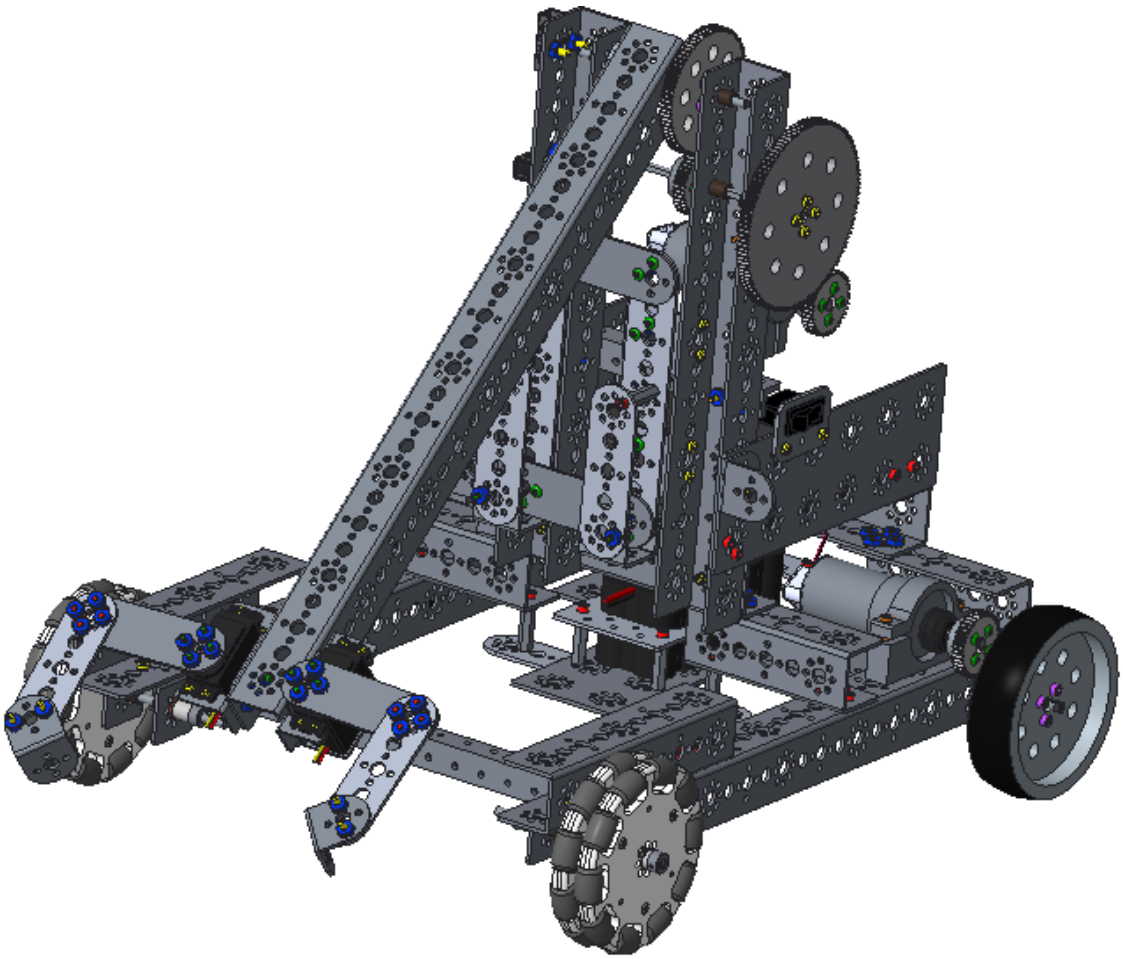
Push ‘Bot v4a
Build Guide

By: SSI Robotics



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Revision History	
2017-08-11	**Initial Draft Complete**
2017-08-13	**Initial Release**
2017-09-12	**Minor edits, updated 3 images**

Introduction

There are three versions of the Push Bot. PBv1 (created in 2014) used the NXT and Samantha units for control and communication. PBv2 (created in 2015) was introduced cell phones to replace the NXT Mindstorm and Samantha units. Modern Robotics modules were introduced to replace the HiTechnic controllers. PBv3 (created in 2016) used the same electronics as PBv2, but had a lower center of gravity. PBv4 is being created in 2017 to introduce the Rev Robotics Expansion hub, which can be used to replace the Modern Robotics controllers. The Modern Robotics electronics are still an option, so if you are using those electronics, then refer to the building instructions for PBv2 and PBv3. Use the latest FTC SDK for programming regardless of the electronics in use.

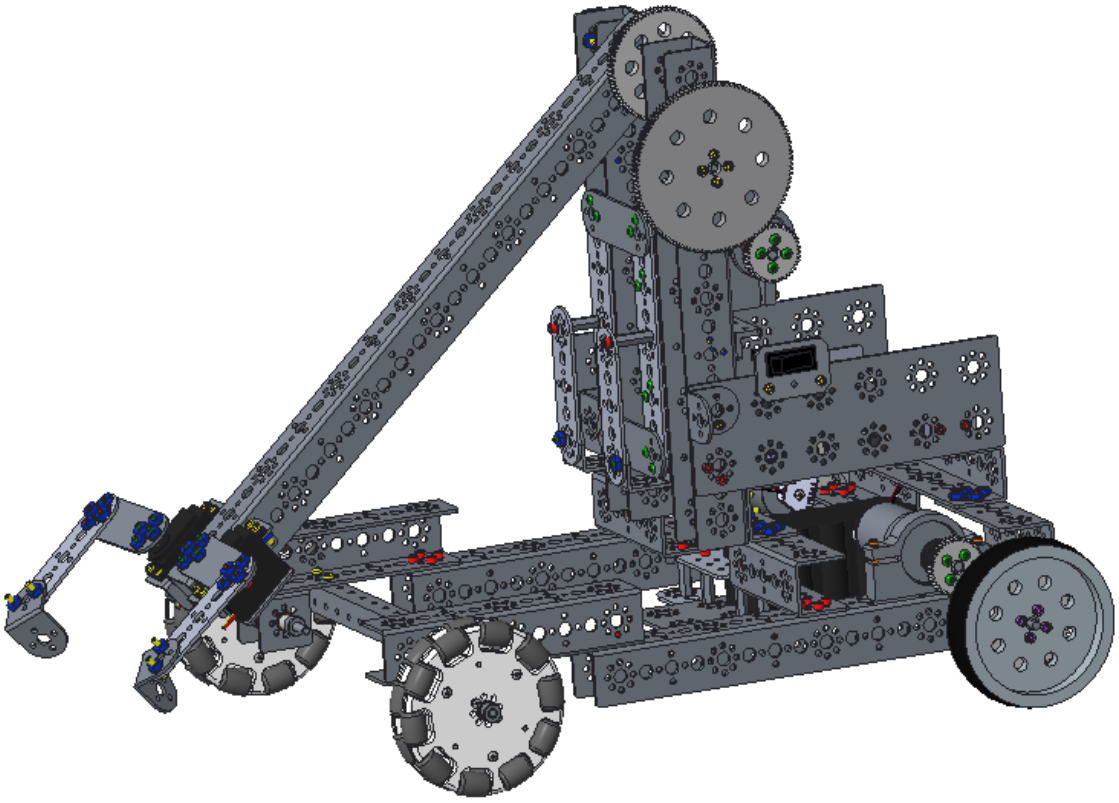
The PBv2 and PBv3 robots are being revised to use the REV expansion hub instead of the Modern Robotics modules for the 2017 season. The revised versions will be known as PBv4a (counterpart of PBv2 - reaches higher with its arm and has a higher center of gravity) and PBv4b (counterpart of PBv3 - reaches further horizontally with its arm and has a lower center of gravity).

Refer to the game rules to determine which version is desired. If the season's game has a goal that requires reaching high objects/goals, then PBv4a would be desired. If the season's game has a ramp onto which the robot must drive, then build PBv4b. This document contains the hardware and wiring instructions to build PBv4a.

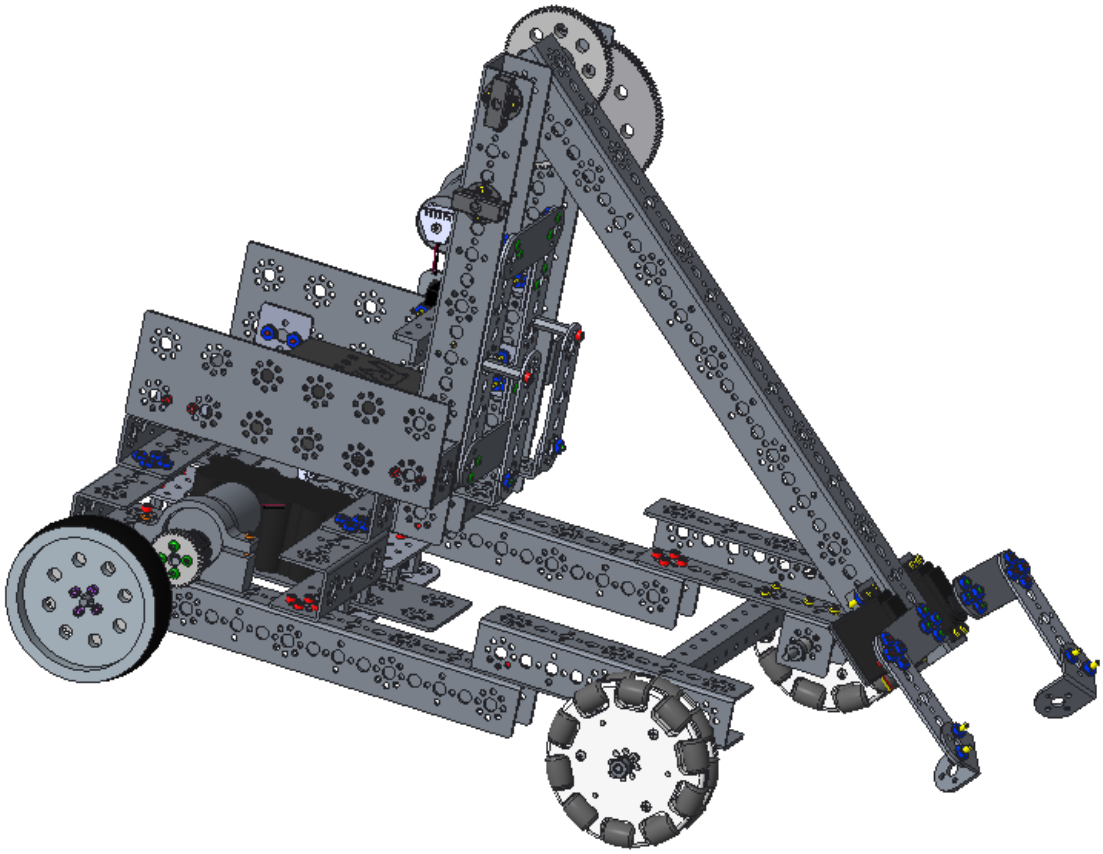
The drawings in this document were generated using Creo Parametric Computer Aided Design (CAD) software. CAD software is used to design an object on a computer. By designing on the computer first, the design can be tested (through the use of the CAD software) to ensure everything will work together before actual construction. The Creo software is available for free to FIRST teams for use in designing robots. The CAD drawings are color coded to help identify parts. Refer to the table below when performing a step to clarify and question that arises while reading this document.

CAD Coloring Legend

Pitsco Part Number	Part	Color
39098	5/16" socket head cap screw	red
39094	keps nut	blue
39111	3/8" button head cap screw	green
39097	1/2" socket head cap screw	yellow
39089 & 39090	motor mount/gear hub spacer screw	orange



The above image shows the left side of the robot.



The above image shows the right side of the robot.

Assemblies

This section will outline the construction of the assemblies that will later be used to complete the chassis. Only the parts and tools included in the TETRIX Kit of Parts will be needed to build the robot. Make sure that set screws are installed in all of the axle hubs, motor hubs, and axle collars. If these parts are unfamiliar, then refer to the legend provided in the Kit of Parts.

PBv4a uses drive wheels on the back of the robot, because that is where the most weight is. This weight is needed to help the wheels grip the surface better. Omni wheels are on the front of the robot, which allows the robot to turn more easily. The omni wheels can slide sideways with very little friction due to the rollers.

PBv4a uses two DC motors to power the drive wheels. It uses one DC motor to raise and lower the arm. The Kit of Parts includes an additional motor, which can be retained as a spare motor (in the event one of the three fail) or it can be used to power another mechanism, such as a sweeper for balls or a lifter for blocks.

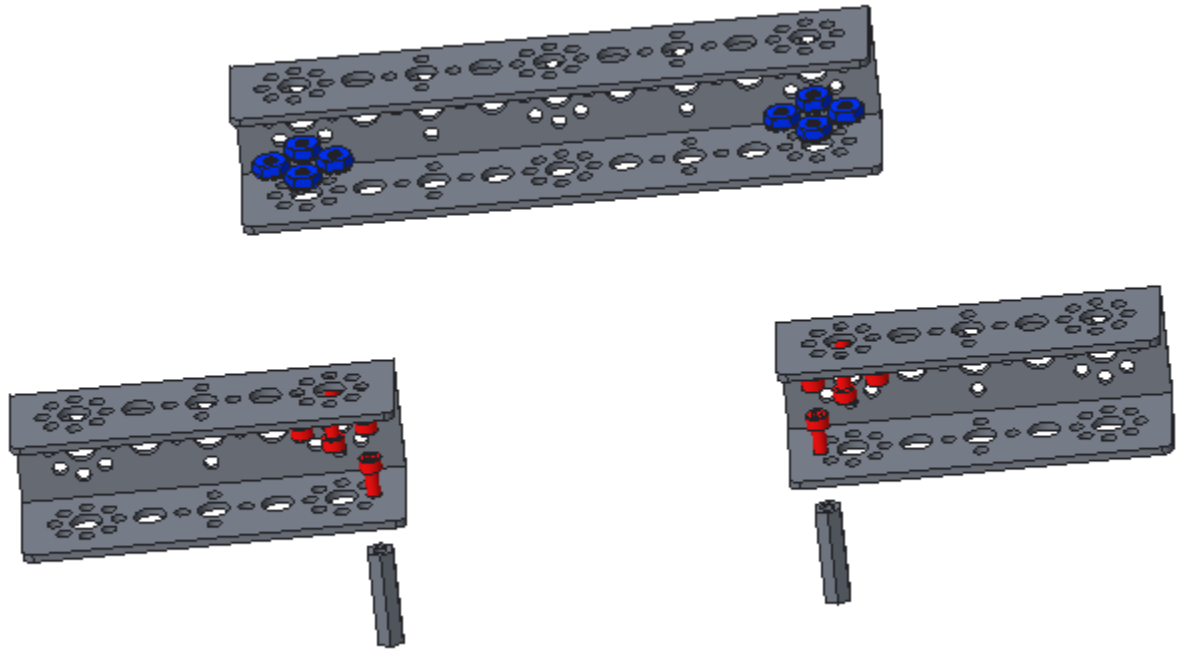
For most of the steps in this section, the top image shows the necessary parts; the lower image shows the completed assembly.

Cross Bar Assemblies

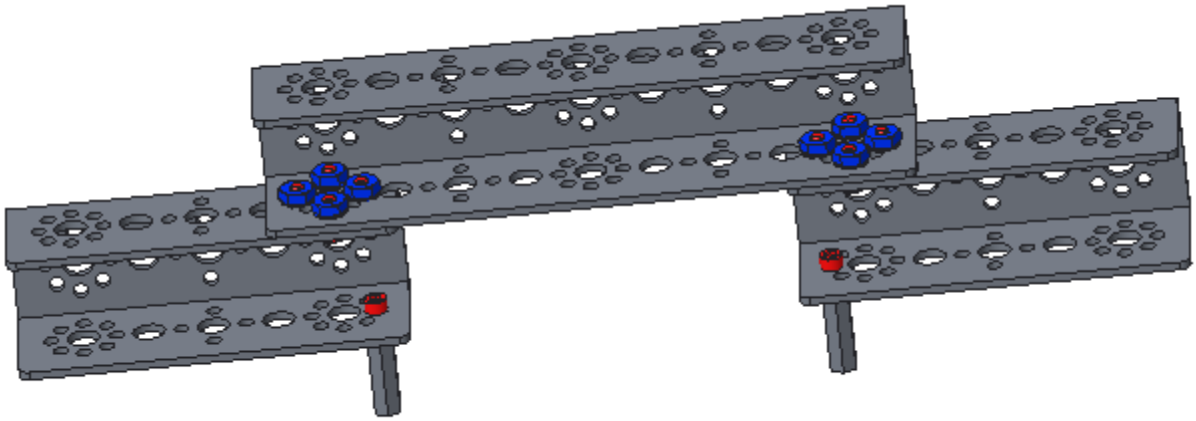
Make two.

Step 1: Cross Bars

160 mm channel (1), 96 mm channels (2), 1” stand-off post (2), 5/16" socket head cap screws (10), keps nuts (8)



The above image shows the parts for only ONE assembly.

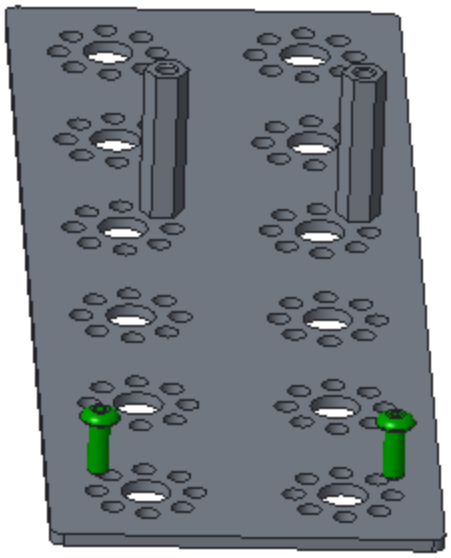


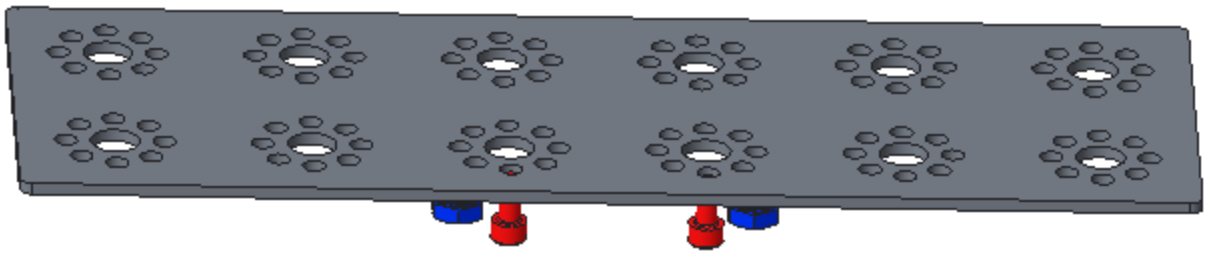
The above image shows ONE completed assembly.

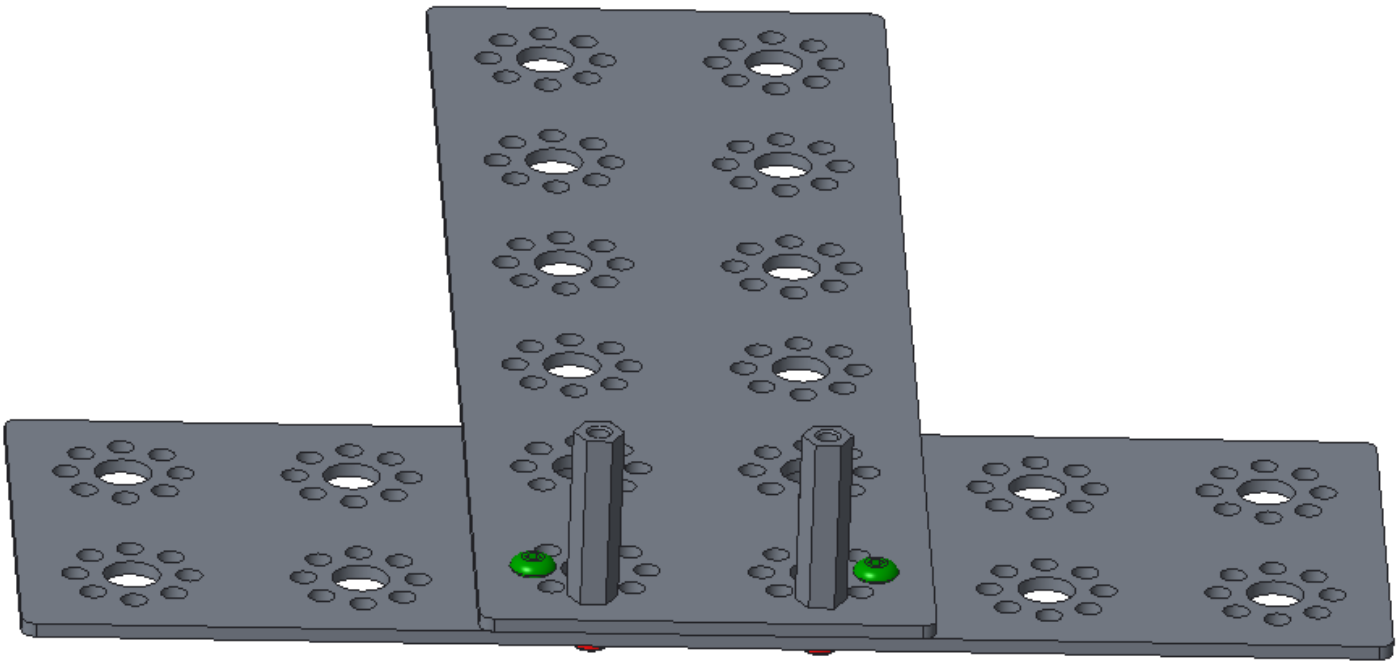
Battery Holder Assembly

Step 1: Back Support

64 mm x 192 mm flat building plate (2), 1” stand-off post (2), 3/8” button head cap screws (2), 5/16" socket head cap screws (2), keps nuts (2)

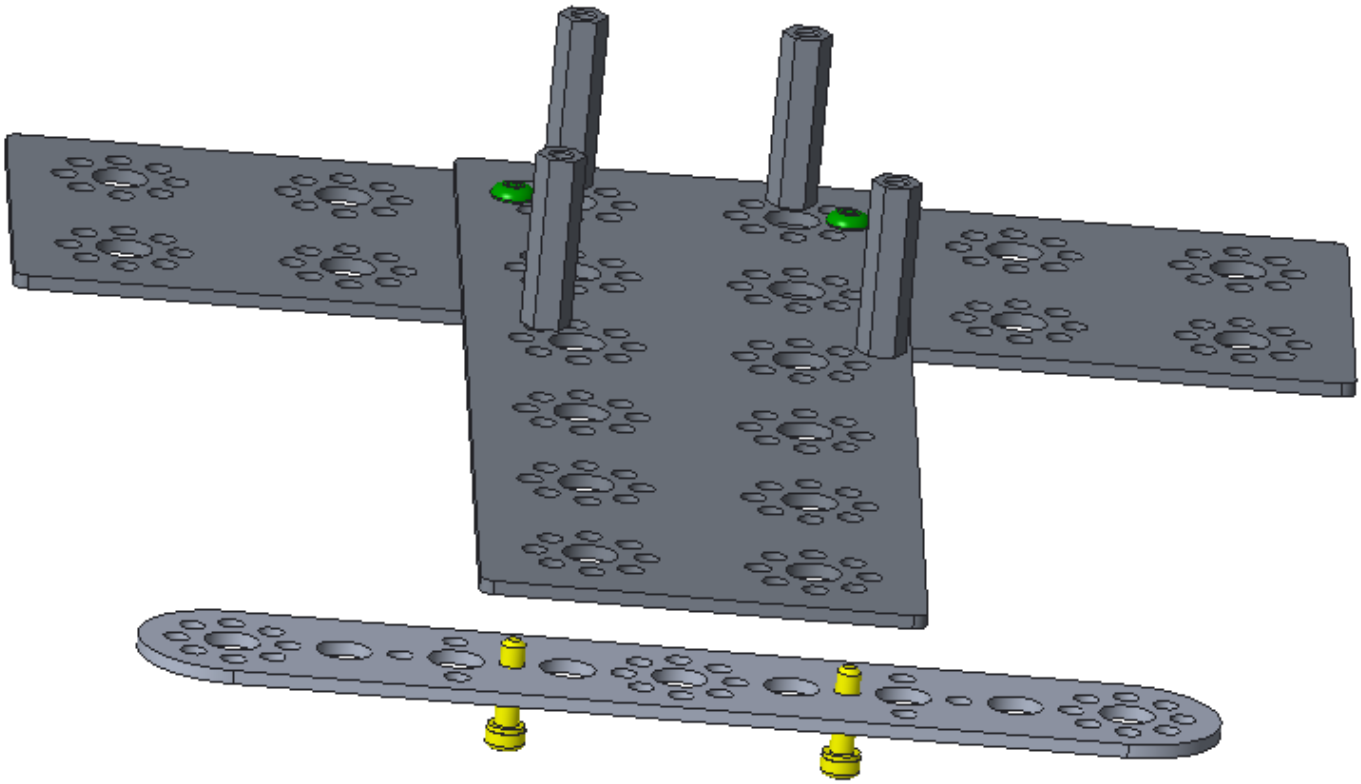


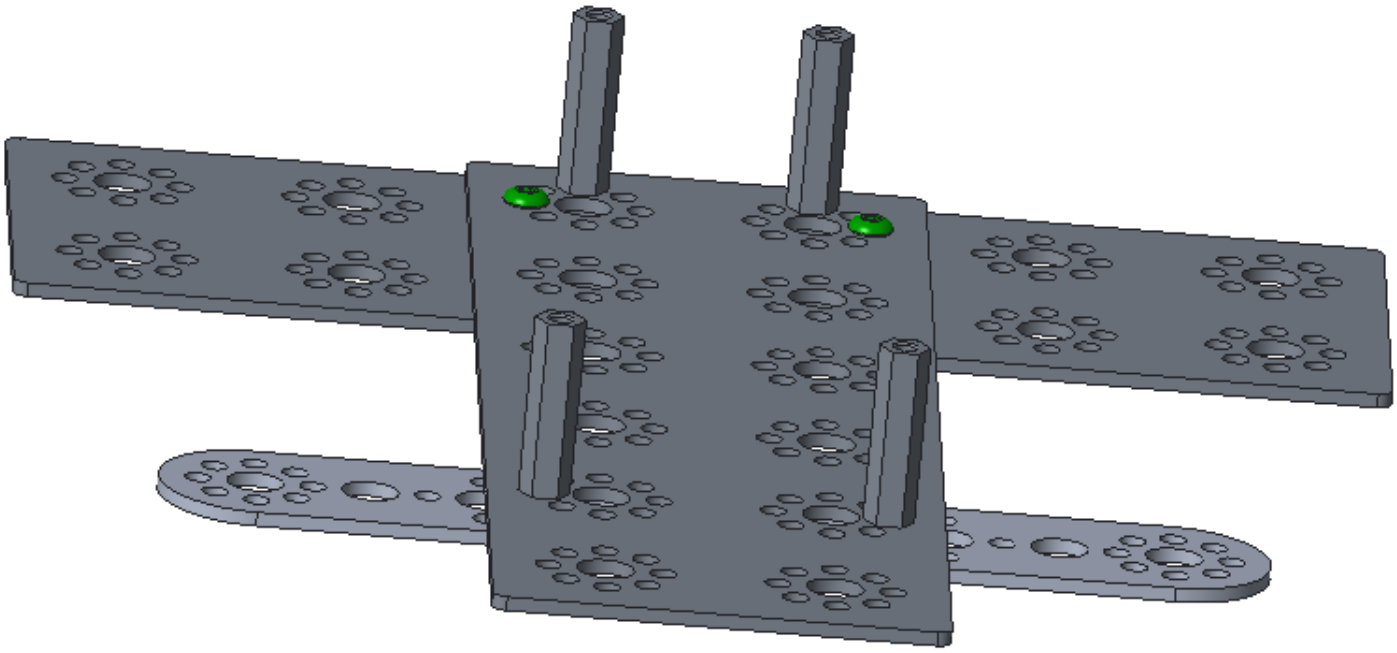




Step 2: Front Support

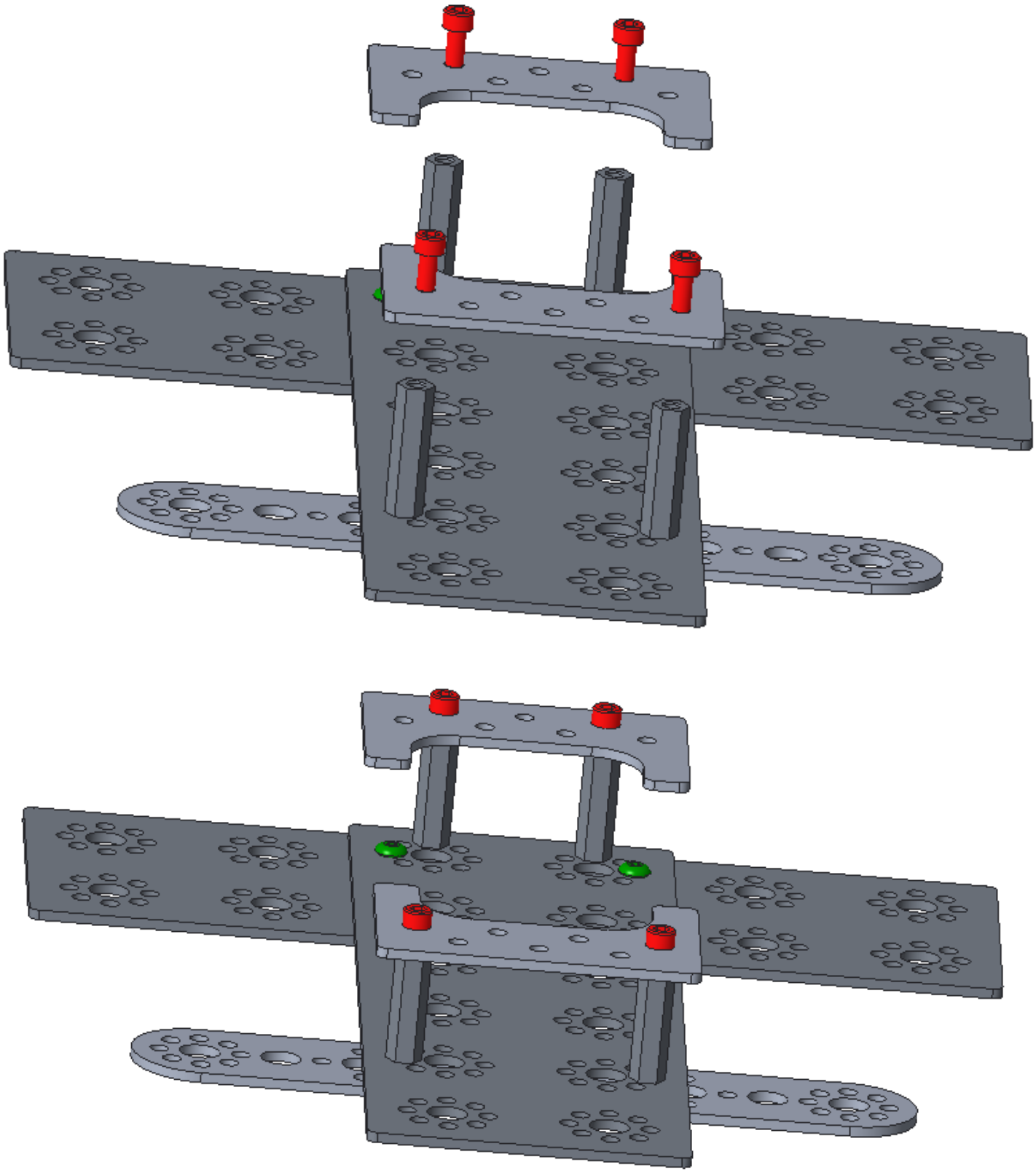
Assembly from previous step (rotated in this view), 160 mm flat (1), 1” stand-off post (2), 5/16" socket head cap screws (2)





Step 3: Side Support

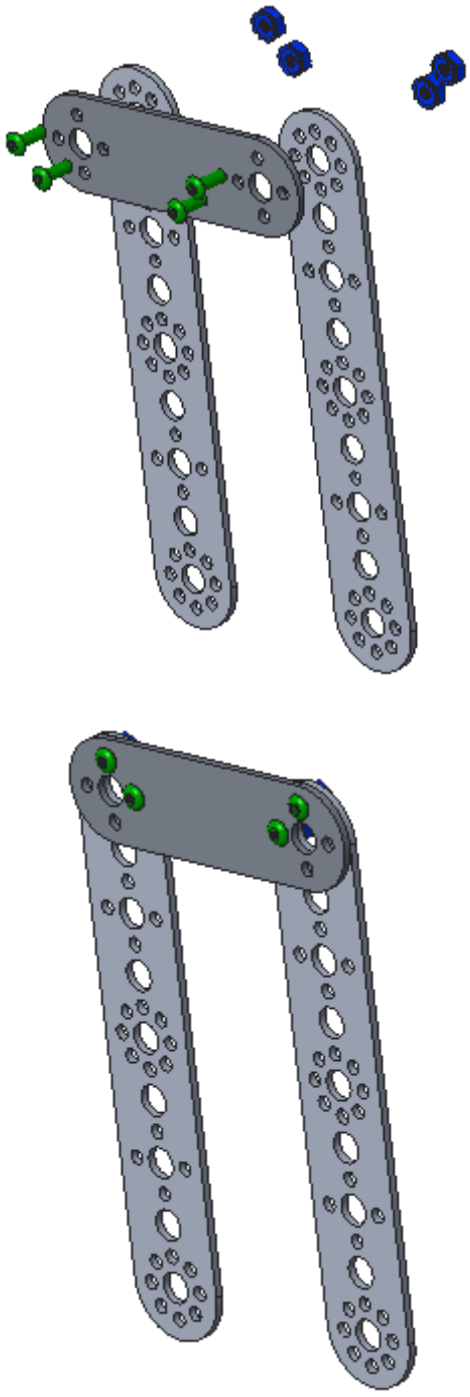
battery clip (2), 5/16" socket head cap screws (4)



Phone Holder Assembly

Step 1: Back Support

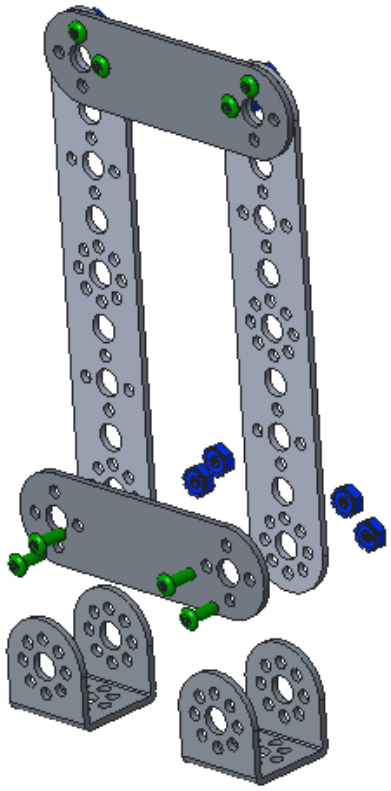
160 mm flats (2), flat bracket (1), 3/8” button head cap screws (4), keps nuts (4)

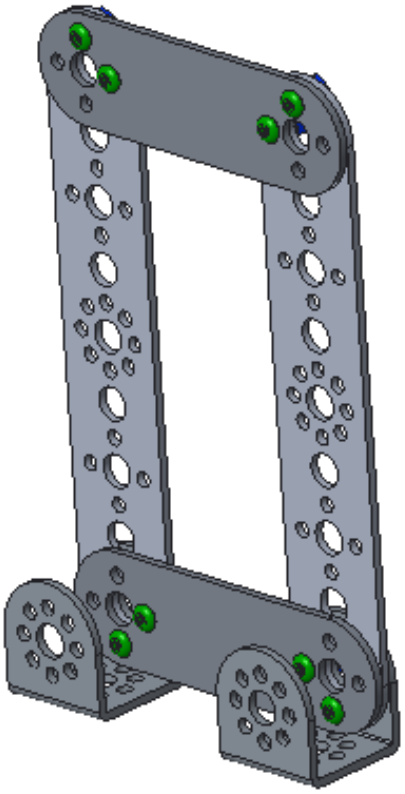


Step 2: Bottom Support

assembly from the previous step, flat bracket (1), inside C connector (2), button head cap screws (4), kep nuts (4).

