FIRST TECH CHALLENGE

Training and Support

2018-2019 *FIRST*® Tech Challenge

Basic Bot Guide for TETRIX-Part 2 Game Specific

ROVER RUCKUS

Presented By Qualcomm

www.firstinspires.org

200 BEDFORD STREET ■ MANCHESTER, NH 03101

FIRST

FOR INSPIRATION & RECOGNITION OF SCIENCE & TECHNOLOGY

Sponsor Thank You

Thank you to our generous sponsors for your continued support of the *FIRST*® Tech Challenge!

***FIRST*® Tech Challenge**
Season Presenting Sponsor

Qualcomm

***FIRST*® Tech Challenge**
Official Program Sponsor

Rockwell Collins

***FIRST*® Tech Challenge**
Official 3D Augmented Reality/
Virtual Reality Sponsor

ptc

Revision History		
Revision	**Date**	**Description**
1	09/10/2018	Initial Release

Contents

Introduction 6
What is *FIRST*® Tech Challenge? 6
FIRST Core Values 6
NOTICE OF NON-DISCRIMINATION 6
Gracious Professionalism® 6
Introduction to the Guide 7
Introduction 7
Parts 7
Tips and Tricks 7
Construction 9
Build the Sweeper 9
Step 1: Attach Axle Support to Motor Support 9
Step 2: Add the Motor Mount 10
Step 3: Add the Axle 11
Step 4: Add the Sweeper Connector 12
Step 5: Add the Motor and Gear 13
Step 6: Add the Brush Support 14
Step 7: Add the Sweeper Support 15
Step 8: Add Brushes to the Sweeper 16
Build the Arm 17
Step 1: Add the Gear to the Arm 17
Step 2: Add Support to the Servo Bracket 18
Step 3: Add the Servo Bracket to the Arm 19
Step 4: Add the Servo to the Bracket 20
Step 5: Add the Axle Hub to the Servo 21
Step 6: Add the Gear to the Axle Hub 22
Step 7: Add the Axle to the Arm 23
Step 8: Add the Basket Gear and Support 24
Step 9: Add Corner Brace 25
Step 10: Add Basket Back Right Support 26
Step 11: Add Basket Bottom Support 27
Step 12: Add More Basket Bottom Support 28
Step 13: Add Basket Back Support 29
Step 14: Add Side Support 30

Step 15: Complete the Basket 31
Build the Tower 32
Step 1: Begin the Vertical Supports 32
Step 2: Add Lower Horizontal Support 33
Step 3: Begin Upper Horizontal Support 34
Step 4: Complete Upper Horizontal Support 35
Step 5: Begin Upper Gear Assembly 36
Step 6: Complete Upper Gear Assembly 37
Step 7: Begin Lower Gear Assembly 38
Step 8: Complete Lower Gear Assembly 39
Step 9: Add the Arm Motor 40
Step 10: Complete the Arm Motor 41
Remove Electronics 42
Remove Battery 42
Step 1: Disconnect the Battery from the Switch 42
Step 2: Remove the Battery from the Chassis 43
Remove the Robot Controller 44
Step 1: Disconnect the Robot Controller from the Expansion Hub (Part 1) 44
Step 2: Disconnect the Robot Controller from the Expansion Hub (Part 2) 45
Step 3: Remove the Robot Controller Cell Phone from the Holder 46
Step 4: Remove the Phone Support Plate 47
Remove the Motor and Sensor Controller 48
Step 1: Unplug the Left and Right Drive Motor Power Cables 48
Step 2: Remove the Rev Robotics Expansion Hub 49
Attach the Sweeper to the Chassis 50
Step 1: Add the Sweeper 50
Attach the Tower to the Robot 52
Step 1: Add Tower Base 52
Step 2: Add Lower Support Channel 53
Step 3: Add Upper Support Channel 54
Step 4: Attach Tower to Upper Support Channel 55
Step 5: Add Side Support 56
Attach the Arm to the Tower 57
Add the Electronics 58
Step 1: Add the Motor and Sensor Controller 58
Step 2: Add Robot Controller Support Plate 59
Step 3: Add the Battery Container 60

Step 4: Add the Switch Plate 62
Step 5: Add the Switch 63
Step 6: Add the Battery 64
Step 7: Complete the Wiring 65
Final Steps 66
Special Thanks and Best Wishes 66
Appendix A – Resources 67
Game Forum Q&A 67
FIRST Tech Challenge Game Manuals 67
FIRST Headquarters Pre-Event Support 67
FIRST Websites 67
FIRST Tech Challenge Social Media 67
Feedback 67
Appendix B: Bill of Material (BoM) List 68

Introduction

What is FIRST® Tech Challenge?

FIRST® Tech Challenge is a student-centered program that focuses on giving students a unique and stimulating experience. Each year, teams engage in a new game where they design, build, test, and program autonomous and driver operated robots that must perform a series of tasks. To learn more about *FIRST*® Tech Challenge and other *FIRST*® Programs, visit www.firstinspires.org.

FIRST Core Values

We express the *FIRST*® philosophies of *Gracious Professionalism*® and *Coopertition*® through our Core Values:

- **Discovery:** *We explore new skills and ideas.*
- **Innovation:** *We use creativity and persistence to solve problems.*
- **Impact:** *We apply what we learn to improve our world.*
- **Inclusion:** *We respect each other and embrace our differences.*
- **Teamwork:** *We are stronger when we work together.*
- **Fun:** *We enjoy and celebrate what we do!*

NOTICE OF NON-DISCRIMINATION

For Inspiration and Recognition of Science and Technology (FIRST®) does not discriminate based on race, color, national origin, sex, disability, age, status as a veteran who served in the military, religion, gender, gender identity, or gender expression in its programs and activities.

Keep updated at: http://www.firstinspires.org/about/legal-notices.

Gracious Professionalism®

FIRST® uses this term to describe our programs' intent and *Gracious Professionalism*® is not clearly defined for a reason. It has different meanings to everyone. Some possible meanings of *Gracious Professionalism* include:

- Gracious attitudes and behaviors are win-win.
- Gracious folks respect others and let that respect show in their actions.
- Gracious Professionals make valued contributions in a way that is pleasing to others and to themselves.

In the end, *Gracious Professionalism*® is part of everyday life. When professionals use their knowledge graciously and individuals act with integrity and sensitivity, everyone wins, and society benefits.

Watch Dr. Woodie Flowers explain *Gracious Professionalism* in this short video.

Introduction to the Guide

Introduction

This season the Push 'Bot is being given a new name - the Basic 'Bot. The chassis build guide for TETRIX has already been released. This guide contains the instructions to build armature for the Basic 'Bot chassis. The armature is specific to this year's game. It can capture a single ball, a silver game element, and deliver it to the lander. It can drive over the crater rim. It is strong enough to lower itself from the lander and lift at the end of the match. With these challenges met, it encourages teams to make it even better. With items outside of the kit of parts, a team should be able to modify the collector to capture more silver or even to capture gold elements too!

