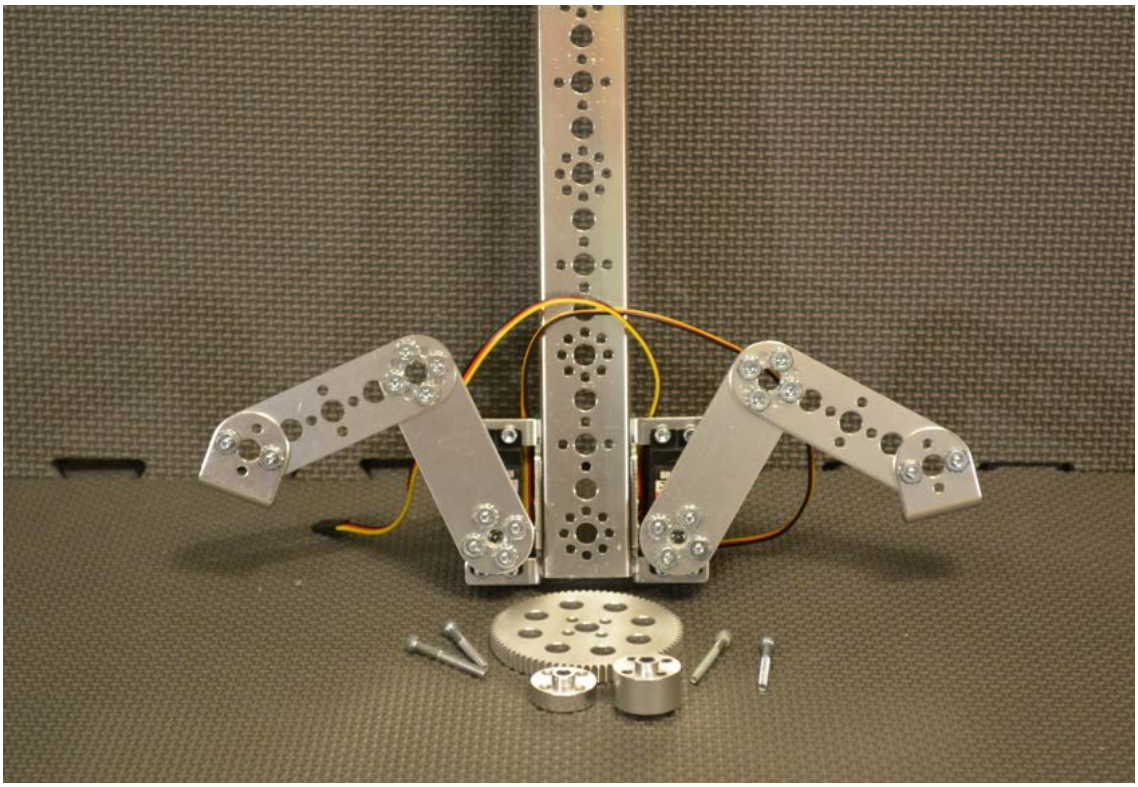
Step 4: assembly from step 3, 96mm flats (2), L bracket (2), 5/16" socket head cap screws (8), 1/2" socket head cap screws (4), and keps nuts (12). The second picture shows the completed step.

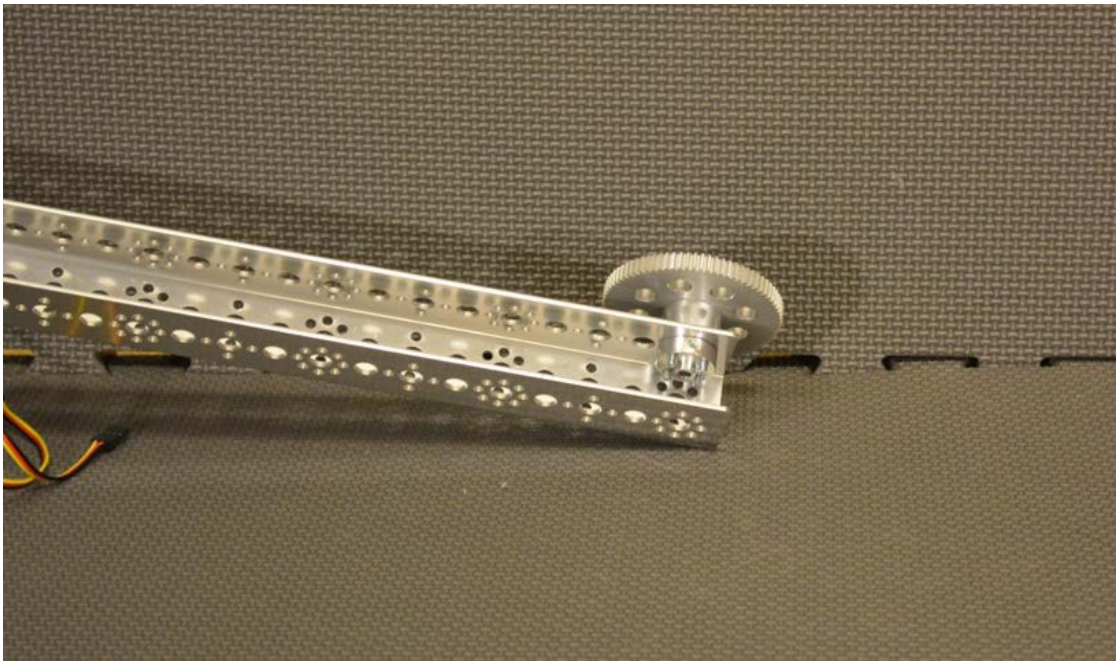
Step 5: assembly from step 2, assemblies from step 4. Remove the black screw from the center of the plastic servo horn. Use this screw to attach the grippers. To set the position of the grippers, rotate the servo to the fully open position and install the gripper so that it is opened just past vertical. This should get the servo in approximately the correct position. The second picture shows the completed step.





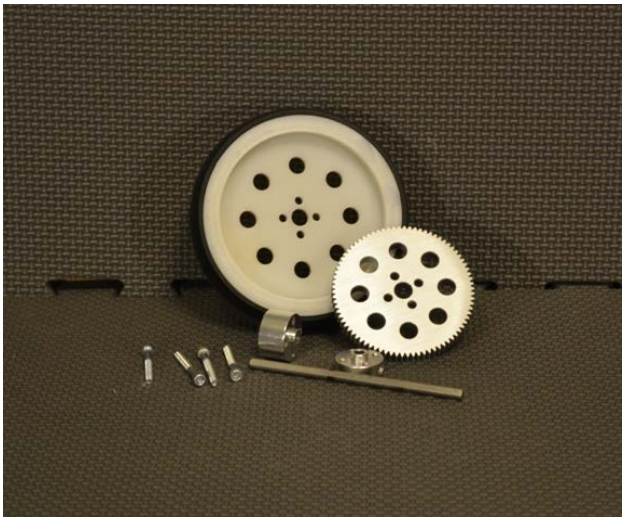
Step 6: assembly from step 5, 80-tooth gear (1), gear hub spacer (1) with included screws (4), and axle hub (1). The second picture shows the completed arm.





Drive Wheel Assembly
Make 2 copies

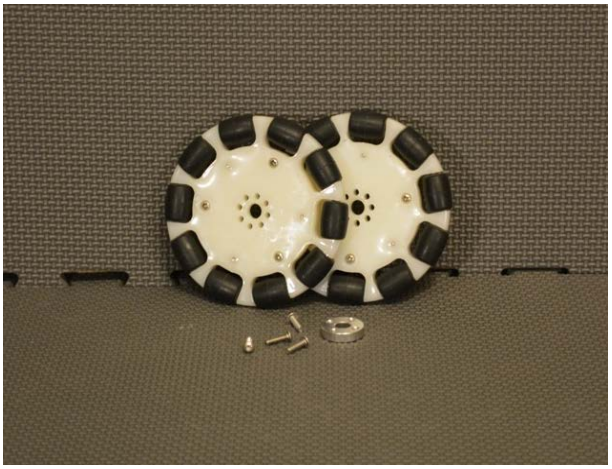
Step 1: 4" wheel (1), gear hub spacer (1) with included screws (4), axle hub (1), and axle (1). The order is wheel, gear hub spacer, gear then axle hub. The second picture shows the two completed assemblies.

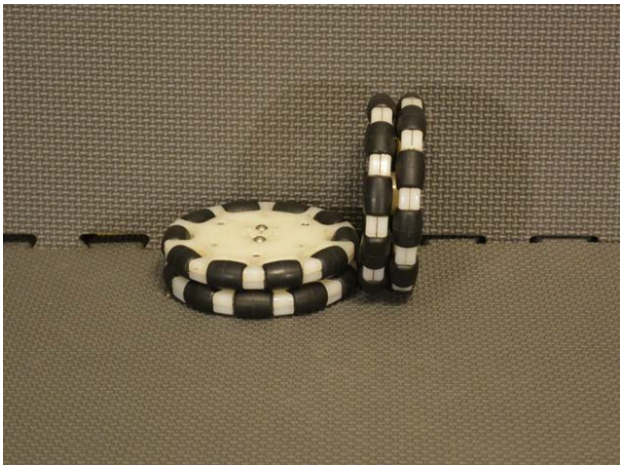


Omni Wheel Assembly
Make 2 copies

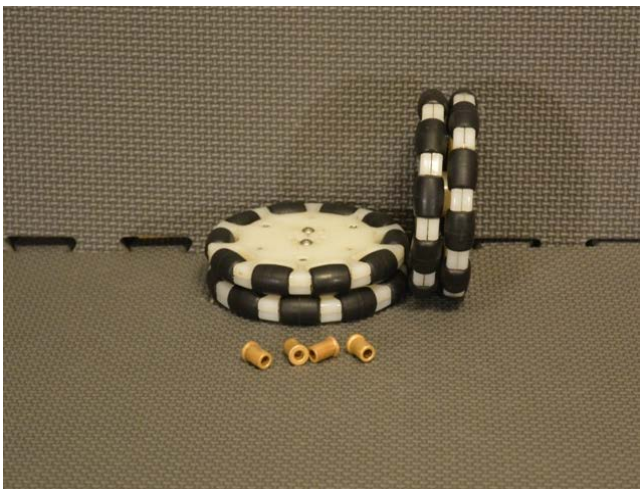
These are assembled as per the instructions that come in the omni wheel pack.

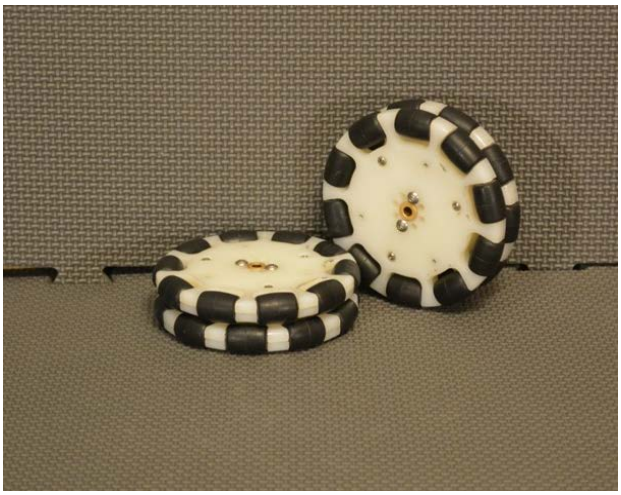
Step 1: 4" omni wheel half (2), joining ring (1) with included screws (4). The order is omni wheel, joining ring, omni wheel. The second picture shows the two completed assemblies.





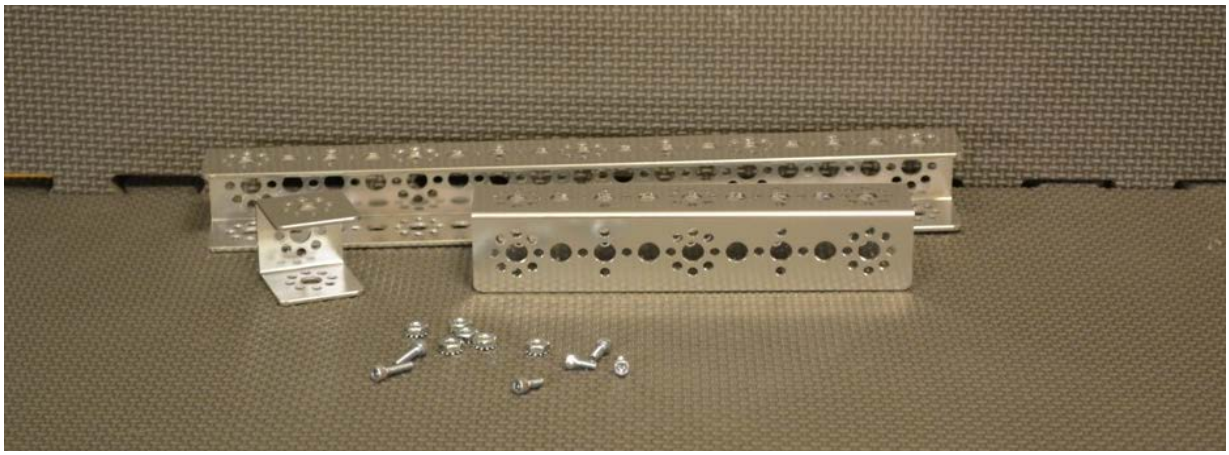
Step 2: assemblies from prior step and bronze bushings (4). The second picture shows the two completed assemblies.