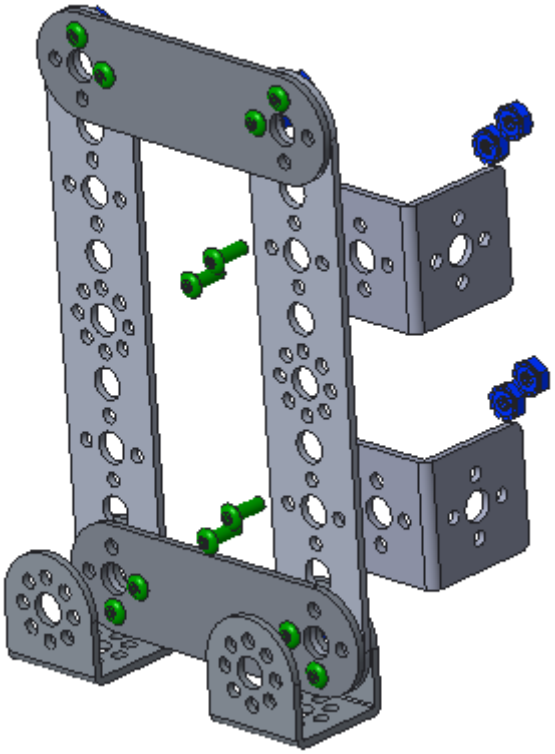
Note: the inside C connector is behind the vertical flat brackets.

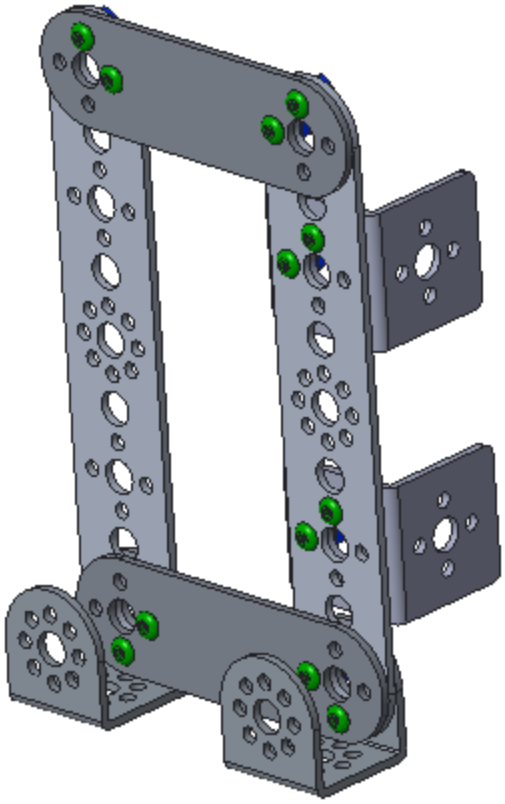




Step 3: Attachment Brackets

assembly from the previous step, inside corner bracket (2), 3/8”button head cap screws (4), keps nuts (4).

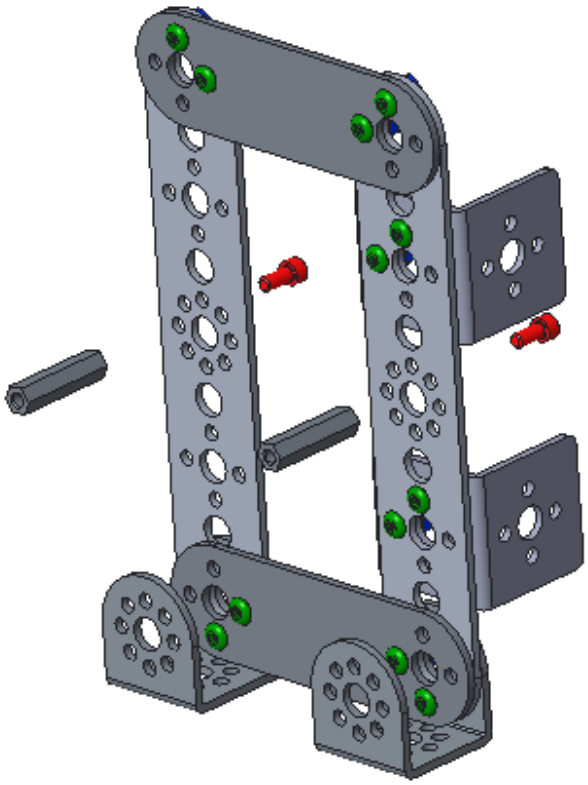


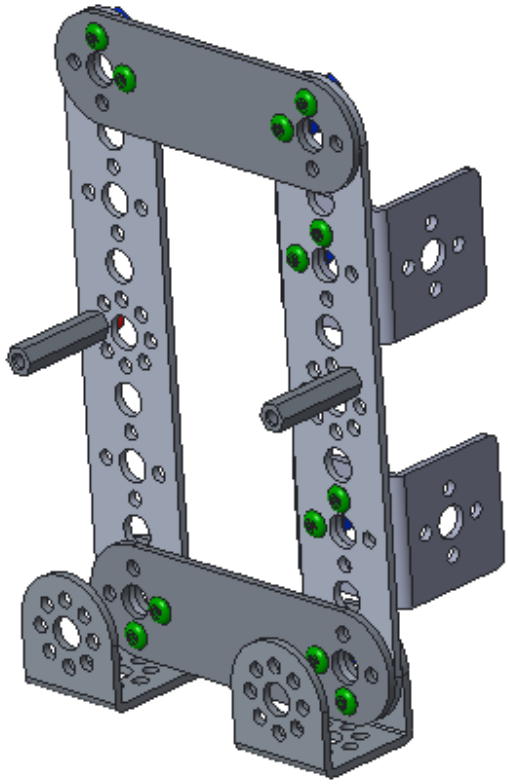


Step 4: Side Support

assembly from the previous step, 1" stand-off posts (2), 1/2" socket head cap screws (2).

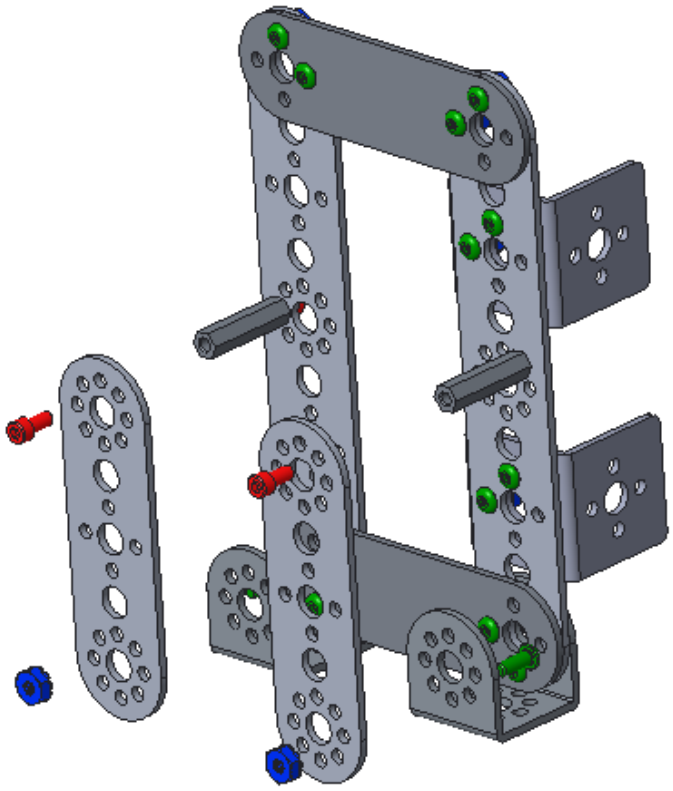
Note: the stand-off posts are not placed symmetrically.

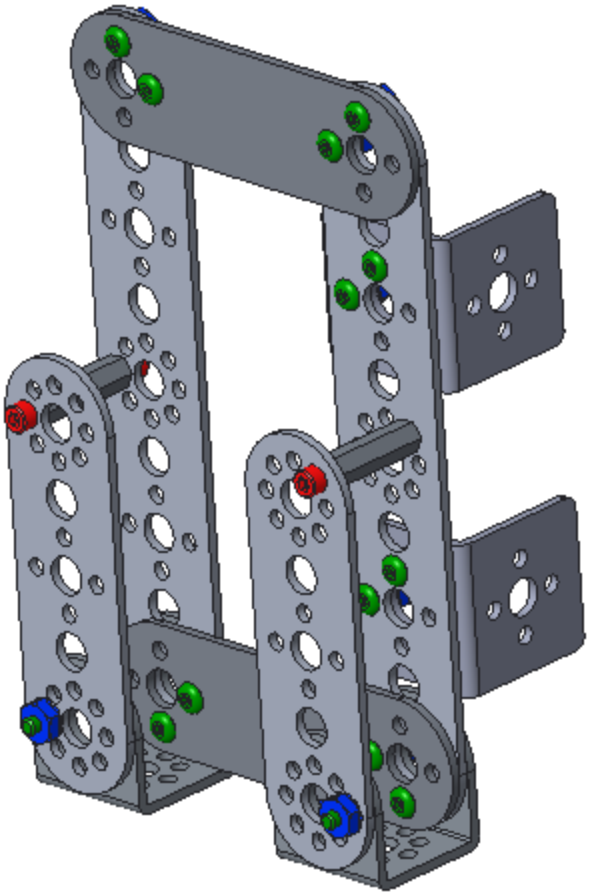




Step 5: Front Support

assembly from the previous step, 96 mm flats (2), 5/16" socket head cap screws (2), button head cap screws (2) (shown in green inside the inside C connectors), keps nuts (2)

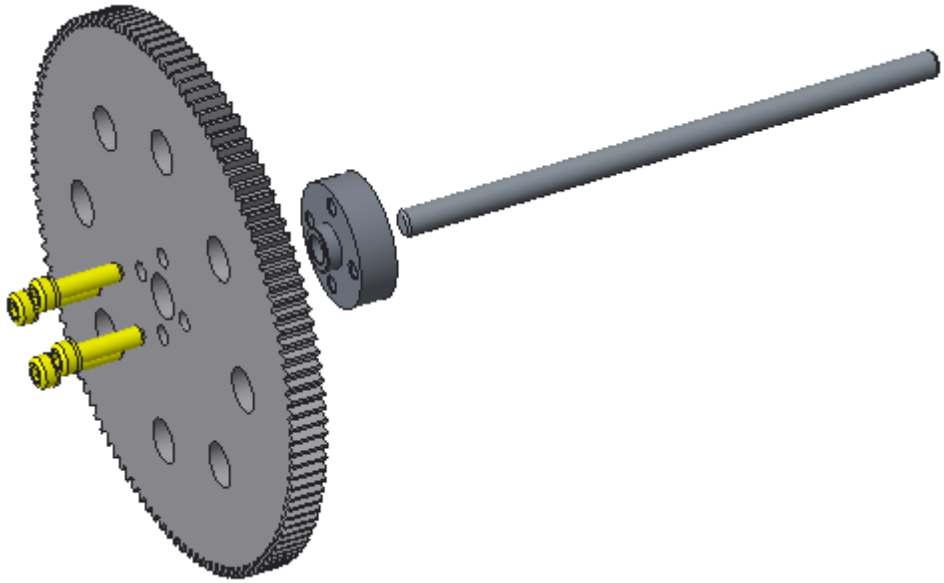


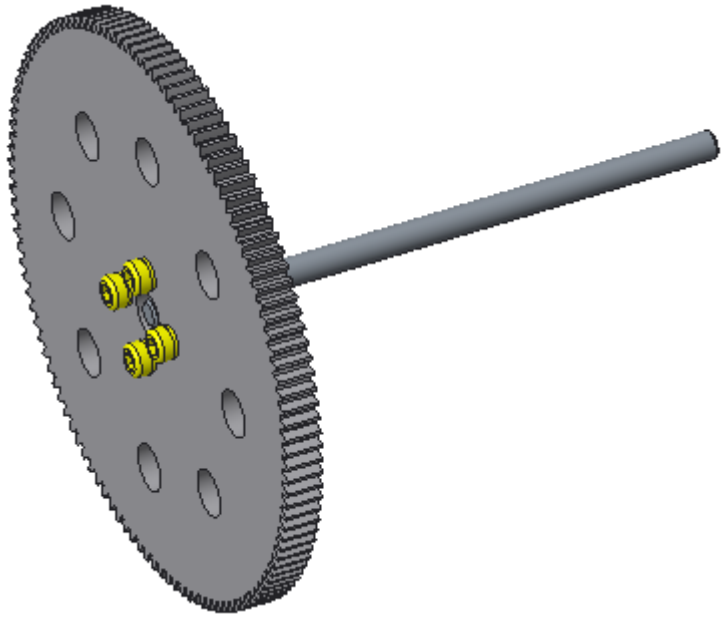


Tower Assembly

Step 1: Large Gear

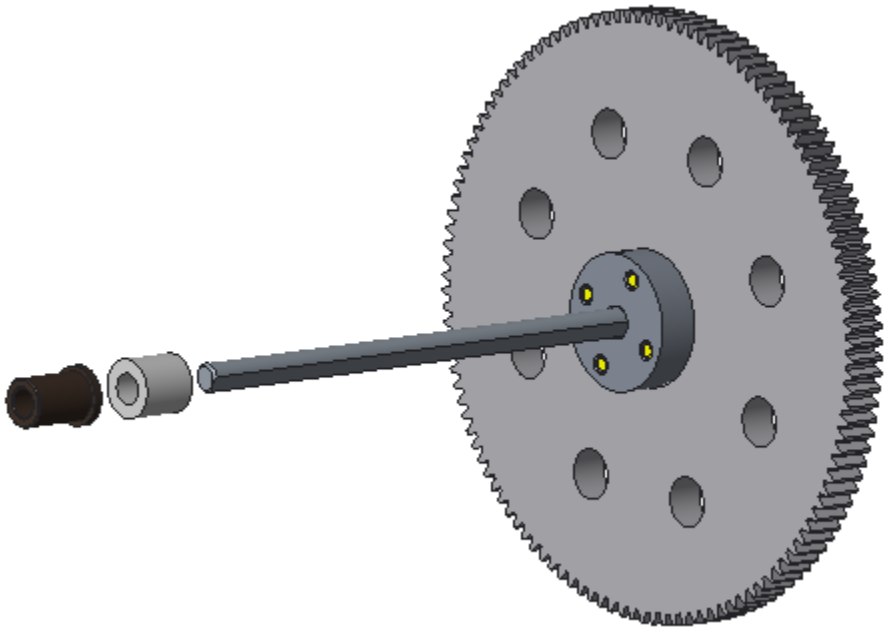
120-tooth gear (1), 100 mm axle hub (1), 1/2" socket head cap screws (4), 100 mm axle (1)

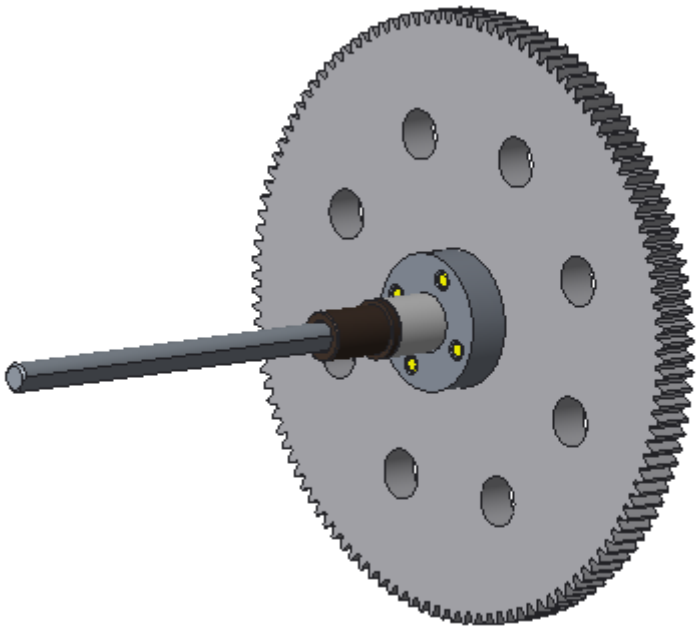




Step 2: Large Gear Support

assembly from previous step, 3/8” nylon axle spacer (1), bronze bushing (1)

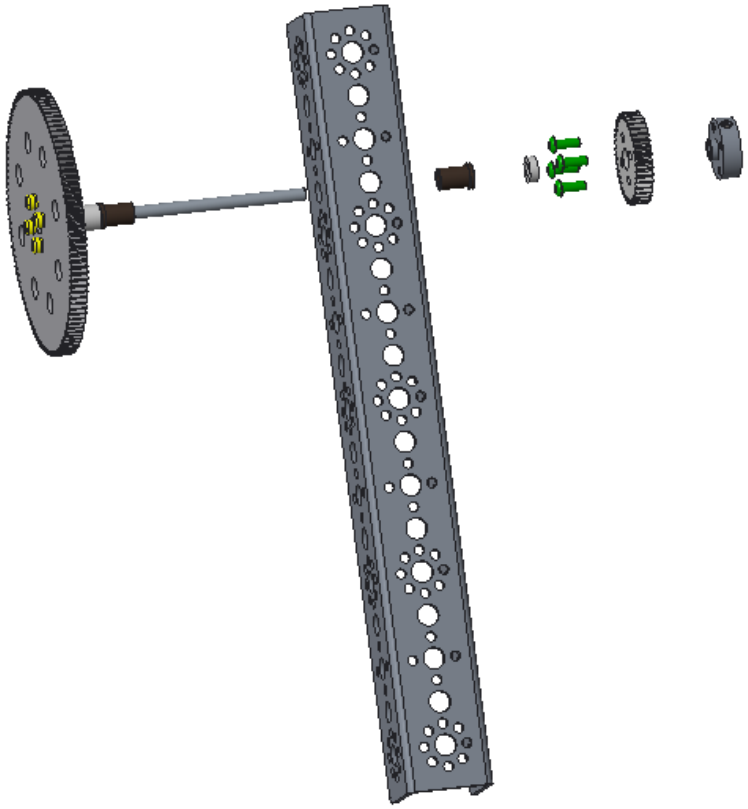


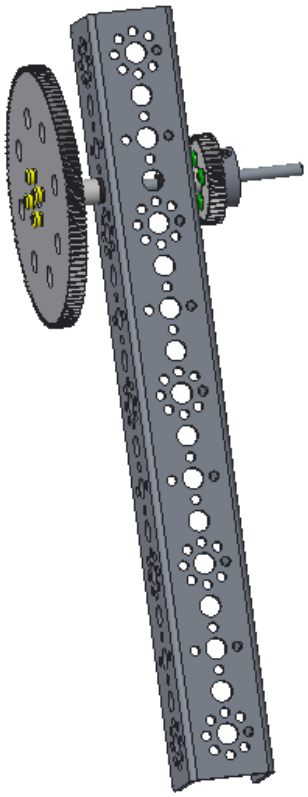


Step 3: Channel and Small Gear

assembly from previous step, 288 mm channel (1), bronze bushing (1), 1/8" axle spacer (1), button head cap screws (4), 40-tooth gear (1), axle hub (1)

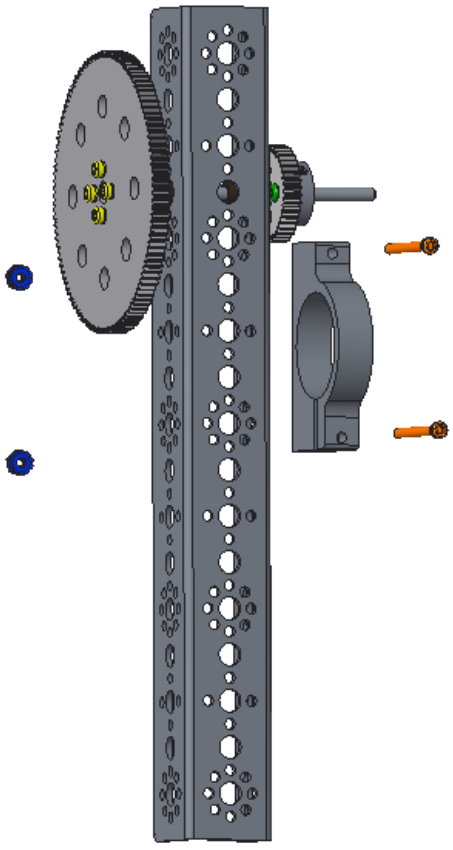
Order from right to left: 120-tooth gear, axle hub, 3/8" axle spacer, bronze bushing, channel, bronze bushing, 1/8" spacer, 40-tooth gear, axle hub

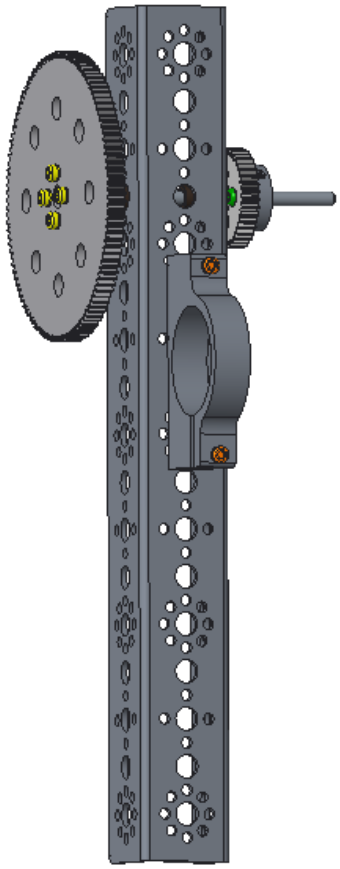




Step 4: Motor Mount

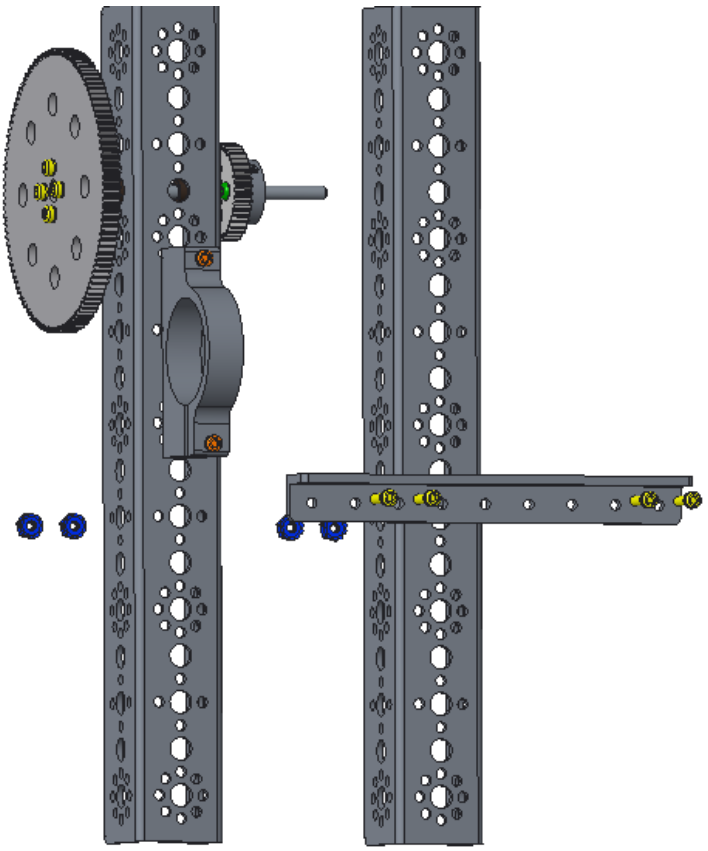
assembly from the previous step, motor mount (1) with included screws (2), keps nuts (2).

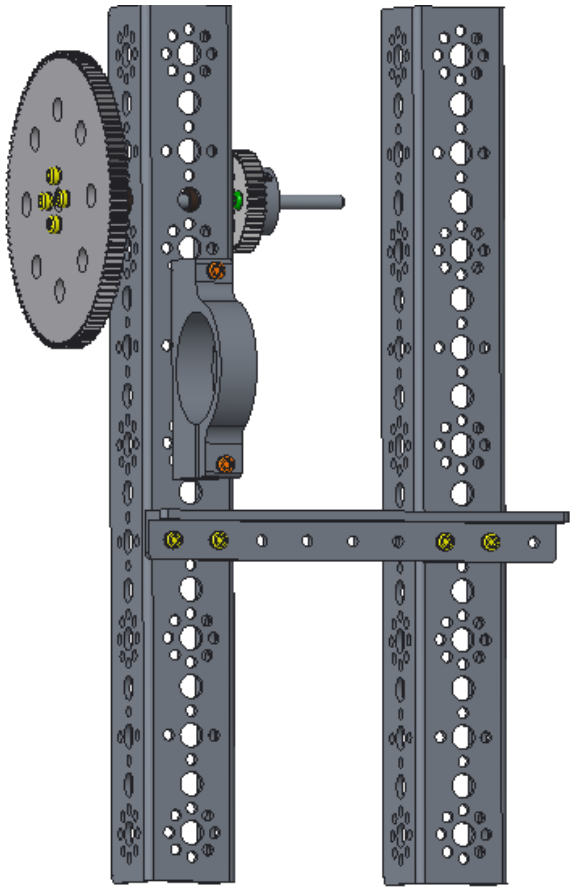




Step 5: Support Brace

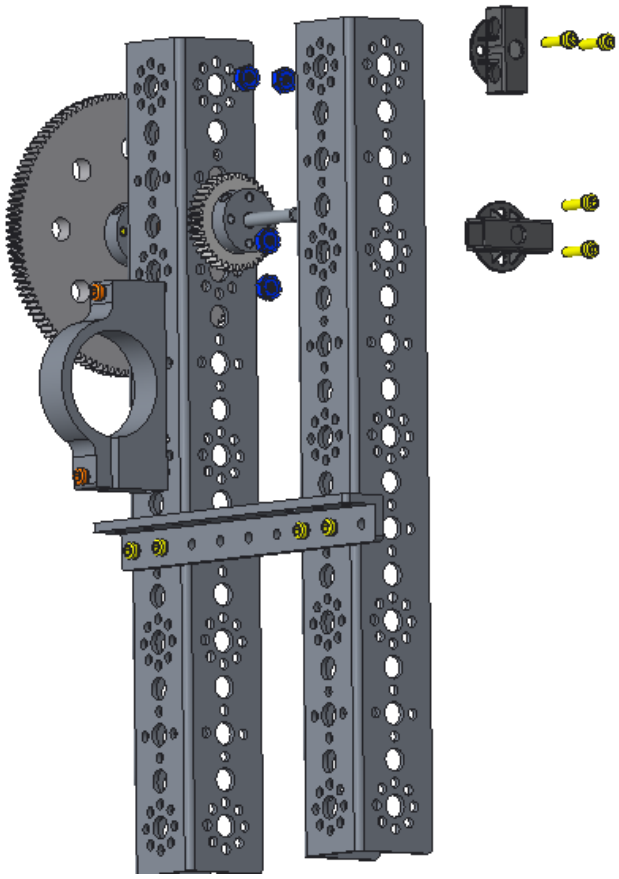
assembly from the previous step, 288 mm channel (1), 144 mm angle (1), 1/2" socket head cap screws (4), keps nuts (4)

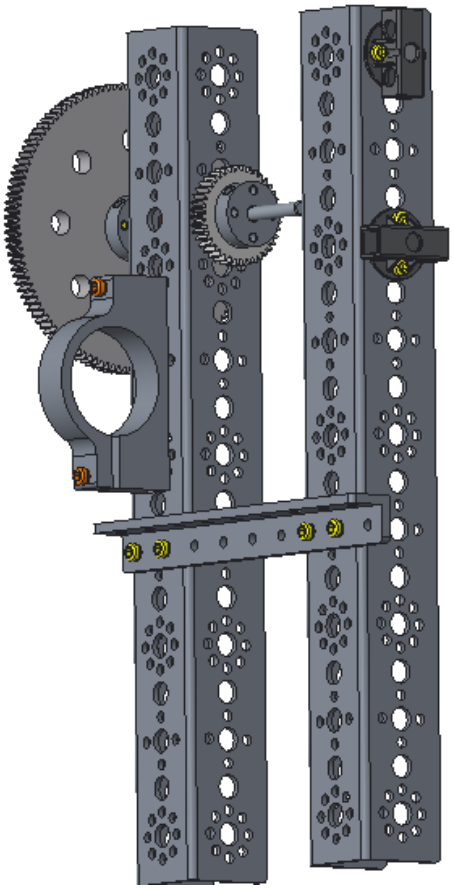




Step 6: Flag Holder

assembly from the previous step, hard point connectors (2), 1/2" socket head cap screws (4), keps nuts (4)

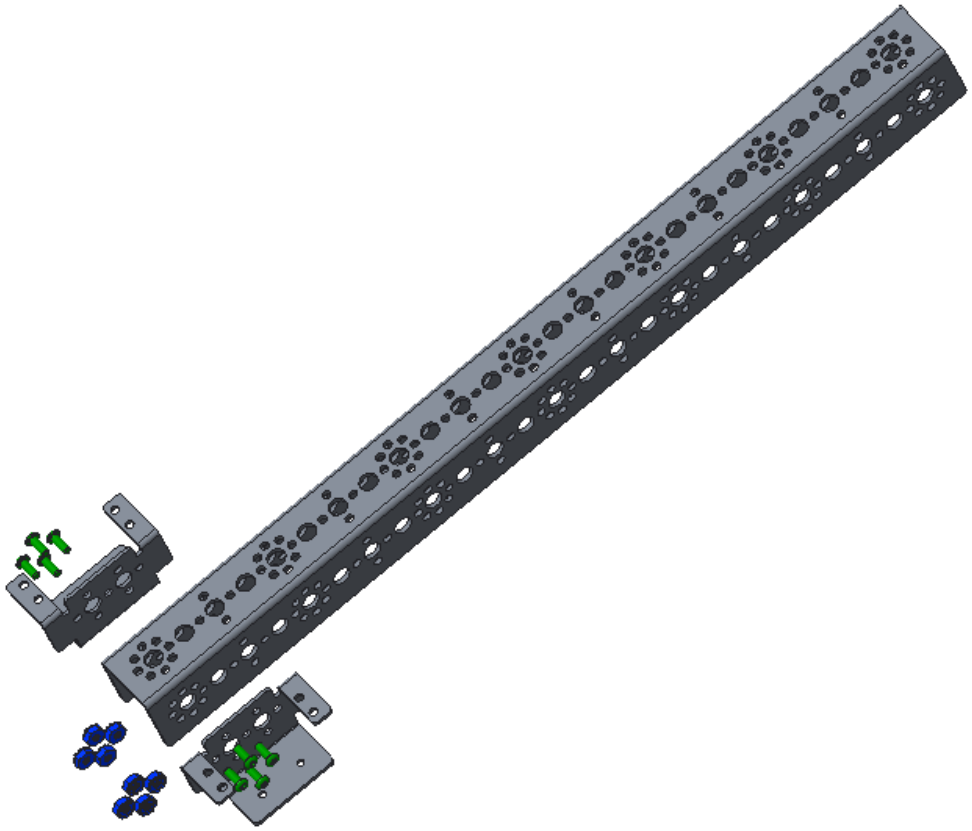


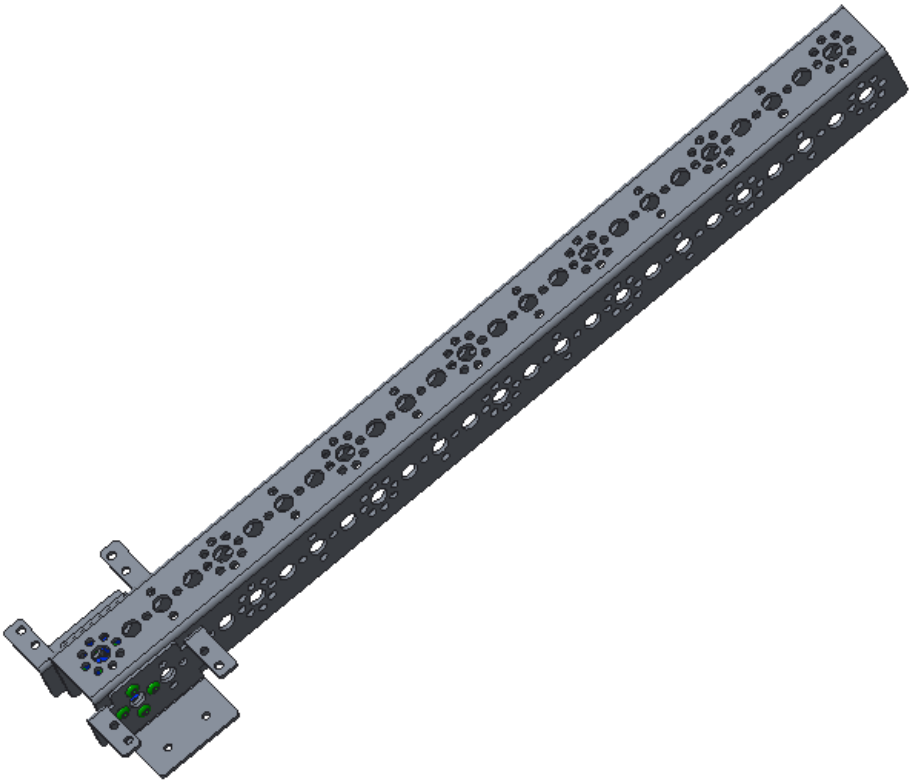


Arm Assembly

Step 1: Motor Mounts

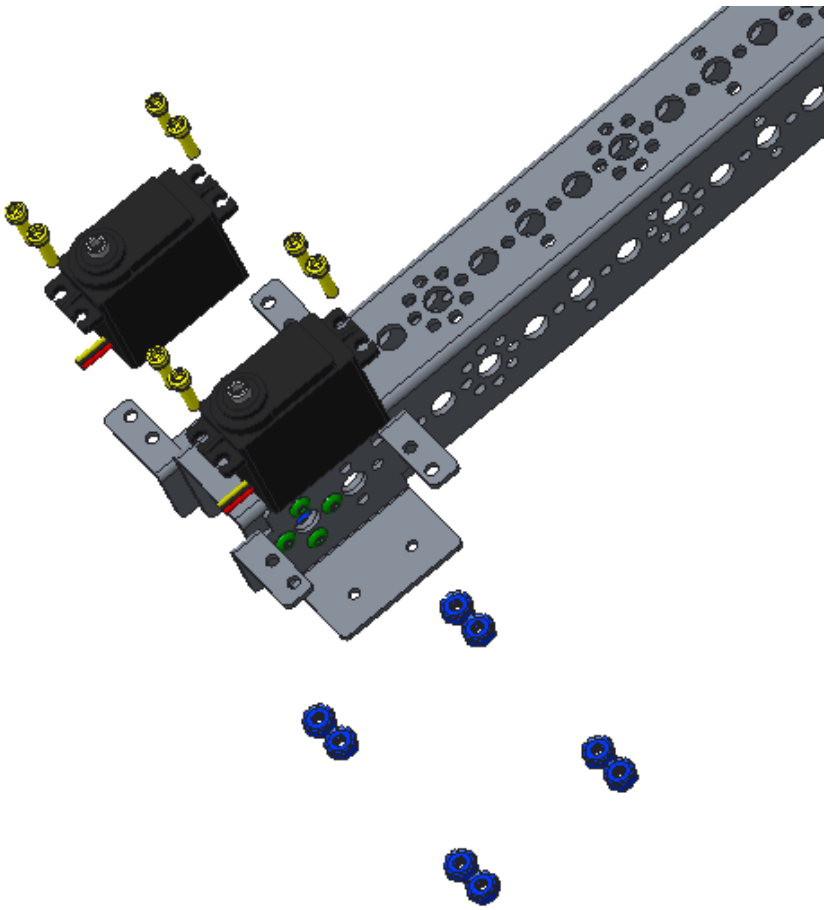
416 mm channel (1), single standard-scale servo motor mounting bracket (2), 3/8” button head cap screws (8), keps nuts (8)