Parts

- TETRIX *FIRST* Tech Challenge Competition Set
- Electronics Modules and Sensors Set
- Control & Communication Set 1 or 2
- (Optional) Only the tools included in the *FIRST* Tech Challenge Competition Set will be needed to build the chassis. The screws and nuts are a standard size and having more tools may allow more students to participate at the same time.
- (Optional) A ruler is not needed to build this robot, but it is necessary to make sure that the robot is competition ready.

Tips and Tricks

- Secure the screws/nuts just enough, so parts do not slide/move relative to each other. Overtightening the screws will damage the aluminum extrusions.
- Make sure that set screws are installed in every axle hub, motor hub, and axle collar.
- Refer to the legend provided in the Kit of Parts, if any parts are unfamiliar.
- Make sure that all assemblies are square. It is hard to drive a crooked robot straight!
- The drive wheels are powered by two DC motors, which are relatively heavy. The drive wheels are 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.
- Unless otherwise noted, the top image in each step shows the necessary parts; the lower image shows the completed assembly.

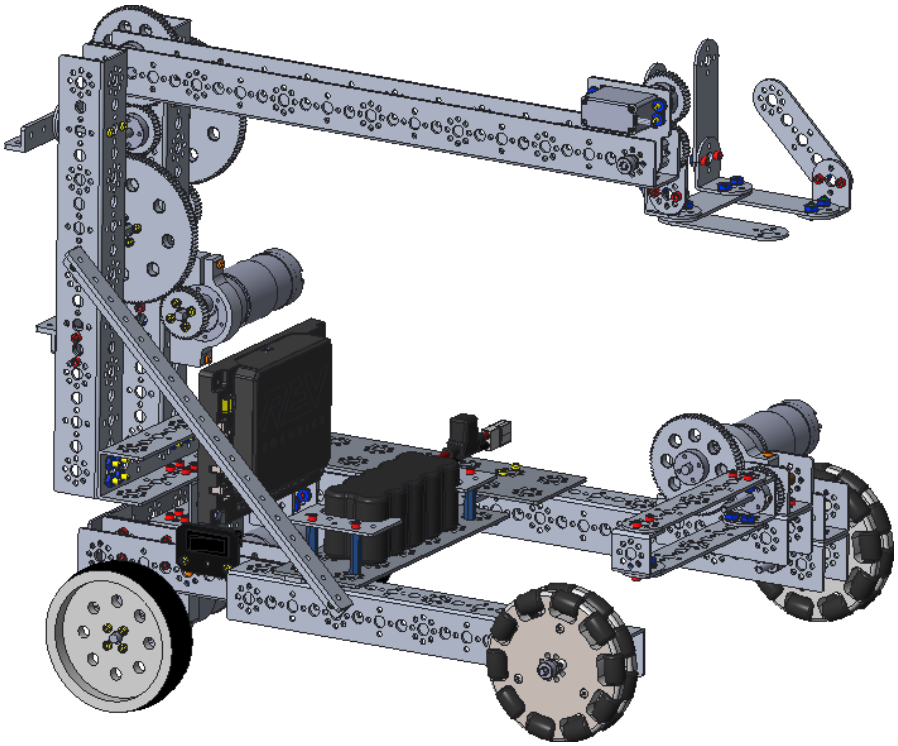


Figure 1 Completed TETRIX robot chassis and armature

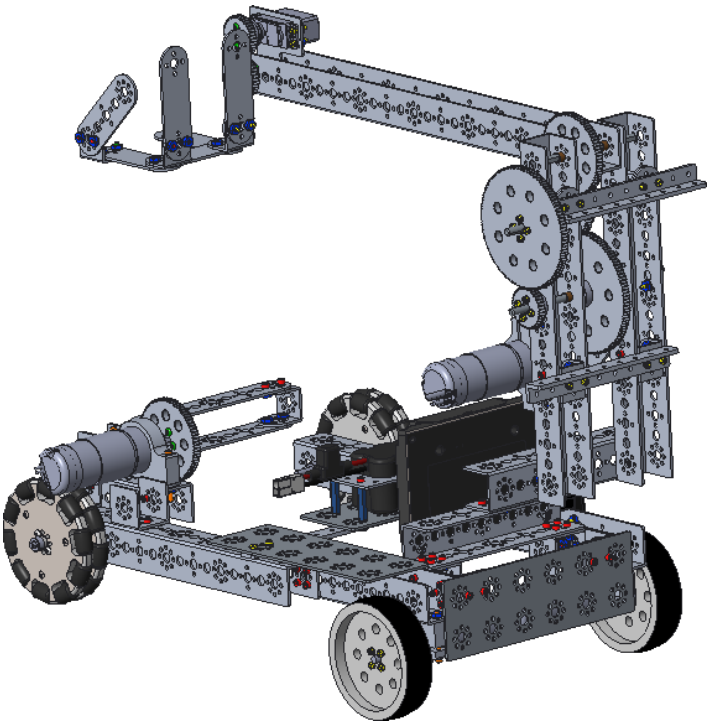


Figure 2 Rear view of completed robot chassis and armature

Construction

Build the Sweeper

Step 1: Attach Axle Support to Motor Support

39065 - 32 mm channel (1)
39066 - 96 mm channel (1)
39098 – 15/16" socket head cap screw (2)
39094 - keps nut (2)

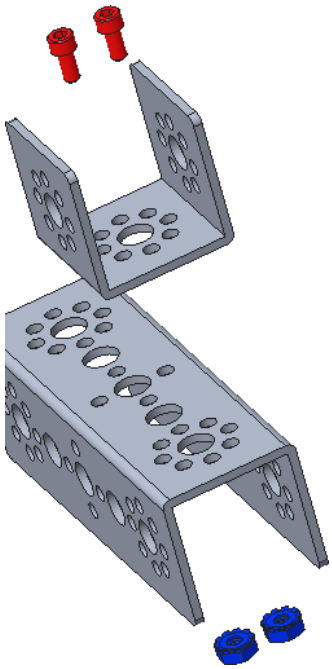


Figure 3 parts required for the step

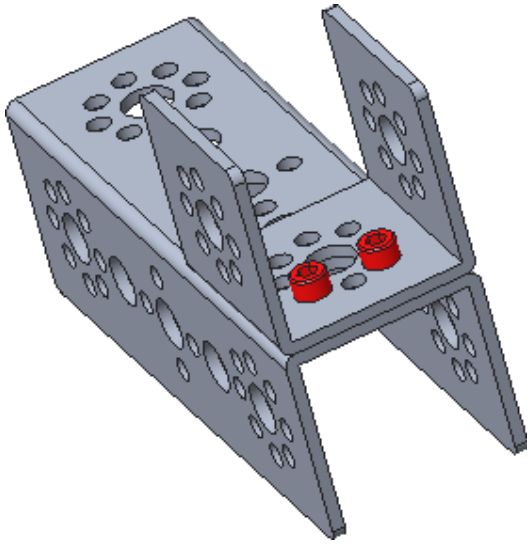


Figure 4 completed assembly

Step 2: Add the Motor Mount

39089 – motor mount with included screws and nuts (1)
39387 – flat round spacer (1)