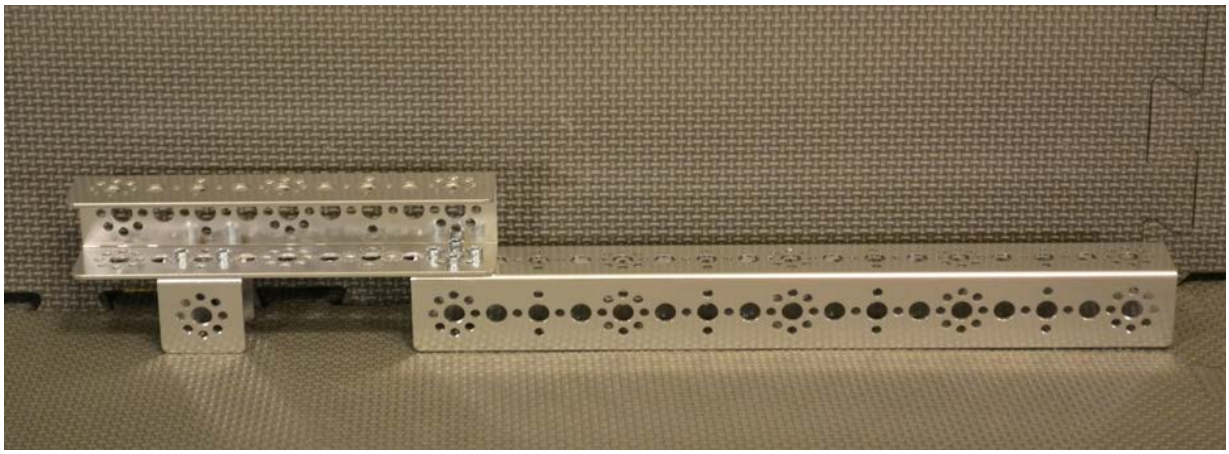




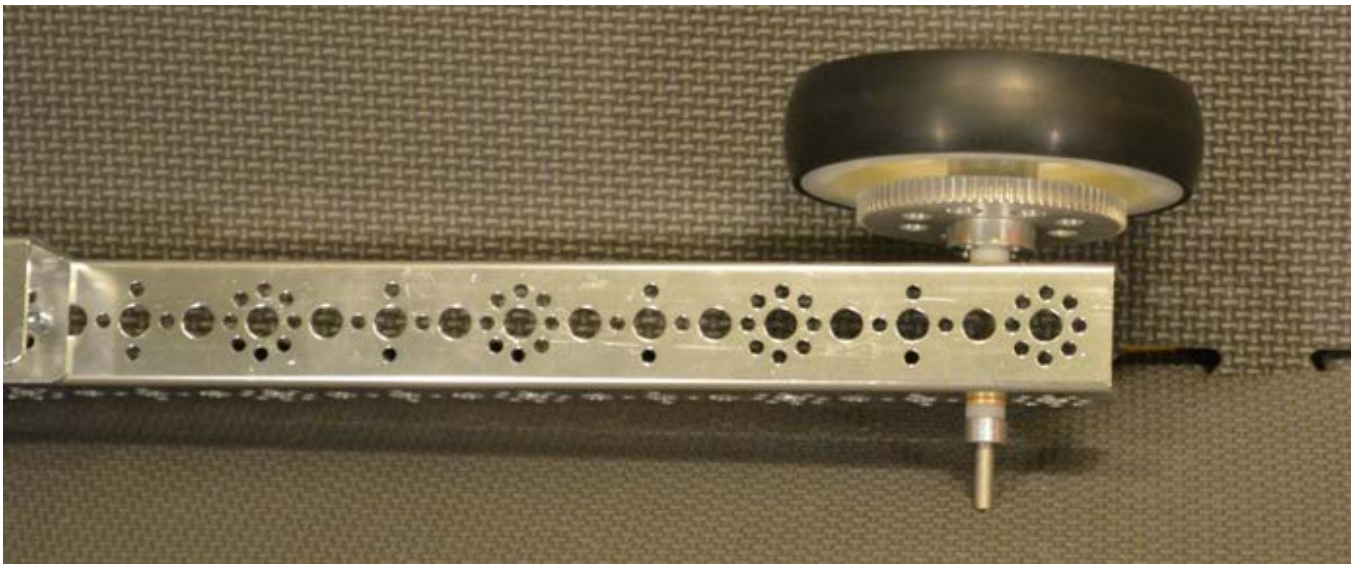
Right Chassis Rail Assembly

Step 1: 32mm channel (1), 160mm channel (1), 288mm channel (1), 5/16" socket head cap screws (4), 1/2" socket head cap screws (2), and keps nuts (6). The second picture shows the completed step.

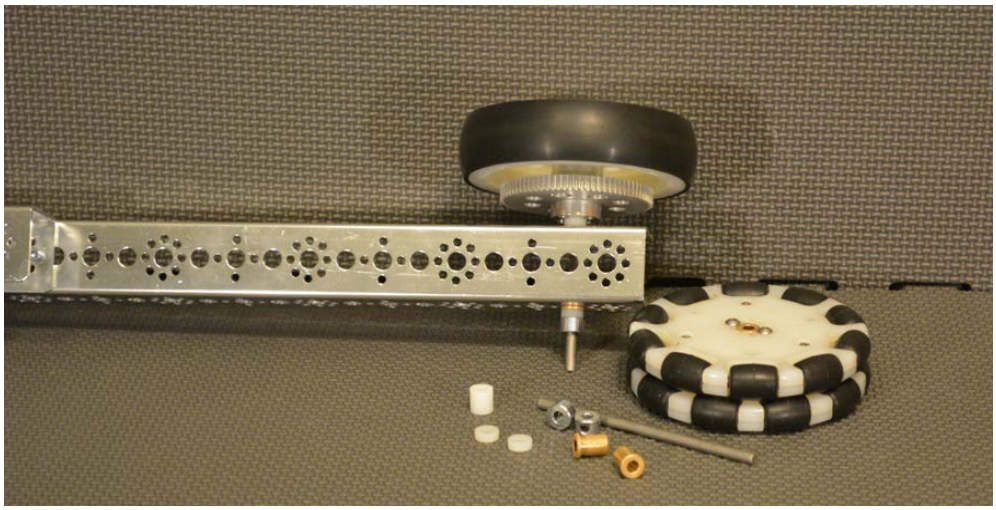


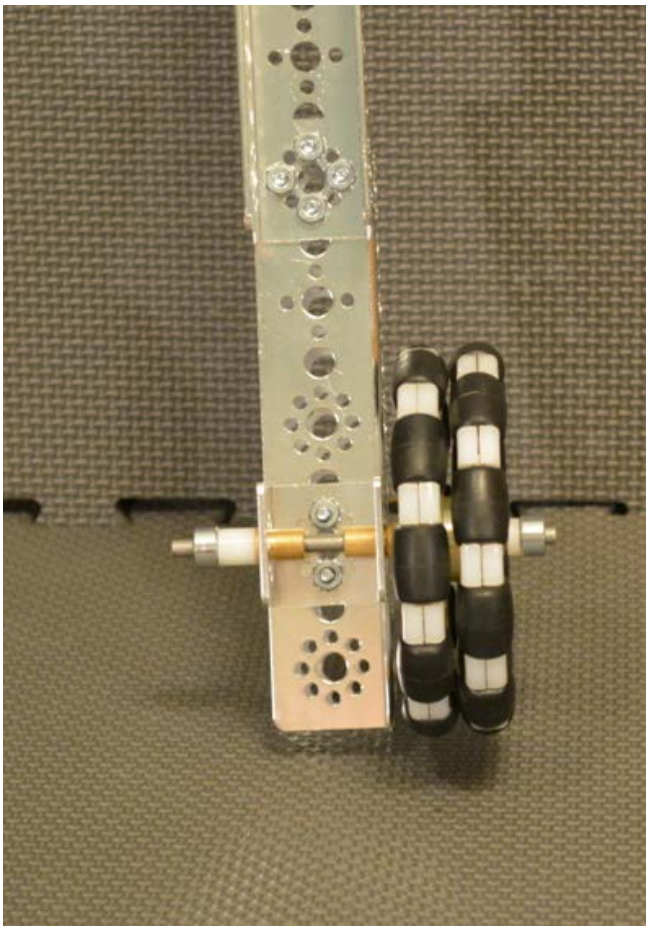


Step 2: assembly from step 1, drive wheel assembly (1), 1/8" axle spacer (2), axle collar (1), and bronze bushing (2). Note: assembly order is drive wheel assembly, 1/8" spacer, bronze bushing, channel, bronze bushing, 1/8" spacer, and axle collar. The second picture shows the completed step.

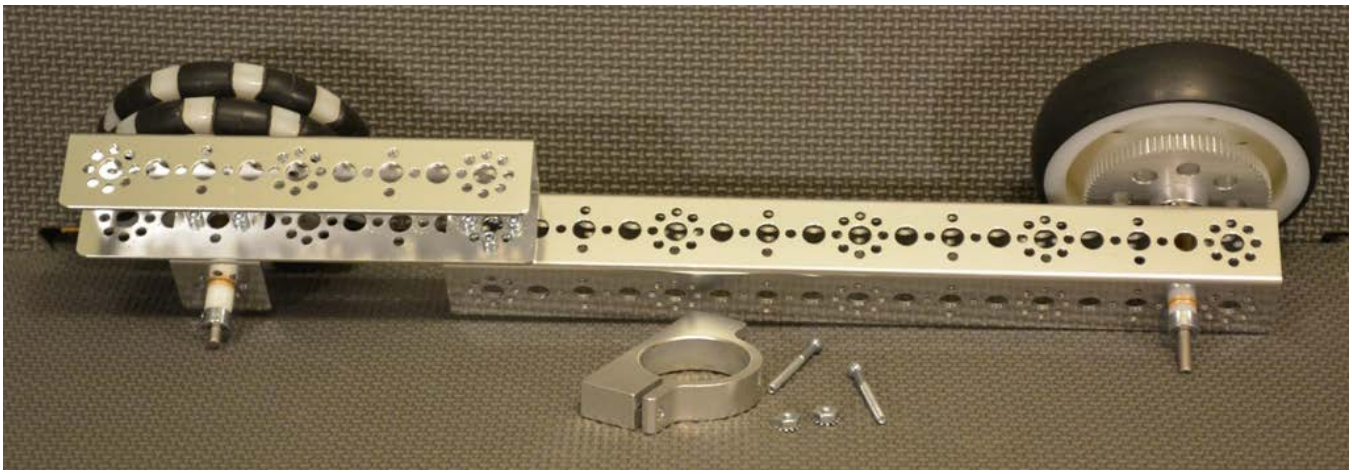


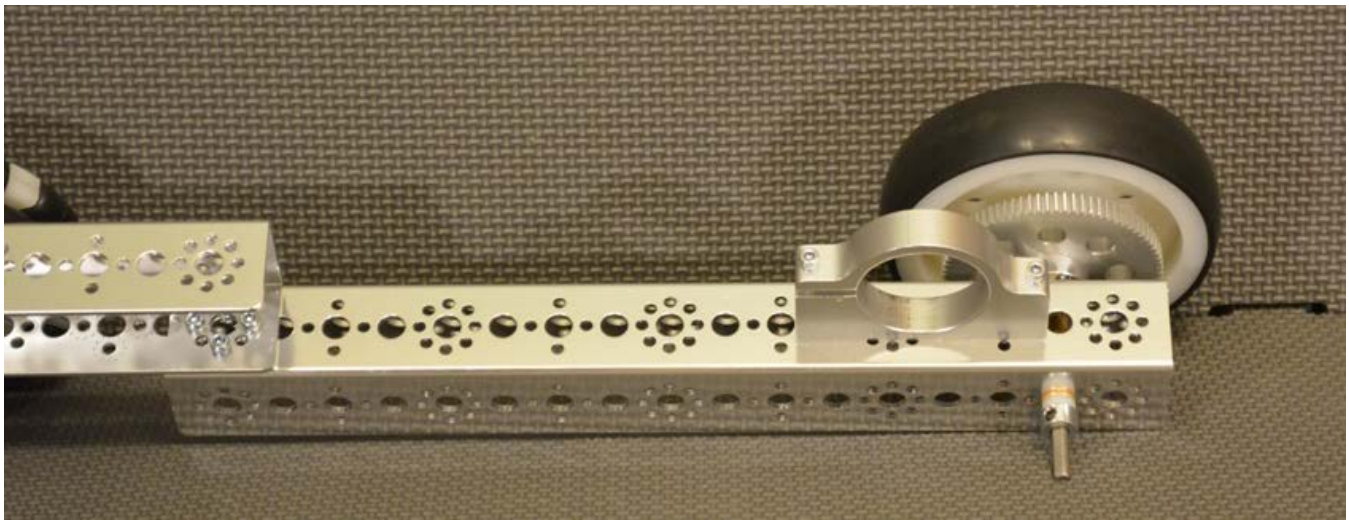
Step 3: assembly from step 2, omni wheel assembly (1), 1/8" axle spacer (2), 3/8" axle spacer, axle collar (2), bronze bushing (2), and axle (1). Note: assembly order is axle collar, 1/8" spacer, omni wheel assembly, 1/8" spacer, bronze bushing, channel, bronze bushing, 3/8" spacer, and axle collar. The second picture shows the completed step.





Step 4: assembly from step 3, motor mount (1) with included screws (2), and keps nuts (2). The second picture shows the completed right chassis rail.