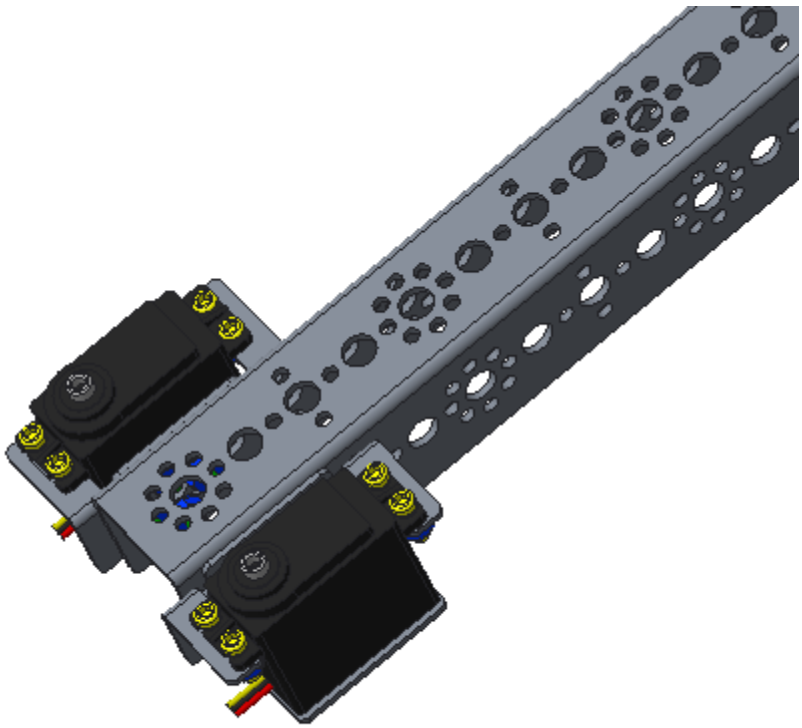




Step 2: Servo Motors

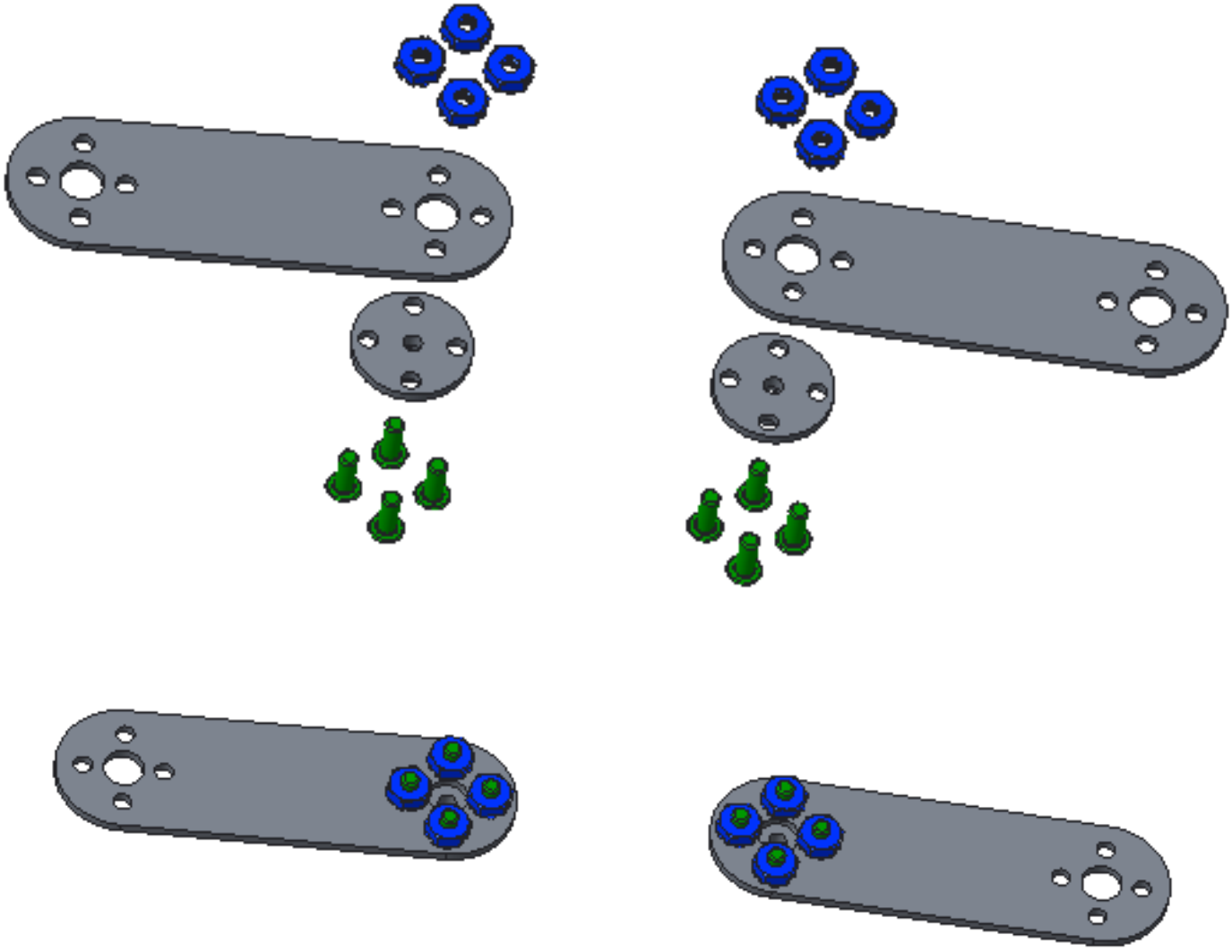
assembly from the previous step, 180^{O} standard-scale HS-485HB servo motor (2), 1/2" socket head cap screws (8), keps nuts (8)





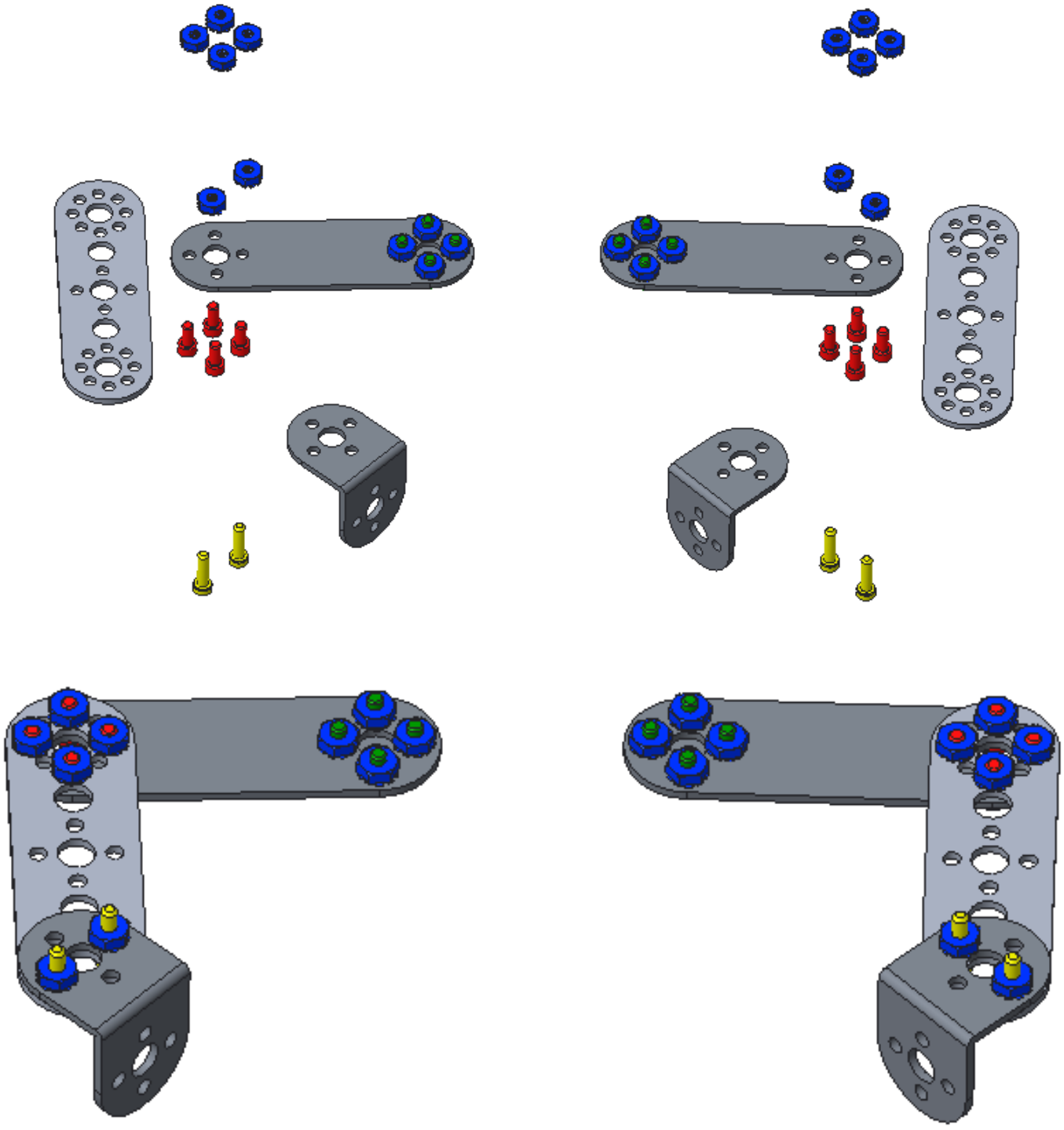
Step 3: Hand Part A

servo horn - metal (2), flat bracket (2), 3/8” button head cap screws (8), keps nuts (8)



Step 4: Hand Part B

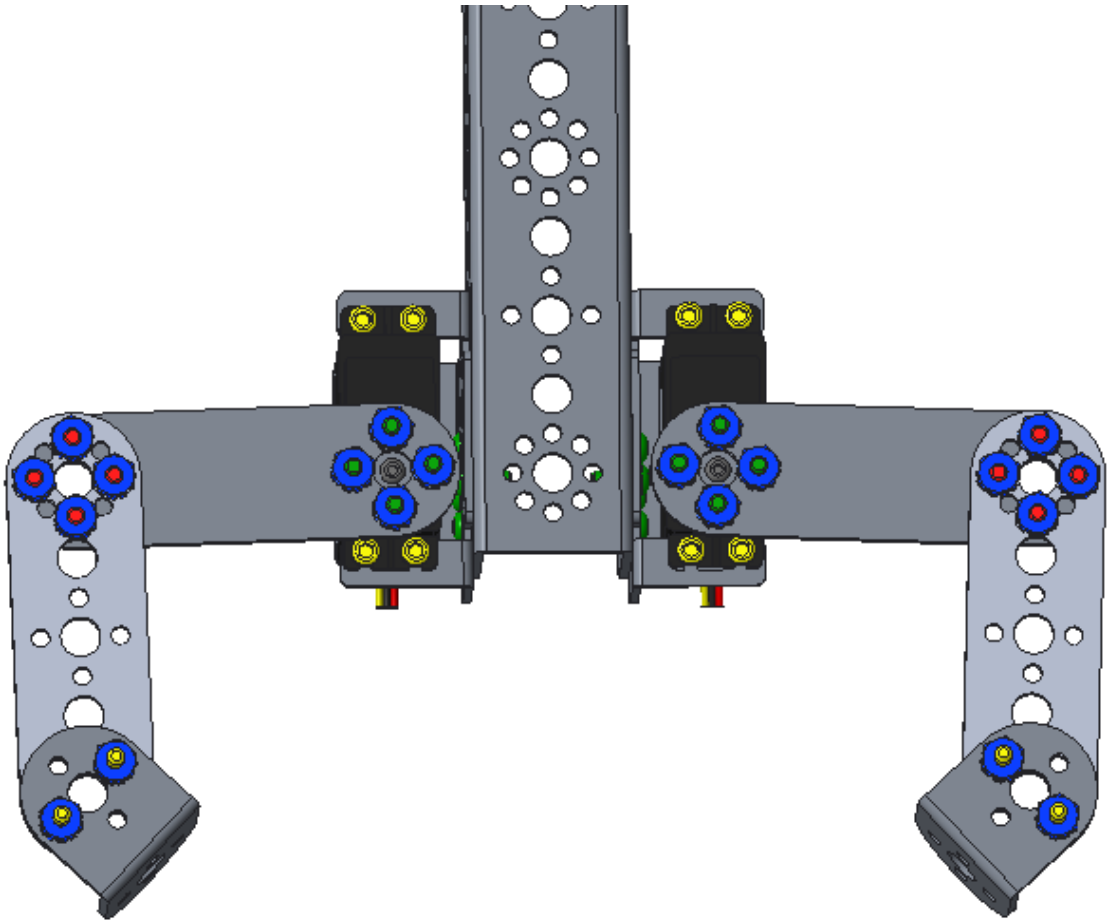
assembly from the previous step, 96 mm flats (2), L bracket (2), 5/16" socket head cap screws (8), 1/2" socket head cap screws (4), keps nuts (12)



Step 5: Hand Attachment

assembly from step 2, assemblies from step 4.

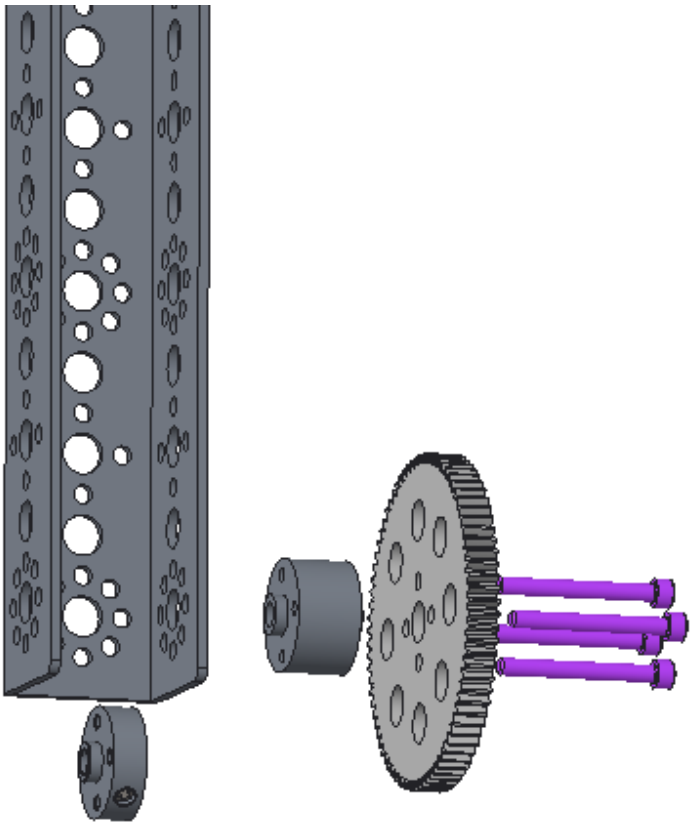
Remove the black screw from the center of the plastic servo horn. Use this screw to attach the hand/grippers. To set the position of the grippers, rotate the servo to the fully open position and install the gripper so that it is opened just past vertical. This should get the servo in approximately the correct position.

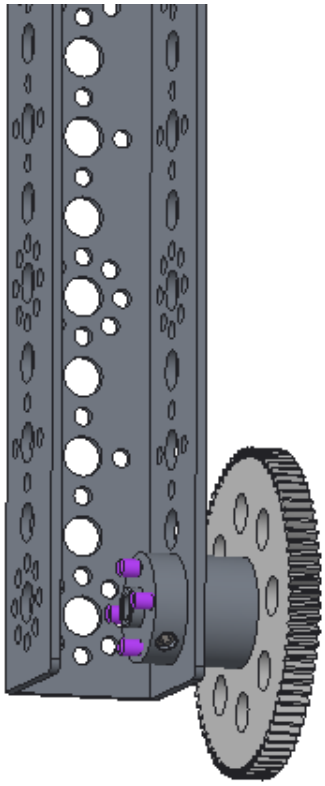


Step 6: Medium Gear

assembly from the previous step, 80-tooth gear (1), gear hub spacer (1) with included screws (4), axle hub (1)

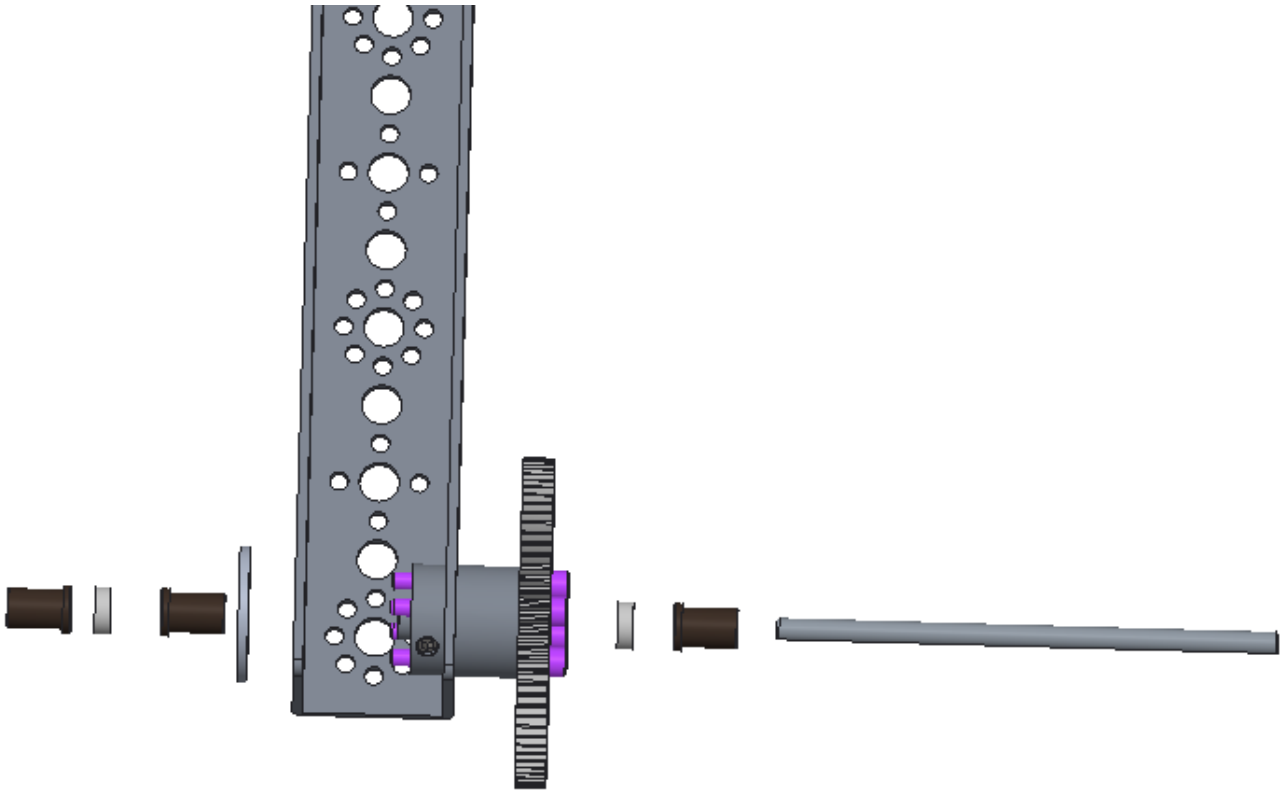
Note: Use the other end of the previous assembly (i.e. the end opposite the hand).

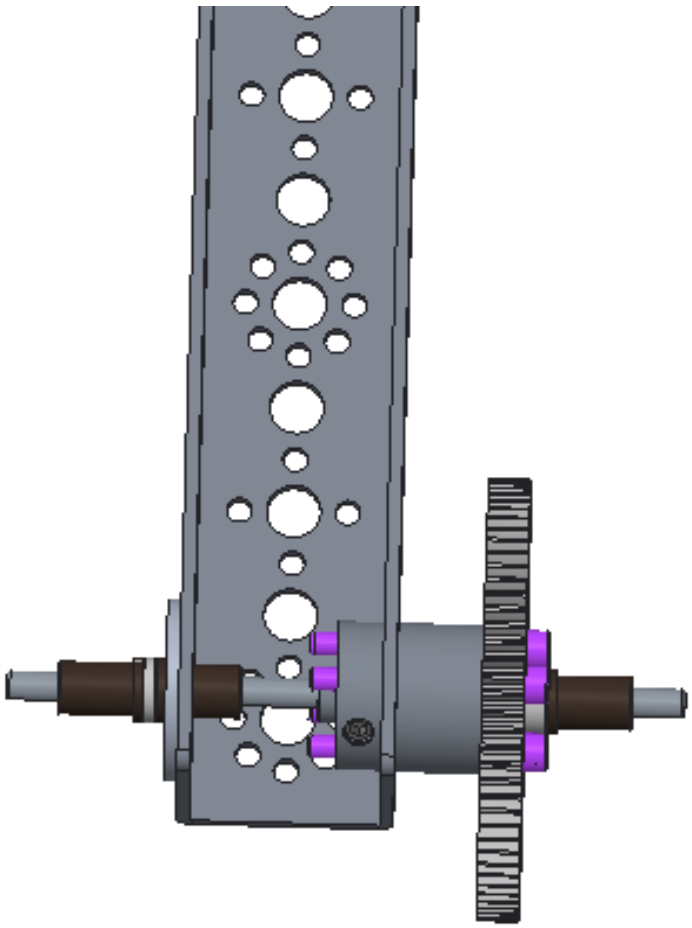




Step 7: Arm/Tower Axle

assembly from the previous step, 1/8” nylon axle spacer (2), bronze bushing (3), flat spacer (1), axle (1)





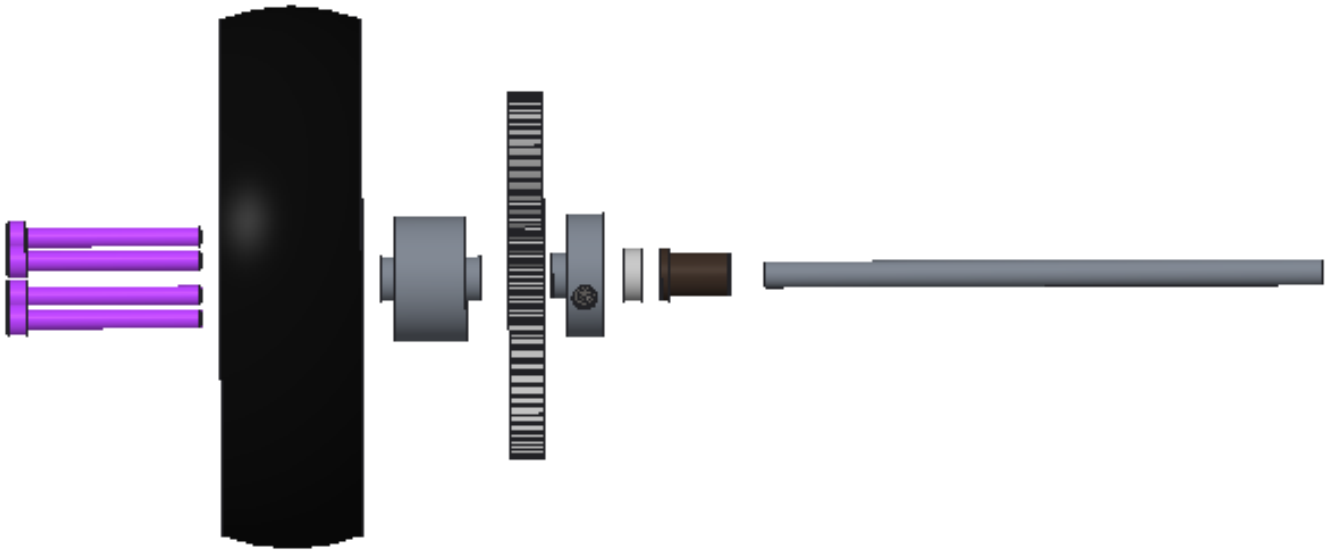
Drive Wheel Assemblies

Make two.

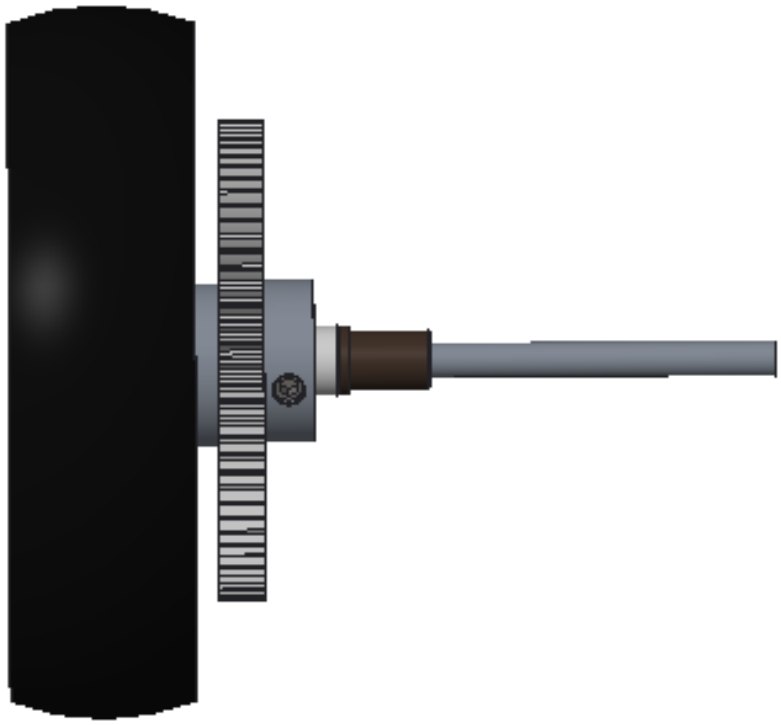
Step 1: Wheel, Gear, and Axle

4" wheel (1), hub gear spacer (1) with included screws (4), 80 tooth gear (1), axle hub (1), 1/8” nylon spacer, bronze bushing (1), 100 mm axle (1)

Order from left to right: screws, wheel, gear hub spacer, gear, axle hub, spacer, bronze bushing



The images show only one wheel. Make two.



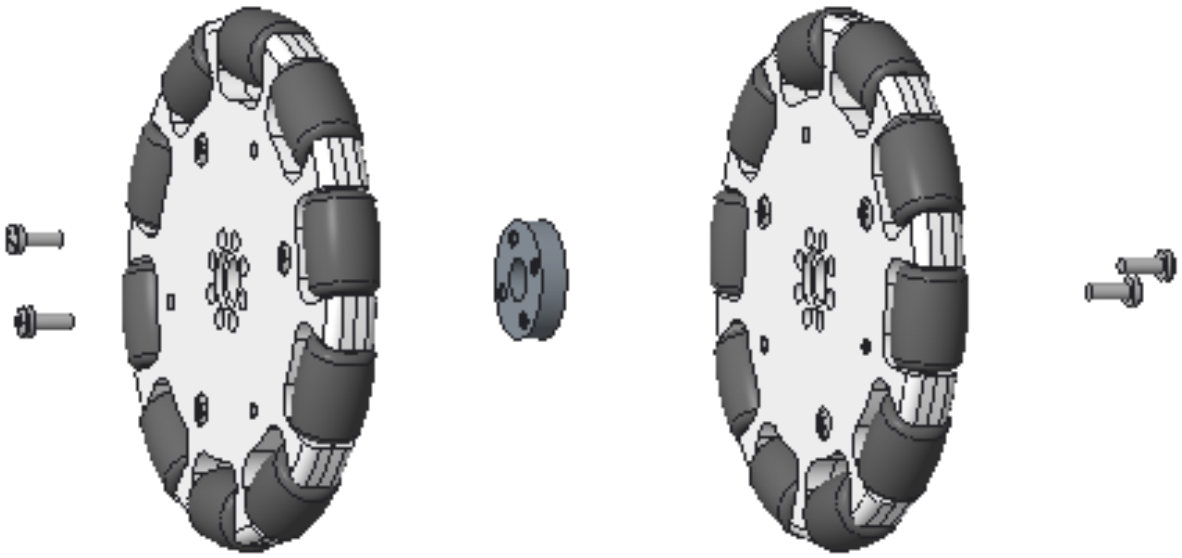
Omni Wheel Assemblies

Make two.

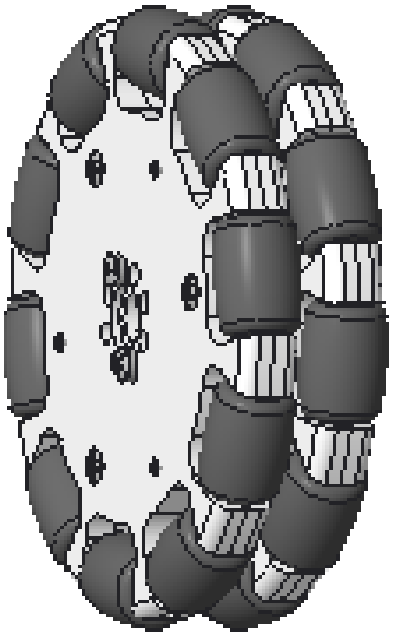
Assemblethe omni wheels according to the instructions that come in the omni wheel pack.

Step 1: Omni Wheel Unit

4" omni wheel half (2), joining ring (1) with included screws (4). The order is omni wheel, joining ring, omni wheel.

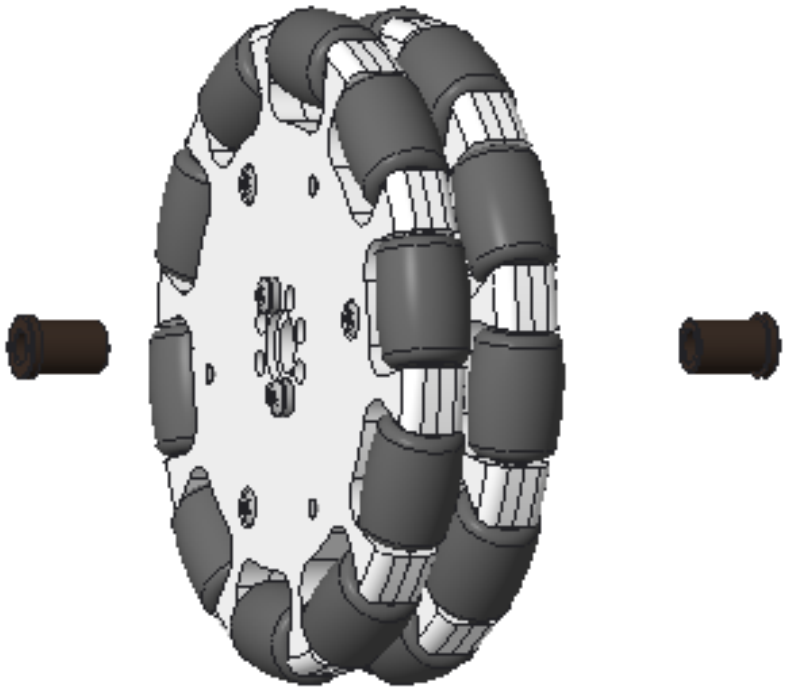


The images show only one wheel. Make two.