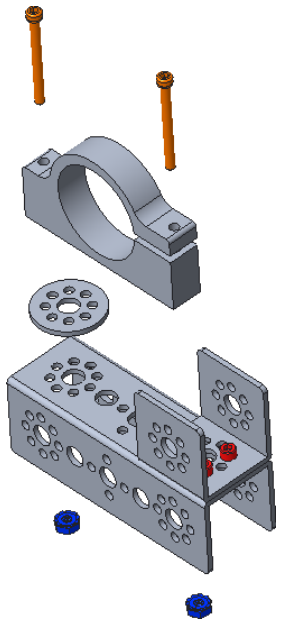


Figure 5 parts required for the step

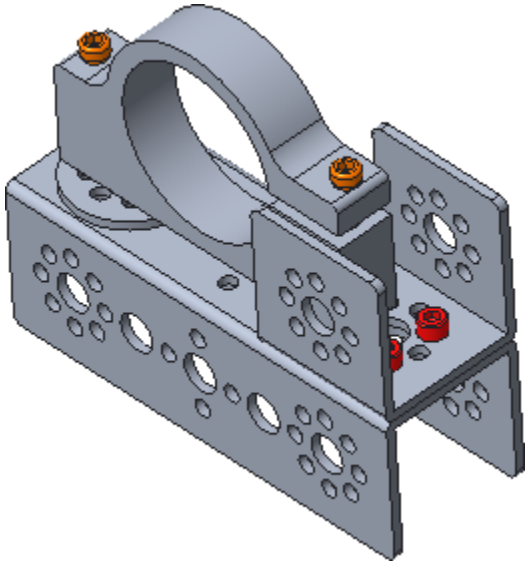
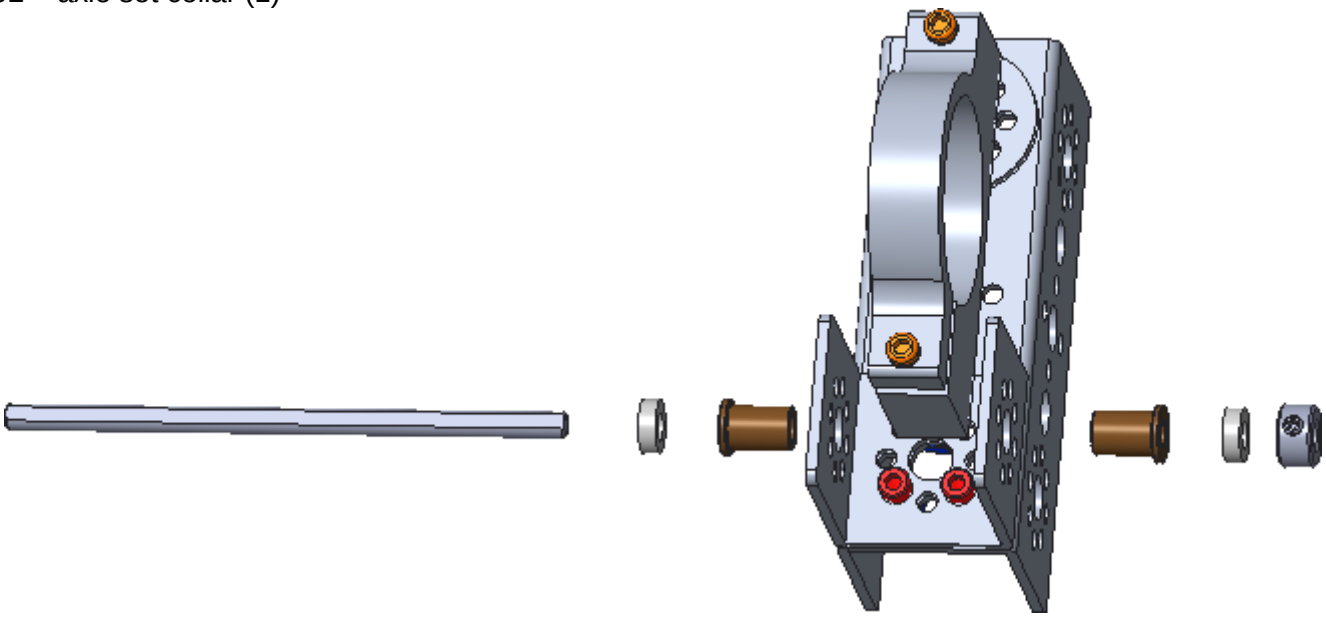


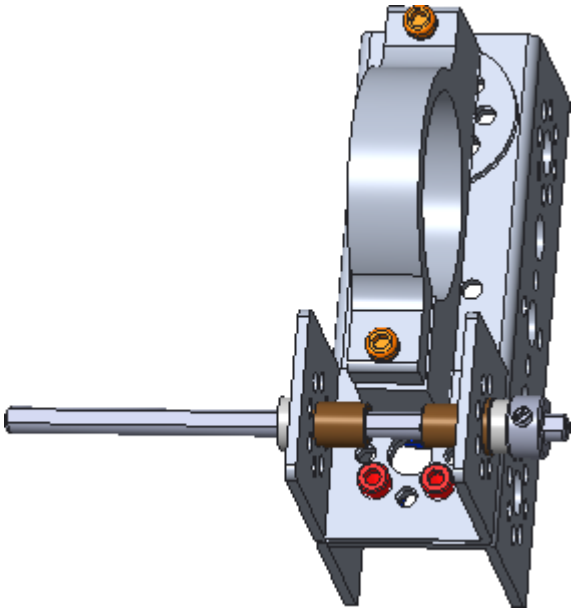
Figure 6 completed assembly

Do not tighten the motor mount bolts that control the clamp (i.e. the gap on one side of the mount) until the motors have been inserted (next step). When this bolt is tightened, the motors can't be inserted into the mount.