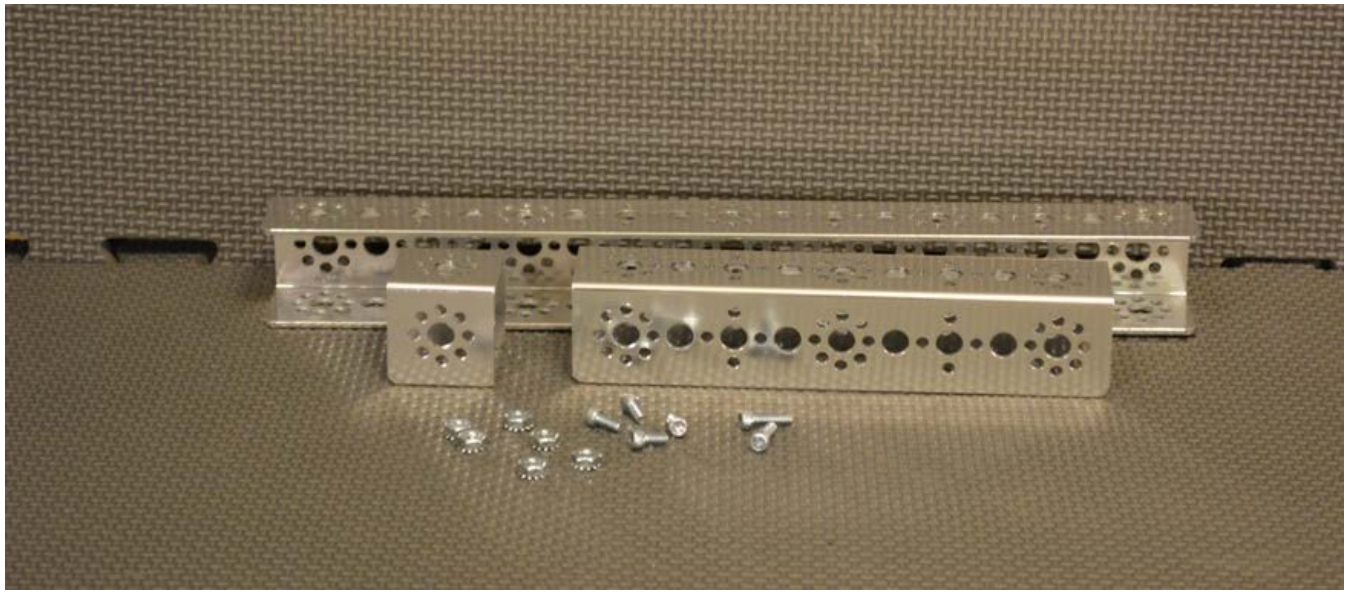


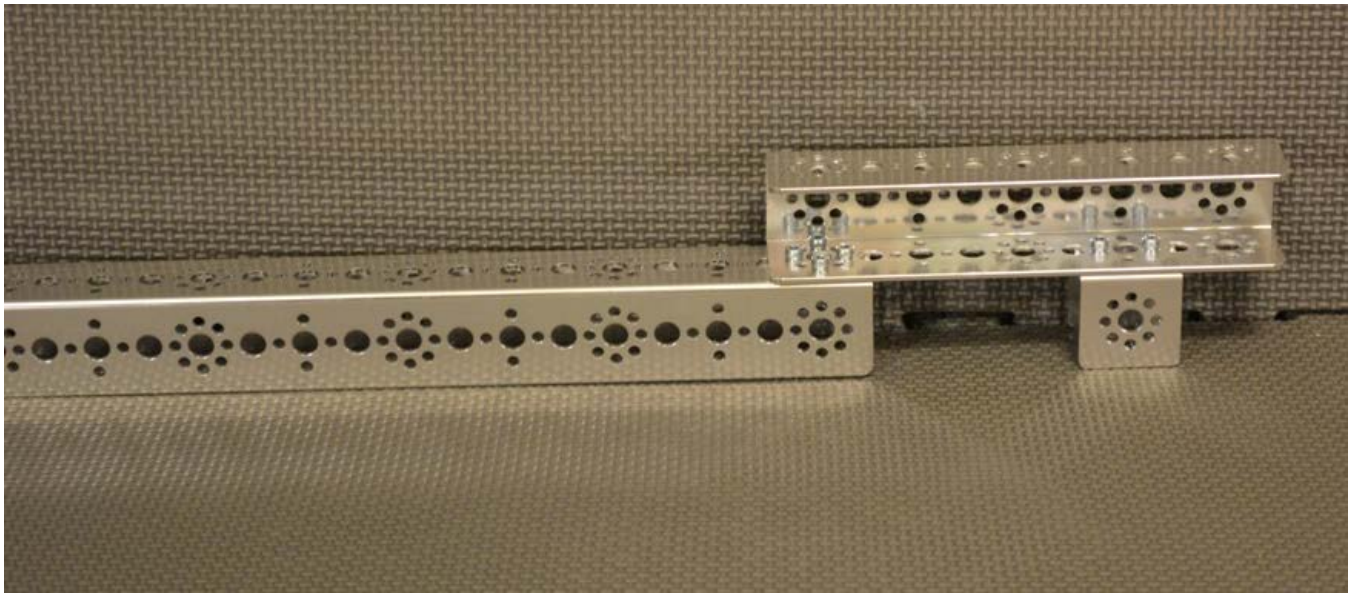


Left Chassis Rail Assembly

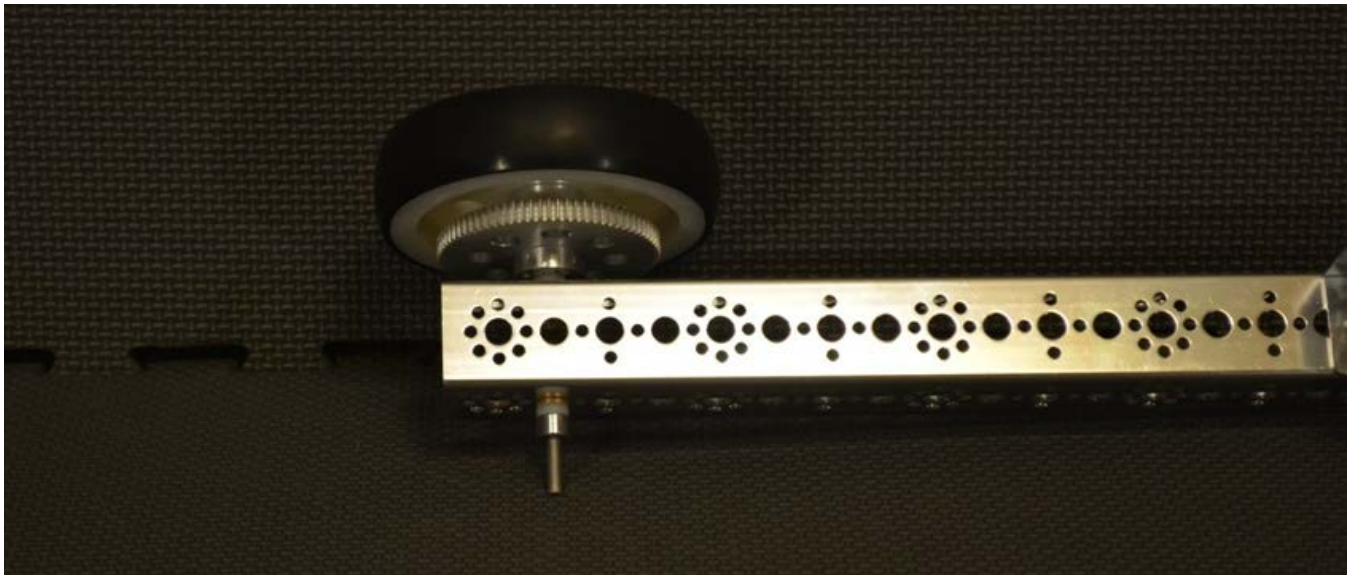
This is built as a mirror image to the right chassis rail assembly.

Step 1: 32mm channel (1), 160mm channel (1), 288mm channel (1), 5/16" socket head cap screws (4), 1/2" socket head cap screws (2), and keps nuts (6). The second picture shows the completed step.

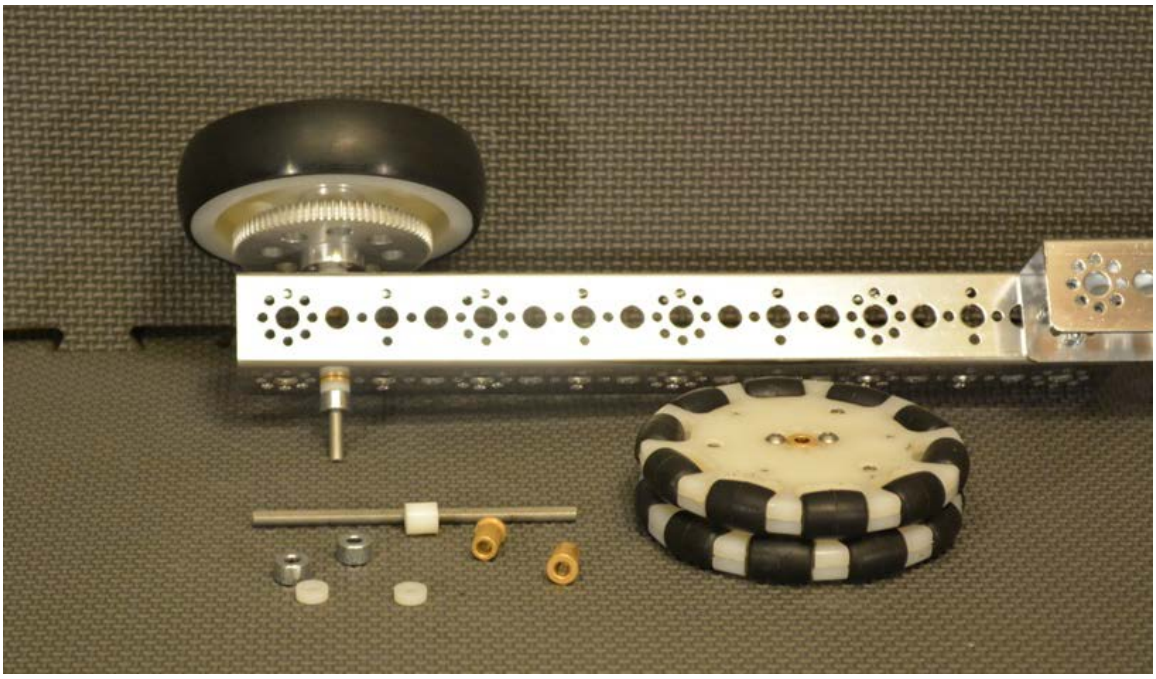


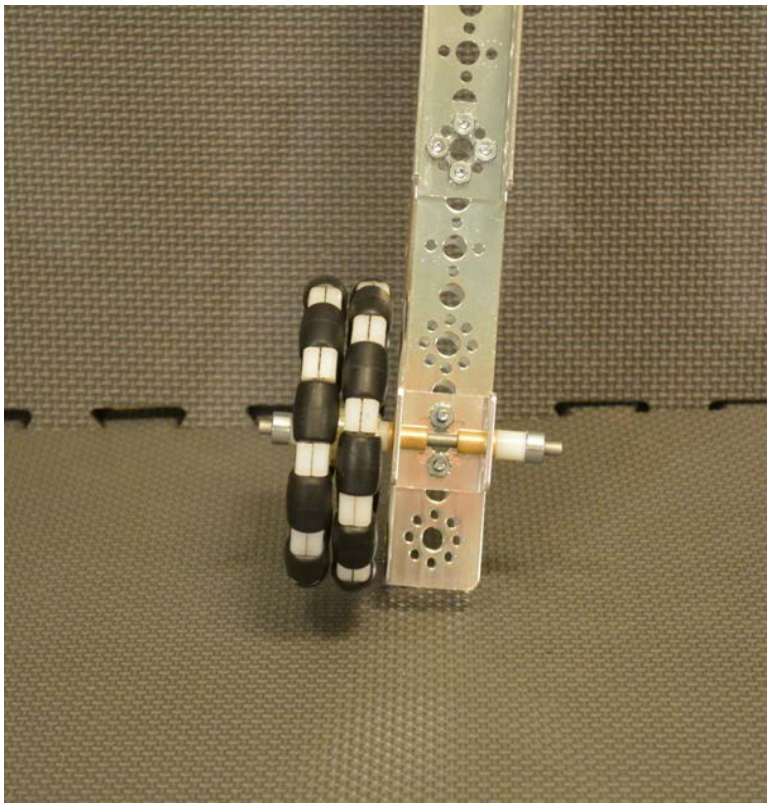


Step 2: assembly from step 1, drive wheel assembly (1), 1/8" axle spacer (2), axle collar (1), and bronze bushing (2). Note: assembly order is drive wheel assembly, 1/8" spacer, bronze bushing, channel, bronze bushing, 1/8" spacer, and axle collar. The second picture shows the completed step.

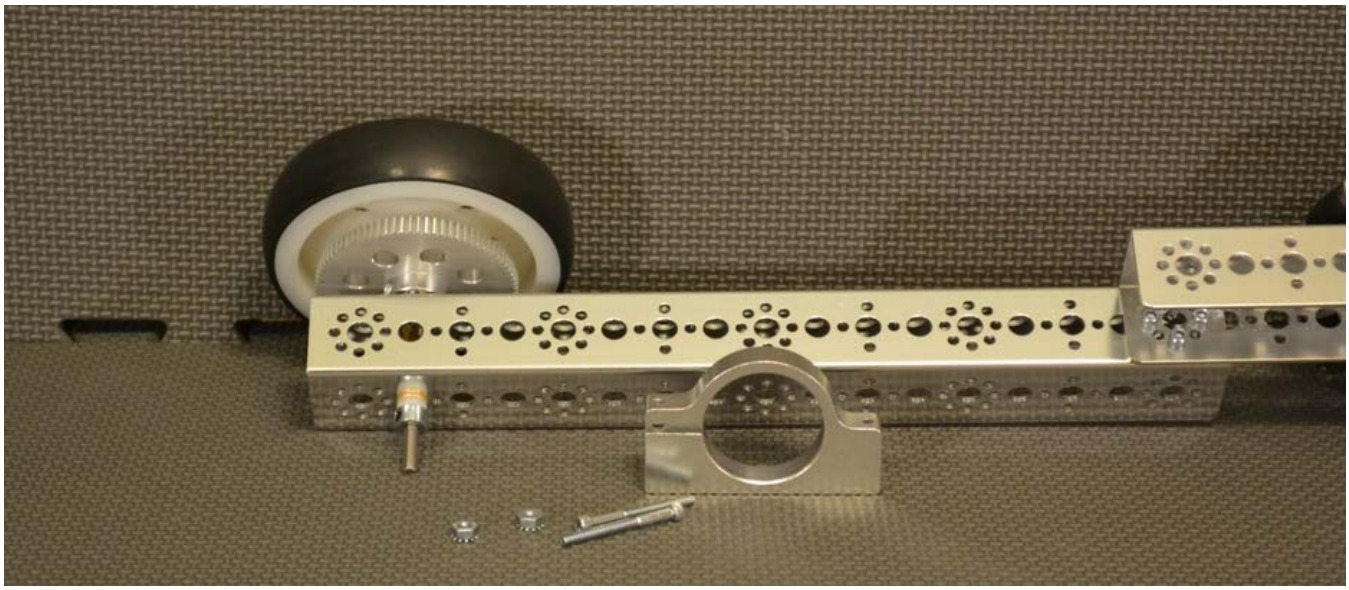


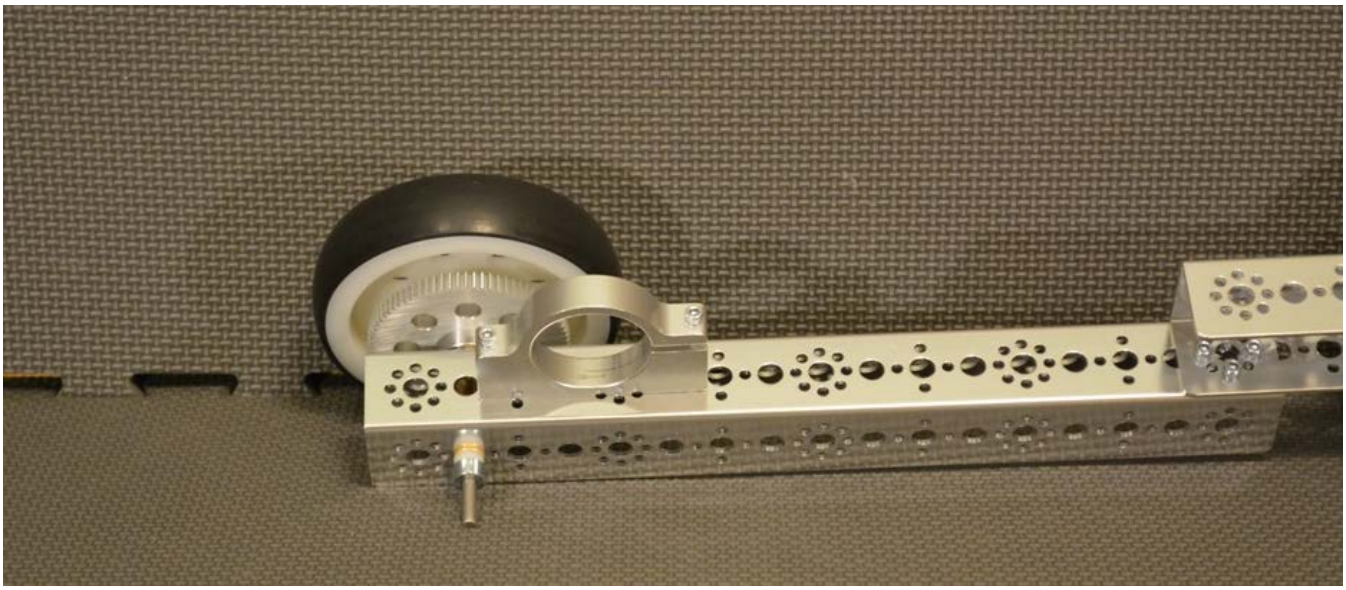
Step 3: assembly from step 2, omni wheel assembly (1), 1/8" axle spacer (2), 3/8" axle spacer, axle collar (2), bronze bushing (2), and axle (1). Note: assembly order is axle collar, 1/8" spacer, omni wheel assembly, 1/8" spacer, bronze bushing, channel, bronze bushing, 3/8" spacer, and axle collar. The second picture shows the completed step.