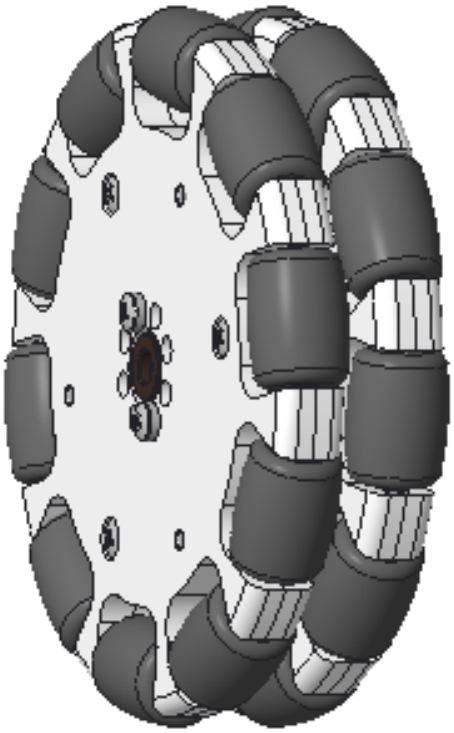


Step 2: Omni Wheel and Bushings

assemblies from previous step, bronze bushings (2)



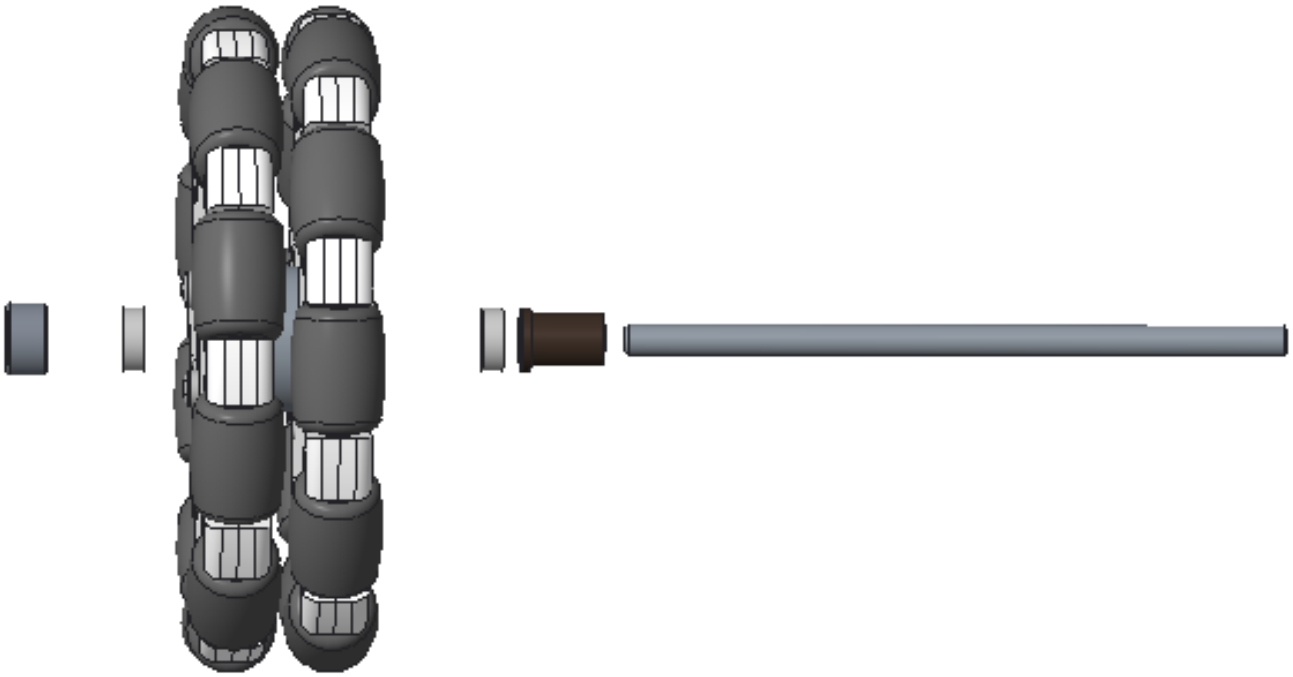
The images show only one wheel. Make two.

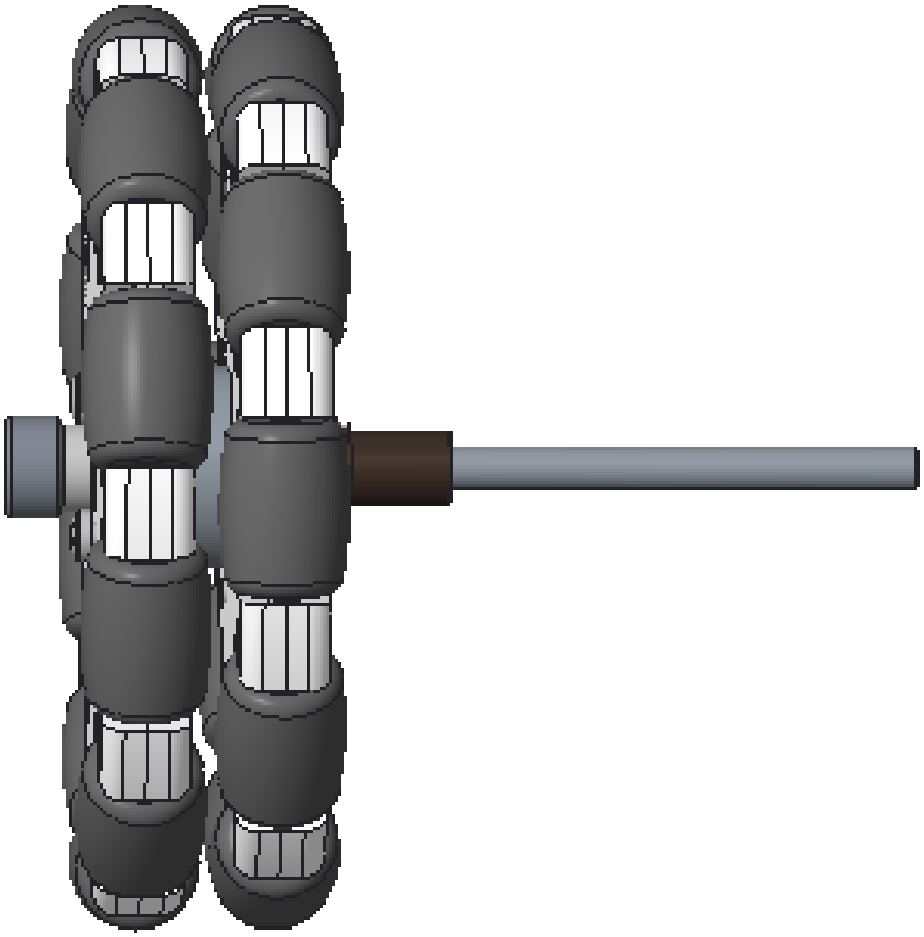


It’s very hard to see, but the bushing is inside the axle opening.

Step 3: Omni Wheel and Axle

axle set collar (1), 1/8” nylon spacer (2), bronze bushing (1), 100 mm axle (1)

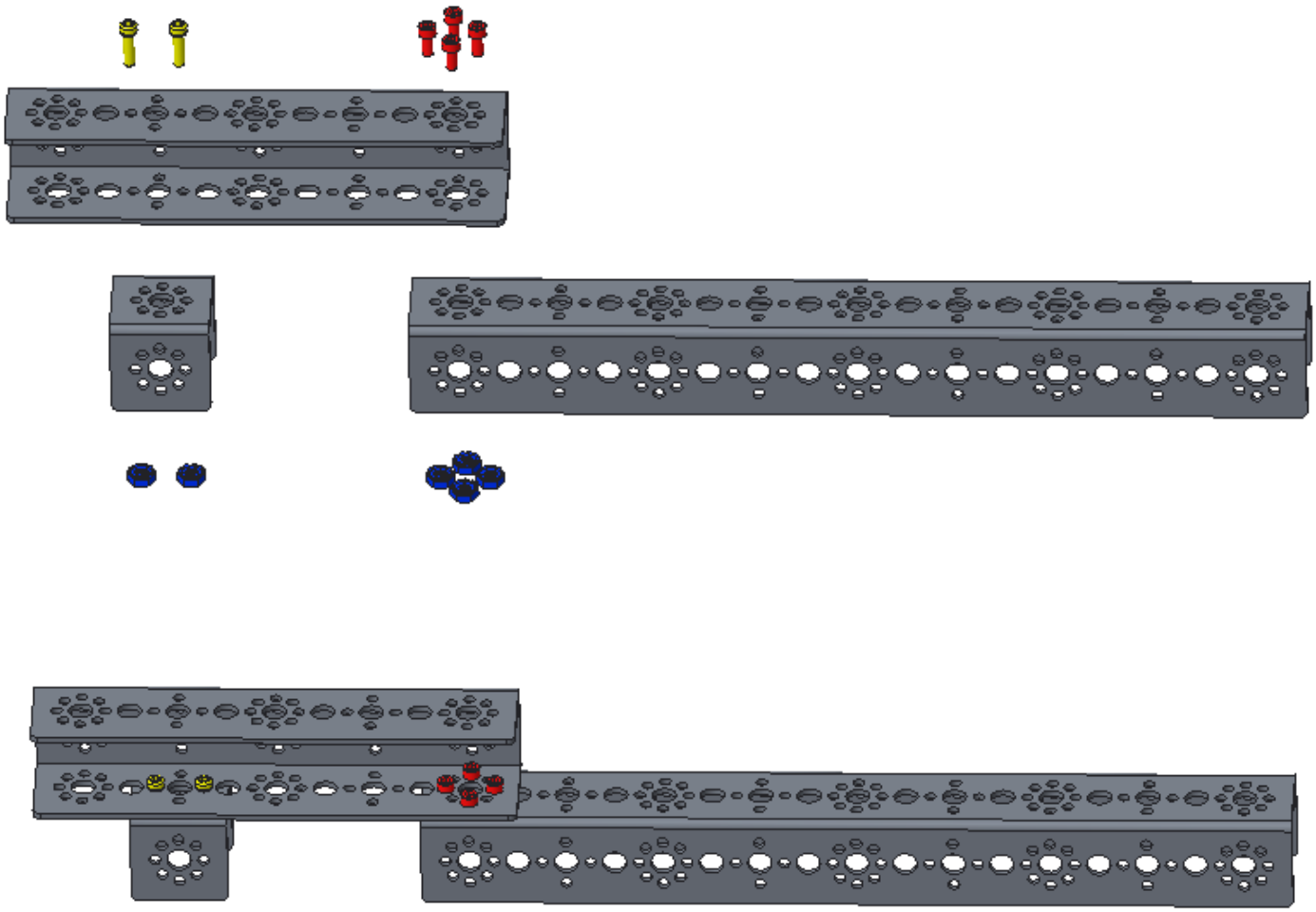




Right Rail Assembly

Step 1: Rail

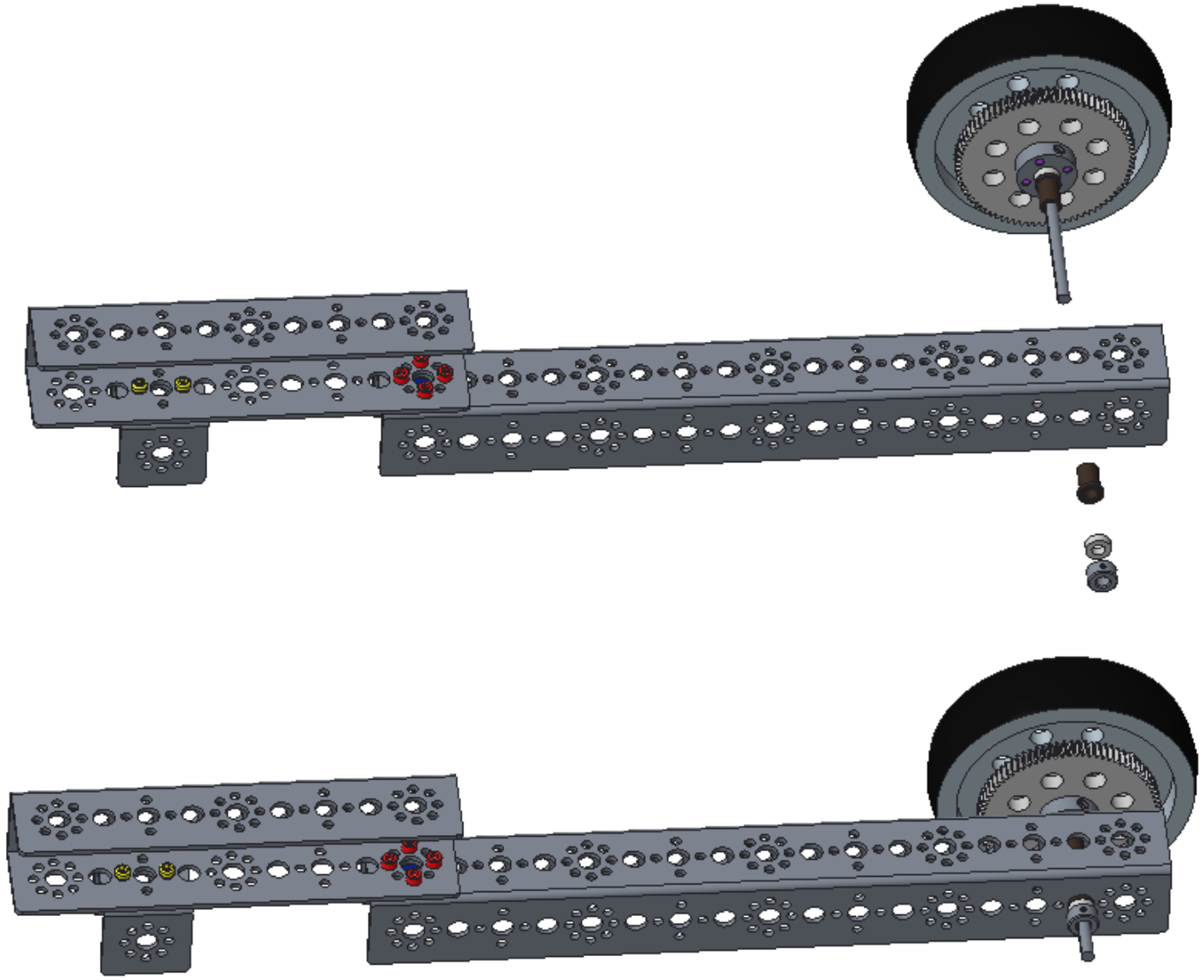
32 mm channel (1), 160 mm channel (1), 288 mm channel (1), 5/16" socket head cap screws (4), 1/2" socket head cap screws (2), keps nuts (6)



Step 2: Rail and Drive Wheel

assembly from the previous step, drive wheel assembly (1), 1/8" nylon spacer (1), axle collar (1), bronze bushing (1)

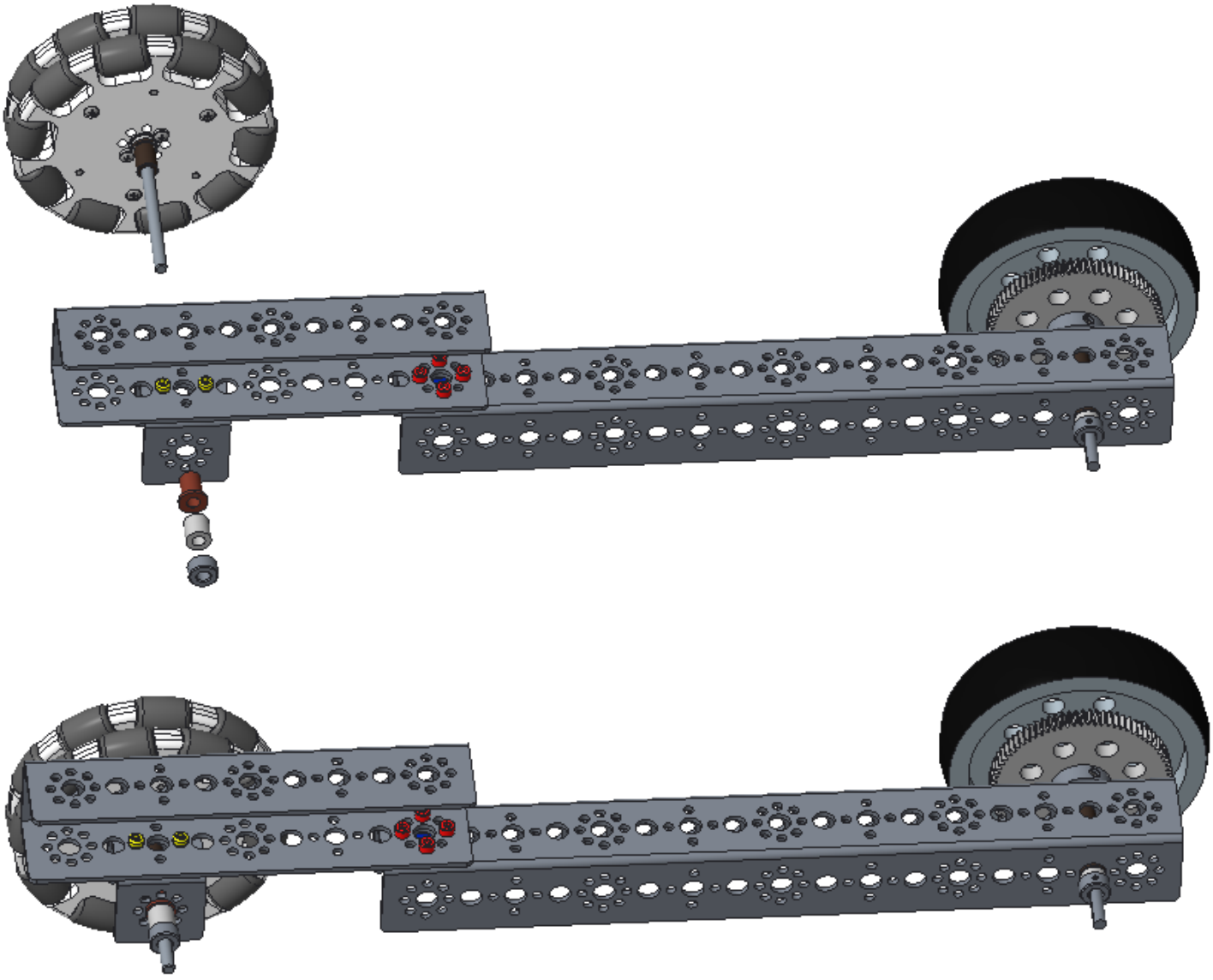
Order from top to bottom: drive wheel assembly (including its 1/8" spacer, bronze bushing), channel, bronze bushing, 1/8" spacer, axle collar



Step 3: Rail and Omni Wheels

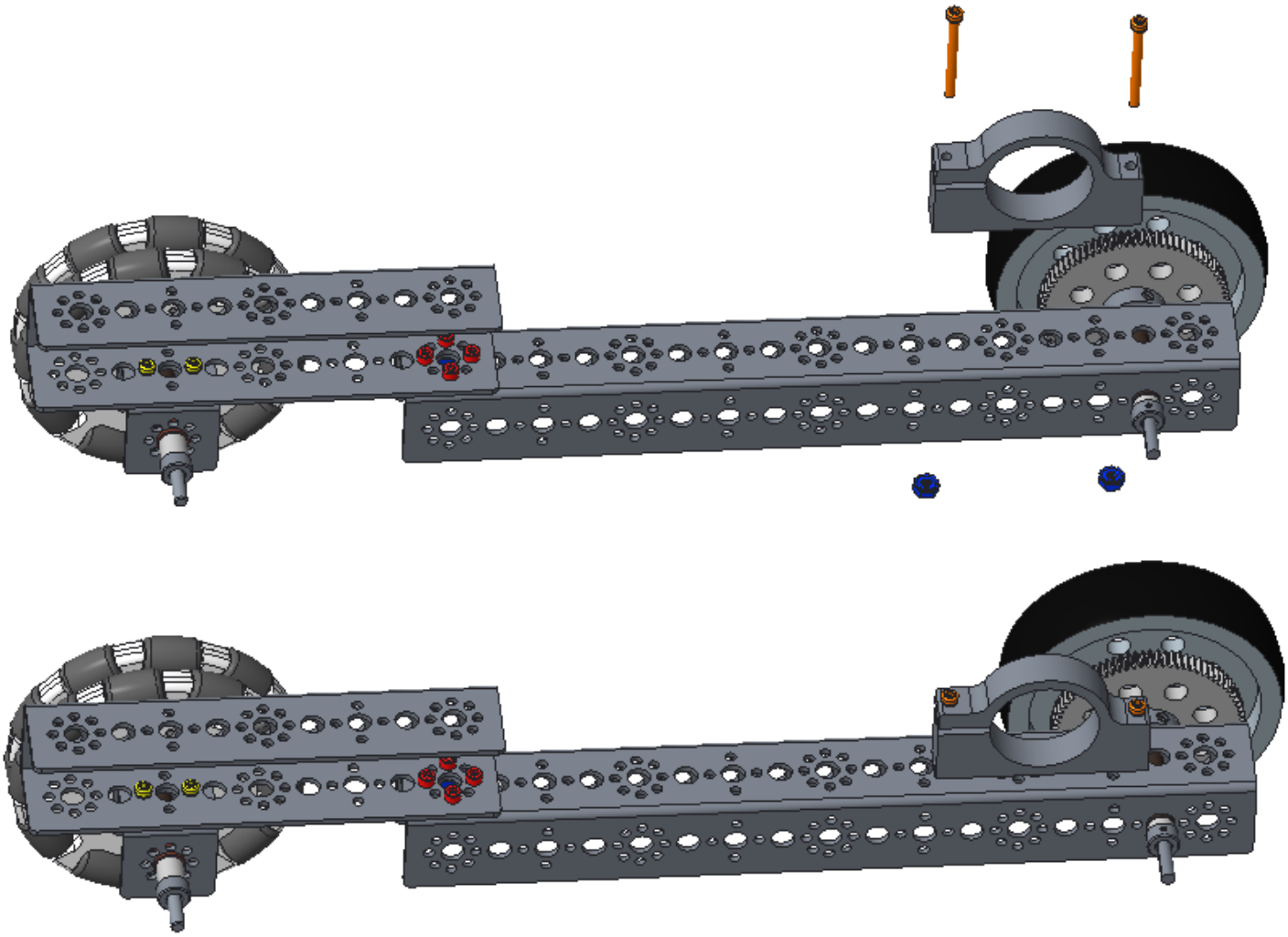
assembly from the previous step, omni wheel assembly (1), bronze bushing (1), 3/8" axle spacer, axle collar (2)

Order from top to bottom: omni wheel assembly (including its 1/8" spacer, bronze bushing), channel, bronze bushing, 3/8" spacer and axle collar



Step 4: Motor Mount

assembly from the previous step, motor mount (1) with included screws (2), keps nuts (2)

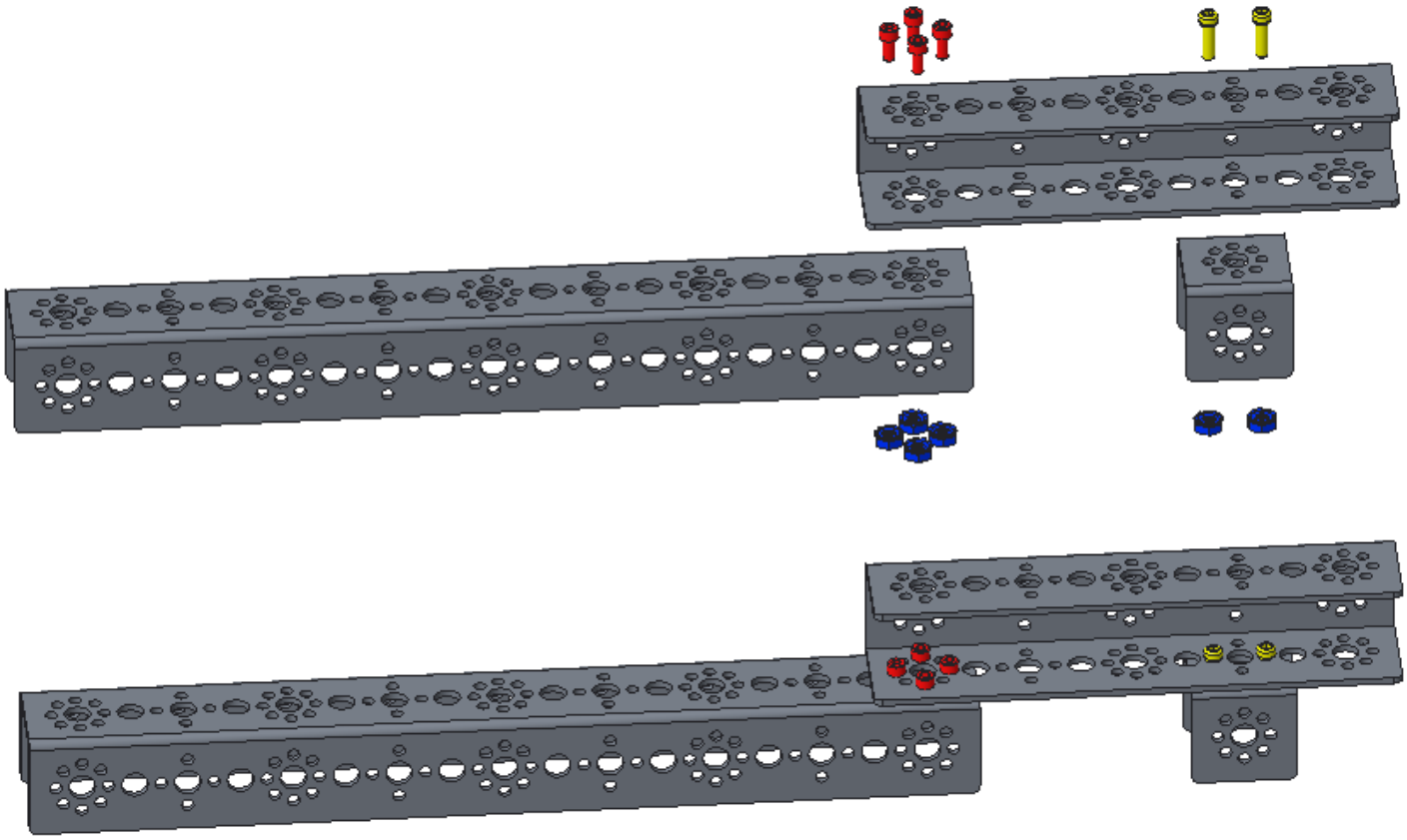


Left Rail Assembly

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

Step 1: Rail

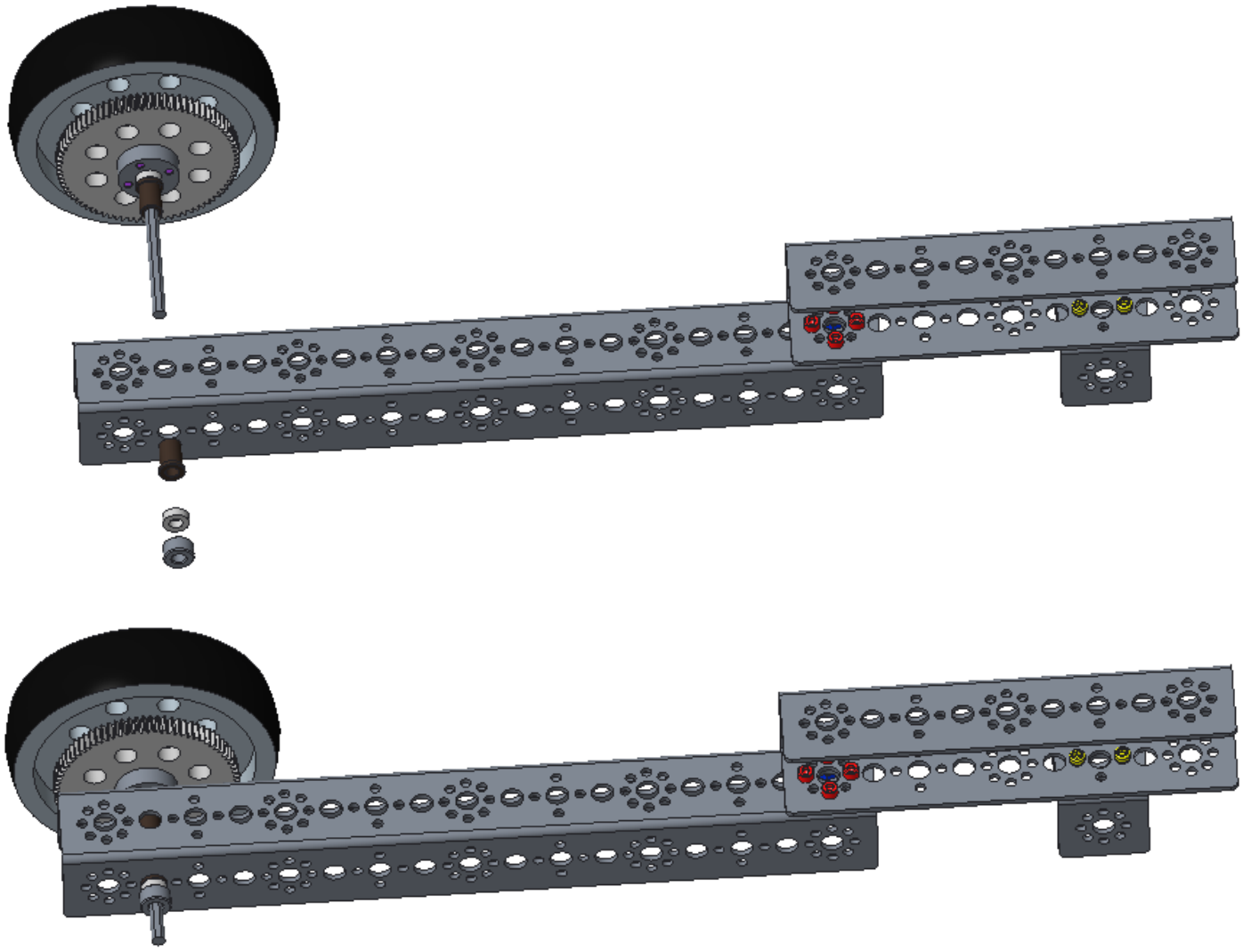
32 mm channel (1), 160 mm channel (1), 288 mm channel (1), 5/16" socket head cap screws (4), 1/2" socket head cap screws (2), keps nuts (6)



Step 2: Rail and Drive Wheel

assembly from the previous step, drive wheel assembly (1), bronze bushing (2), 1/8" axle spacer (2), axle collar (1)

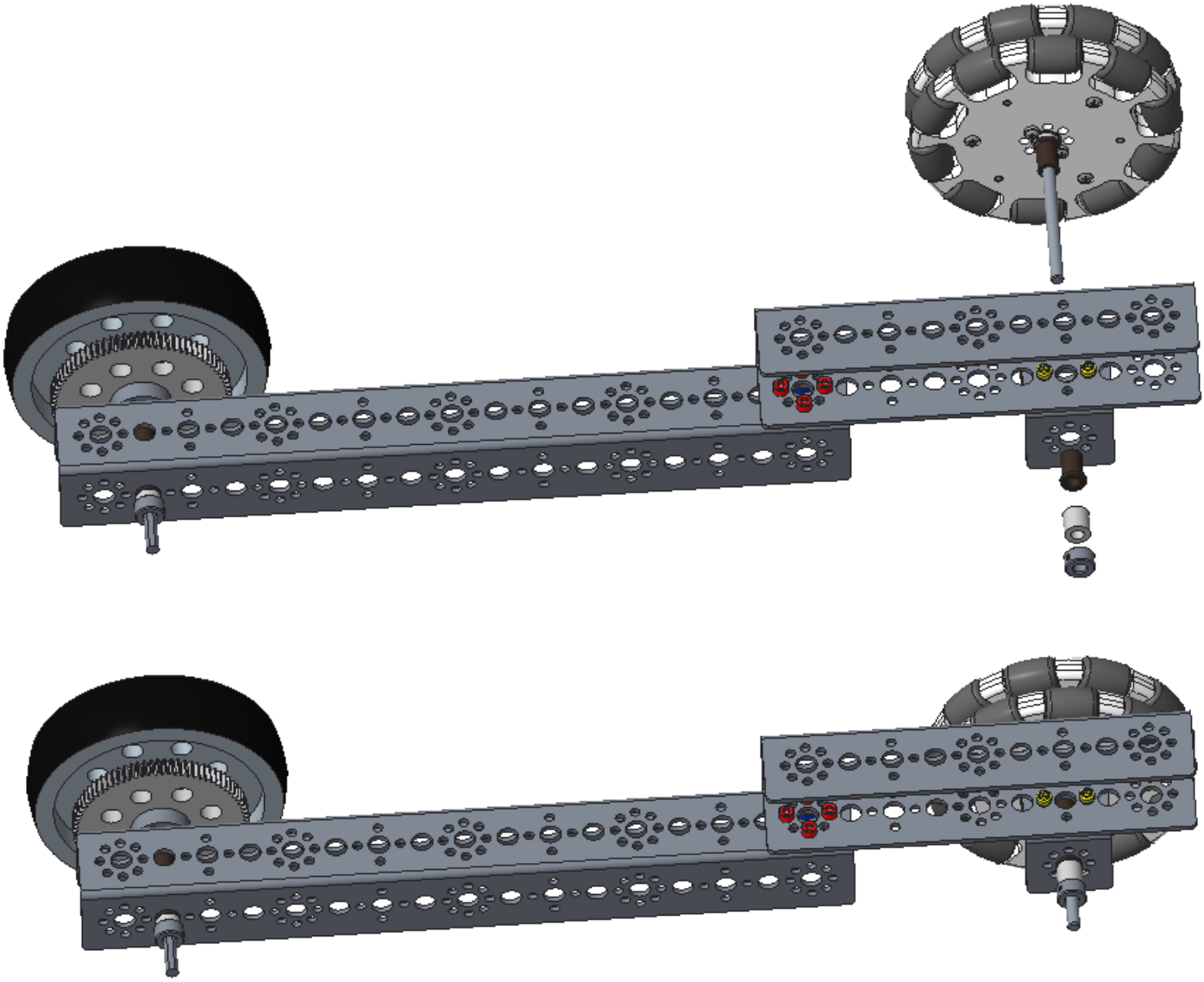
Order from top to bottom: drive wheel assembly (including its 1/8" spacer, bronze bushing), channel, bronze bushing, 1/8" spacer, axle collar



Step 3: Rail and Omni Wheels

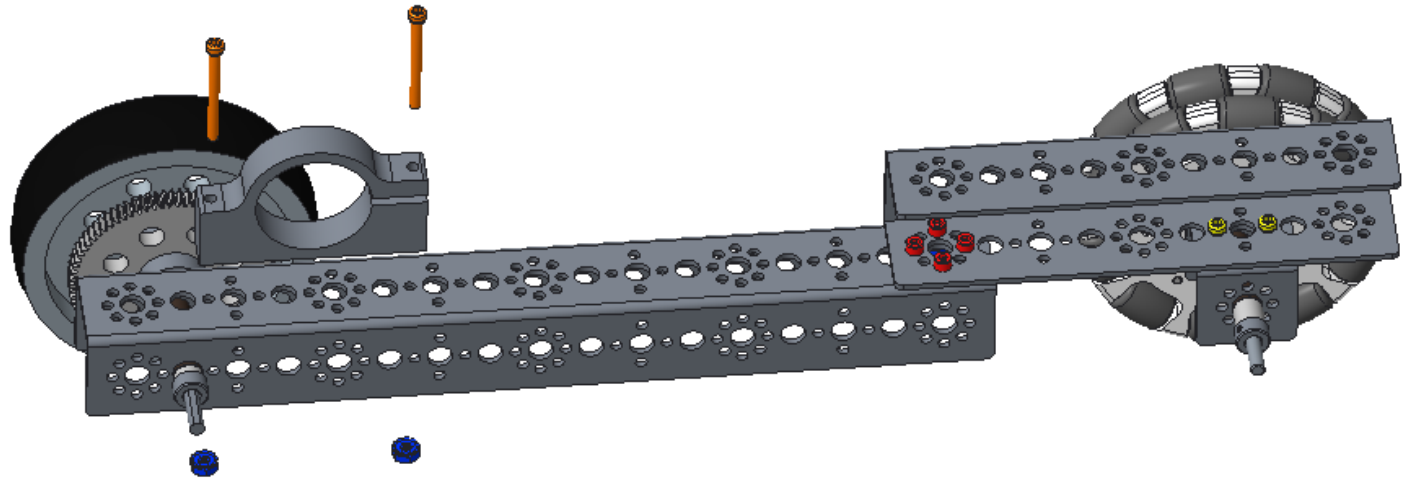
assembly from the previous step, omni wheel assembly (1), bronze bushing (1), 3/8" axle spacer, axle collar (2), 100 mm axle (1)

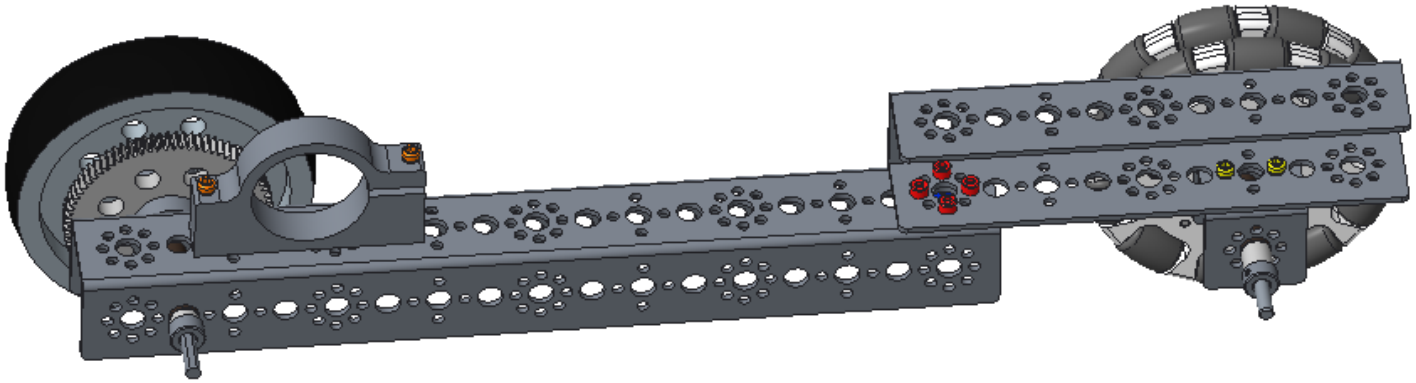
Order from top to bottom: omni wheel assembly (including its 1/8" spacer, bronze bushing), channel, bronze bushing, 3/8" spacer, axle collar



Step 4: Motor Mount

assembly from the previous step, motor mount (1) with included screws (2), keps nuts (2)



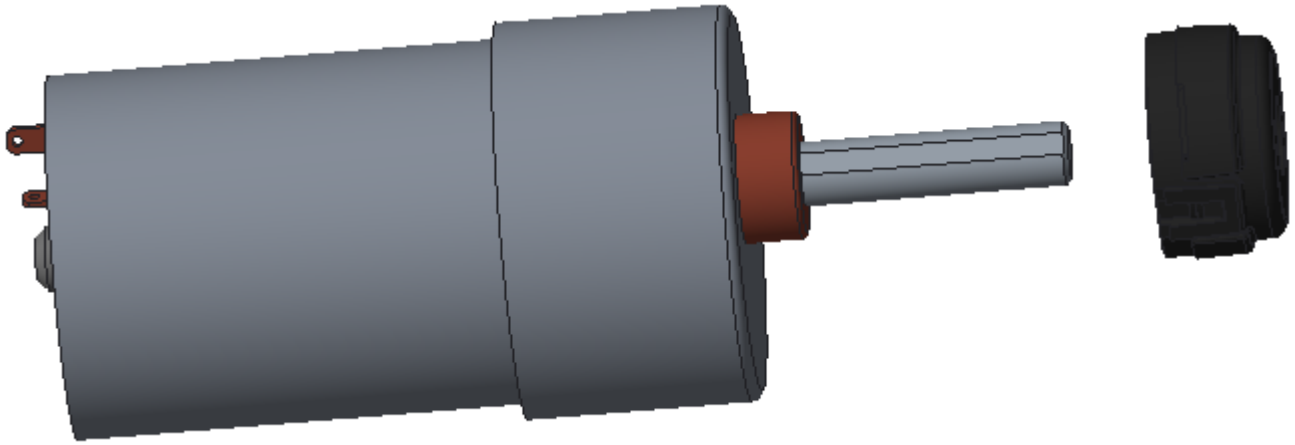


Motor Hub and Gear Assemblies
Make three.