Step 3: Add the Axle

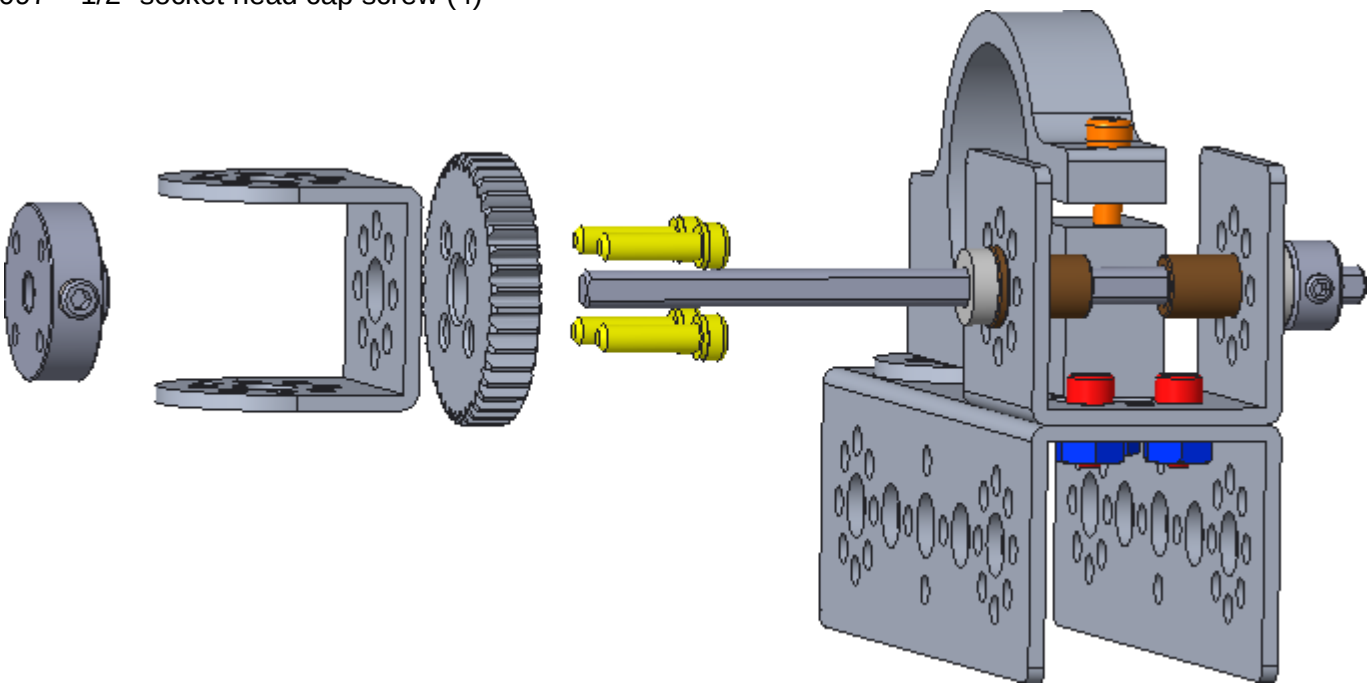
39088 – 100 mm axle (1)
41665 – 6mm plastic bushing spacer (2)
39091 – bronze bushing (2)
39092 – axle set collar (1)

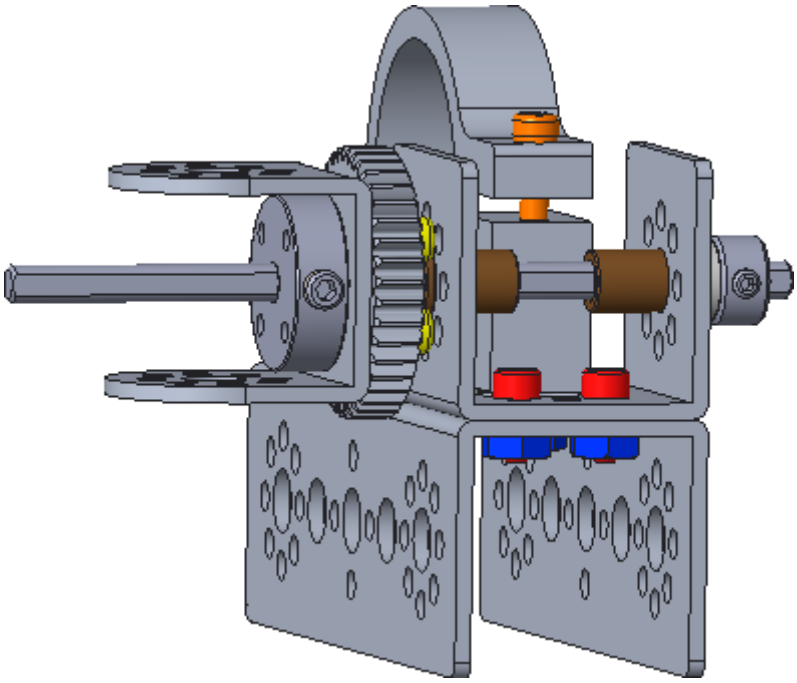




Step 4: Add the Sweeper Connector

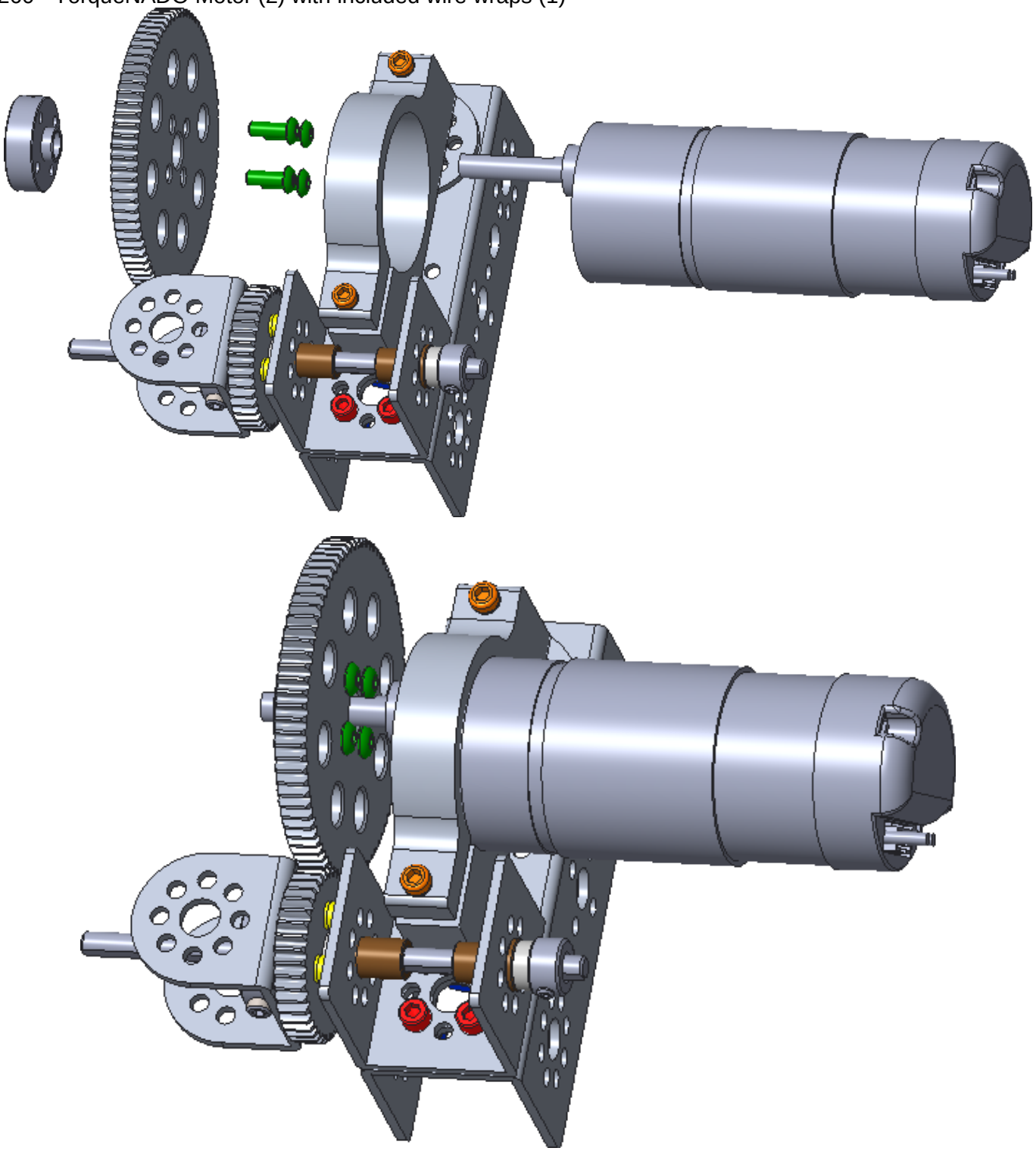
39172 – axle hub (1)
39065 – 32mm channel (1)
39028 – 40-tooth gear (1)
39097 – 1/2" socket head cap screw (4)