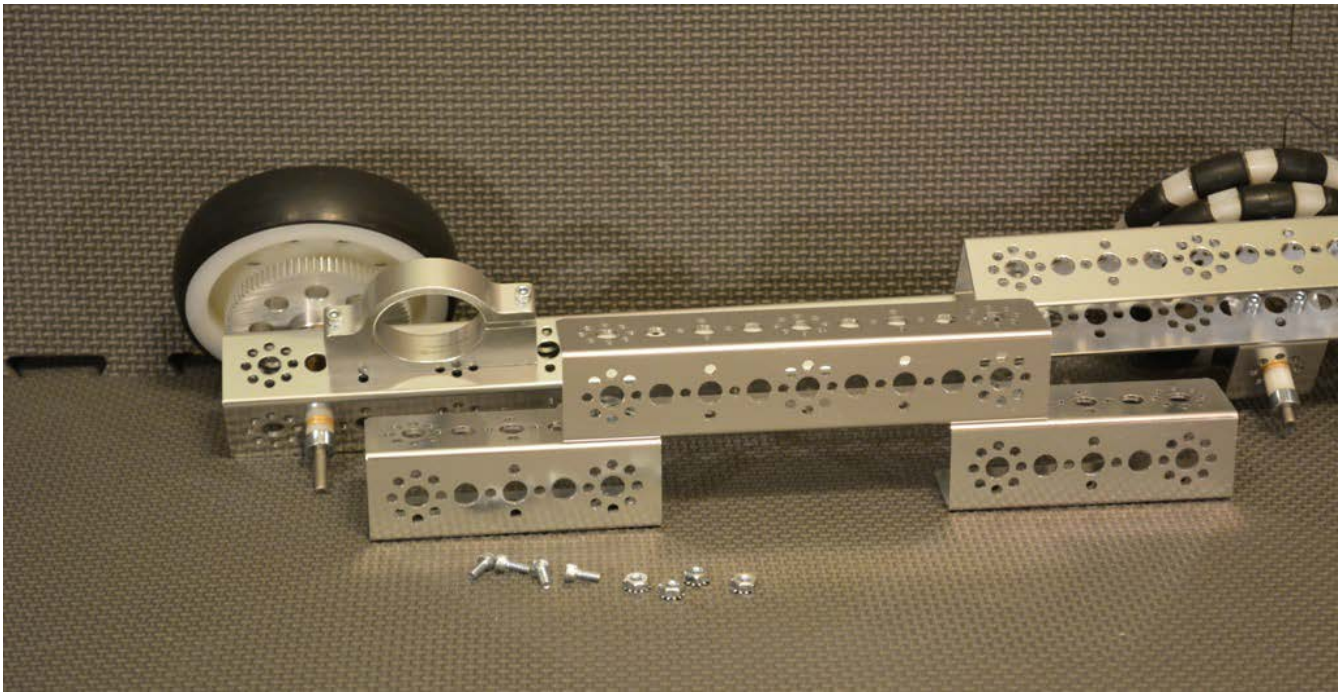
Step 4: assembly from step 3, motor mount (1) with included screws (2), and keps nuts (2). The second picture shows the completed left chassis rail.

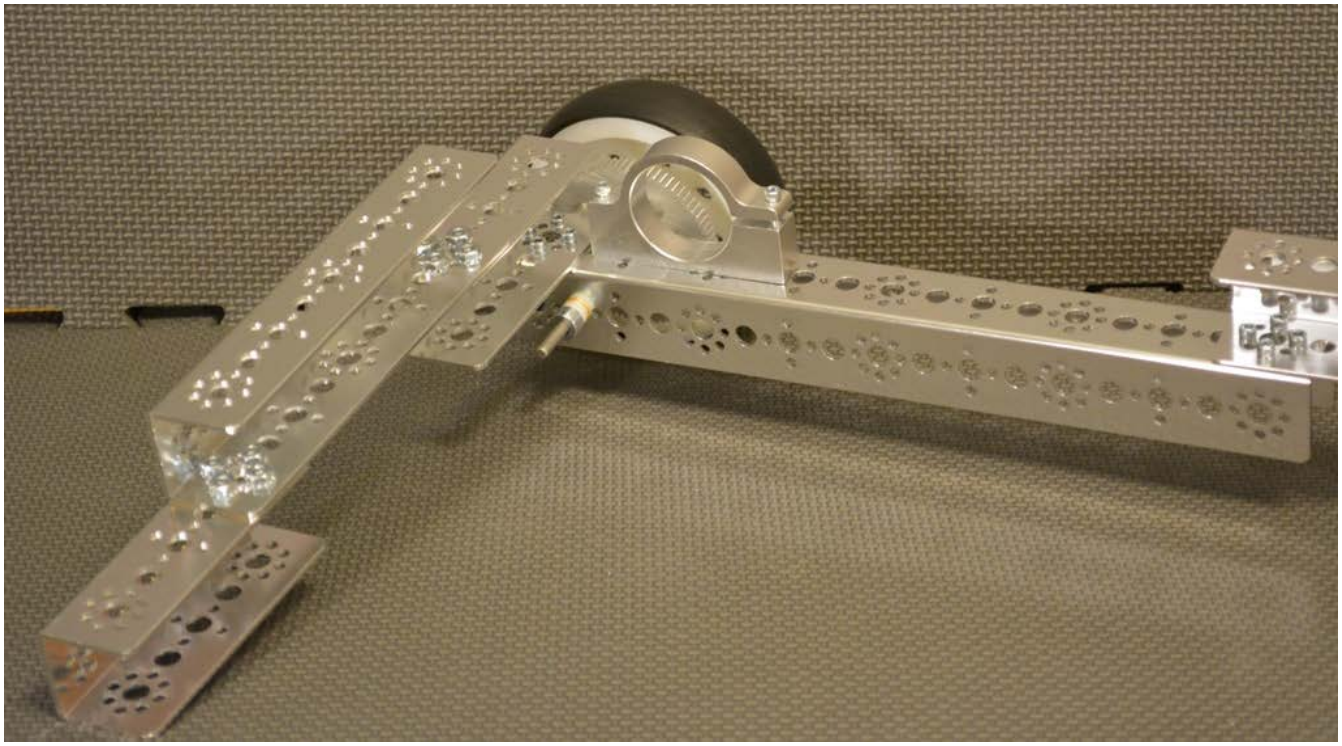




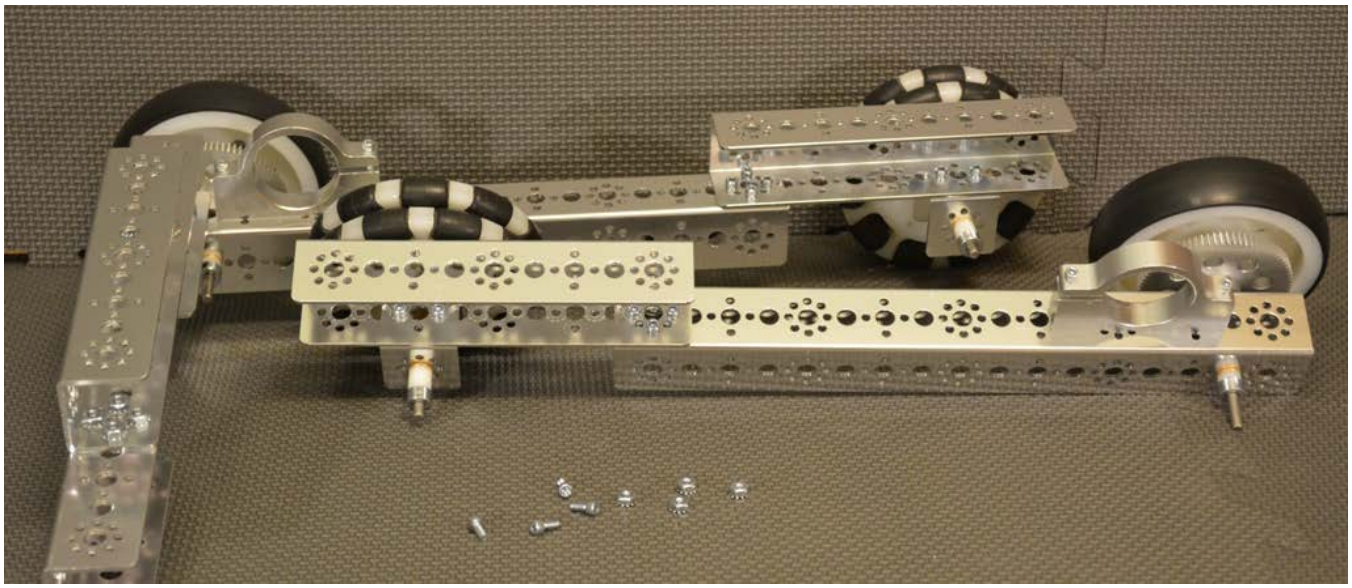
Robot Assembly

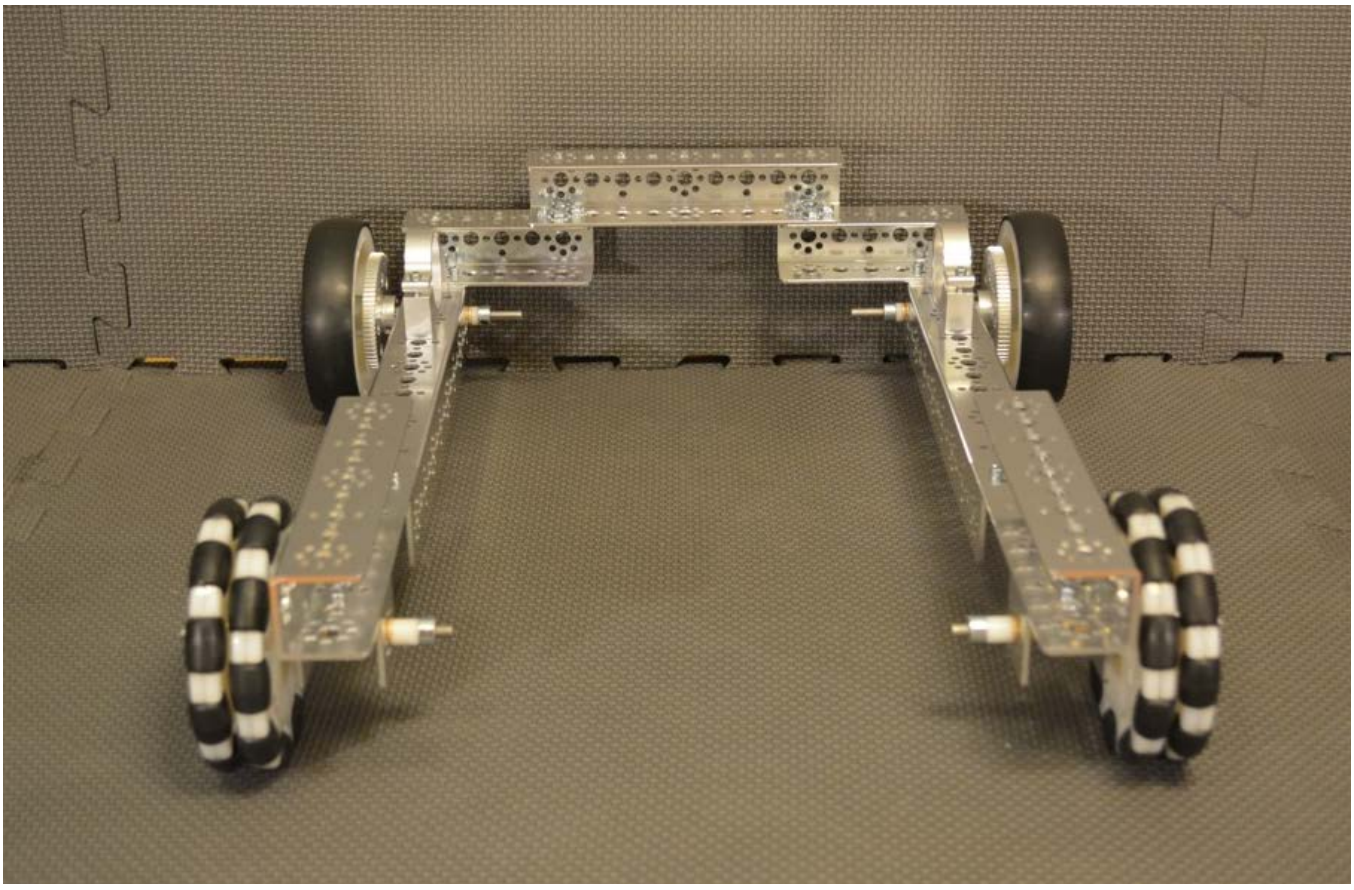
Step 1: left chassis rail assembly (1), cross bar assembly (1), 5/16" socket head cap screws (4), and keps nuts (4). The second picture shows the completed step.



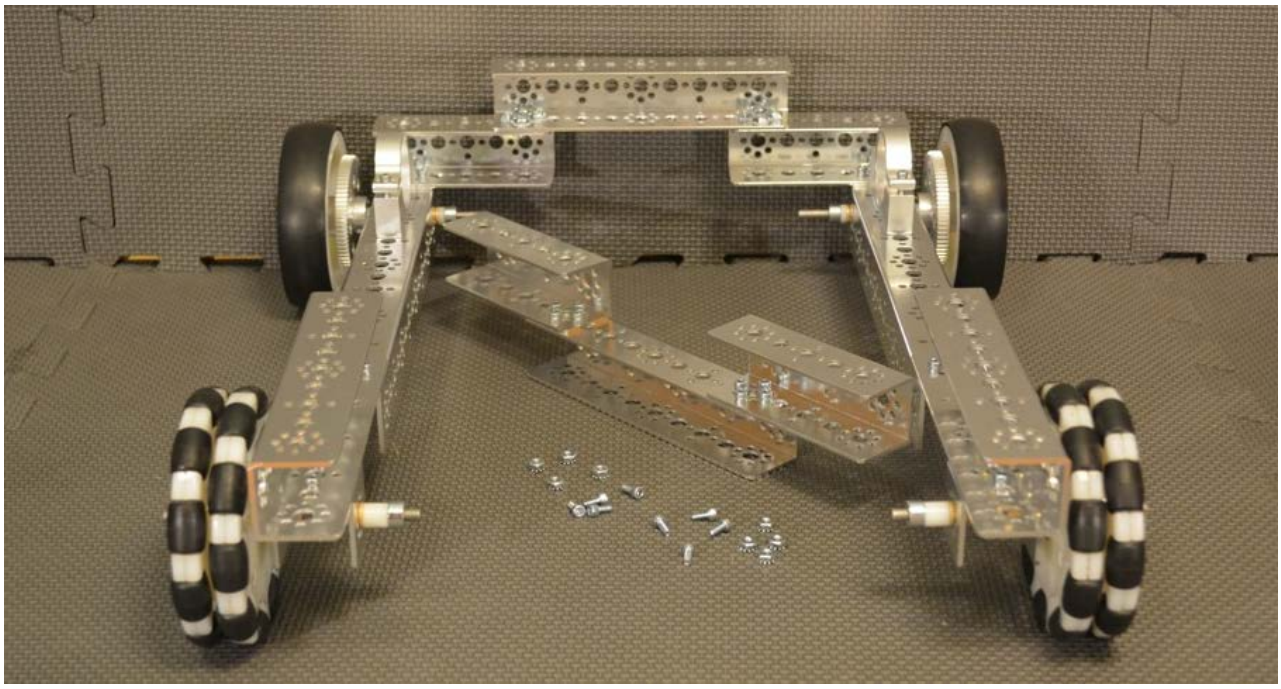


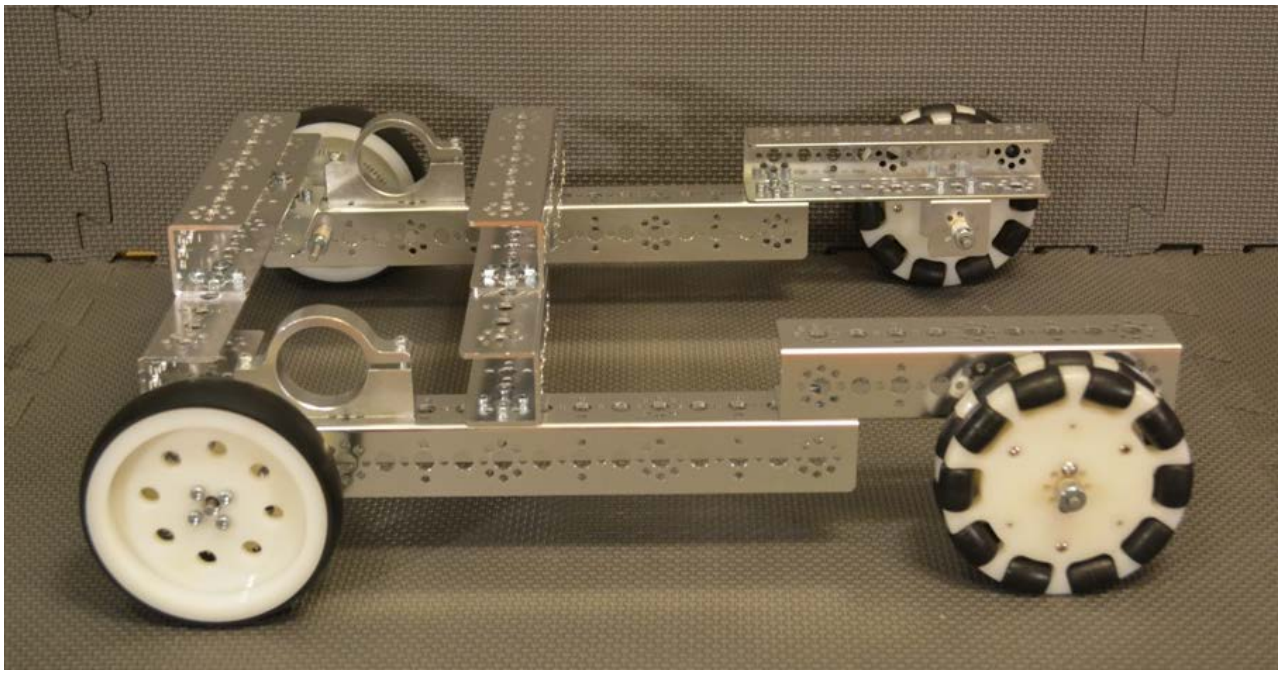
Step 2: assembly from step 1, right chassis rail assembly (1), 5/16" socket head cap screws (4), and keps nuts (4). The second picture shows the completed step.