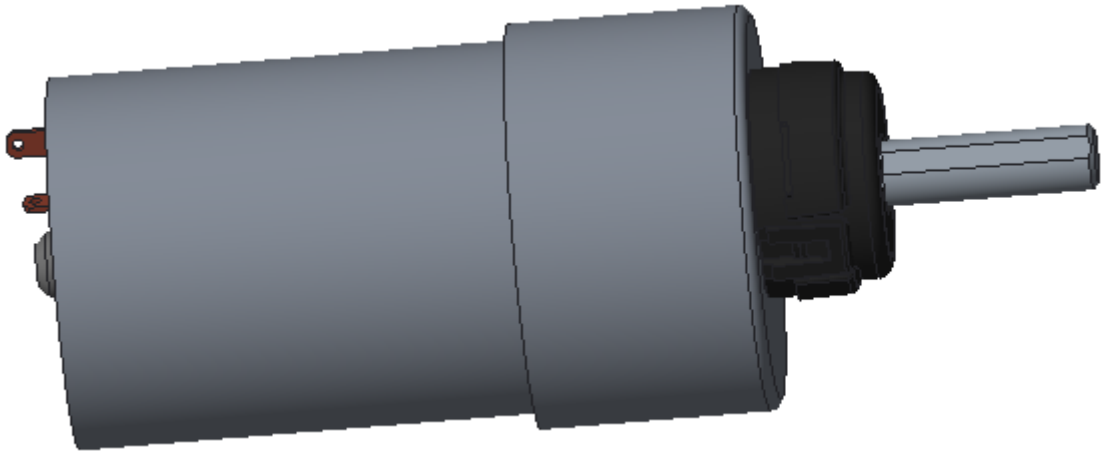
Step 1: Motor Encoders
Make two.

DC motor (1), encoder (1)

Refer to the instructions from the encoder package to install the encoder onto the motor. Encoder styles vary, so the one in the kit of parts may not look like the one in this document.



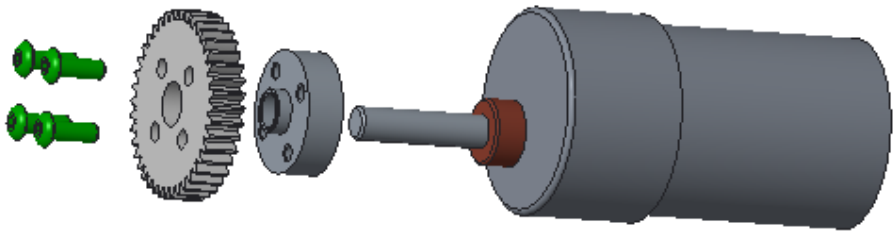
These images show only one motor. Make two.

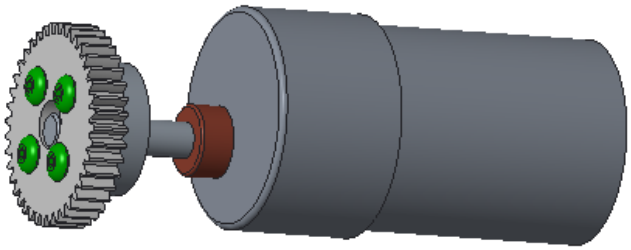


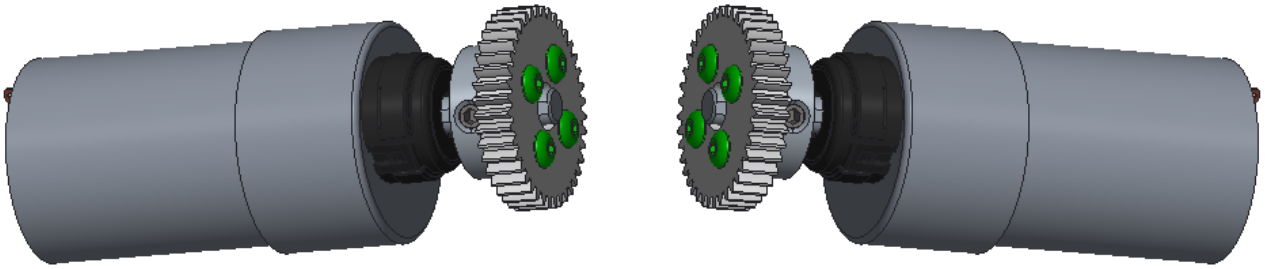
Step 2: Gear and DC Motor

40-tooth gear (3), motor shaft hub (3). button head cap screws (12), assemblies from the previous step (2), DC motor (1)

Note: Install the hubs as close as possible to the encoders without touching.



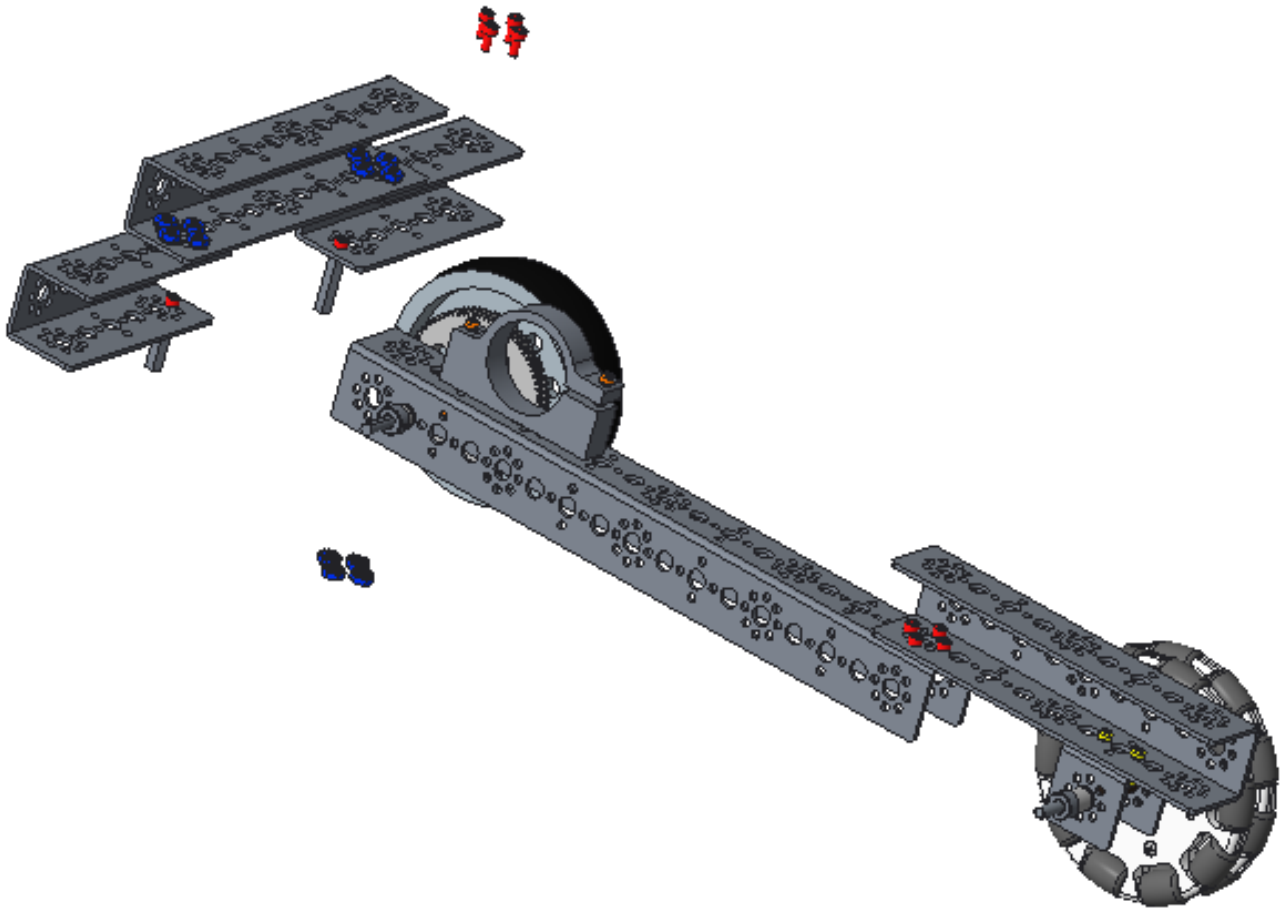


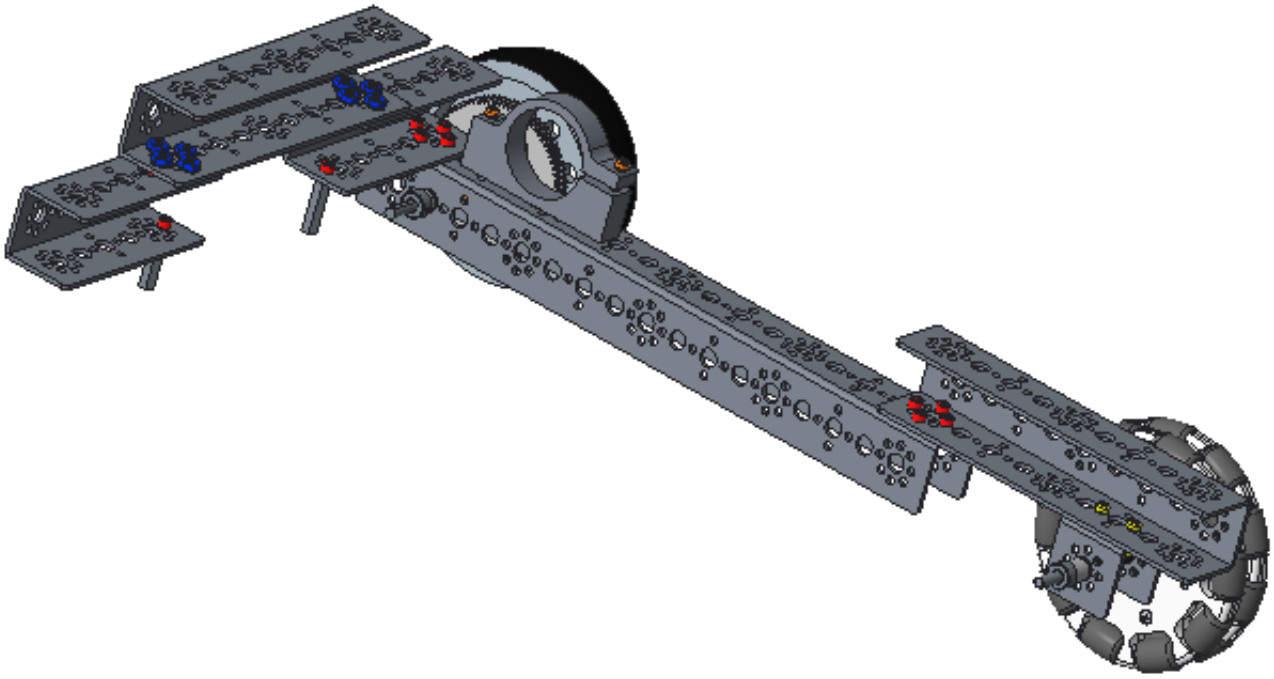


Chassis

Step 1: Left Rail and Back Cross Bar

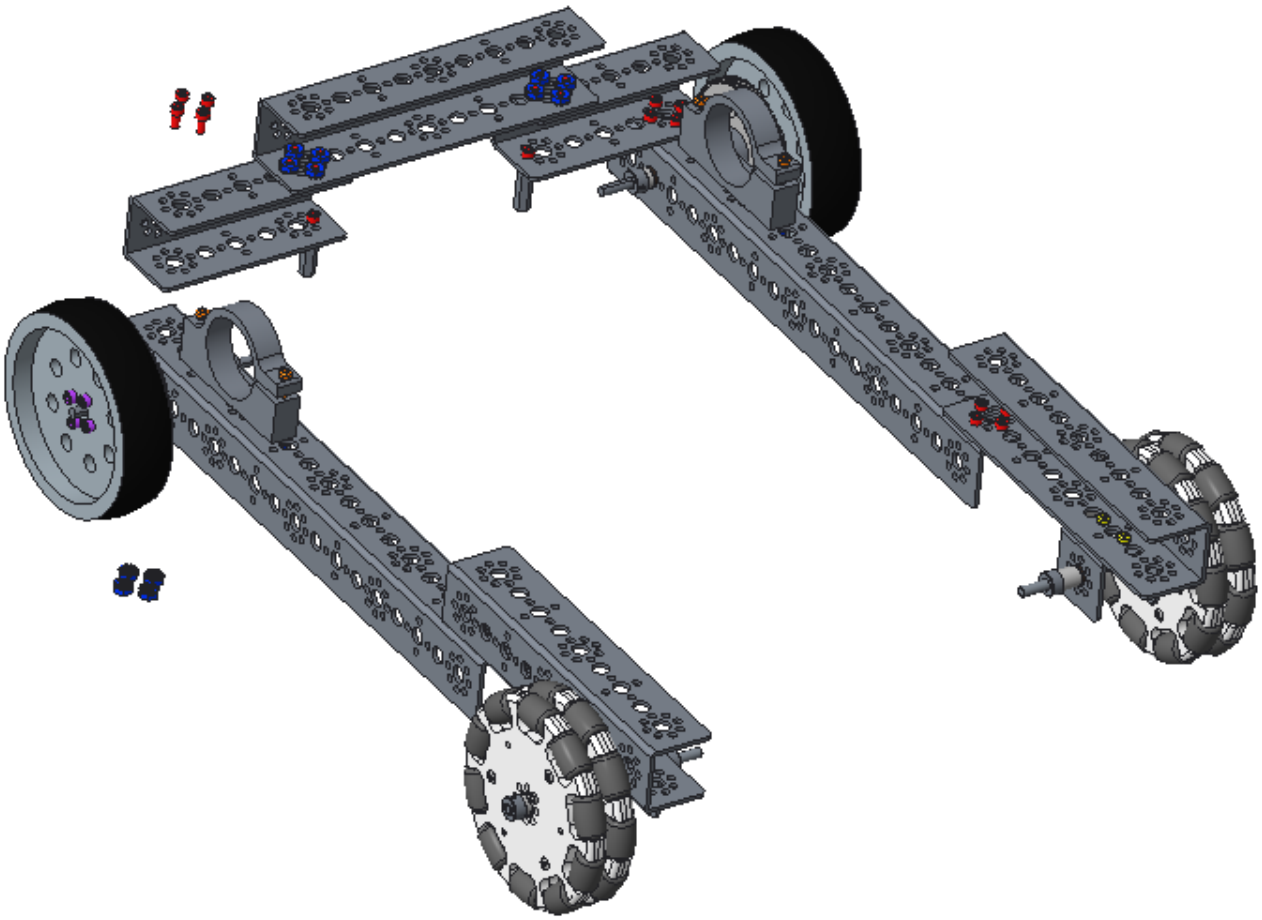
left chassis rail assembly (1), cross bar assembly (1), 5/16" socket head cap screws (4), keps nuts (4)

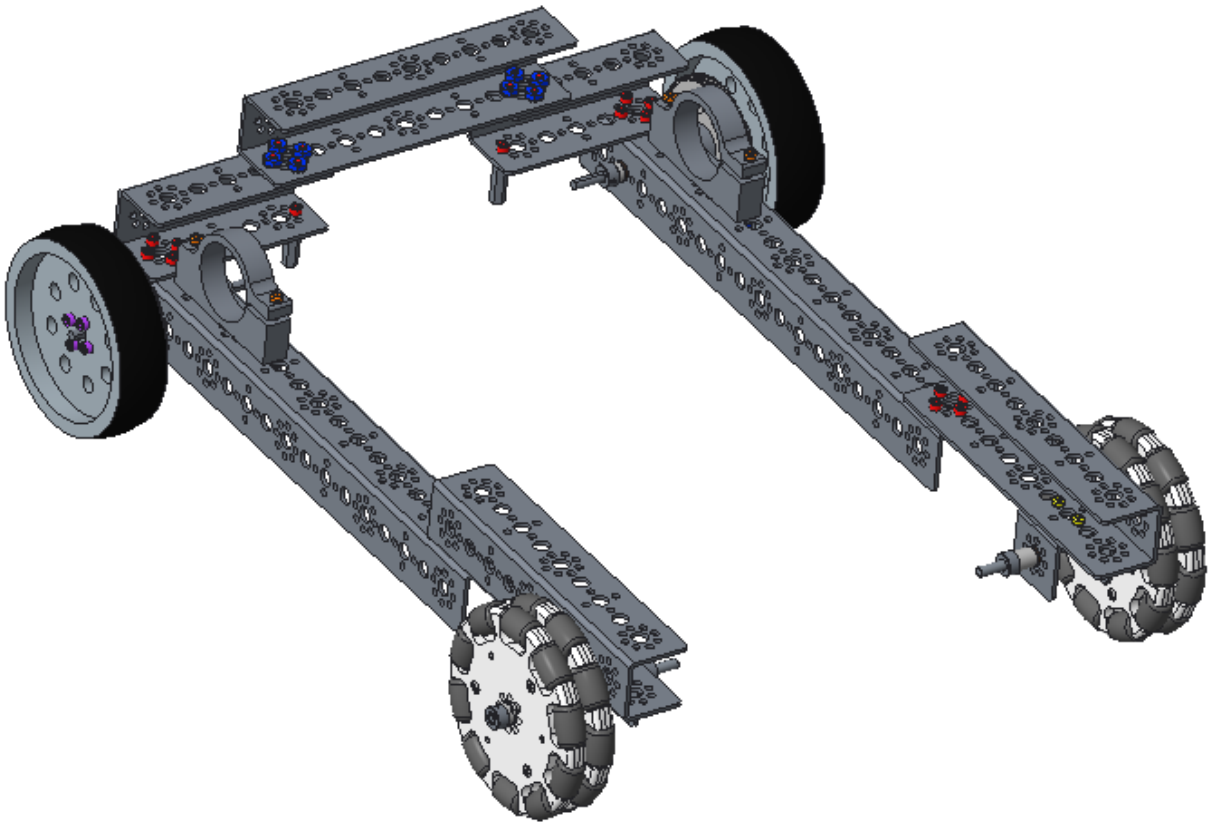




Step 2: Adding the Right Rail

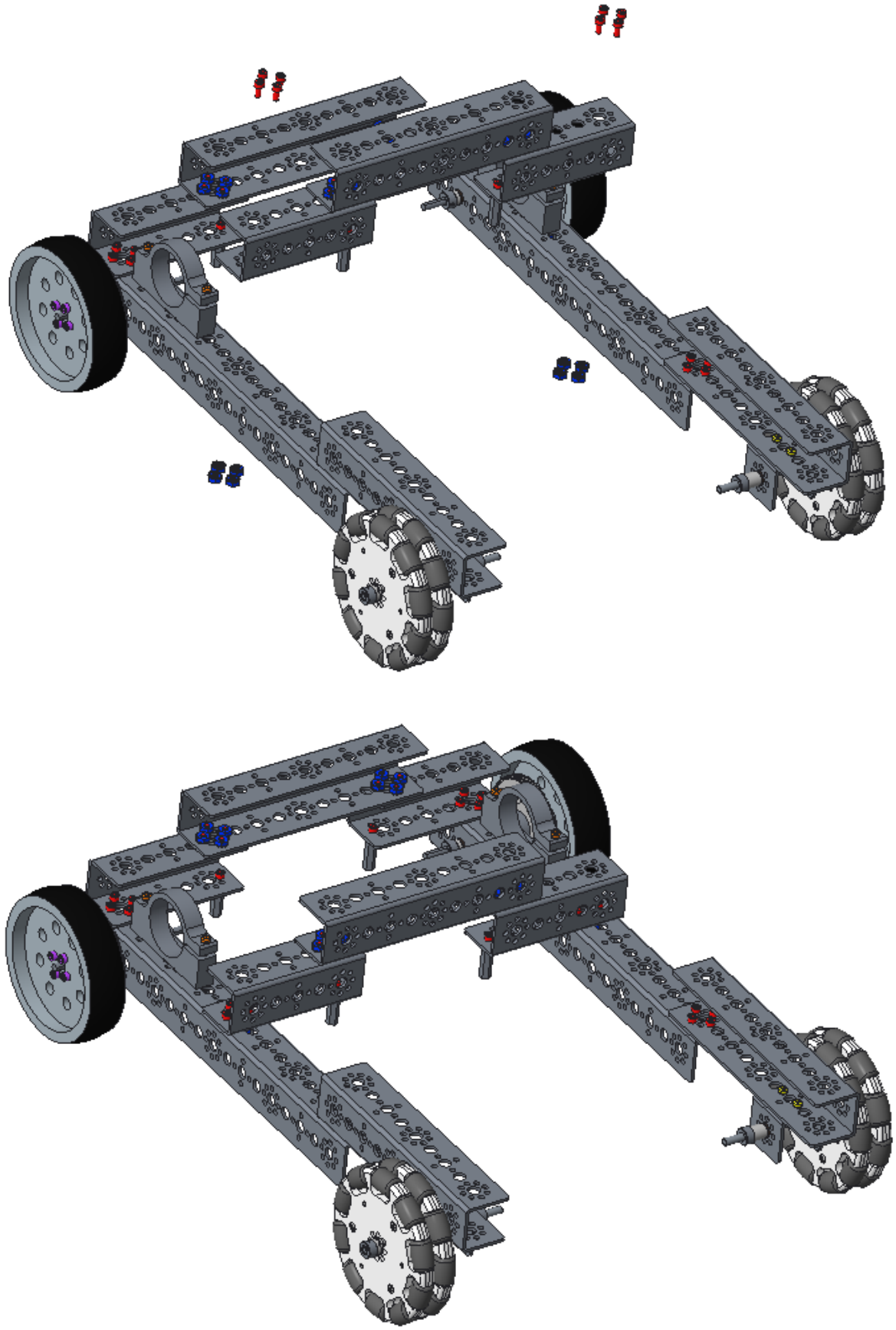
assembly from the previous step, right chassis rail assembly (1), 5/16" socket head cap screws (4), keps nuts (4)





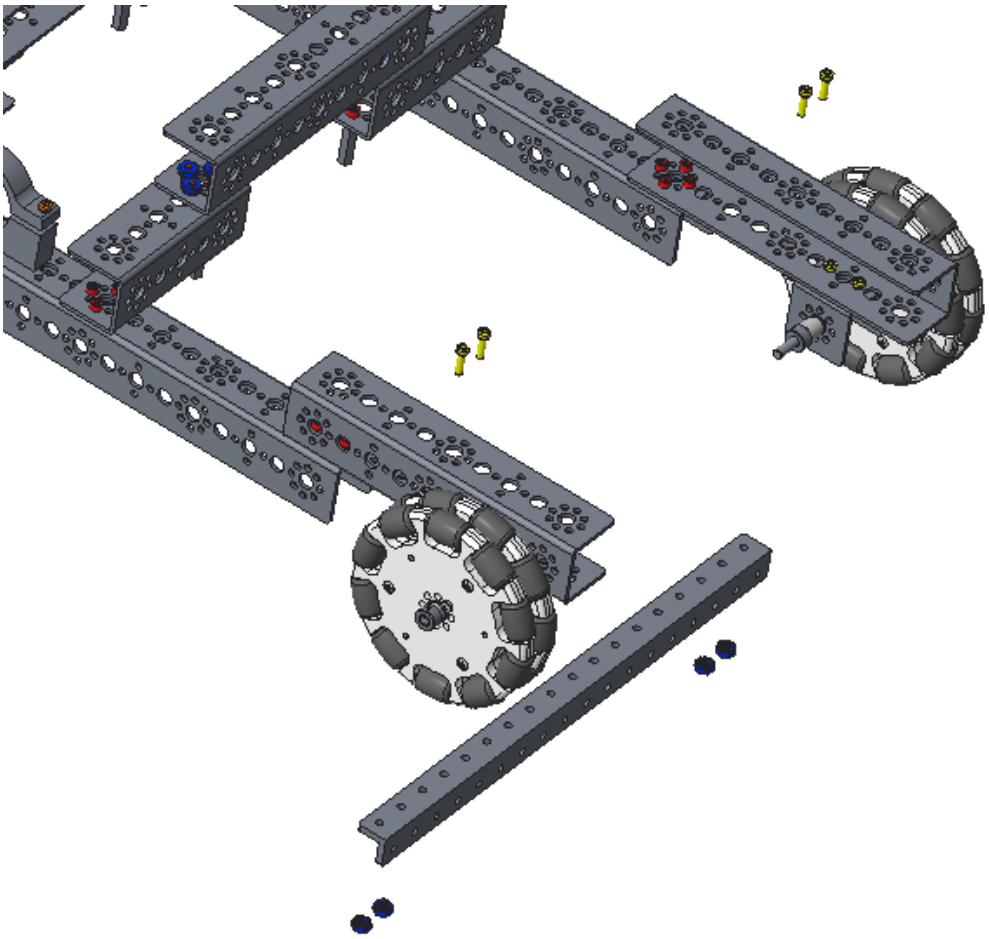
Step 3: Adding the Front Cross Bar

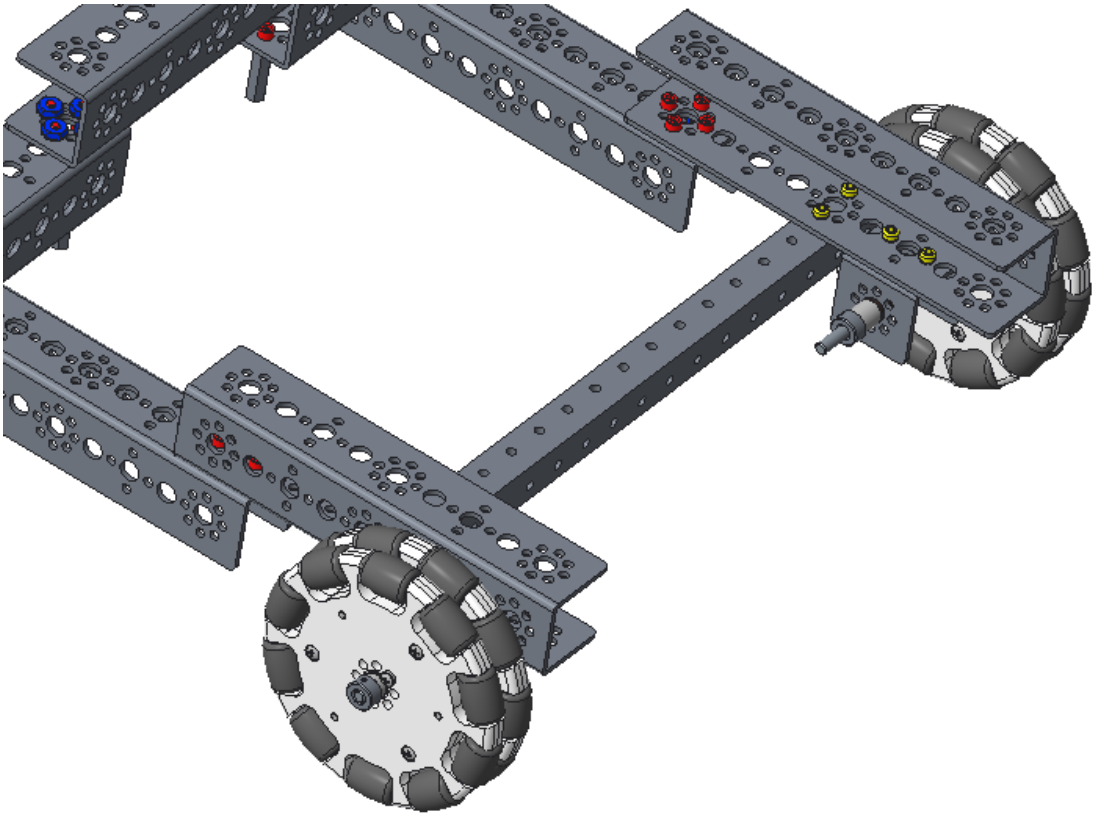
assembly from the previous step, cross bar assembly (1), 5/16" socket head cap screws (8), keps nuts (8)



Step 4: Adding the Front Brace

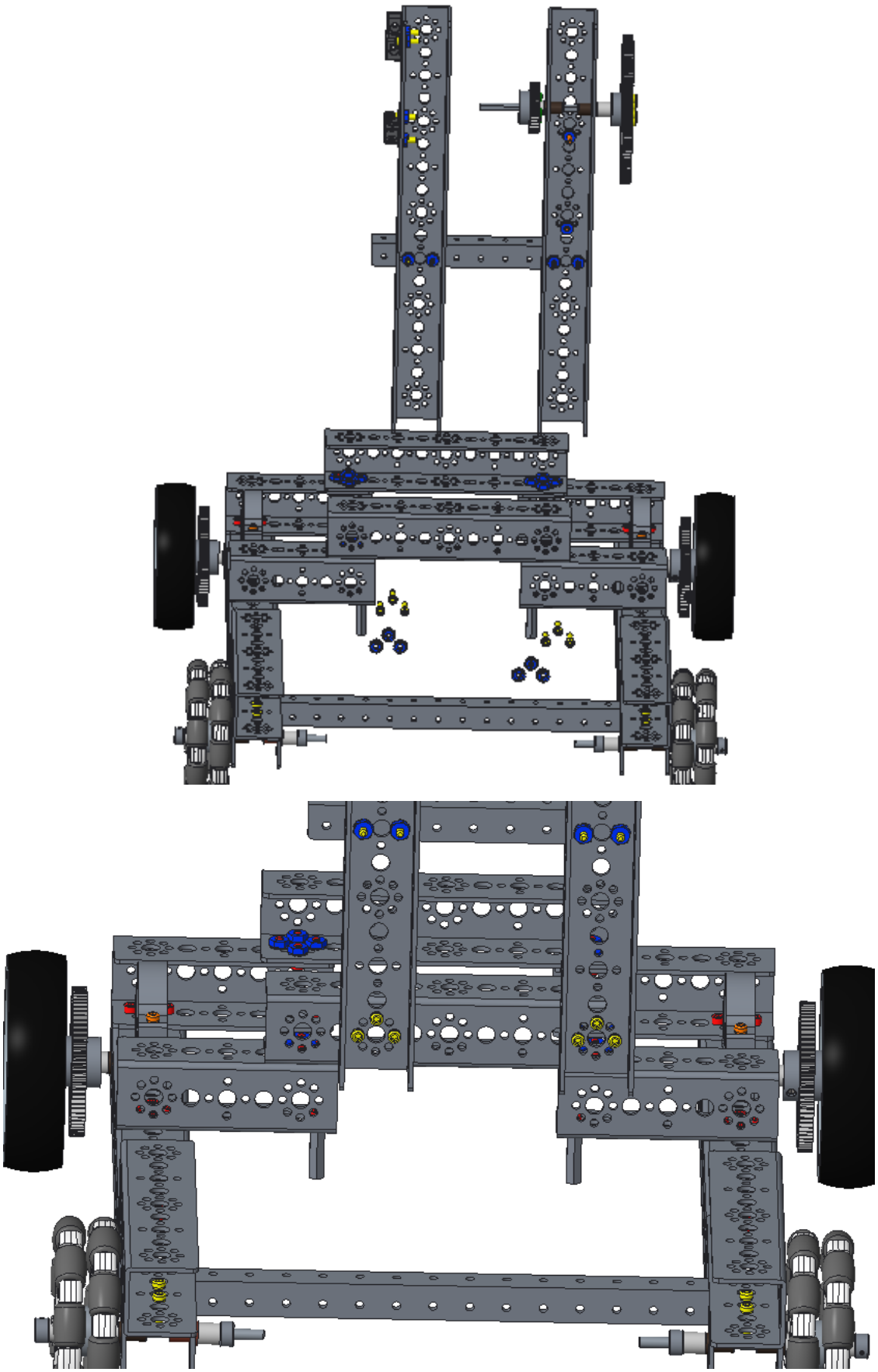
assembly from the previous step, 288 mm angle (1), 1/2" socket head cap screws (4), keps nuts (4)