Step 5: Add the Motor and Gear

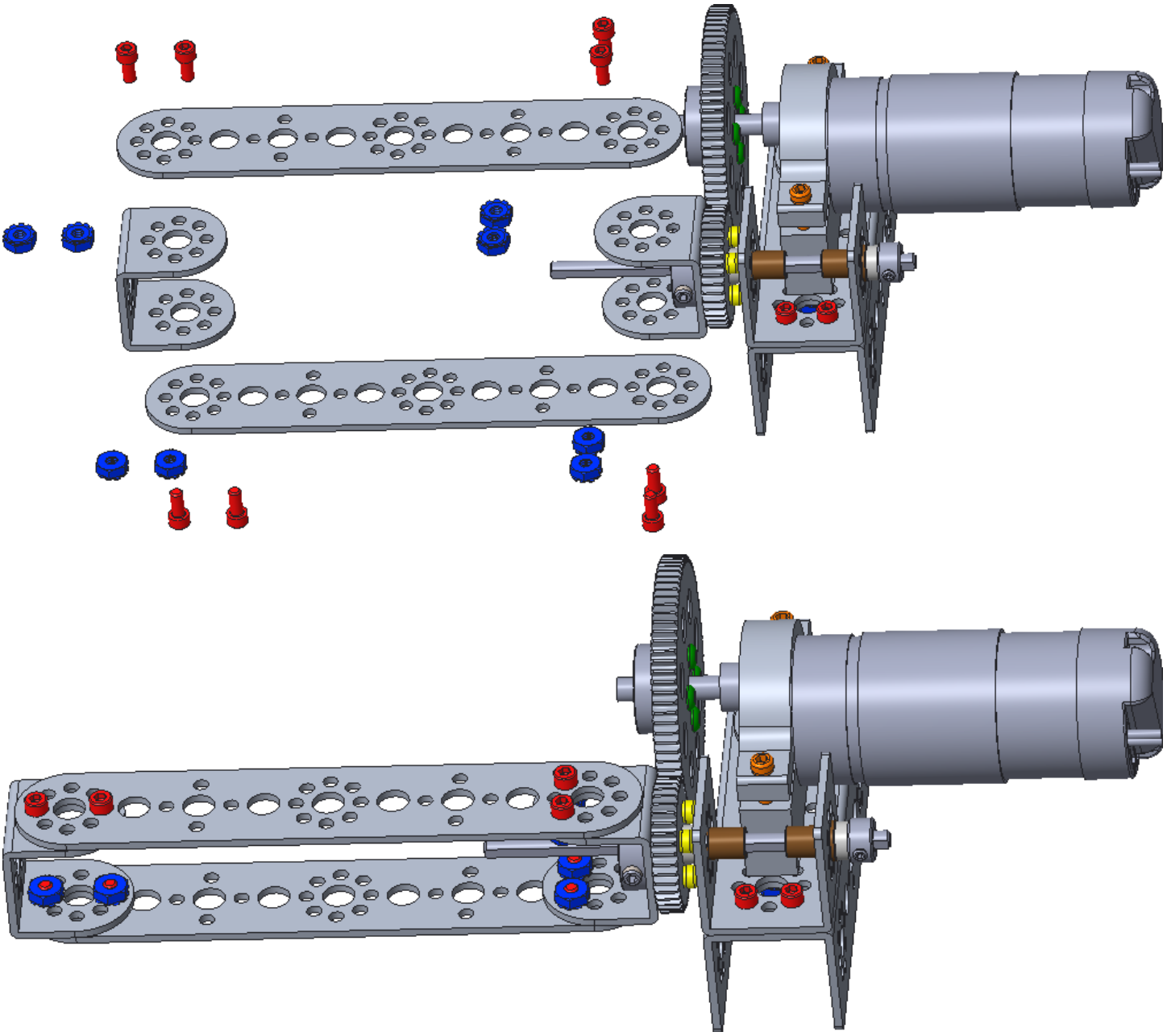
39079 – motor hub (1)
39086 – 80-tooth gear (1)
39111 - 3/8” button head cap screw (4)
44260 - TorqueNADO Motor (2) with included wire wraps (1)



Rotate the motor until the teeth mesh. Tighten the motor mount bolt (lower bolt in the above image), so the motor will not rotate