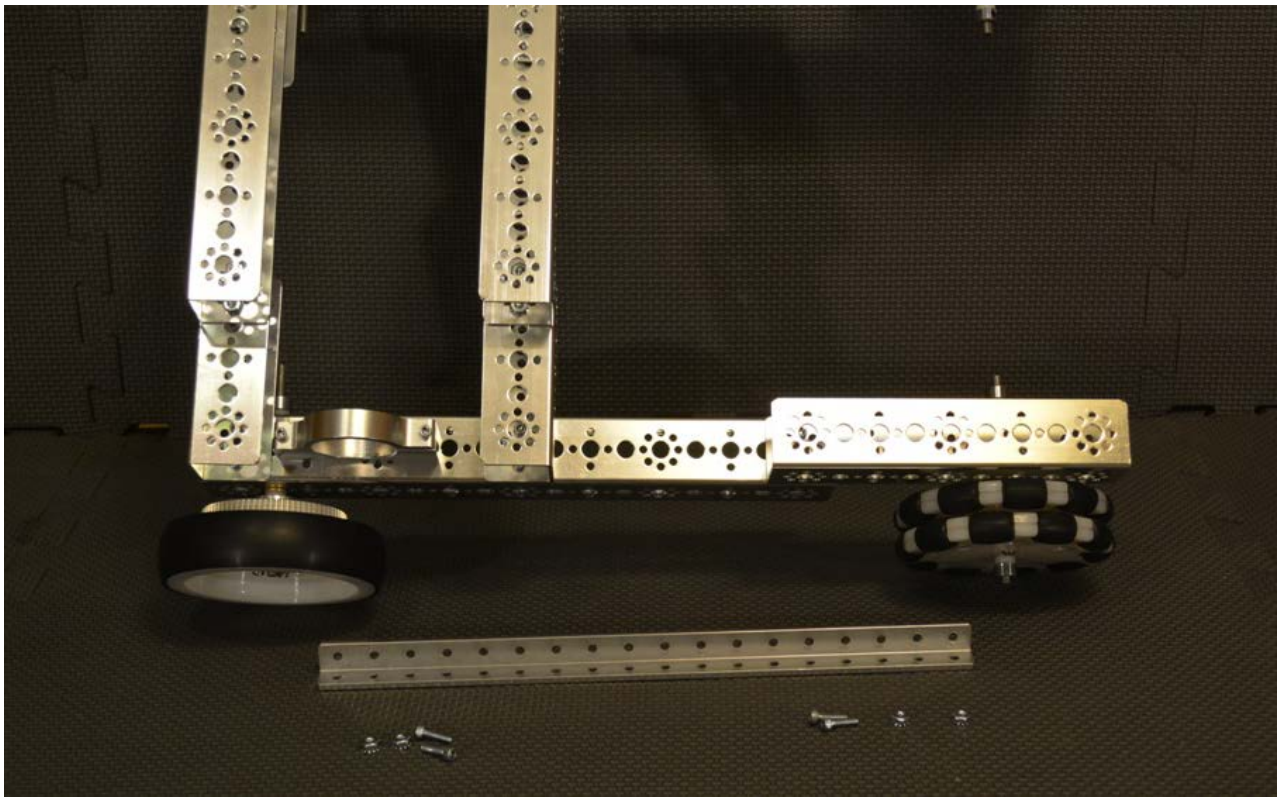


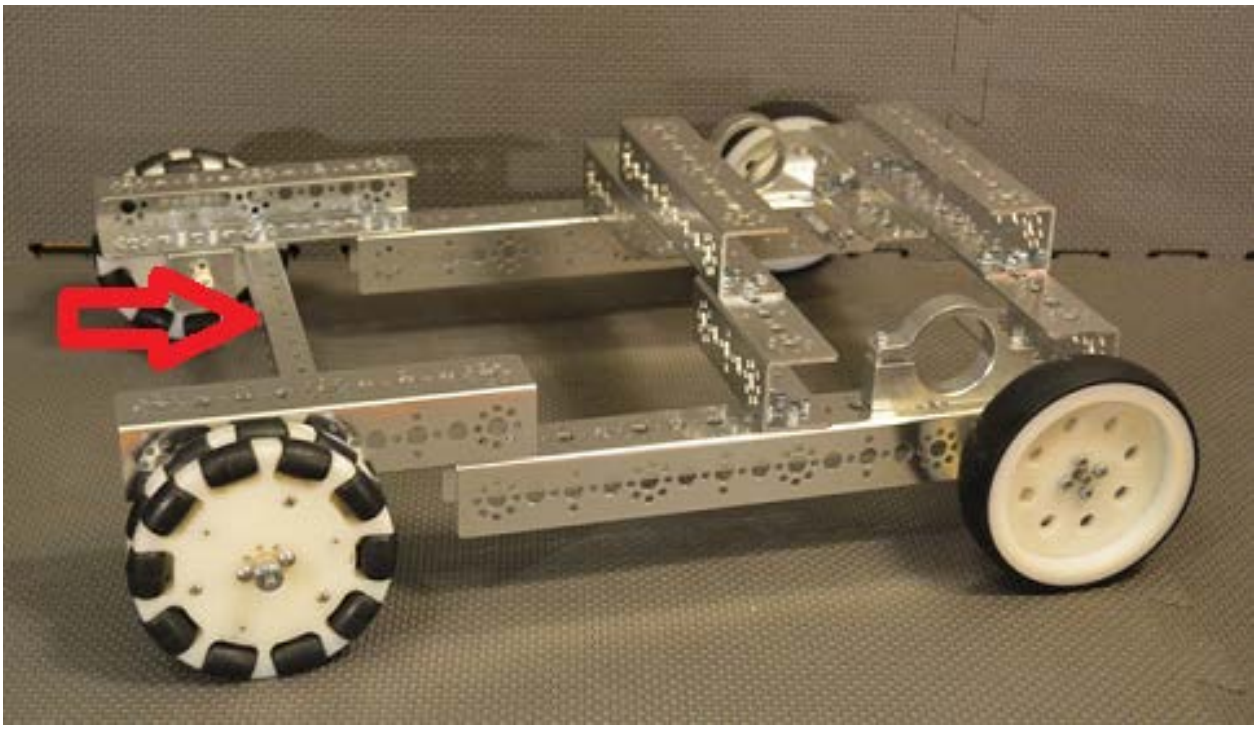
Step 3: assembly from step 2, cross bar assembly (1), 5/16" socket head cap screws (8), and keps nuts (8). The second picture shows the completed step.



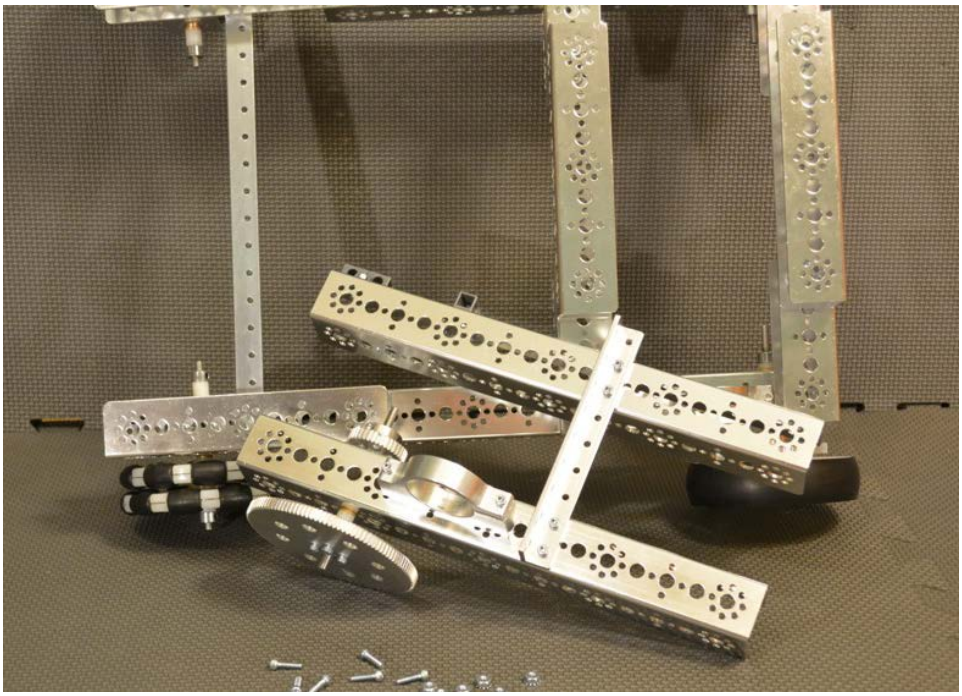


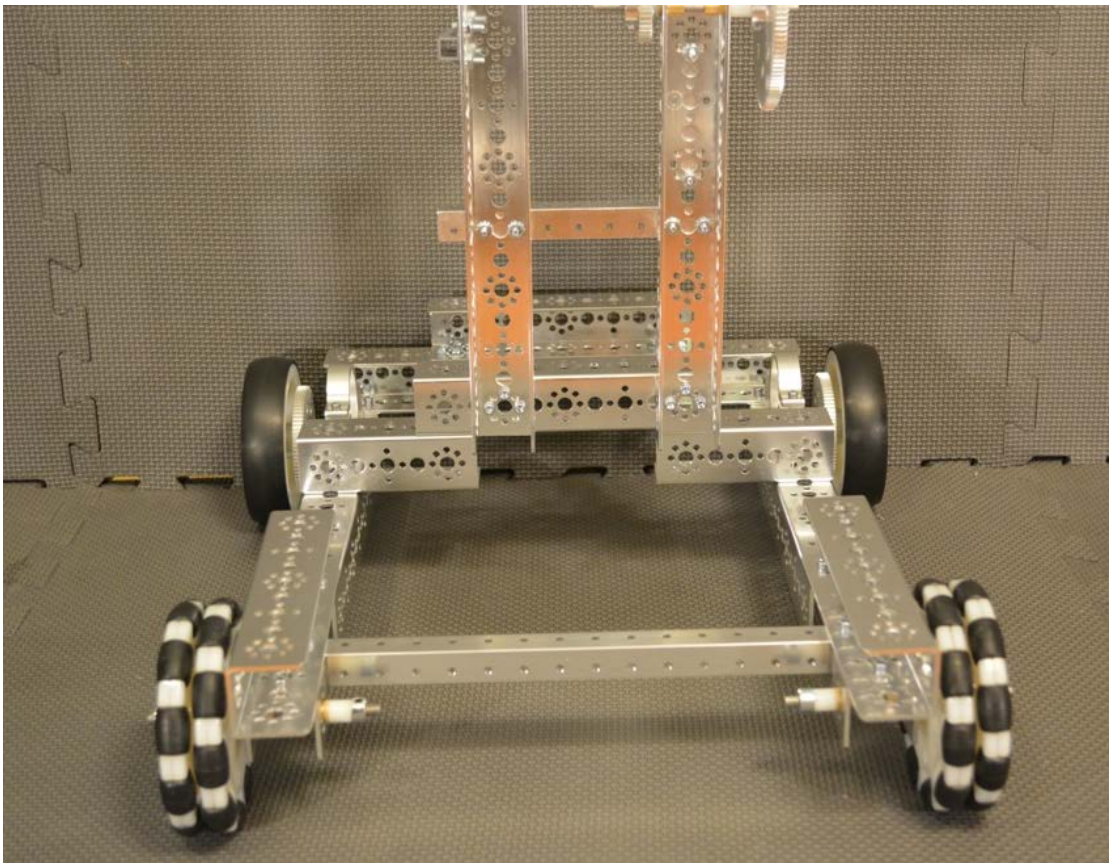
Step 4: assembly from step 3, 288mm angle (1), 1/2" socket head cap screws (4), and keps nuts (4). The second picture shows the completed step.