Step 5: Adding the Tower

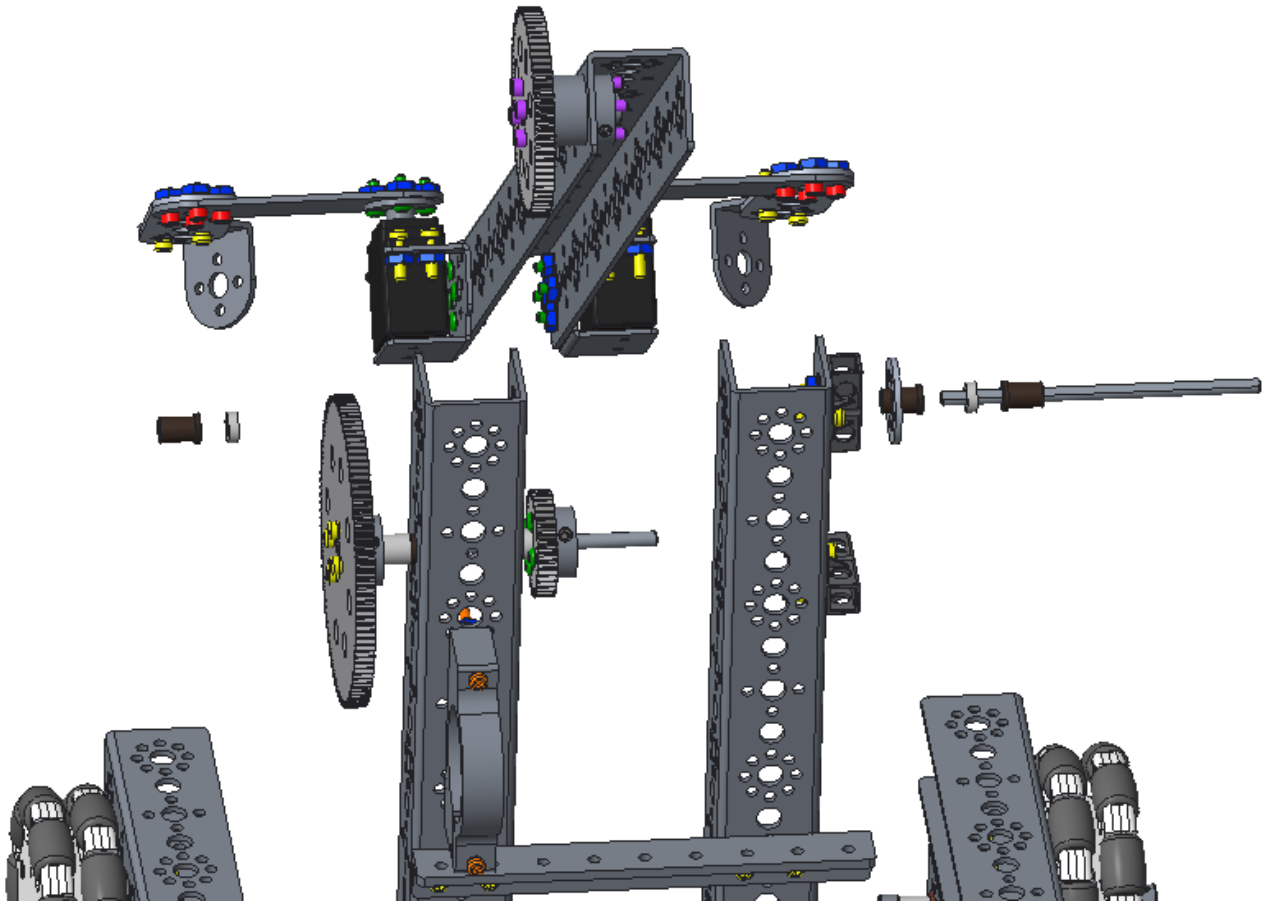
assembly from the previous step, tower assembly, 1/2" socket head cap screws (6), keps nuts (6)

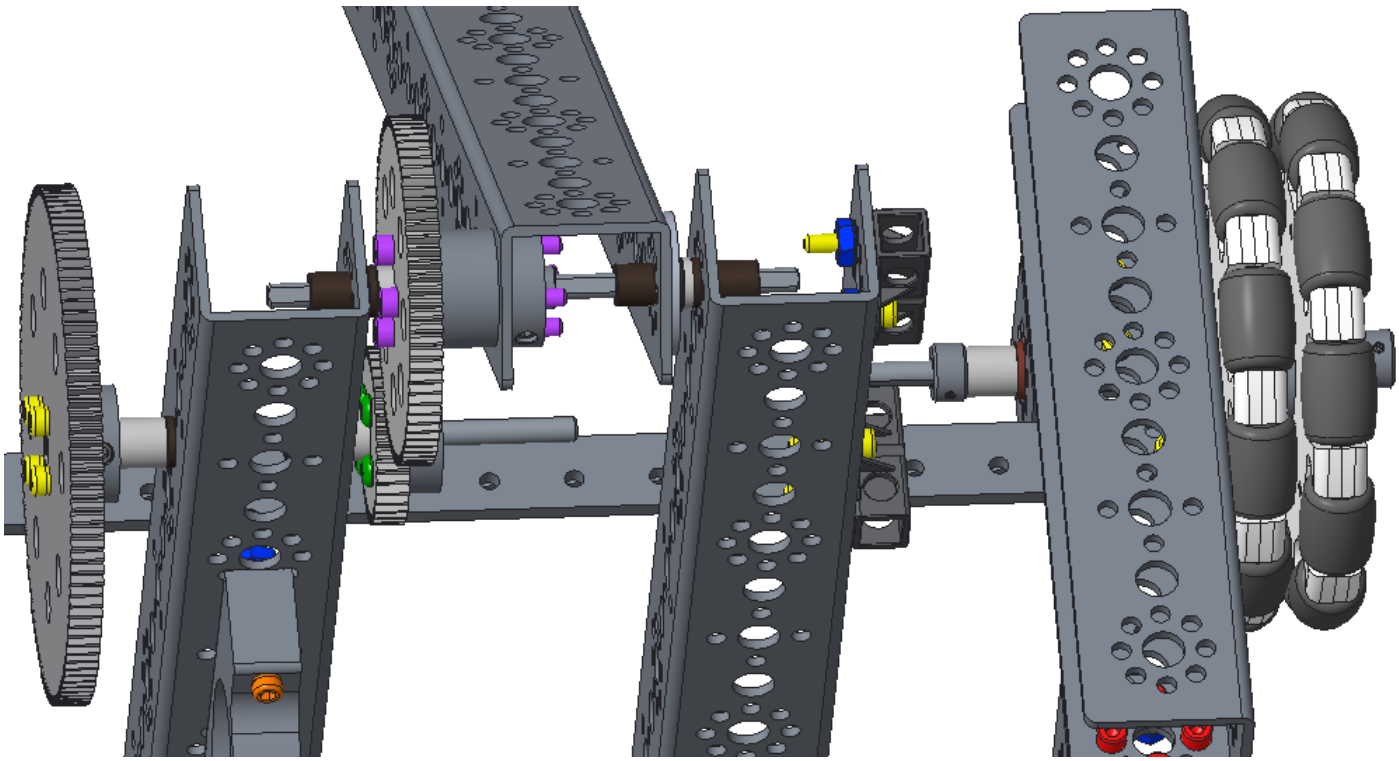


Step 6: Adding the Arm

assembly from the previous step, arm assembly

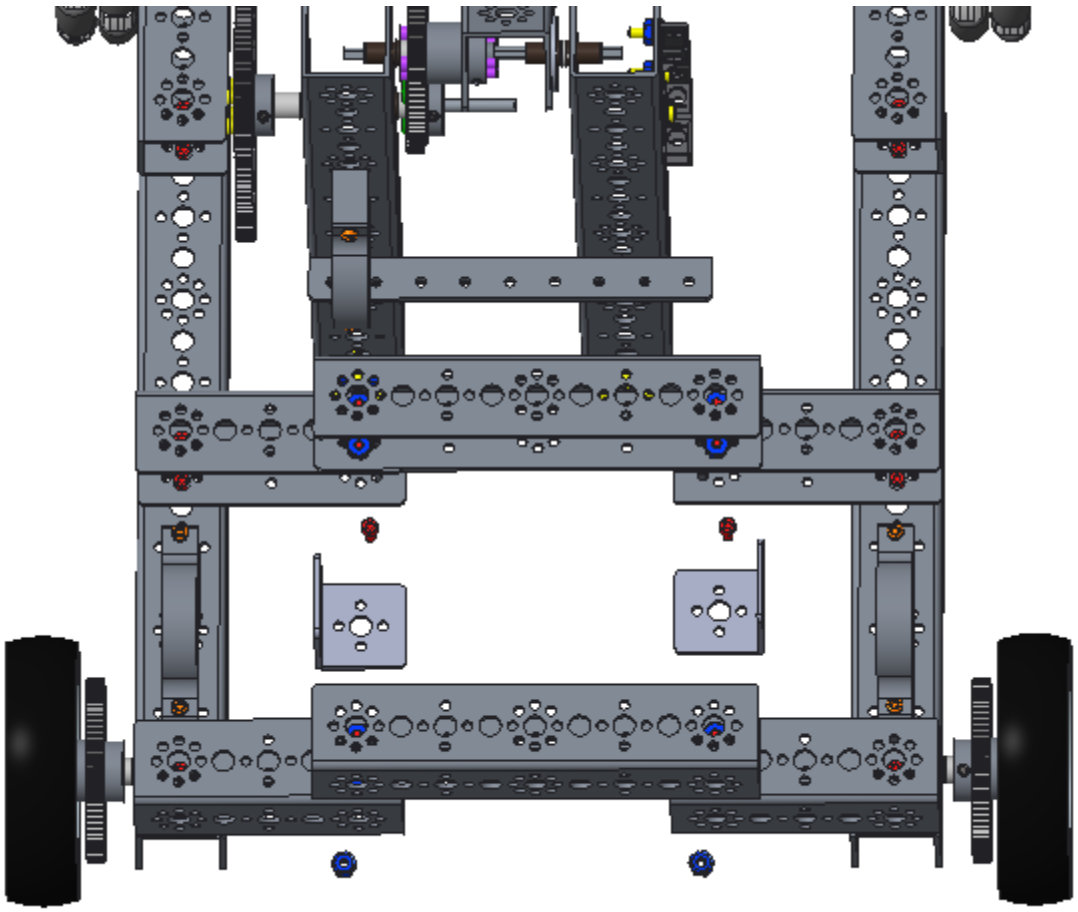
Order from left to right: channel, bronze bushing, 1/8" nylon spacer, arm, flat spacer, bronze bushing, 1/8” nylon spacer, bronze bushing, channel

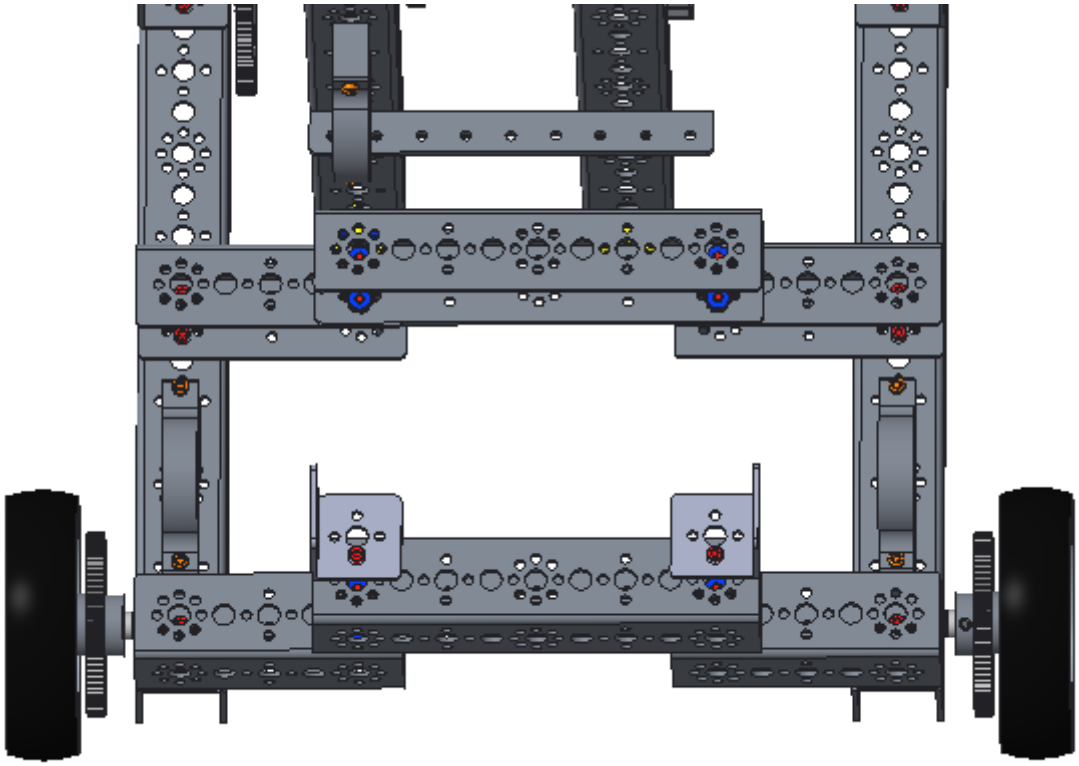




Step 7: Adding the Expansion Hub Support Brackets

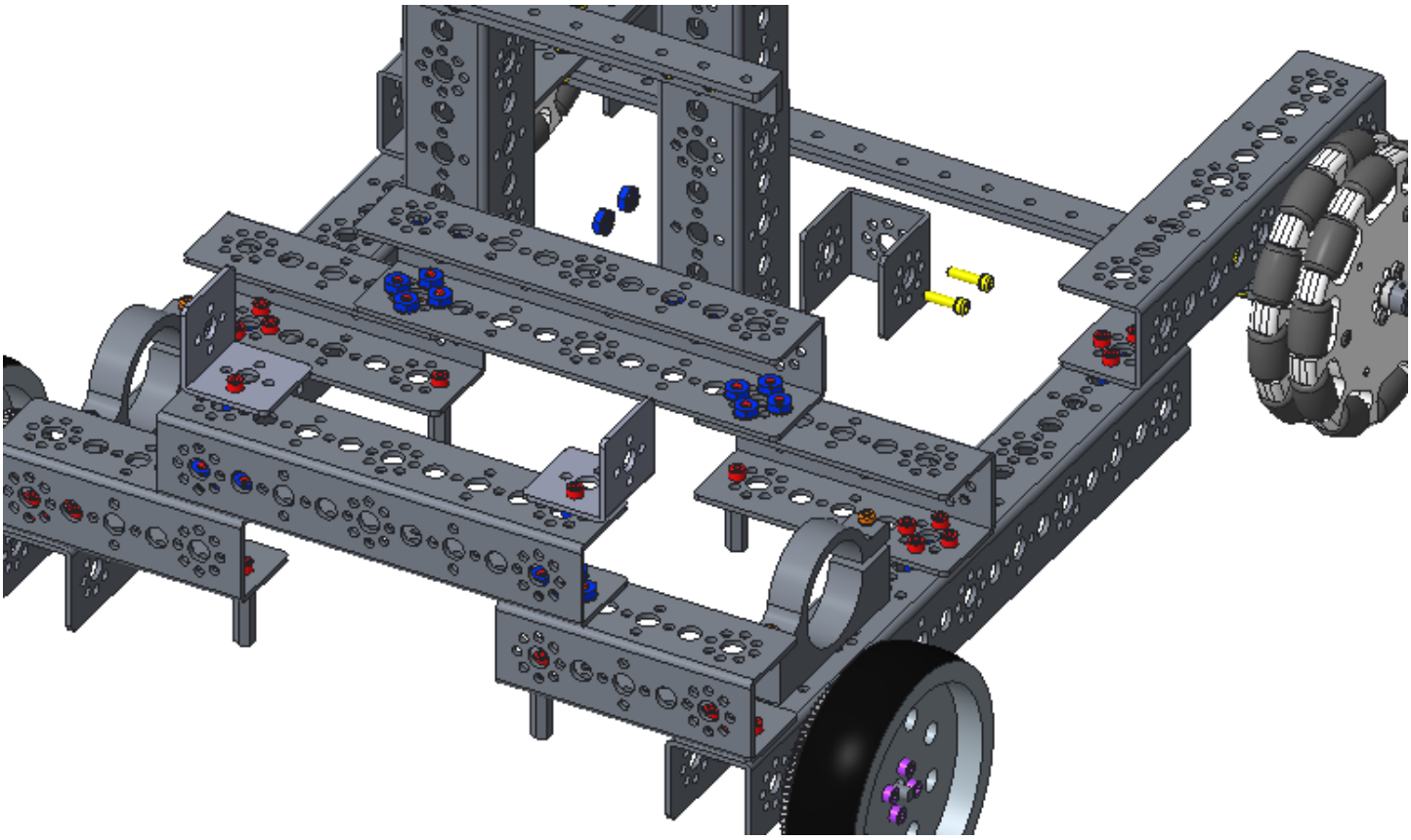
assembly from the previous step, inside corner bracket (2), 1/2" socket head cap screw (2), keps nut (2)

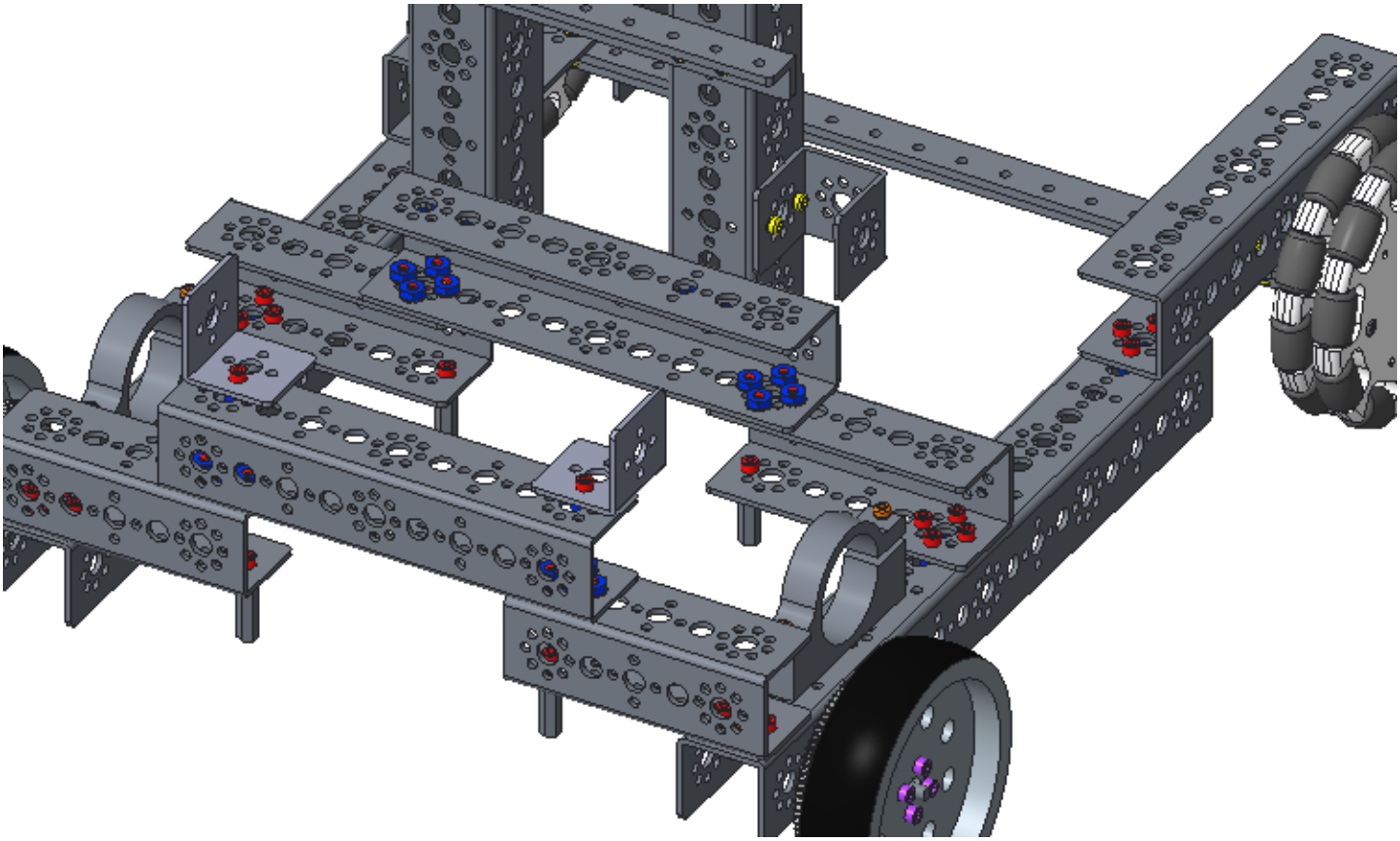




Step 8: Adding the Right Side Panel Support Bracket

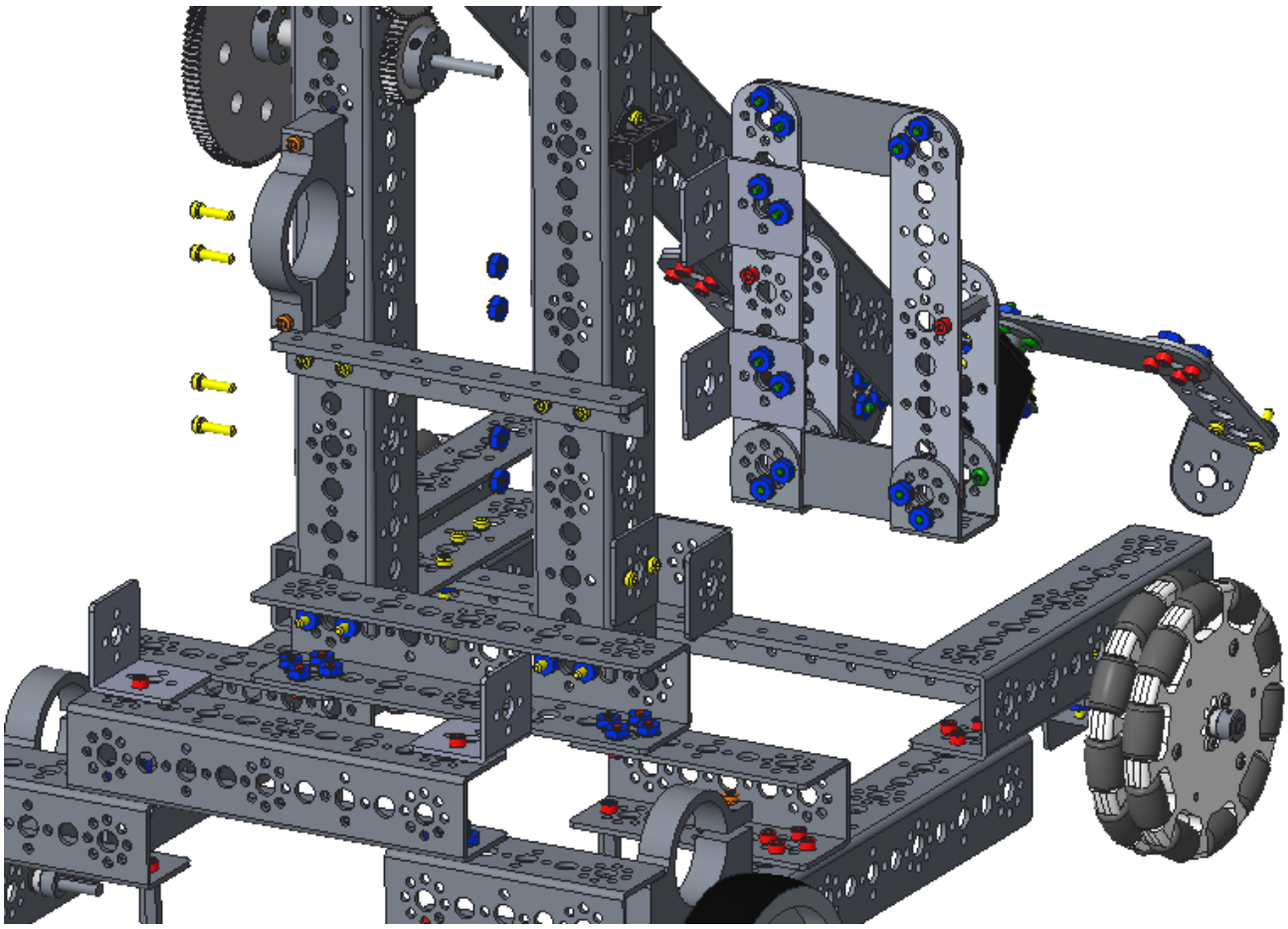
assembly from the previous step, 32 mm channel (1), 1/2” socket head cap screws (2), keps nuts (2)

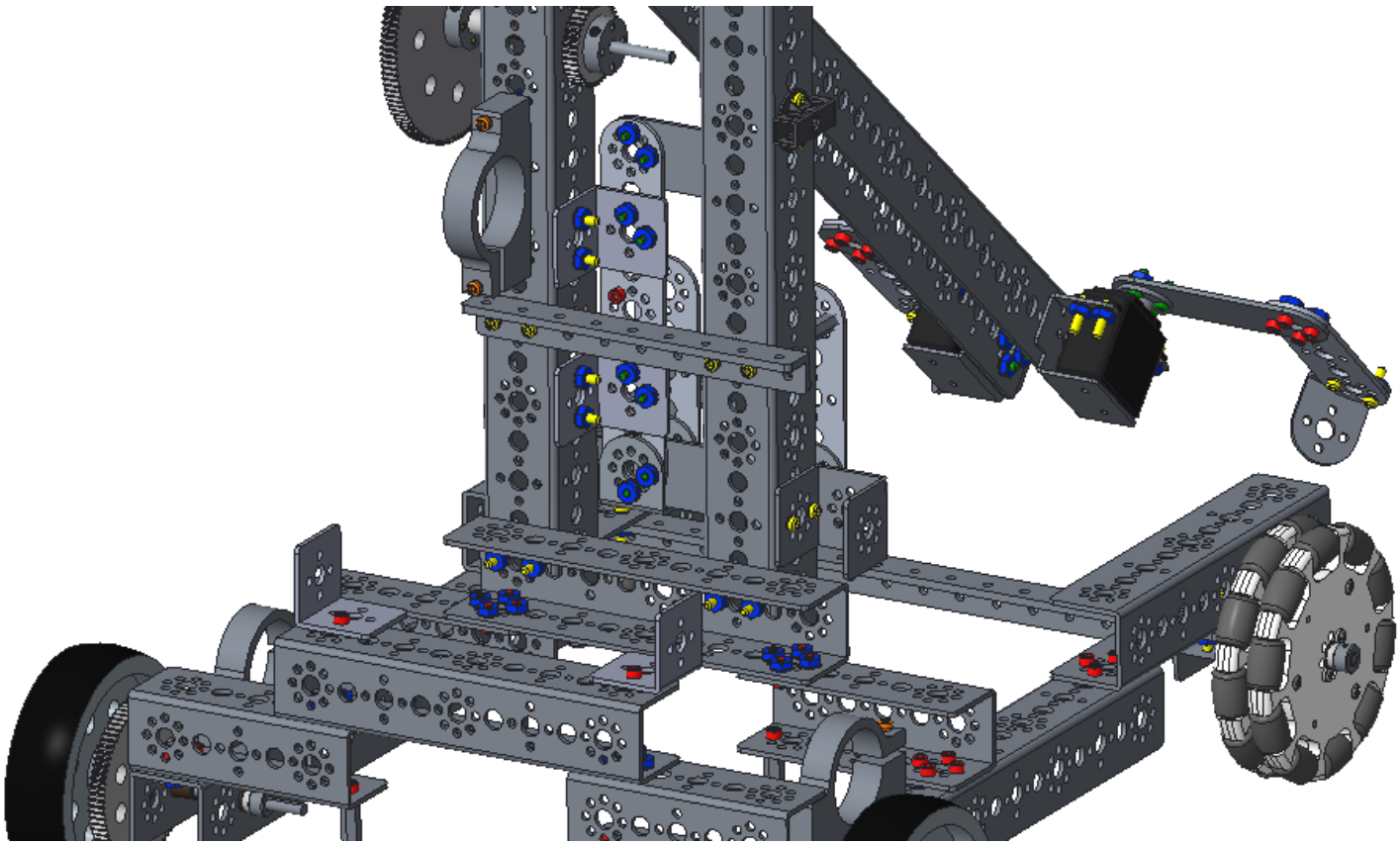




Step 9: Adding the Phone Holder

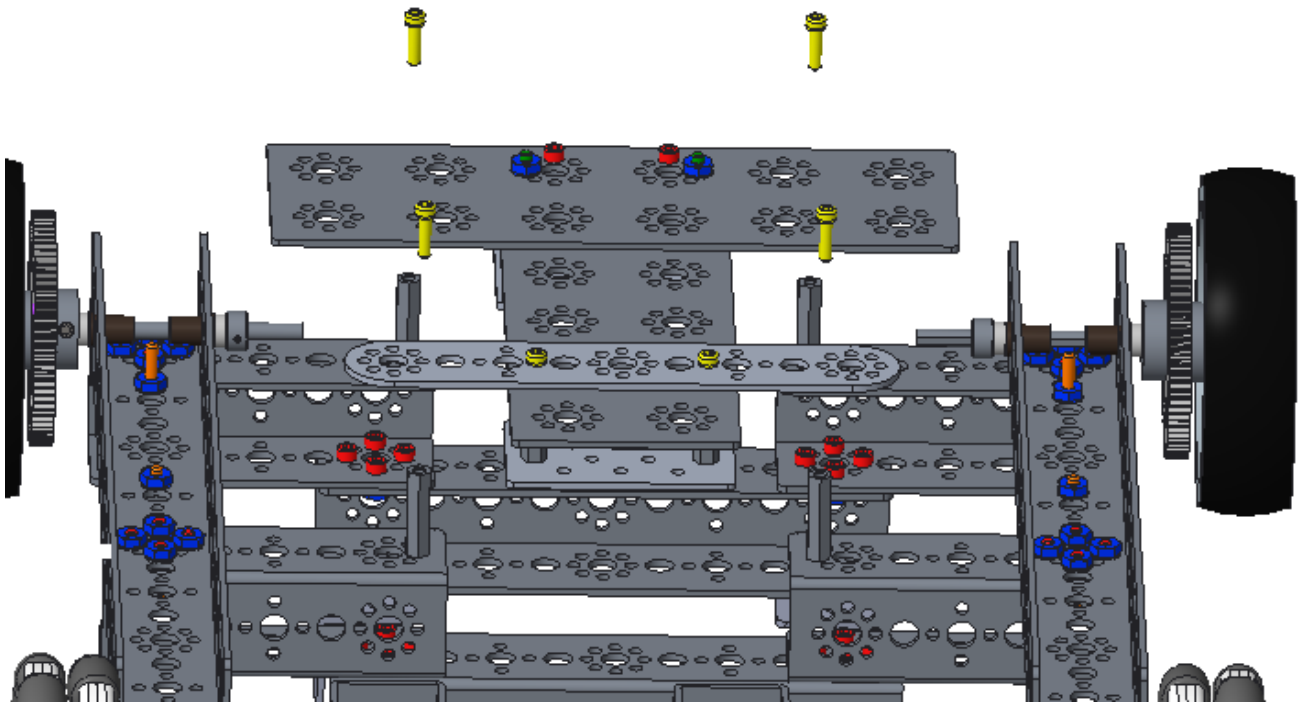
assembly from the previous step, phone holder assembly, 1/2” socket head cap screws (4), keps nut (4)