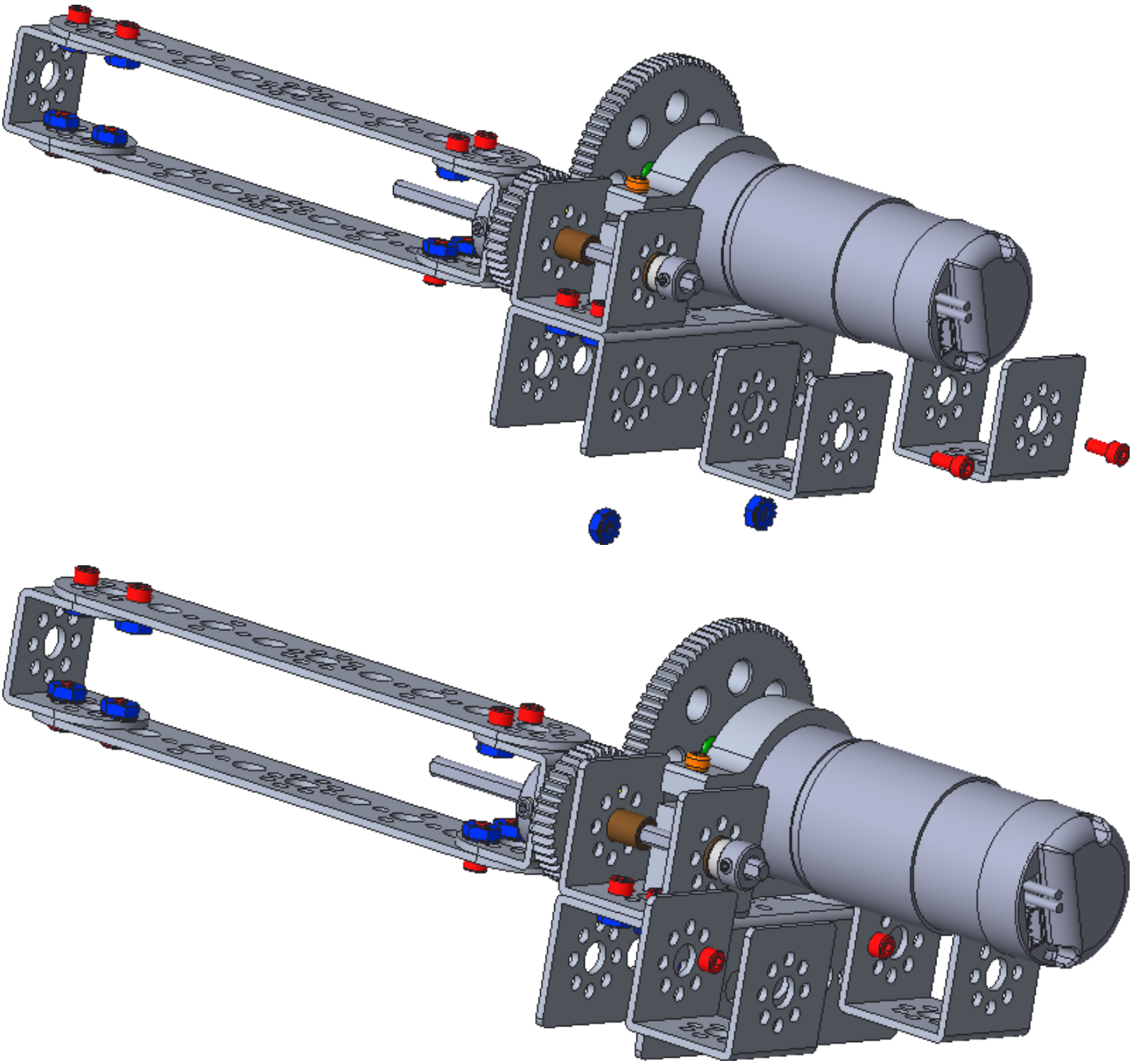
Step 6: Add the Brush Support

39065 – 32mm channel (1)
39271 – 288 mm flat (2)
39098 – 15/16" socket head cap screw (8)
39094 - keps nut (8)



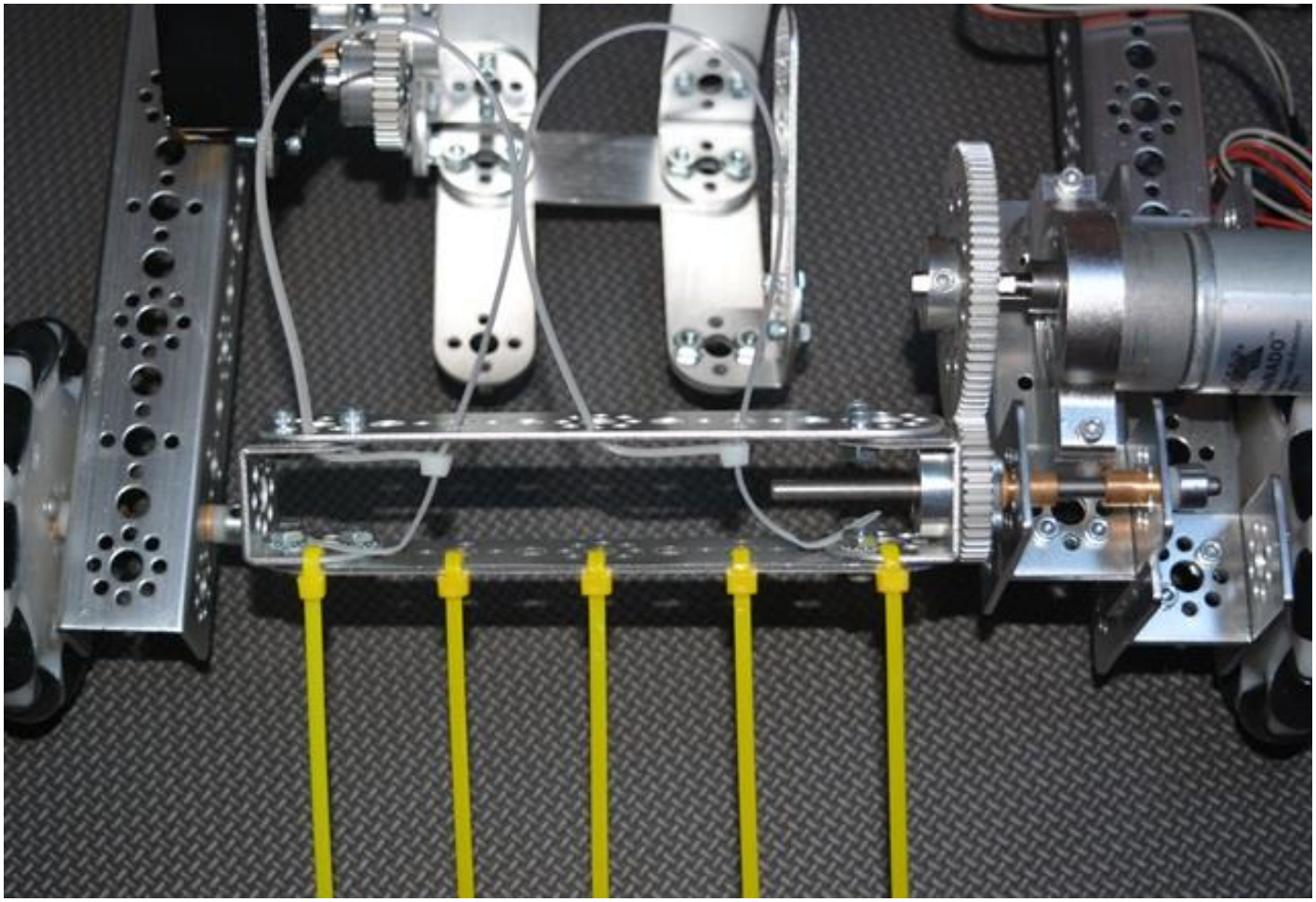
Step 7: Add the Sweeper Support

39065 – 32mm channel (2)
39098 – 15/16" socket head cap screw (2)
39094 - keps nut (2)



Step 8: Add Brushes to the Sweeper

Zip Ties (as required)