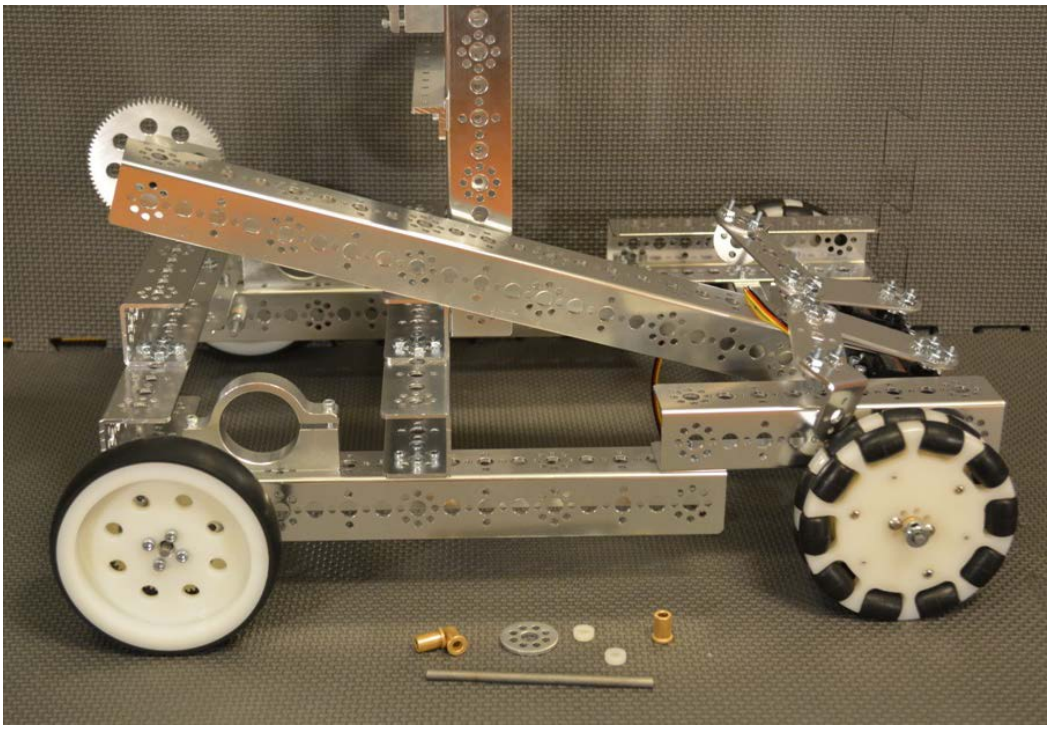


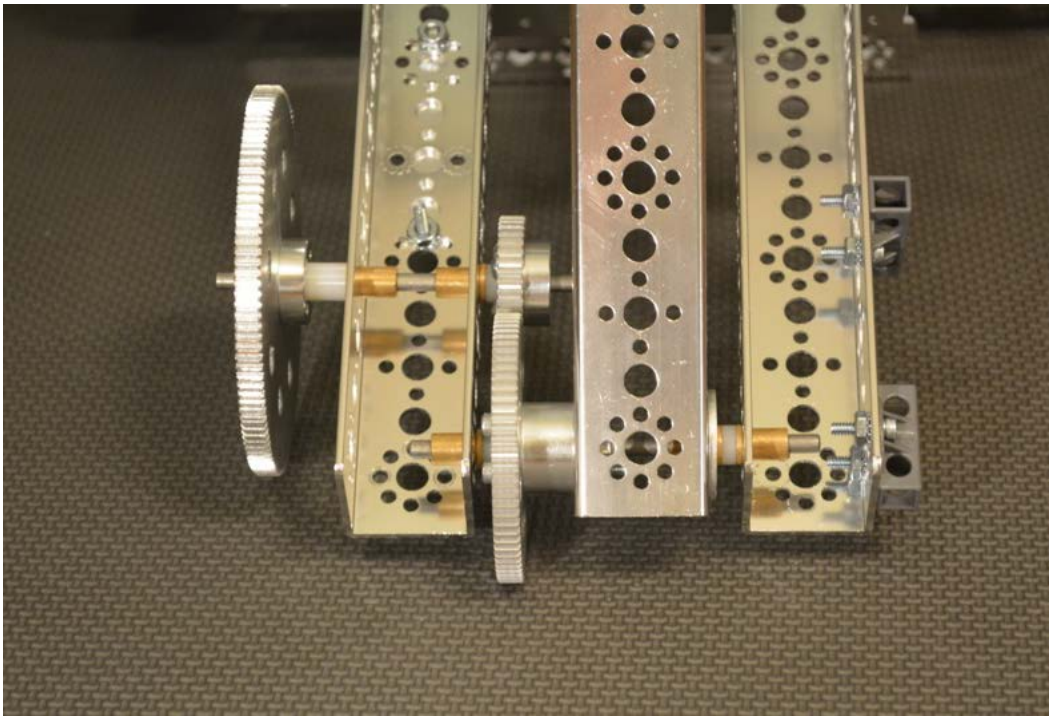
Step 5: assembly from step 4, tower assembly, 1/2" socket head cap screws (6), and keps nuts (6). The second picture shows the completed step.



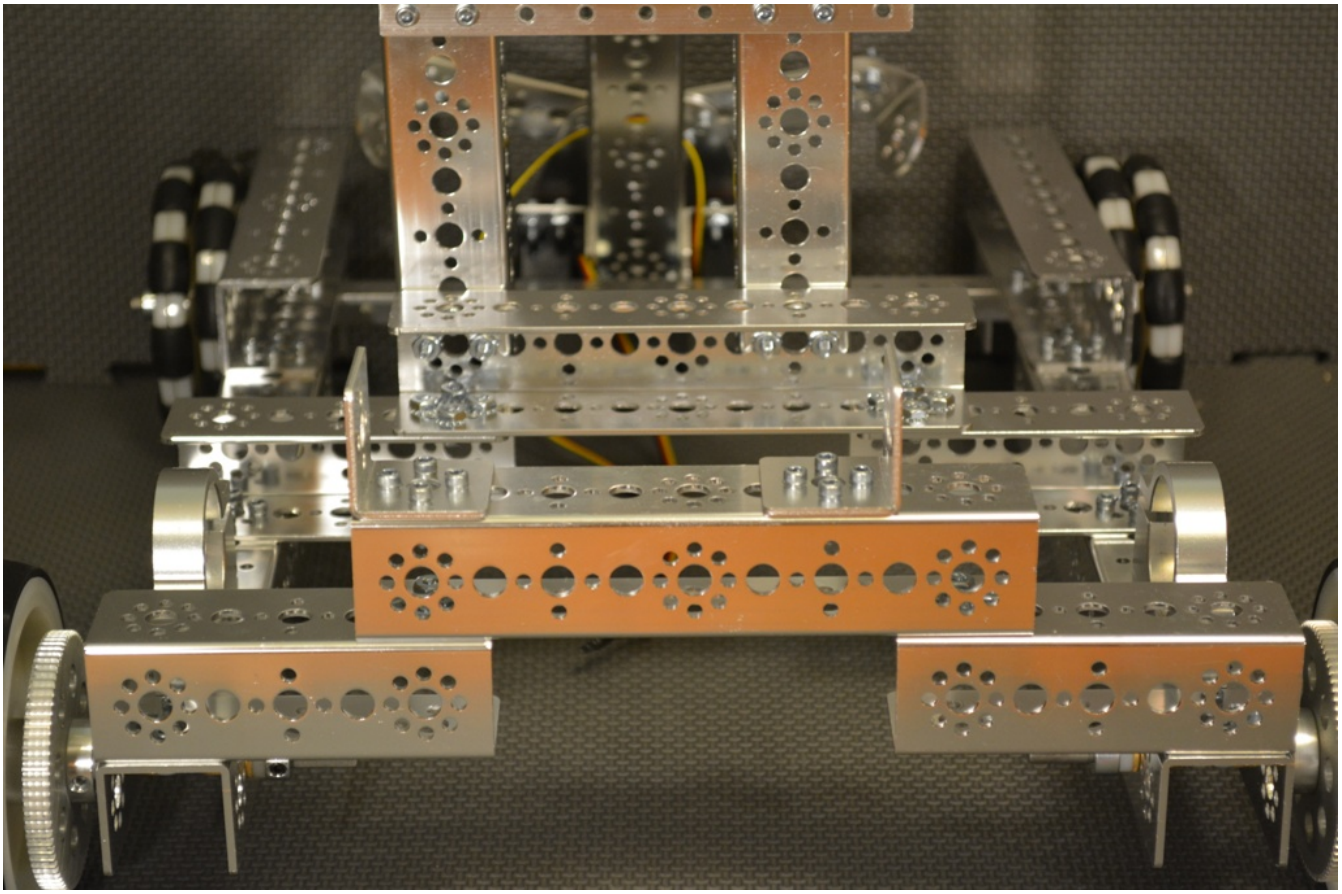


Step 6: assembly from step 5, arm assembly, bronze bushing (3), 1/8" axle spacer (2), axle (1), and flat spacer (1). Note: order of assembly is tower channel with hardpoint connector, bronze bushing, axle spacer, bronze bushing, flat spacer, arm, axle spacer, bronze bushing, tower channel with gears. The second picture shows the completed step.

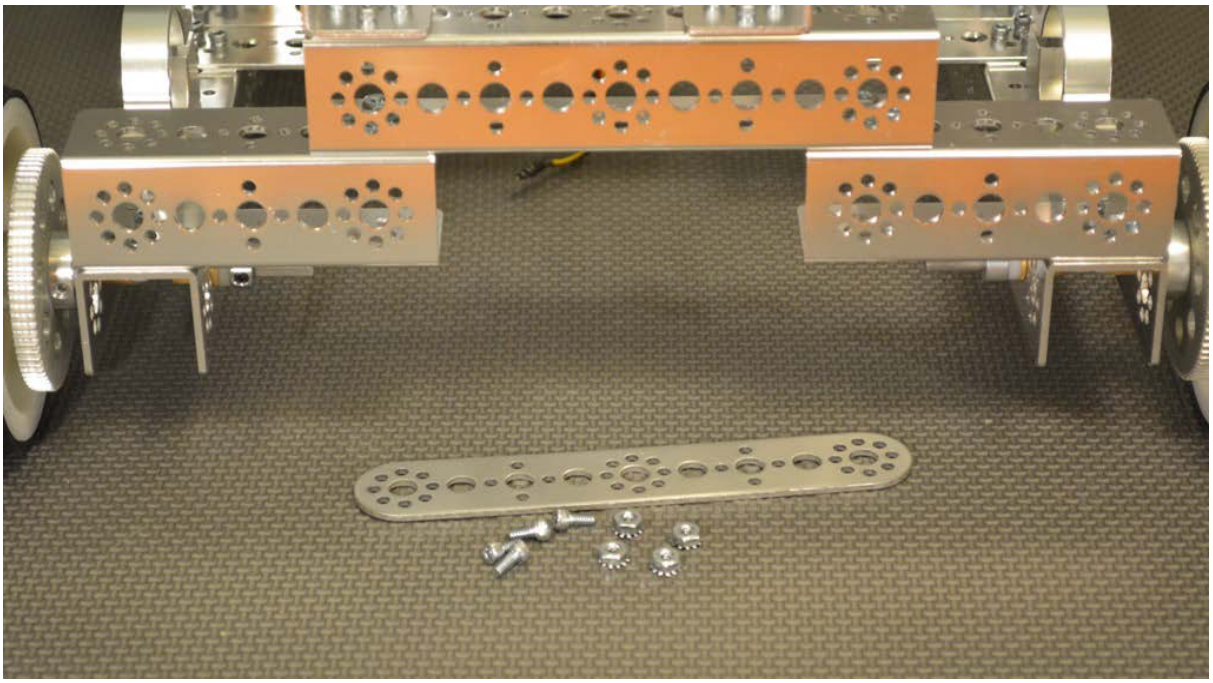


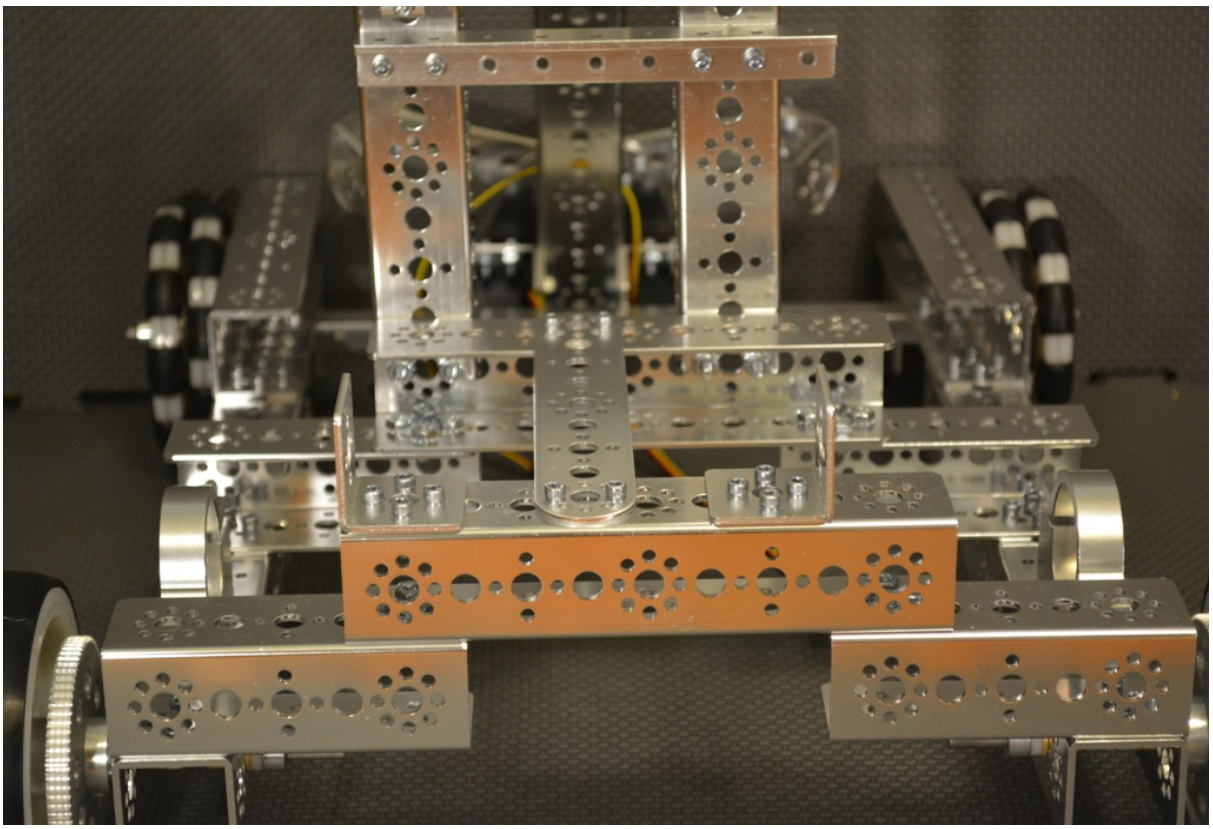


Step 7: assembly from step 6, inside corner bracket (2), 1/2" socket head cap screw (8), and keps nut (8). The second picture shows the completed step.