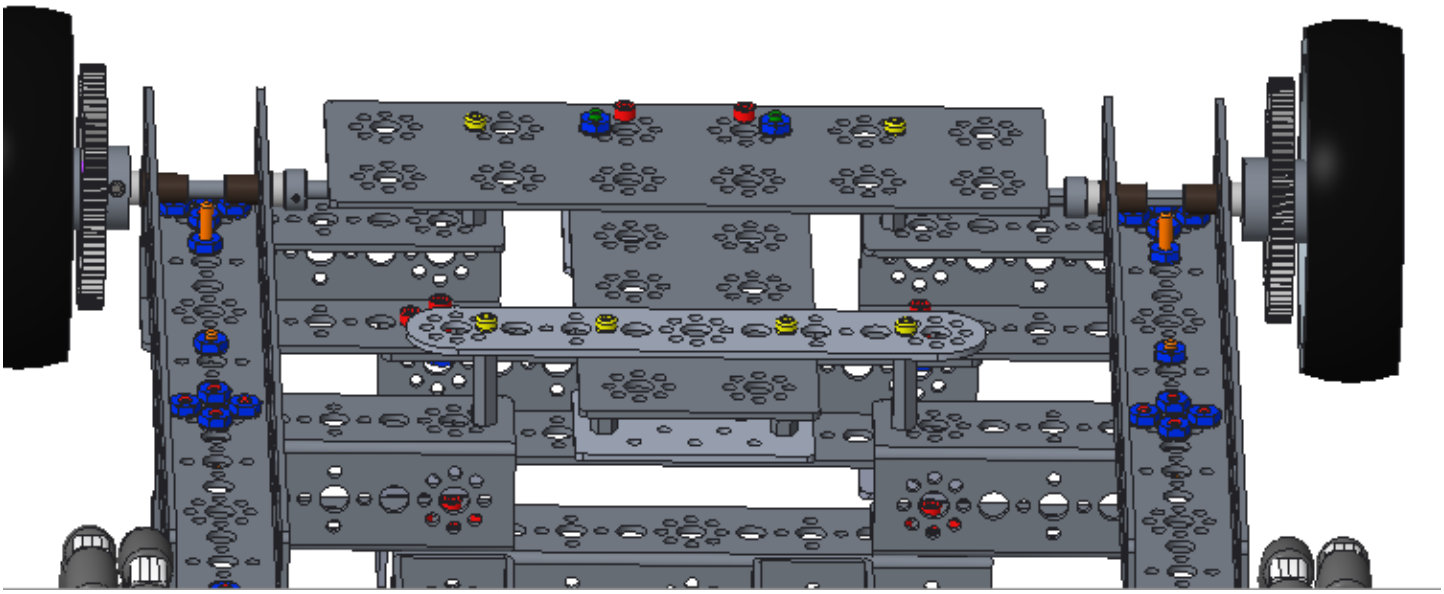




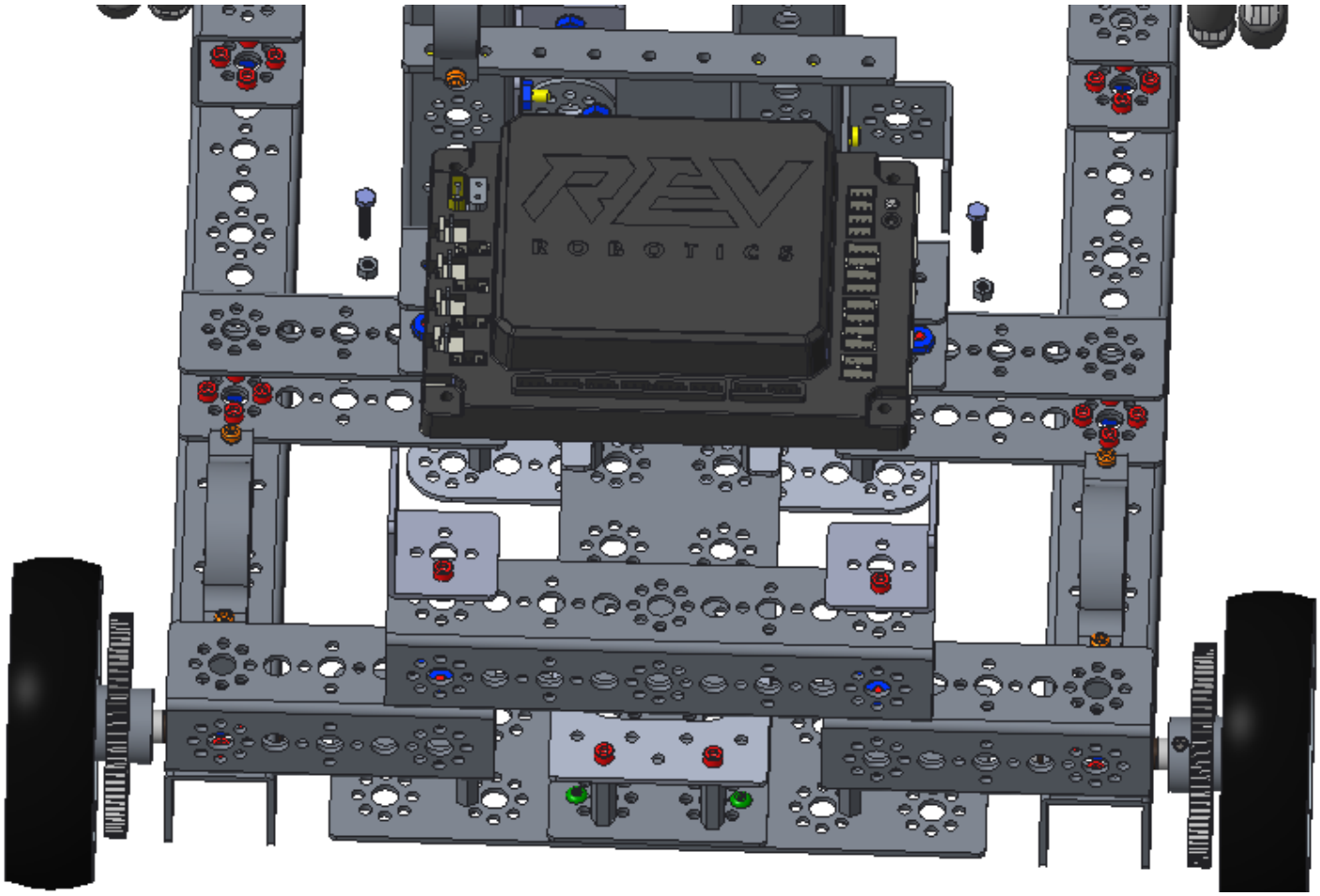
Step 10: Adding the Battery Holder

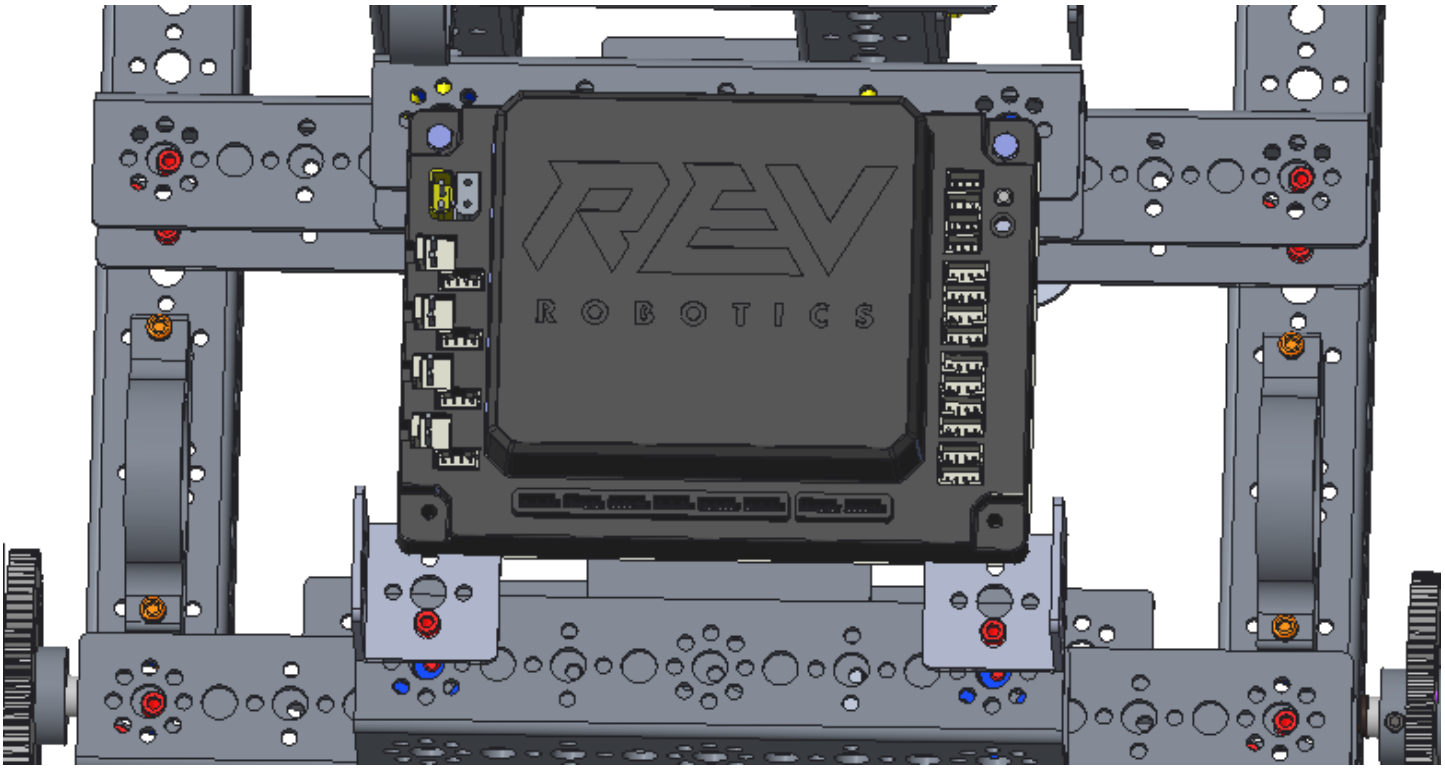
assembly from the previous step, battery holder assembly, 1/2” socket head cap screws (4)





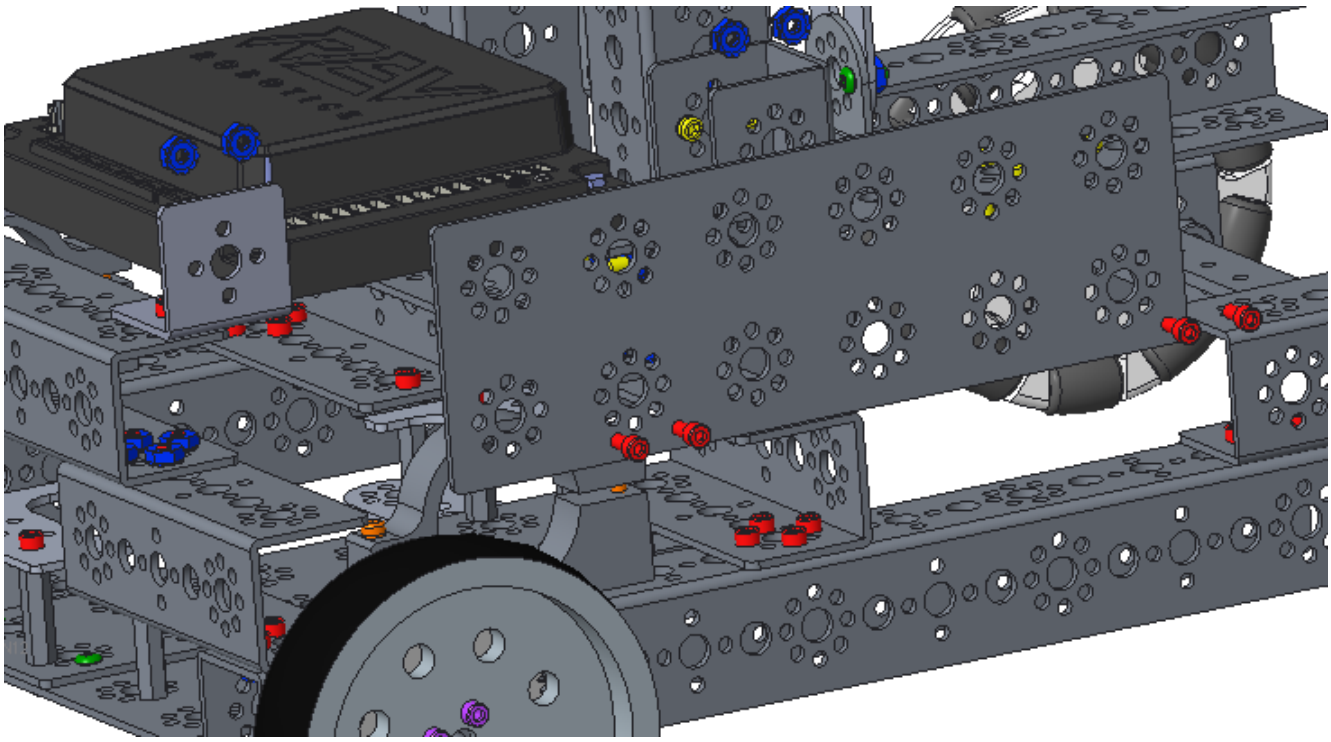
Step 11: Adding the Rev Robotics Expansion Hub

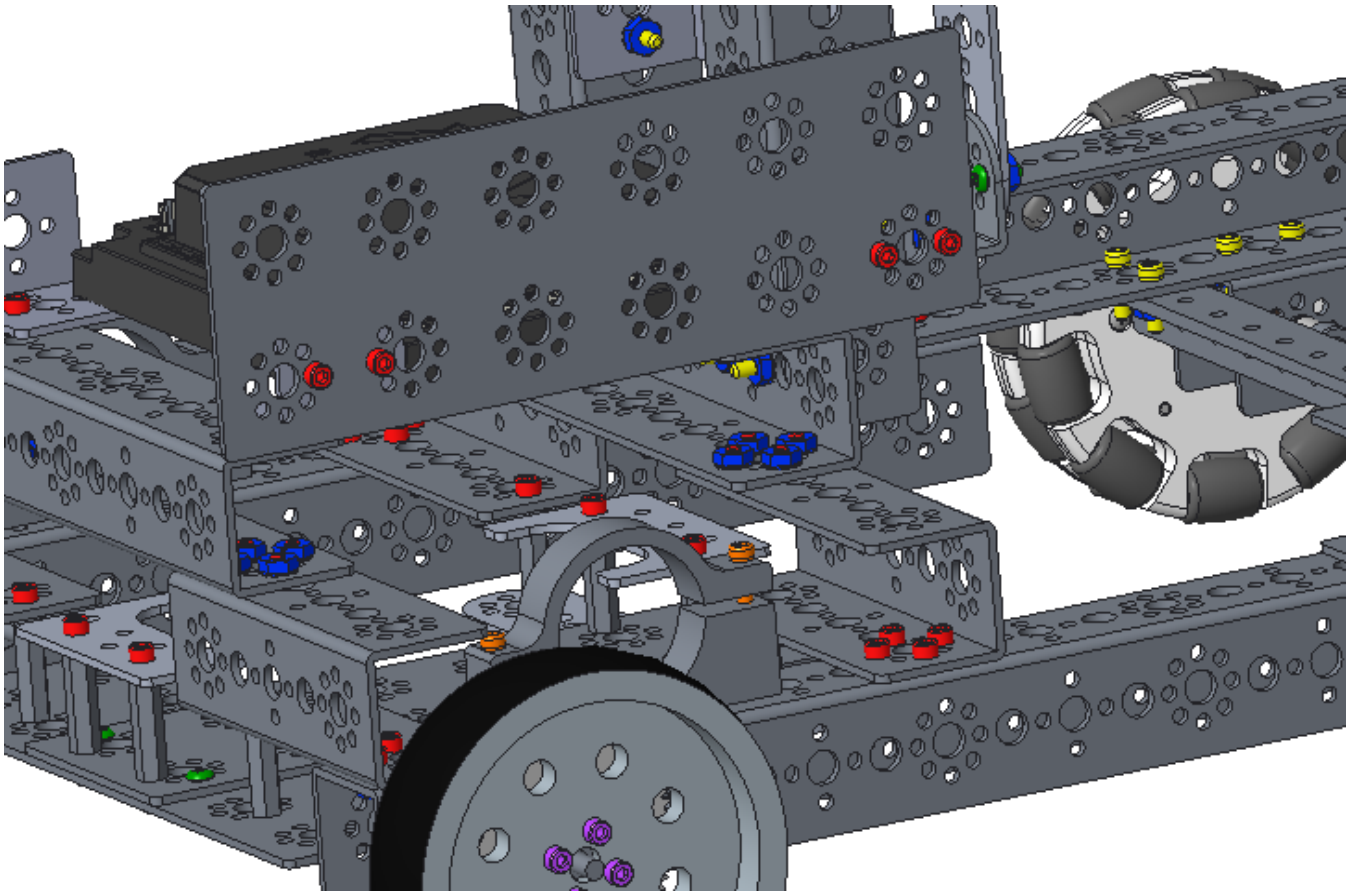




Step 12: Adding the Right Side Panel

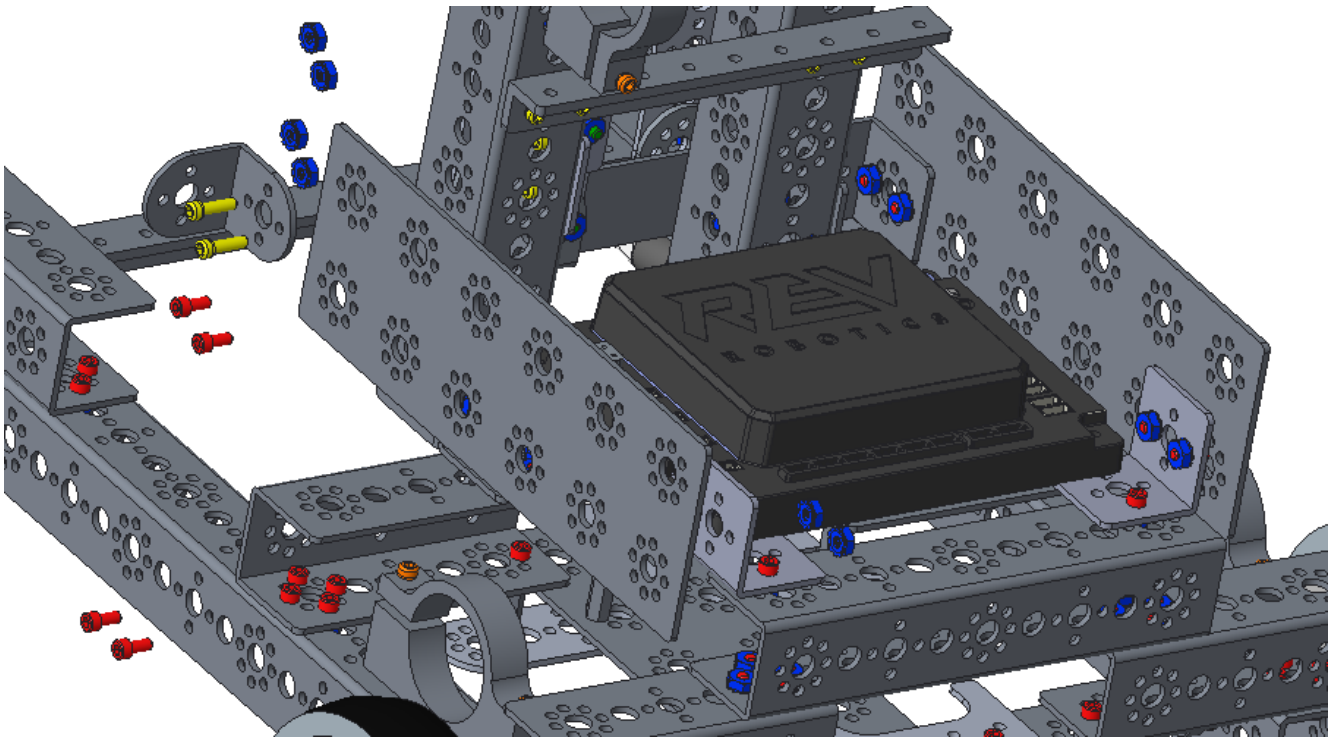
assembly from the previous step, 64 mm x 192 mm flat building plate (1), 5/16" socket head cap screws (4), keps nuts (4)

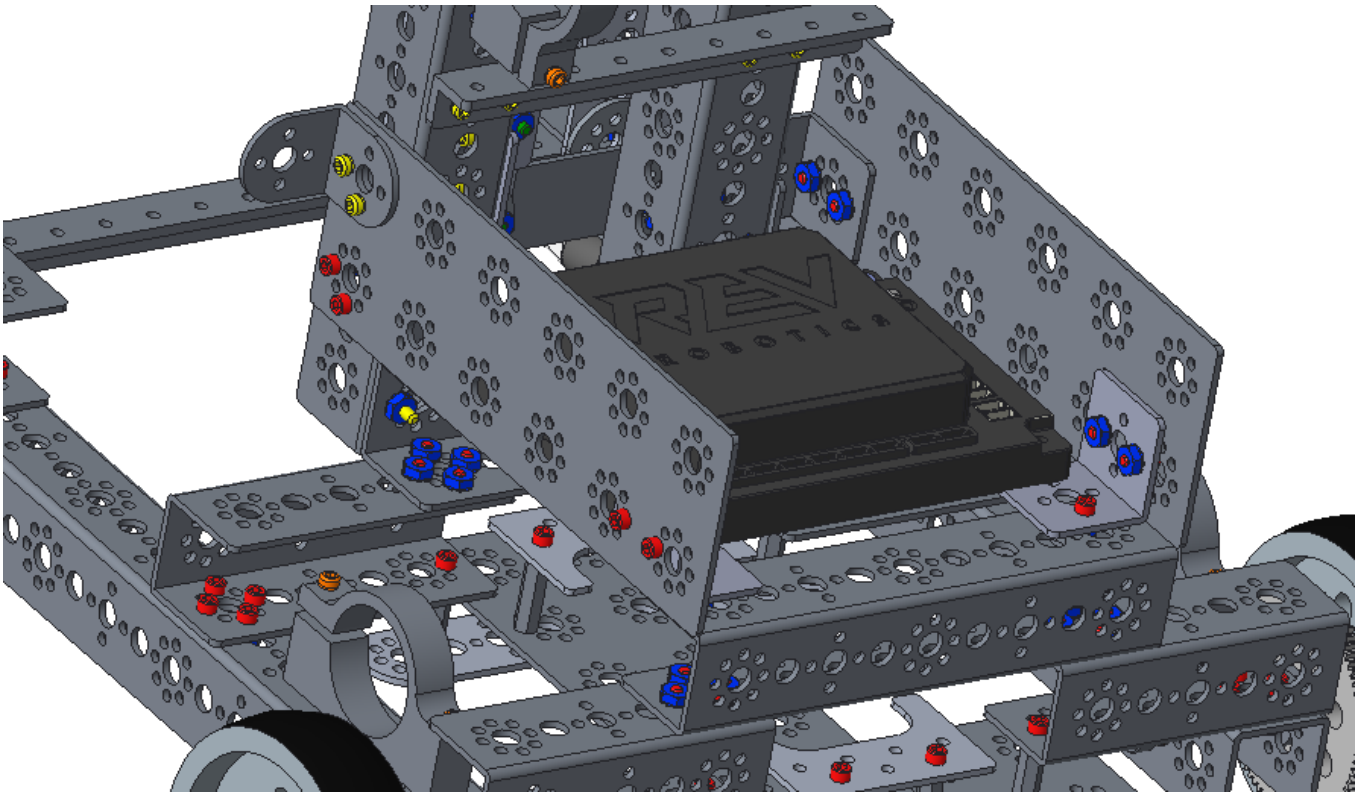




Step 13: Adding the Left Side Panel and Wiring Bracket

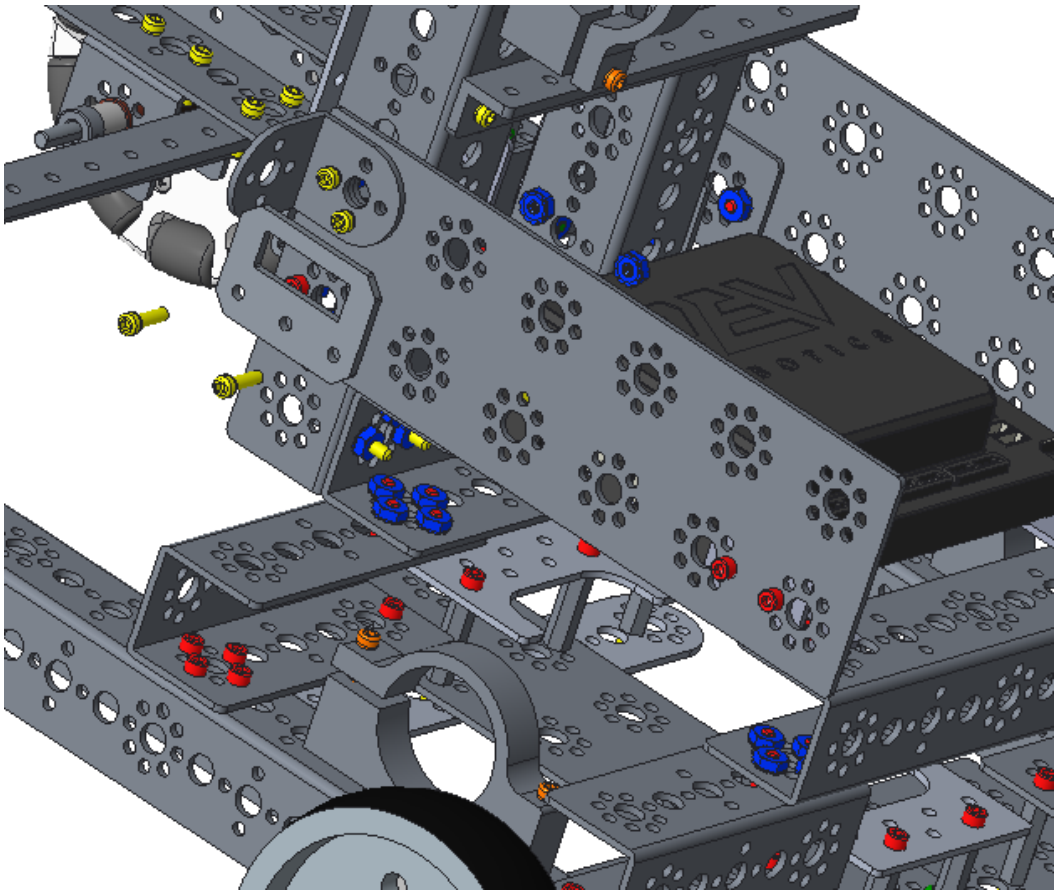
assembly from previous step, 64 mm x 192 mm flat building plate (1), 5/16" socket head cap screws (4), 1/2” socket head cap screws (2), l-bracket (1), keps nuts (6)

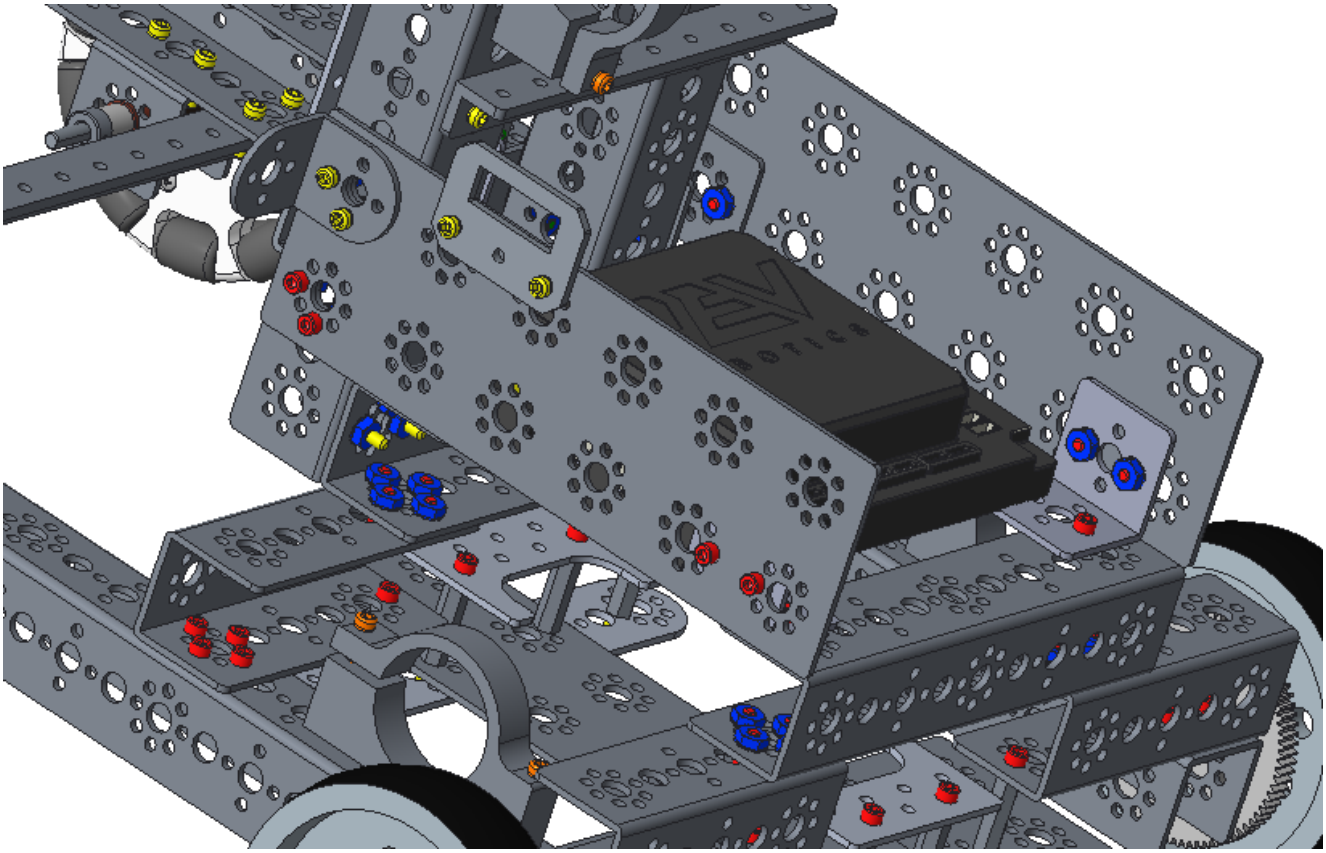




Step 14: Adding the Power Switch Plate

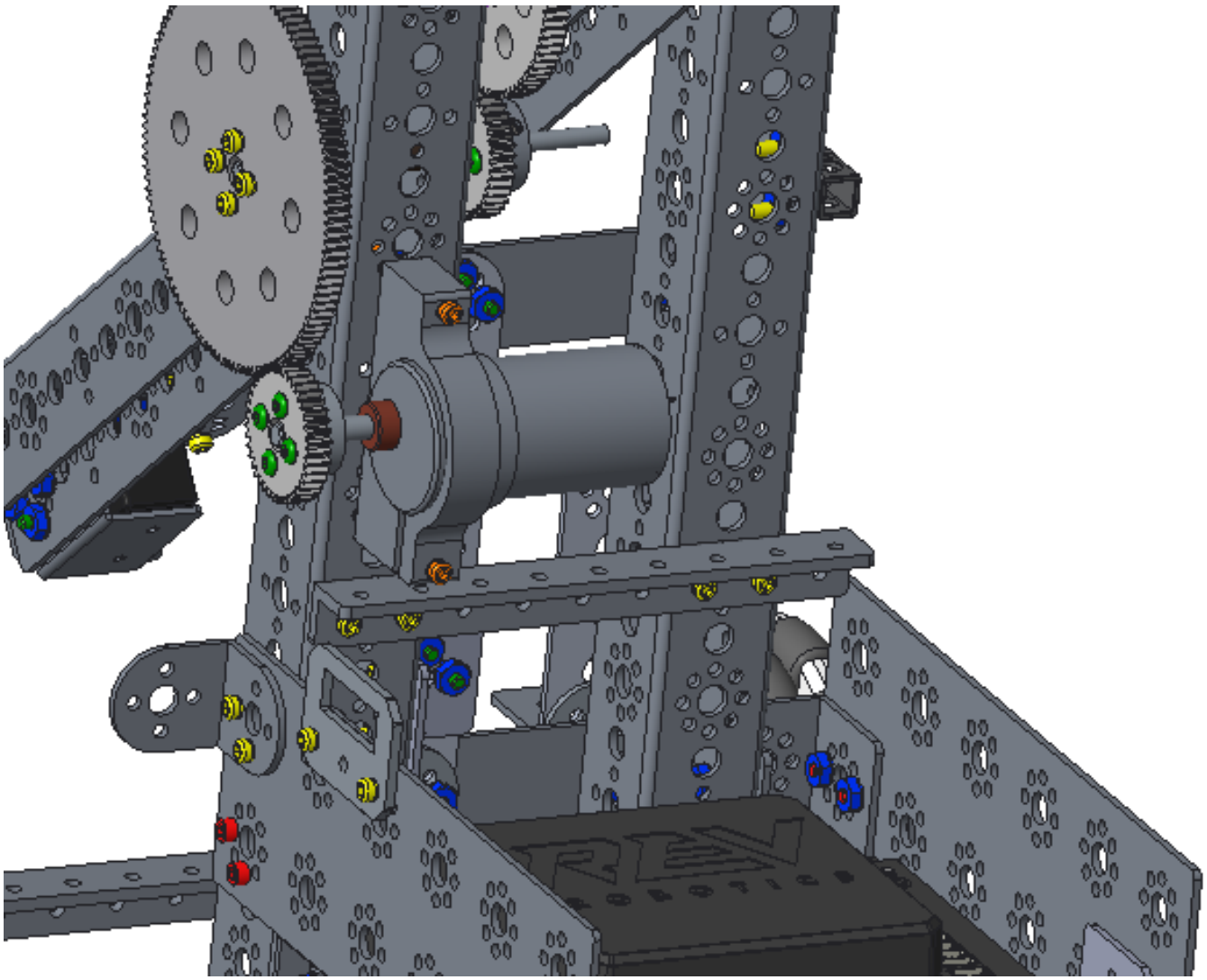
assembly from the previous step, power switch plate (1), 1/2” socket head cap screws (2), keps nuts (2)





Step 15: Install Arm Motor

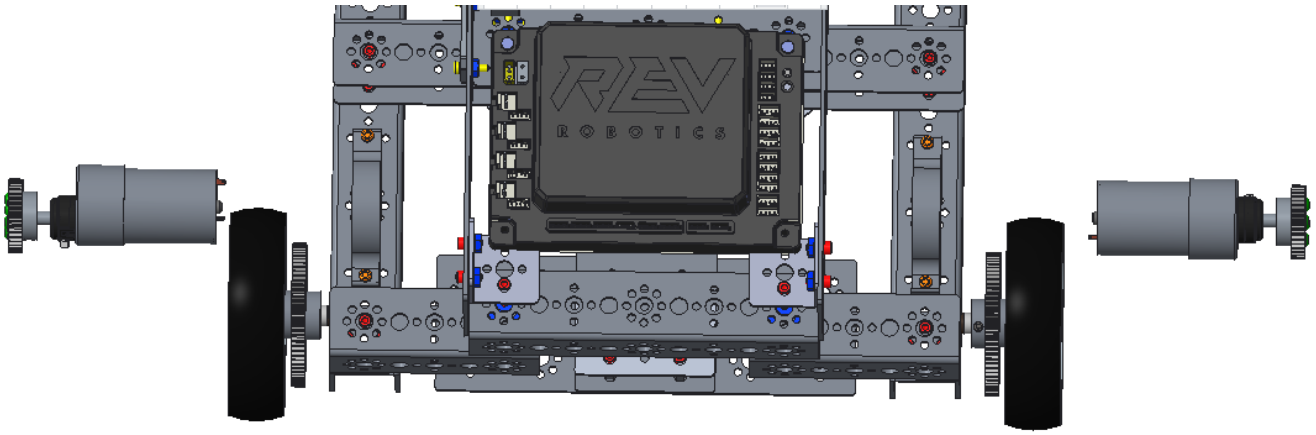
chassis, gear and DC motor assembly (1)

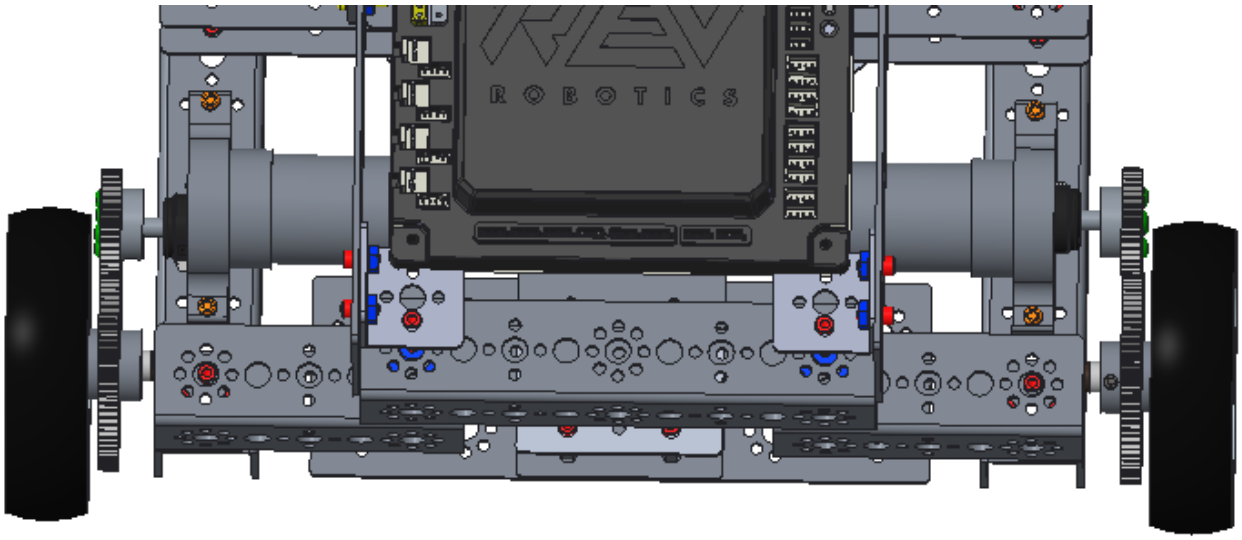


Step 16: Install Drive Motors

chassis, gear and DC motor assembly (2)

Note that the switch plate and wiring bracket are hidden from the images below.