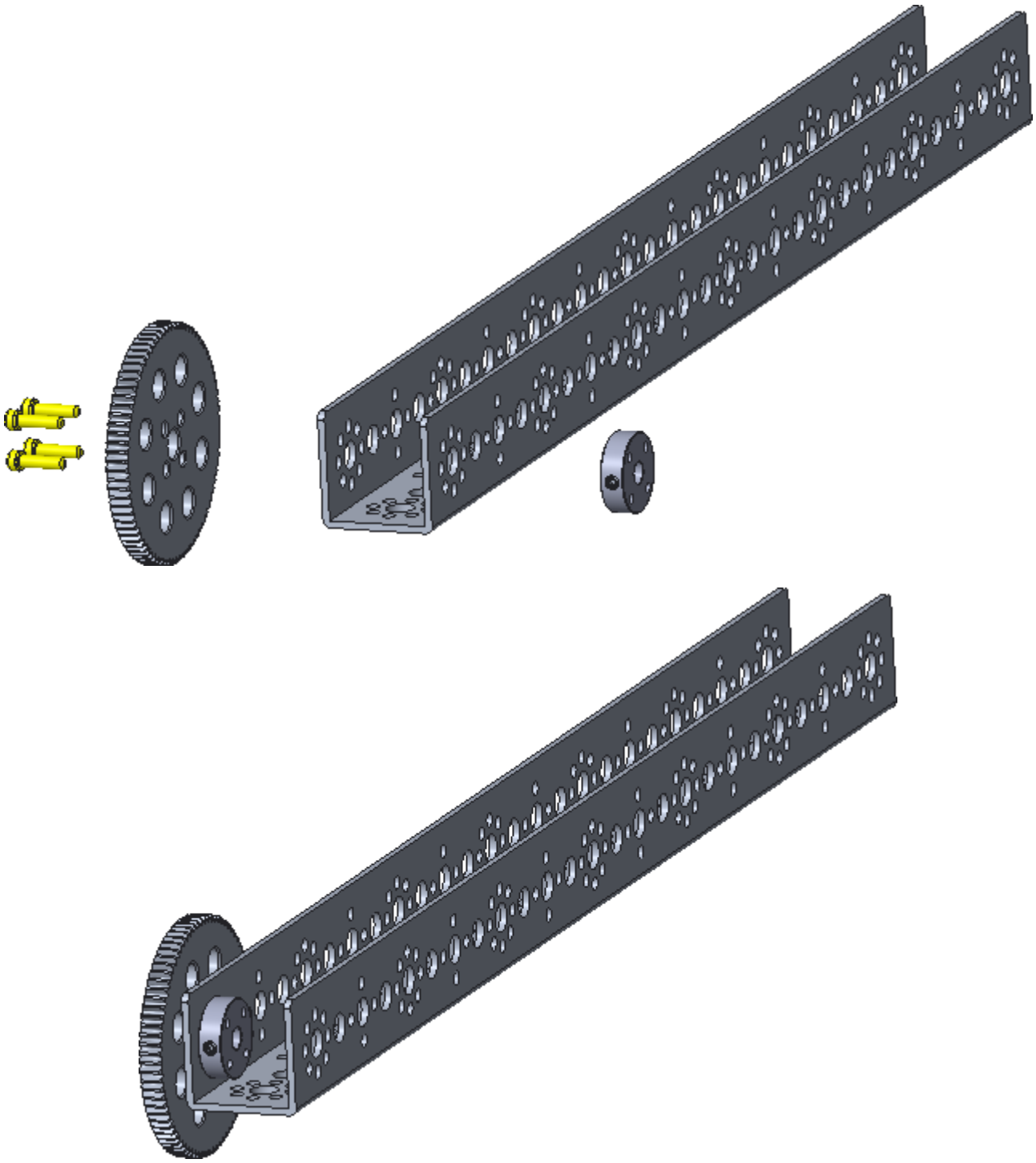


The yellow zip ties show one option. The white zip ties show another option. Conduct testing and chose the style that performs best. A third option would be to buy heavier zip ties and attach them in a similar fashion to the yellow ones.

Build the Arm

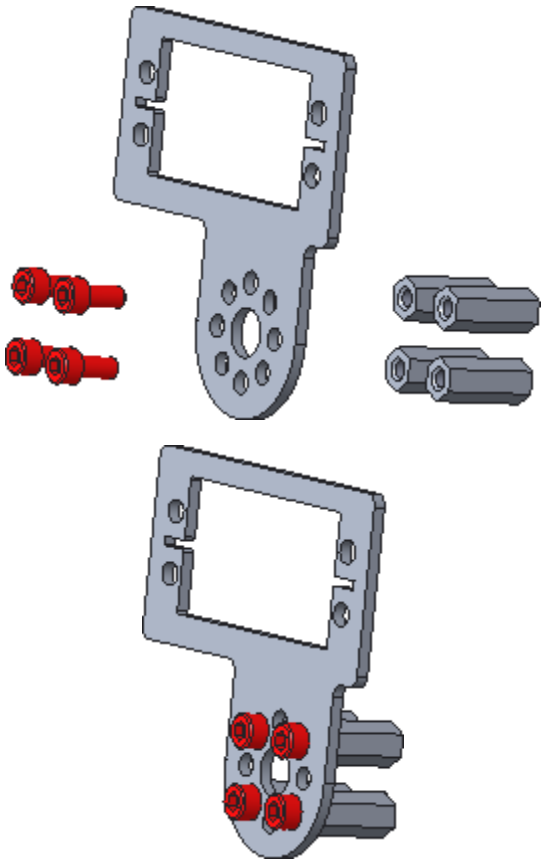
Step 1: Add the Gear to the Arm

39097 – 1/2" socket head cap screw (4)
39086 – 80-tooth gear (1)
39079 – motor hub (1)