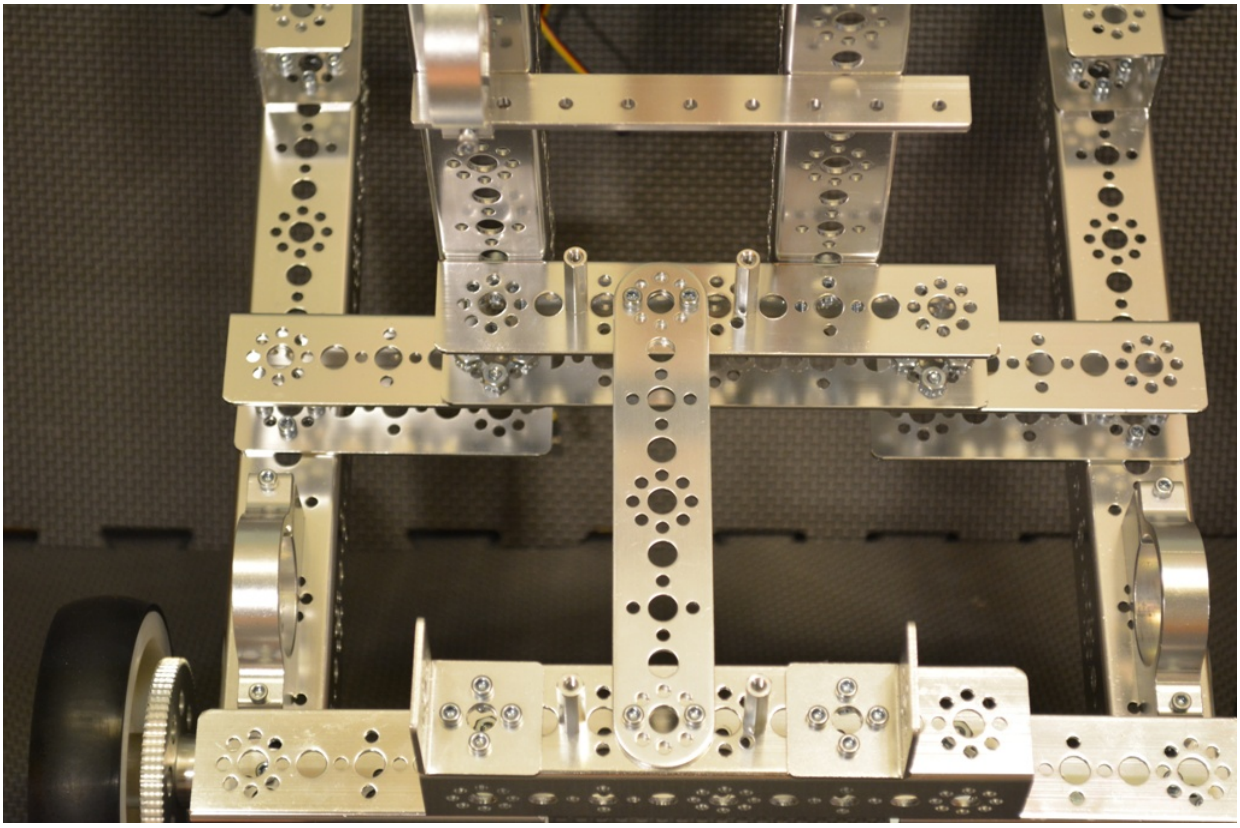


Step 8: assembly from step 7, 160mm flat (1), 5/16" socket head cap screw (4), and keps nut (4). The second picture shows the completed step.

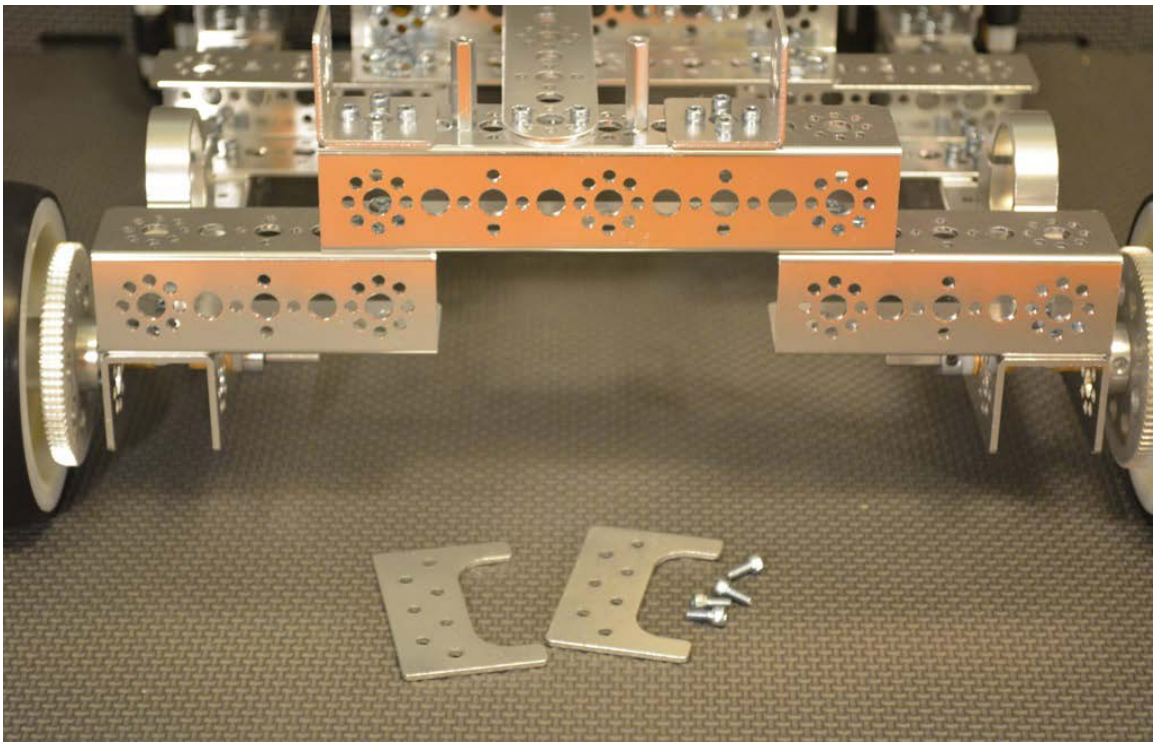


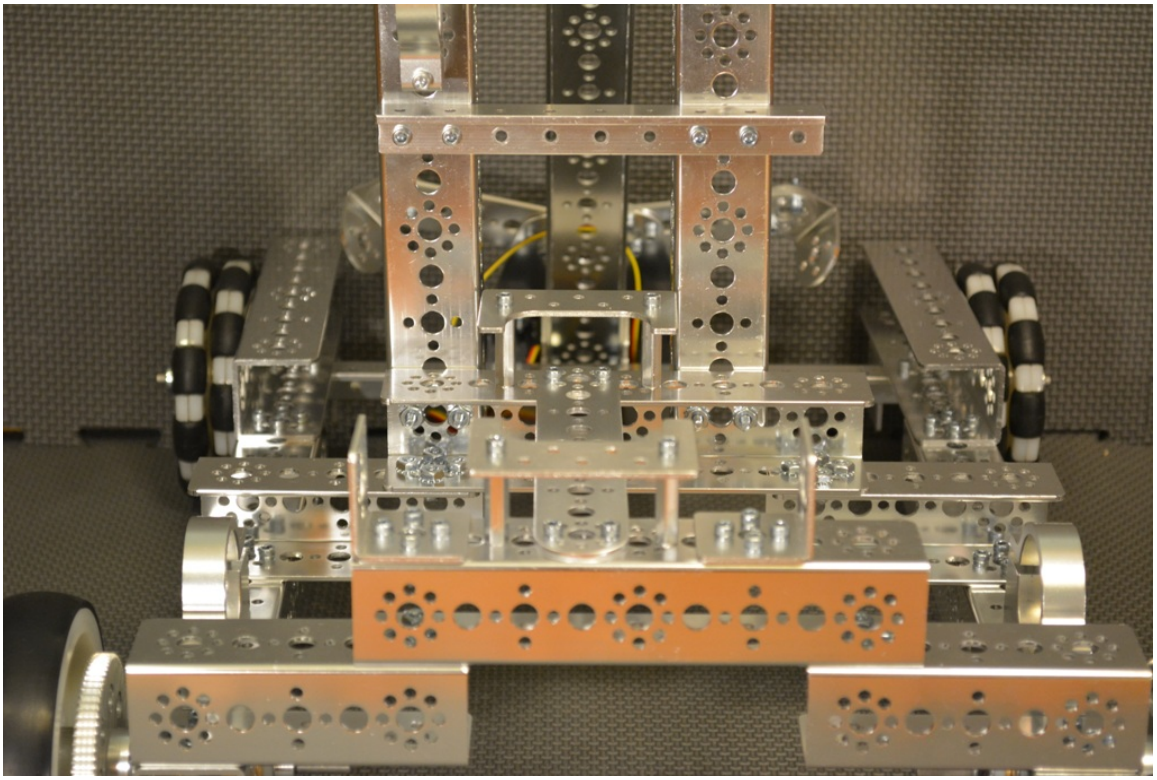


Step 9: assembly from step 8, 160mm flat (1), 1" stand-off posts (4), and 5/16" socket head cap screw (4). The second picture shows the completed step.

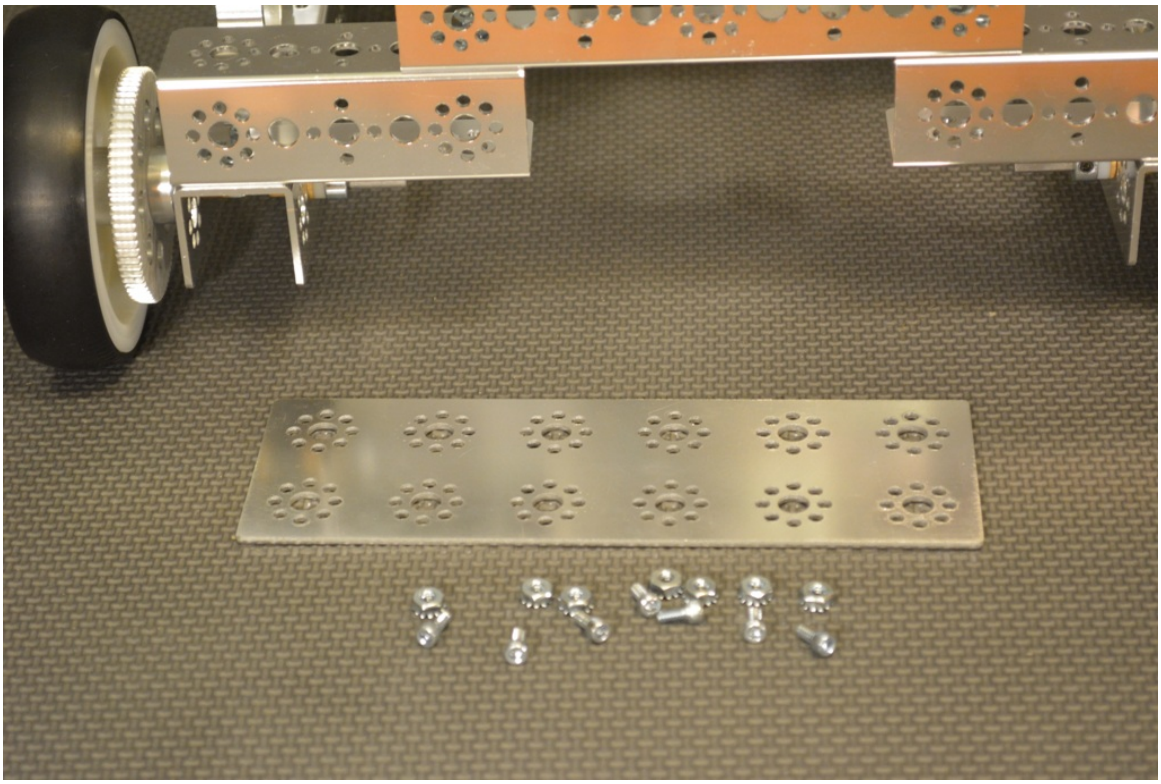


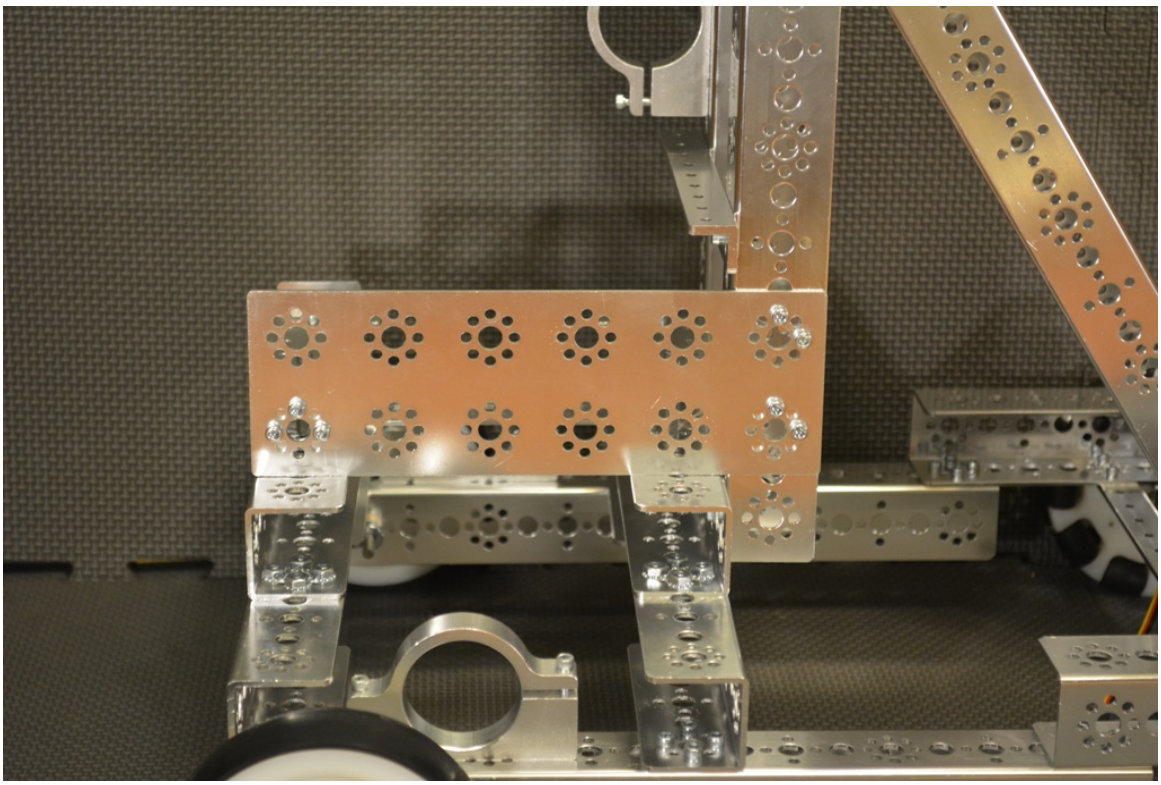
Step 9: assembly from step 8, battery clip (2), 5/16" socket head cap screw (4). The second picture shows the completed step.



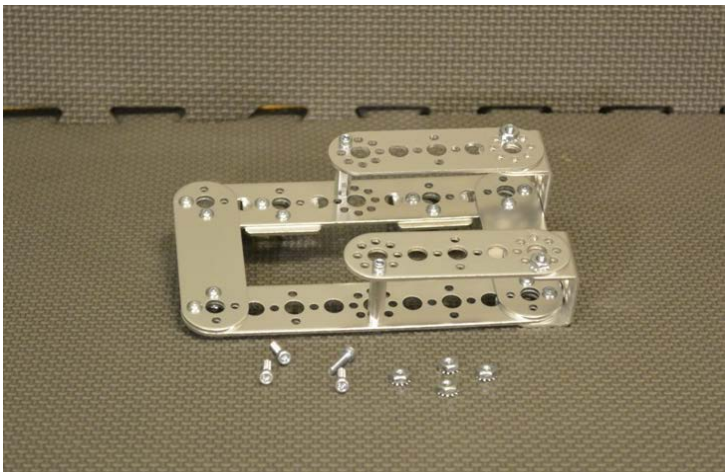


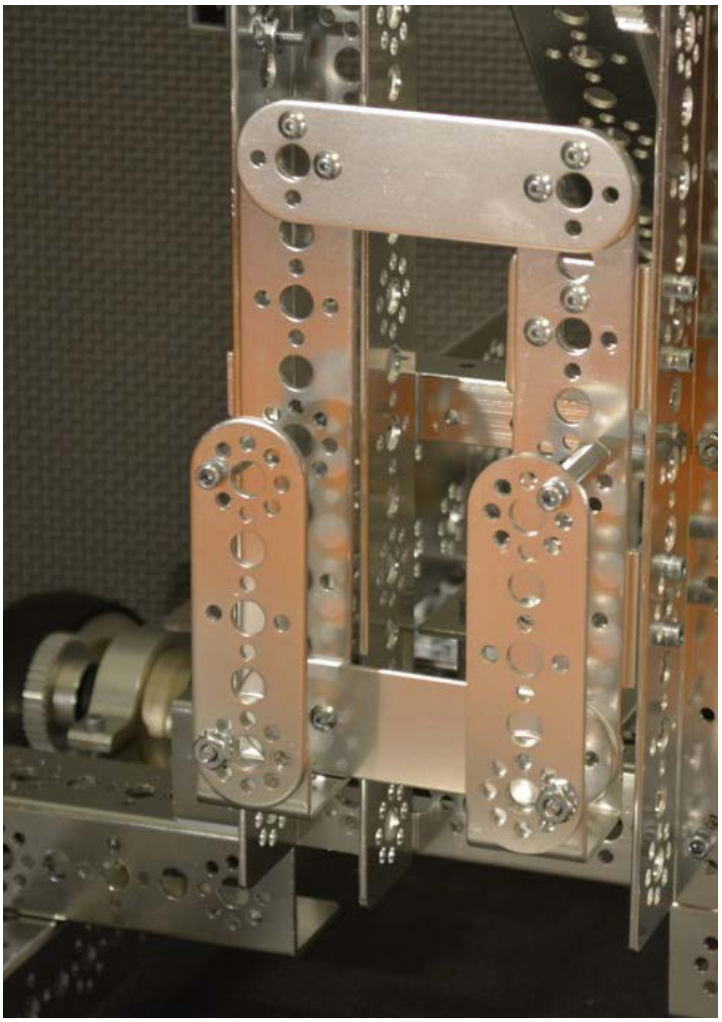
Step 10: assembly from step 9, flat building plate (1), 5/16" socket head cap screw (7), and keps nut (7). The second picture shows the completed step.