Electronics

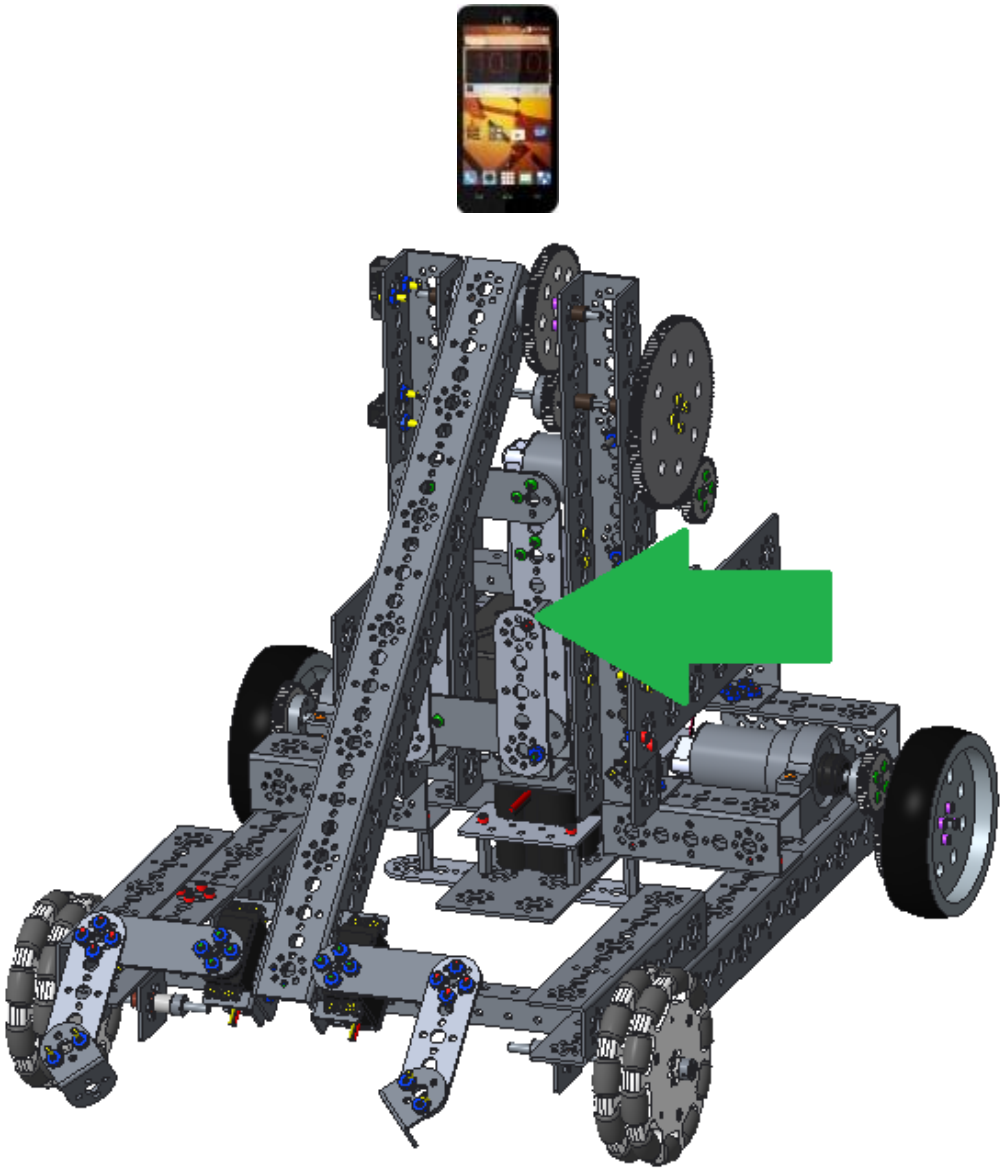
This section will outline the installation of the electronics onto the chassis.

Robot Controller

Step 1: Add the Robot Controller Cell Phone to the Chassis

chassis, robot controller cell phone (1)

Place the robot controller cell phone (check the game rules to determine which phones are approved for this year's game - the ZTE Speed is shown) into the holder (green arrow).



Step 2: Connect the Phone to the USB Cable

chassis, USB Type A male to type mini-B male cable (1)

Connect the mini-b end of the cable with the port on the phone.

Note: The phone is inside the phone holder, but the robot is not shown in the image below.

Step 3: Connect the USB Cable to the Micro USB OTG Adapter Cable

chassis, micro USB OTG adapter cable (1)

Connect the USB end of the USB Type A male to type mini-B male cable with the USB end of the OTG adapter cable.

Note: The USB cable is attached to the phone, which is on the robot. This is not shown in the images below.

Step 4: Connect the Micro USB OTG Adapter Cable to the Expansion Hub

chassis

Connect the micro USB end of the OTG adapter cable with the port on the expansion hub.

Note: The cable and expansion hub are on the robot. This is not shown in the images below.

Servos

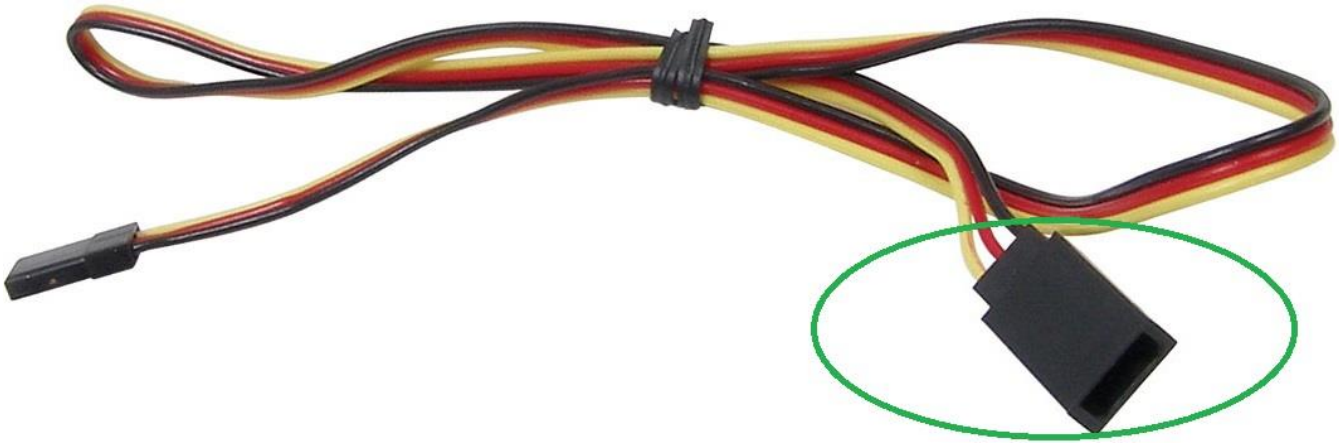
Step 1: Servo Extension Wires to Servos

Perform twice.

servo extension wires (2)

Connect the wire coming from the servo with the servo extension wire (the connector circled in green).

Note: Match the colors.



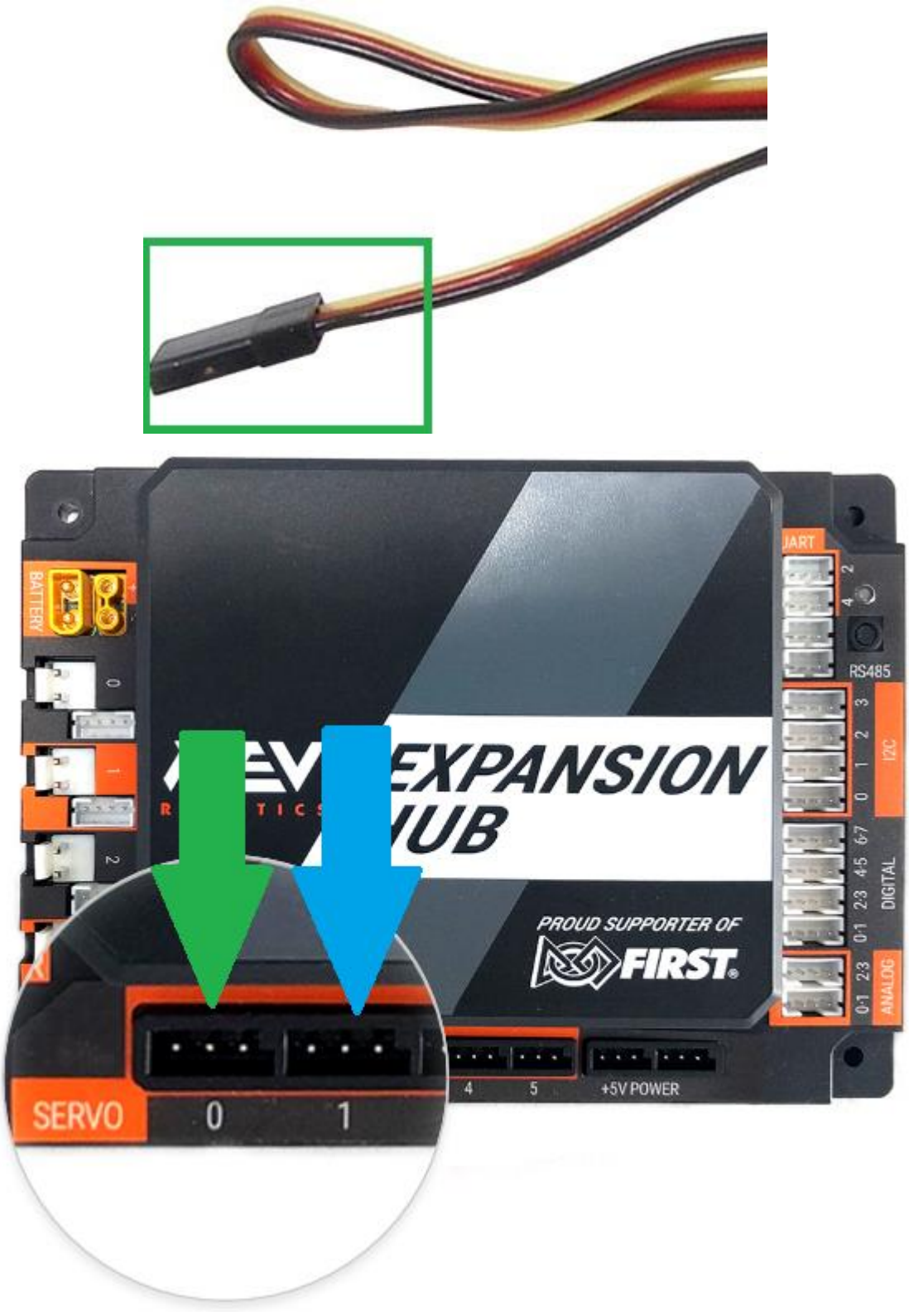
The image only shows one; make two.

Step 2: Servo Extension Wires to Expansion Hub

chassis (with the now attached servo extension wires)

Run the extension wires down the center of the arm channel and over the axle to prevent damage to the wires.

Plug the **left servo**'s extension wire into the expansion hub's **servo port 0**. Plug the **right servo**'s extension into the hub's **servo port 1**.



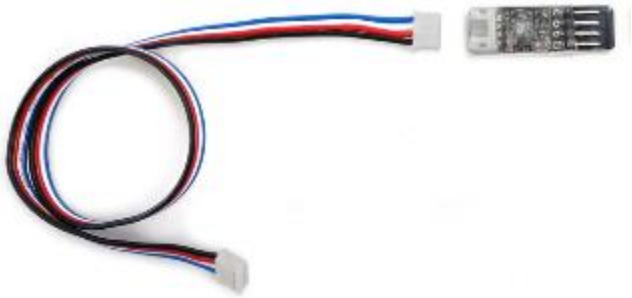
Encoders

Make two.

Step 1: Level Shifter Wires to Level Shifters

level shifter wires (2), level shifters (2)

Connect the wires with the shifters.



The image only shows one; make two.

Step 2: Level Shifters to Encoder Wires

level shifter (2), encoder wire (2)

The image only shows one; make two.

Step 3: Level Shifter Wires to Expansion Hub

chassis, level shifter wire assemblies (2)

Connect the end of one level shifter wire (circled in green) with **port 0** of the expansion hub (indicated by a green arrow in the bottom image). Connect the other end (the encoder wire of the level shifter assembly) with the encoder on the **left** drive motor (not shown).

Connect the end of the other wire with **port 1** of the expansion hub (indicated by a blue arrow in the bottom image). Connect the other end with the encoder on the **right** drive motor (not shown).

The above image only shows one assembly; use two.


EXPANSION HUB
PROUD SUPPORTER OF
FIRST
UART
RS485
I2C
DIGITAL
ANALOG
MOTOR ENCODER
SERVO
0 1 2 3 4 5
+5V POWER

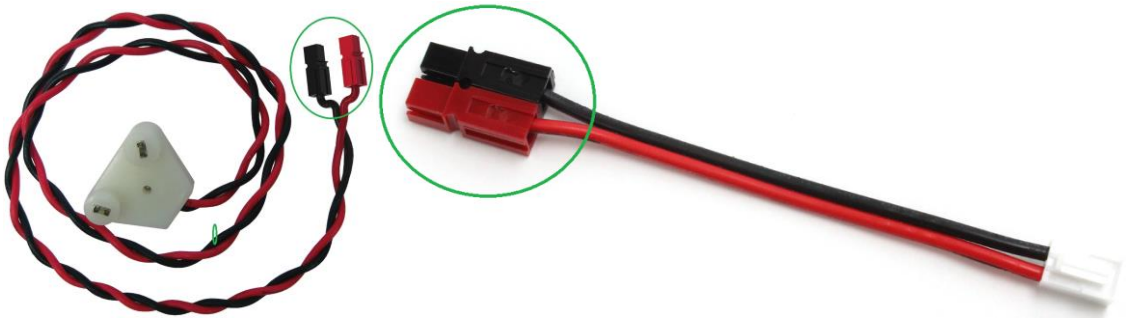
DC Motors

Step 1: Motor Power Cable to Extension Hub Cable

Make two.

motor power cable (2), Anderson to JST VH cable (2)

Plug the end of one motor power cable (circled in green) into the Anderson power pole end (circled in green) of the Anderson to JST VH cable.



The images show only one of each cable; use twp.

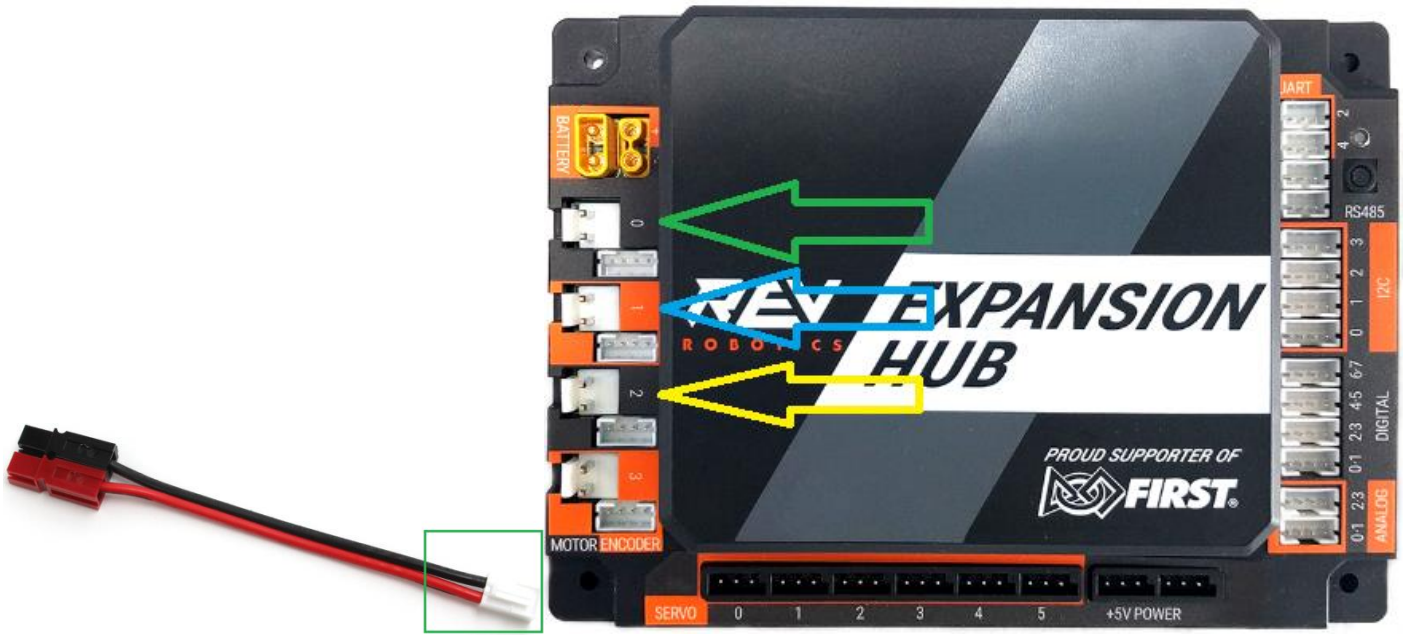
Step 2: Motor Power Cable to Extension Hub Cable

chassis, assemblies from the previous step

Connect the JST VH end (circled in green) of the Anderson to JST VH cable with **port 0** of the expansion hub (indicated by a **green** arrow in the bottom image). Connect the other end (the DC motor wire of the cable assembly) into the DC motor on the **left** side of the robot (not shown).

Connect the JST VH end of a second wire assembly with **port 1** of the expansion hub (indicated by a **blue** arrow in the bottom image). Connect the other end with the DC motor on the **right** side of the robot (not shown).

Connect the JST VH end of a third wire assembly with **port 2** of the expansion hub (indicated by a **yellow** arrow in the bottom image). Connect the other end with the DC motor on the **arm** of the robot (not shown).

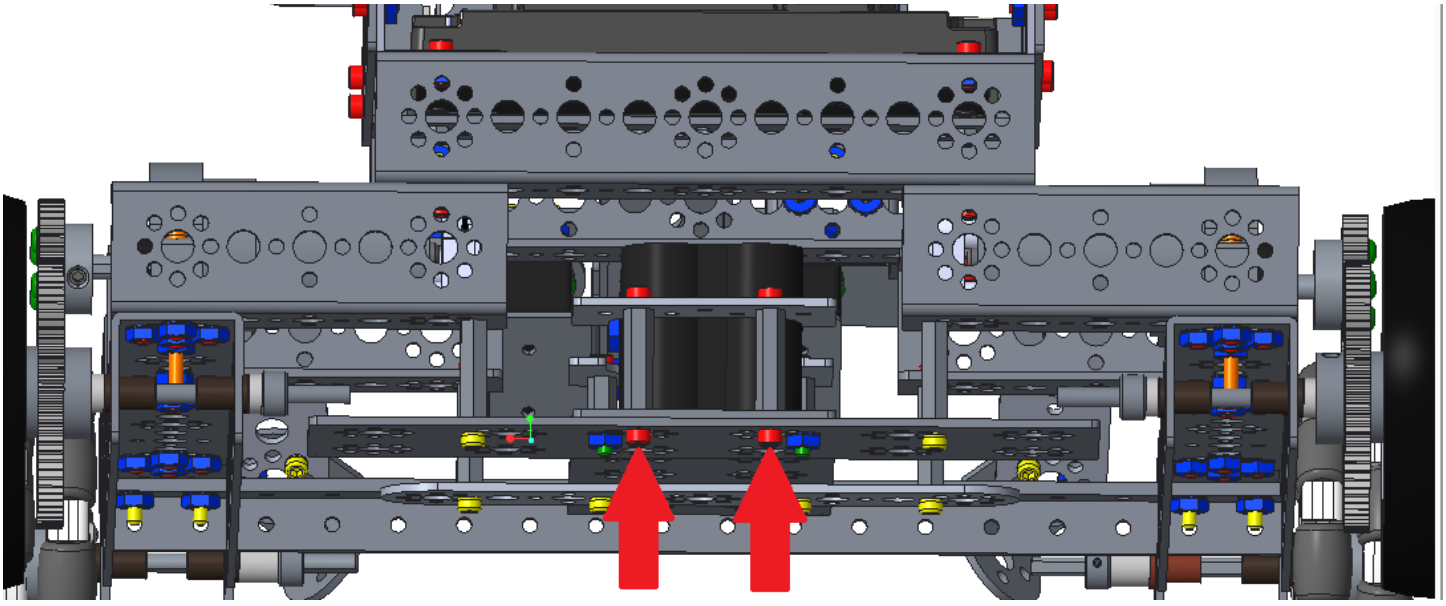


Battery and Switch

Step 1: Install Battery

chassis, battery

Remove the battery support bracket by removing the two 5/16" socket head cap screws marked by the red arrows. Place the battery in the opening with the power cable end nearest to the front of the robot. Replace the battery support brace.



Step 2: Install Switch

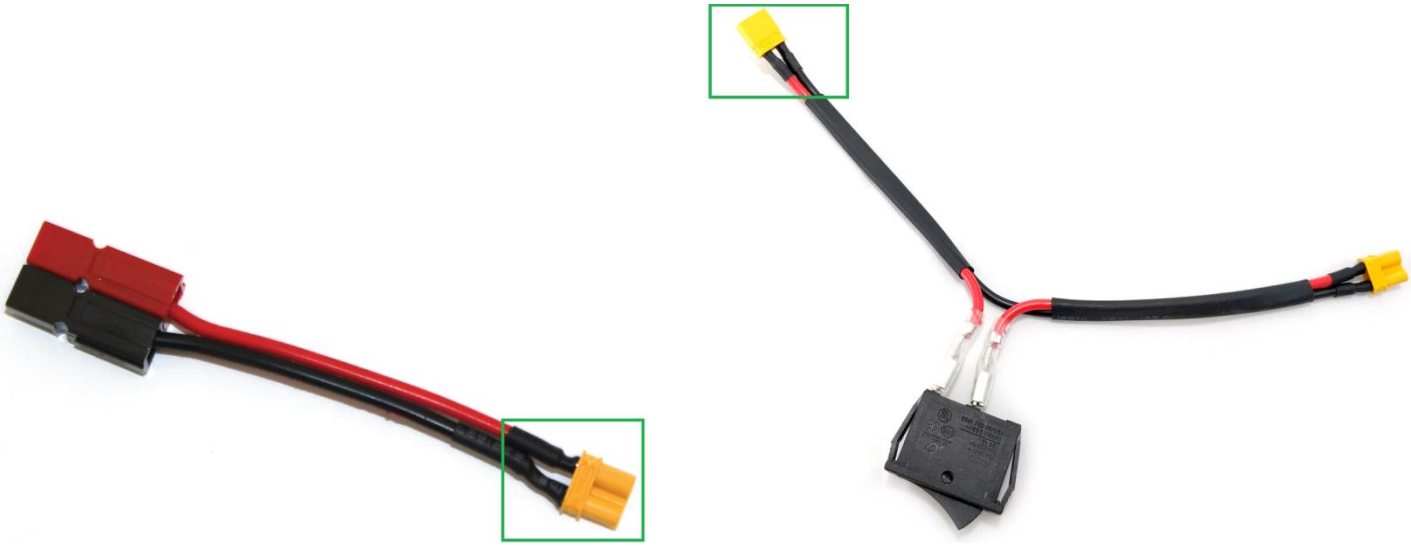
switch (1), chassis

Run the wires through the switch bracket, which is mounted on the left side panel. Plug the expansion hub end of the switch (green square) into the expansion hub (green square).

Step 3: Connect the Switch to the Switch Adapter Cable

chassis, Anderson Power Pole to XT30 Adapter (1)

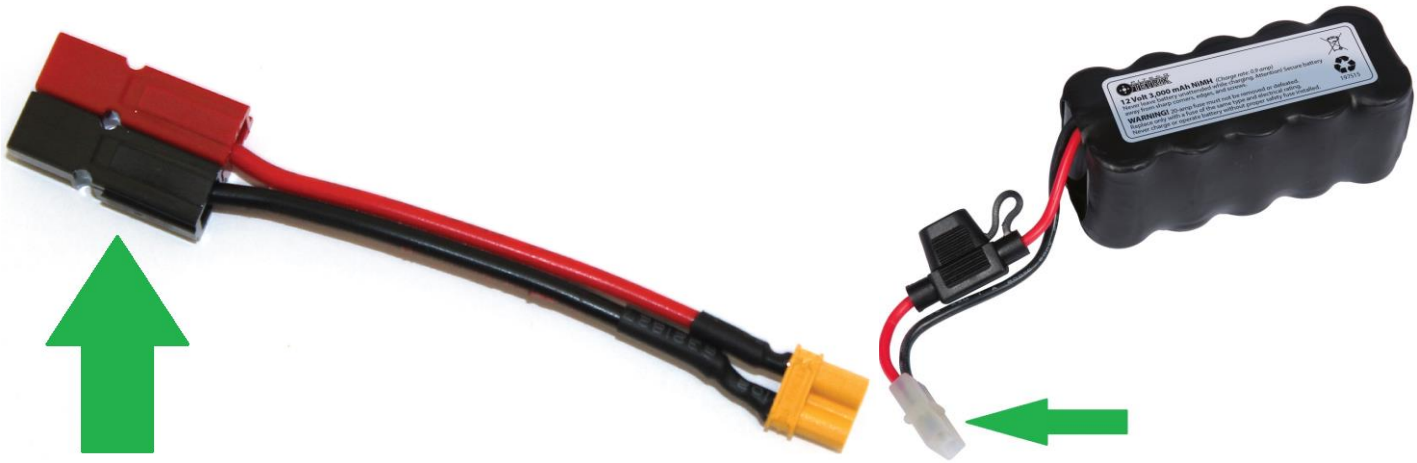
Plug the XT30 end of the adapter into the switch wire - green squares.



Step 4: Connect the Battery to the Switch Adapter Cable

chassis

Plug the Anderson Power Pole end of the adapter (green arrow) into the battery connector (green arrow).



Final Steps

The robot has been built, but that is only the beginning. Gear Trains need fine adjustments. Wires need to be secured. Programming will be needed to make the robot functional. Testing should be done to determine whether anything needs to be changed or optimized for the season's game rules. It will also show whether more cables need to be secured or re-routed. Numbers and other stickers will be needed to make the robot competition ready. Check the game rules for all of the applicable stickers - usually the game rules include a self-inspection check list. USE THIS CHECK LIST BEFORE COMPETITION!

Visit the FIRST website for programming instructions and game rules.

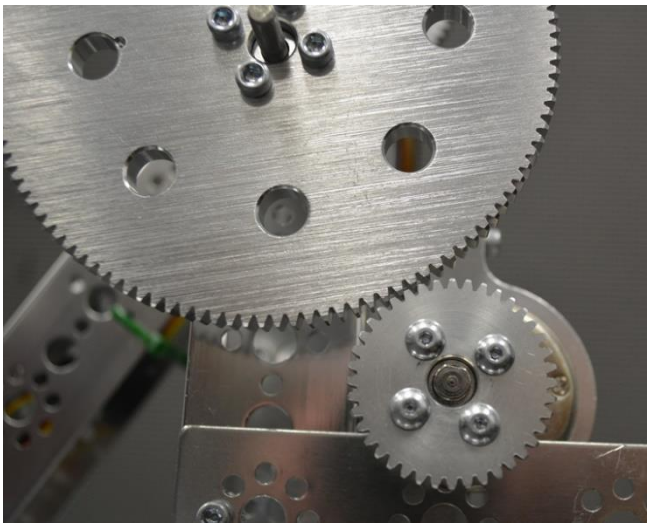
Wiring Safety

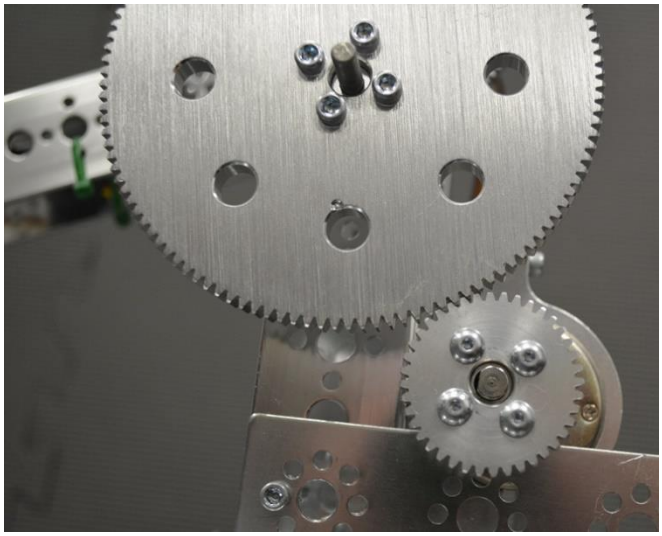
Additional zip ties should be purchased for securing wires to the chassis. The standard four-inch size works well for this. Also, electrical tape can be used to secure motor wires to the motor. Longer zip ties or Velcro straps can be used to keep the battery from falling out of the robot in case it tips over. Make sure that axle hub, motor hub, and axle collar set screws are installed, so that the screw is on the flat side of the axle, which will prevent assemblies from spinning on the axle.

Mesh Gears Properly

The following pictures show examples of meshing the gears. The first is too loose; the second is too tight; the third (center below) 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.

Remember to tighten the motor mount bolt, so the motor will not rotate.





Square the Frame

Make sure that the frame is square. Once the frame is square, make sure that all of the frames bolts are tight. It is hard to drive a crooked robot straight!

Optimizing the Phone Holder

It is recommended that an approved material such as non-skid be layered in the back of the phone holder to prevent damage to the phone.

It is recommended that the phone be secured in the holder using a zip tie or some other mechanism to prevent it from being separated from the robot during competition.

Optimizing the Battery Holder

It is recommended that the battery be secured in the holder using a zip tie or some other mechanism to prevent it from being separated from the robot during competition.

Optimizing the Hand/Grippers

Place non-skid around the gripper to provide extra grip…so hockey pucks, wiffle balls, pipes, racquetballs, crates, rings, blocks or practice golf balls, or red herrings can be collected with ease!

Add Team Numbers

Usually team numbers need to be on both sides of the robot. Make them BIG (the team numbers below are not to scale - refer to the game manual for height, width and stroke width, etc.). Make them easy to distinguish from other robots. Show off team numbers. They will be examined by many scouts while the robot is on the field.

Appendix A: Bill of Materials List

This list does not include the cell phones, the Rev Robotics Expansion Hub, nor the cables that connect the electronics.

Quantity	Name	Common Name
4	TETRIX_739068_2012	288 mm Channel
4	TETRIX_739067_2012	160 mm Channel
76	TETRIX_739098_2012	6-32 x 5/16” Socket Head Cap Screws
162	TETRIX_739094_2013	Kep Nuts
3	TETRIX_739065_2012	32 mm Channel
66	TETRIX_739097_2013	6-32 x 1/2” Socket Head Cap Screws
8	TETRIX_736466_HUB_2012	4” Omni Wheel
18	TETRIX_739091_2013	Bronze Bushing

11	TETRIX_739100_2012	1/8” Nylon Axle Spacer
8	TETRIX_739092_COLLAR_2012	Axle Set Collar
6	TETRIX_739088_2013	100 mm Axle
2	TETRIX_739101_2012	3/8” Nylon Axle Spacer
2	TETRIX_739055_2012	4” Tire/Wheel
2	TETRIX_739090_2012	Hub Gear Spacer
2	TETRIX_739086_2012	80-Tooth Gear
5	TETRIX_739172_COLLAR_2012	Axle Hub
4	TETRIX_739066_2012	96 mm Channel
1	TETRIX_739071_2012	288 mm Angle
1	TETRIX_739028_2012	40-Tooth Gear
2	TETRIX_739069_2012	416 mm Channel
4	TETRIX_739060_2012	Standard-Scale Servo Motor Brackets
4	TETRIX_739197_SERVO_2012	Standard-Scale HS-485HB Servo Motor
48	TETRIX_739111_2012	6-32 x 3/8” Button Head Cap Screws
6	TETRIX_739061_2012	Flat Bracket
6	TETRIX_739273_2013	96 mm Flat
5	TETRIX_739062_2012	L-Bracket
3	TETRIX_739272_2013	160 mm Flat
2	TETRIX_739270_2013	Inside C Connector
4	TETRIX_739281_CORNER_BRA_2013	Inside Corner Bracket
6	TETRIX_739102_2012	1” Stand-off Post
4	TETRIX_739073_2012	64 mm x 192 mm Flat Building Plate
2	TETRIX_738009_BATPACK_BRKT_2013	Battery Clip
1	TETRIX_739057_2012	12-Volt Rechargeable NiMH Battery Pack
1	ACRYLIC_SWITCH_BRACKET	Power Switch Bracket
1	SWITCH	Power Switch

Special Thanks and Best Wishes

We'd like to thank Mary and Laura Spangler for helping us finish this project. Mary stepped in at the last minute and helped with CREO while David was otherwise occupied. Laura made yummy peach ice cream and used that to help encourage us to finish.

We hope you have enjoyed the time you spent building your Push 'Bot. If you have any questions or comments, please feel free to contact us at ssi@lydean-david.net.

David and Lydean

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