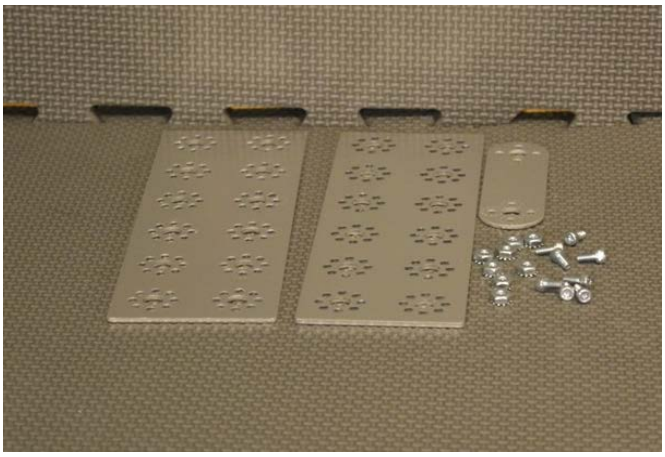


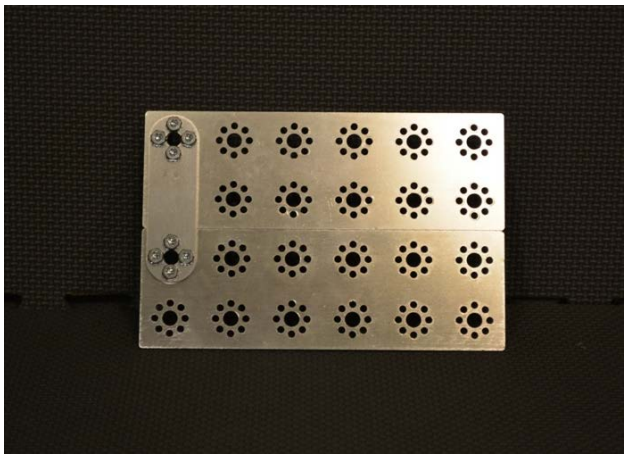
Step 11: assembly from step 10, phone mounting assembly (1), 1/2" socket head cap screw (4), and keps nut (4). The second picture shows the completed step.



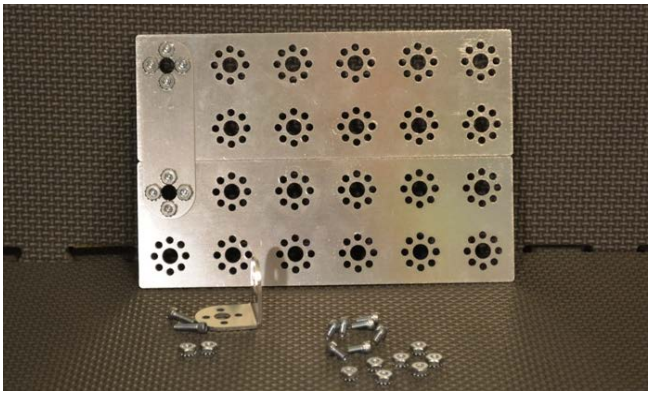


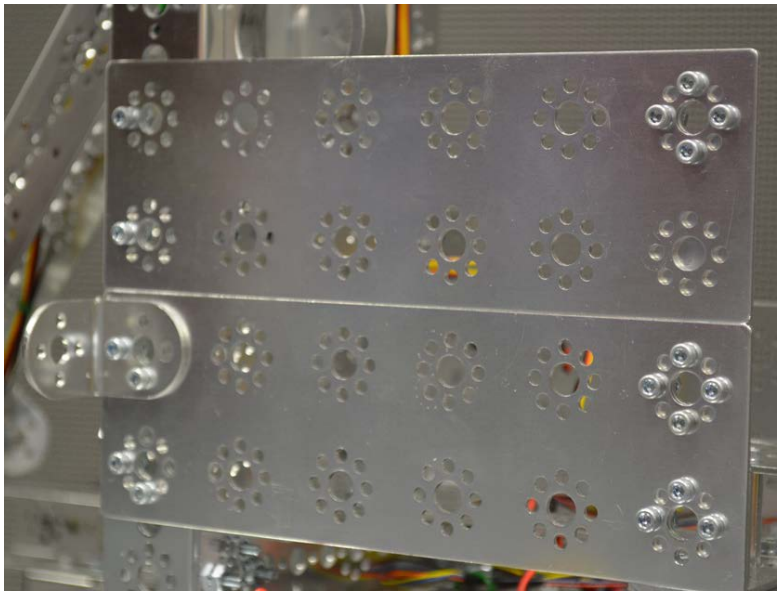
Step 12: flat building plate (2), flat bracket (1), 5/16" socket head cap screw (8), and keps nut (8). The second picture shows the completed step.





Step 13: Robot from step 11, assembly from step 12, L bracket (1), 5/16" socket head cap screw (7), 1/2" socket head cap screw (2), and keps nut (9). The second picture shows the completed step.





Install Encoders on Motors

Make 2 copies

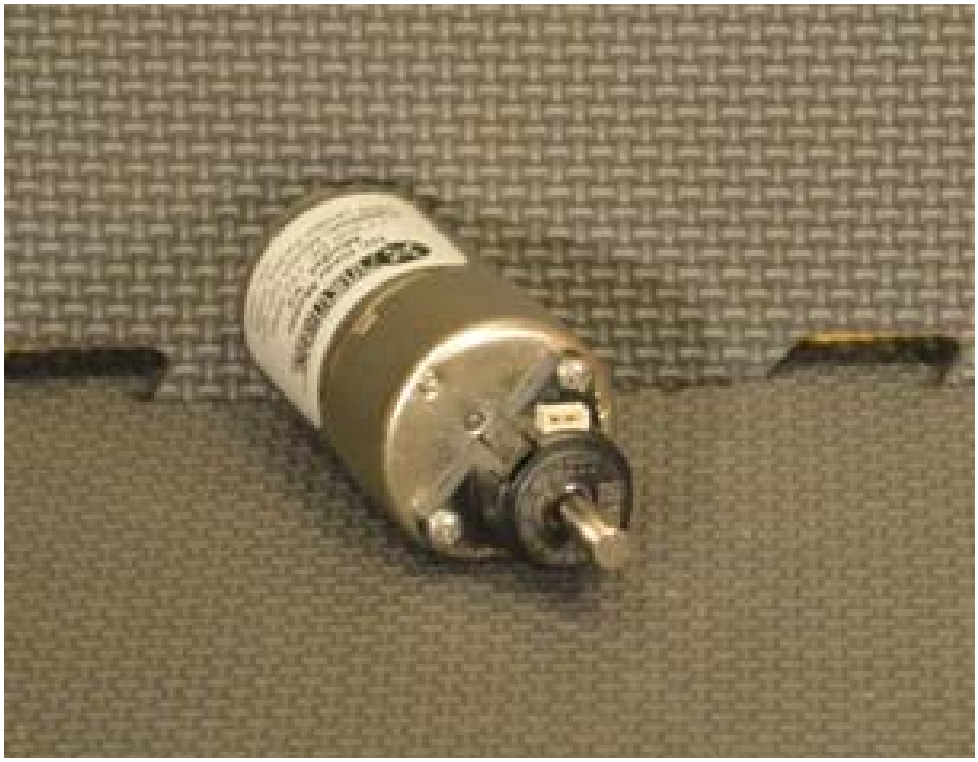
These are assembled as per the instructions that come in the encoder pack.

Step 1: encoder kit (1) and TETRIX DC motor (1). The second picture shows the separate encoder parts.

Step 2: install the encoder printed circuit board assembly to the motor with the provided screws.

Step 3: install the encoder disk on the motor shaft using the provided spacer tool. The first photo shows the spacer tool on the motor shaft setting the disk position. The second photo shows it without the spacer tool.

Step 4: snap the encoder cover onto the motor encoder.



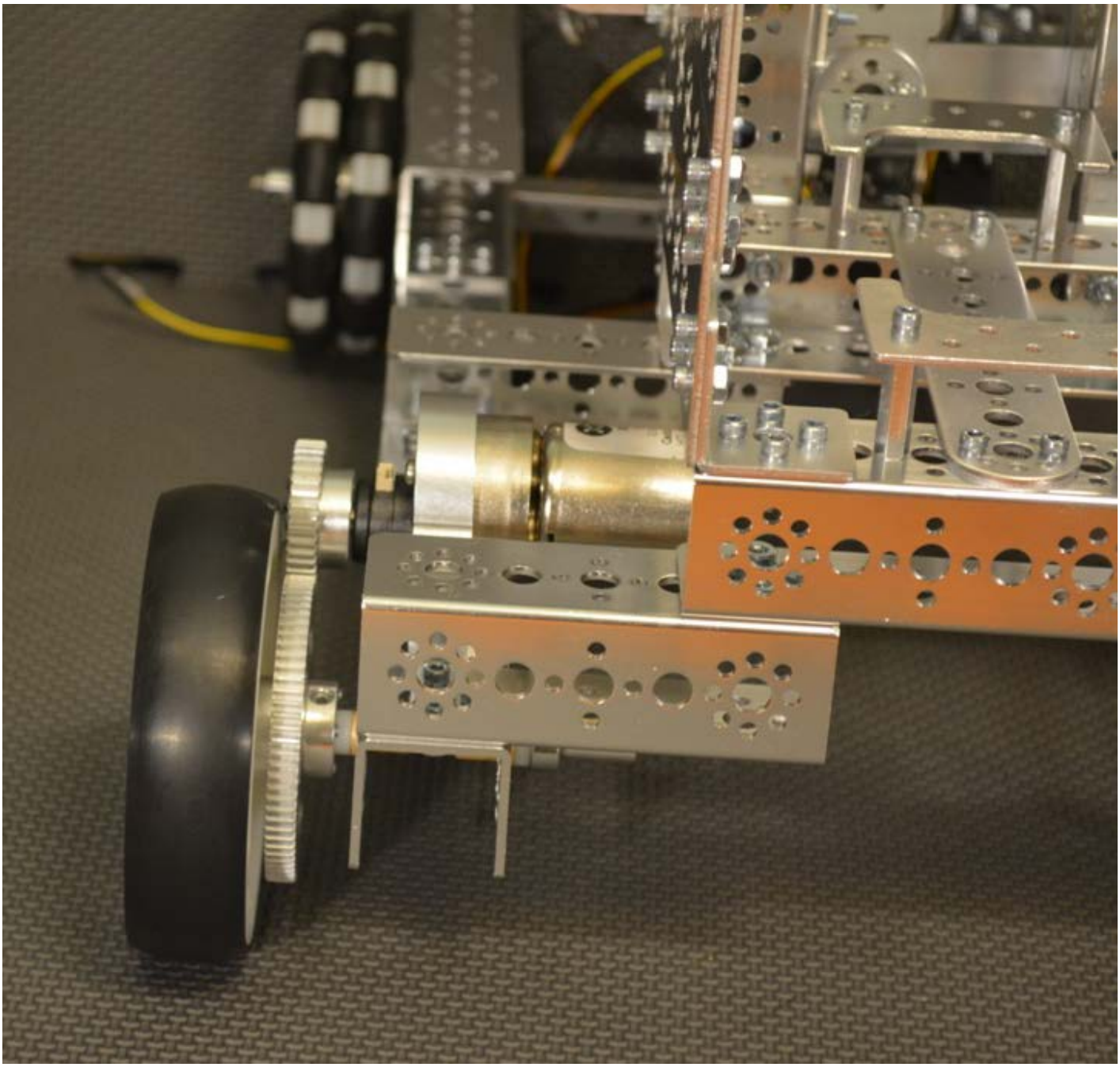
Motor Hub and Gear Assembly
Make 3 copies

Step 1: 40-tooth gear (1), motor shaft hub (1), and button head cap screws (4). The second picture shows the completed assemblies.

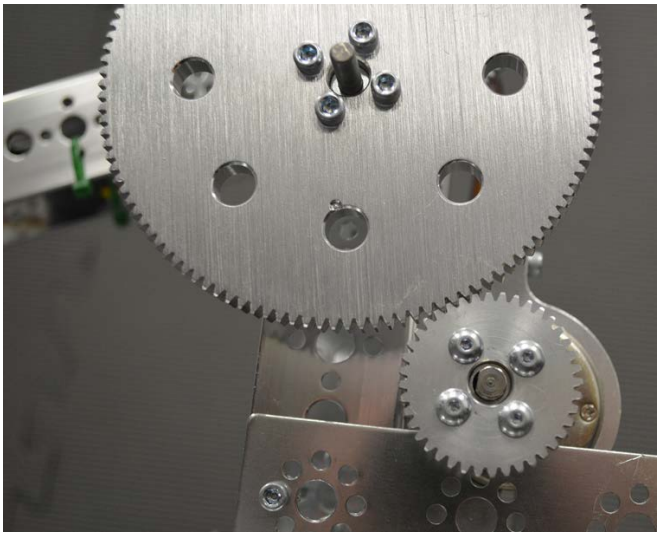

Drive Motor Assembly
Step 1: motor and encoder assembly (2) and motor hub and gear assembly (2). The second picture shows the completed assemblies. Note: install the hub as close as possible to the encoder without touching.


Install Drive Motors on Robot

Step 1: drive motor assembly (2) and Robot (1) The picture shows the completed assembly for the left chassis rail. The right chassis rail will be similar. Note: rotate the motor in the motor mount until the gears mesh well but not too tight. If they are too tight, they will bind, if they are too loose, they will slip.



The following pictures show examples of meshing the gears. The first is too loose, the second is too tight, the third is a good mesh. To test, rotate the mechanism by hand. If the gear teeth slip, then it is too loose, if the mechanism binds, then it is too tight



We will finish the final assembly after the Robot is programmed and we have determined which motor controller will be operating the drive motors and which will be operating the arm motor.