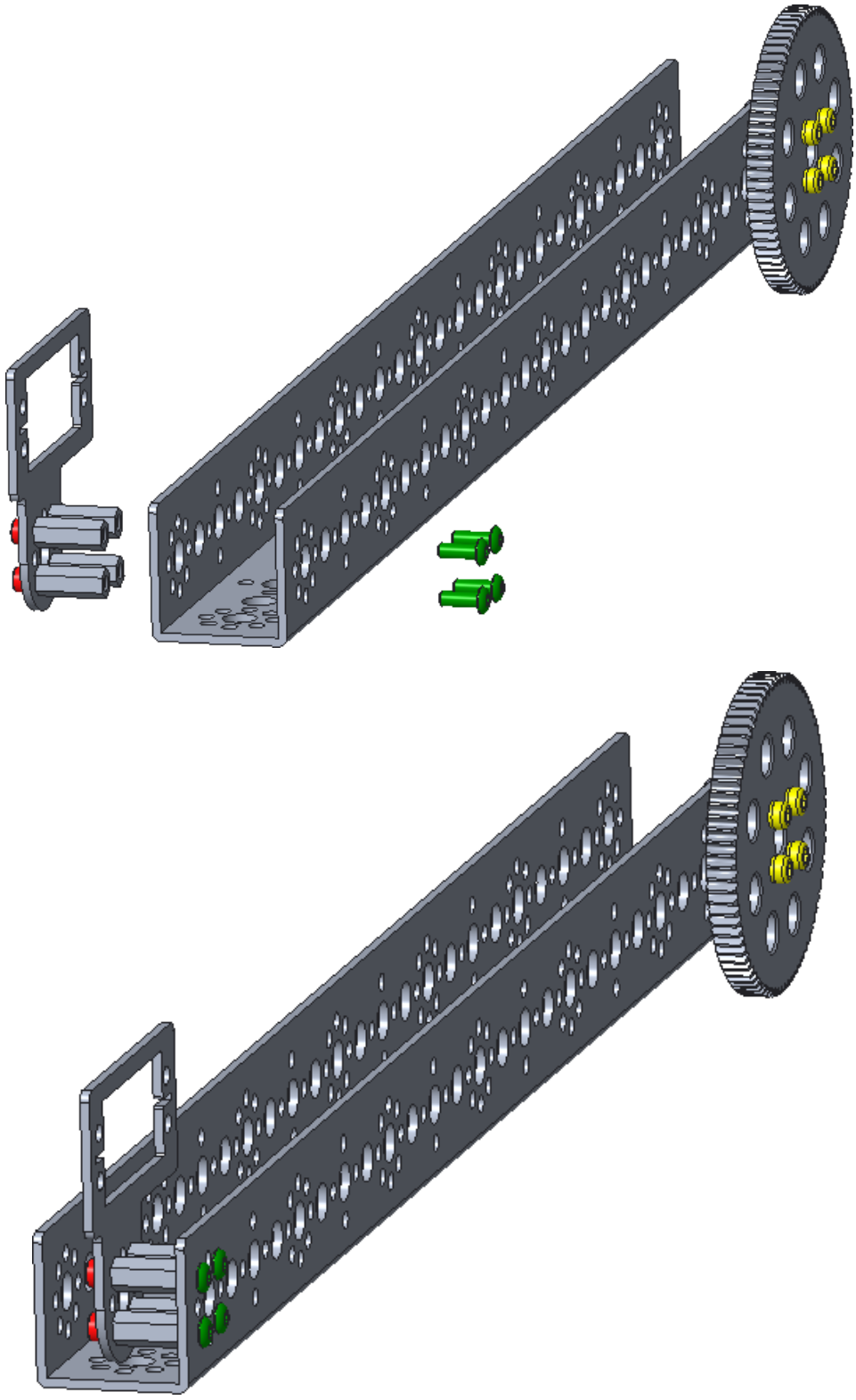
Step 2: Add Support to the Servo Bracket

39098 – 15/16" socket head cap screw (4)
41789 – the plate from the standard servo mounting kit (1)
41253 – 6-32 X 16 mm stand-off (4)



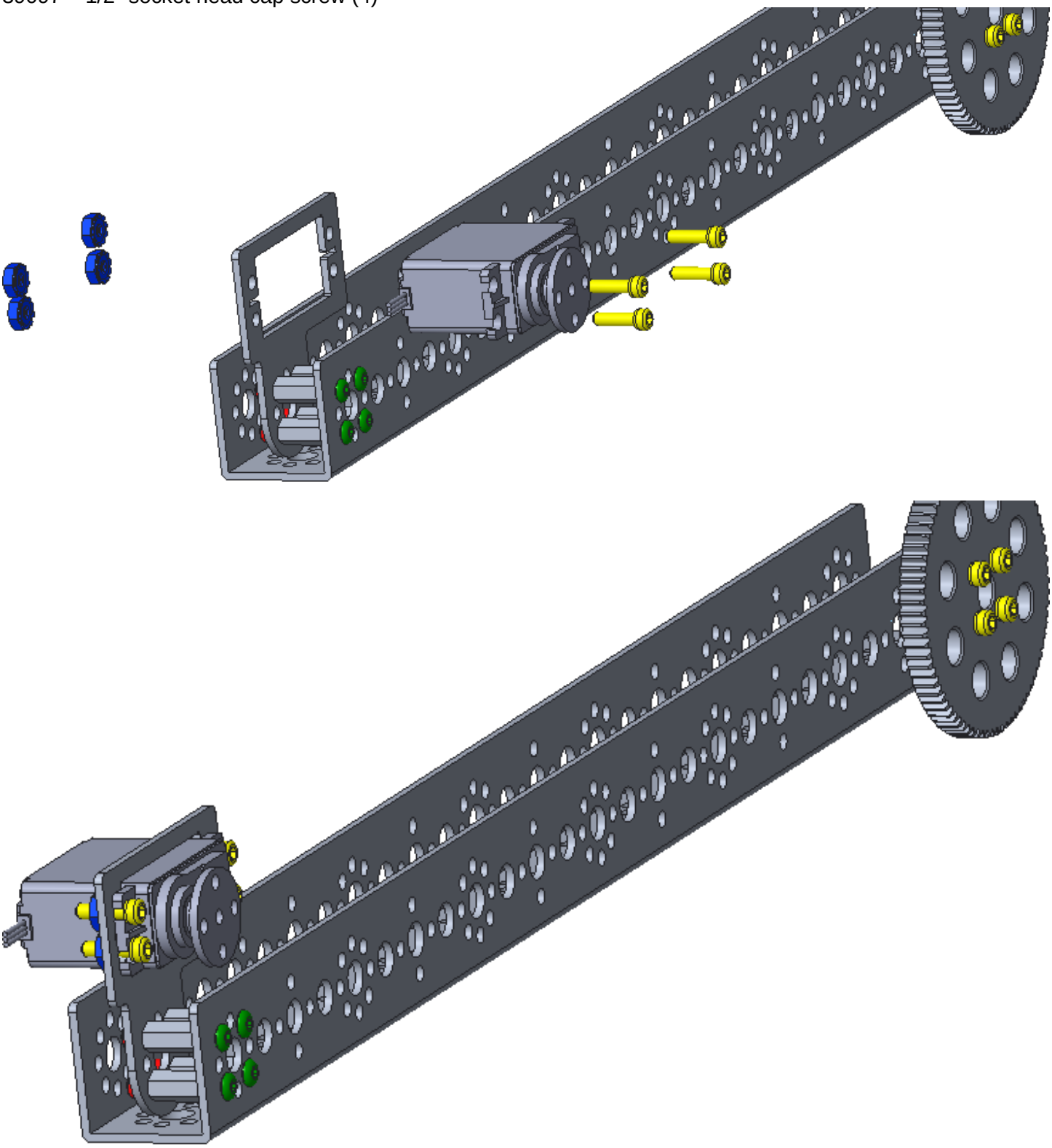
Step 3: Add the Servo Bracket to the Arm

39111 - 3/8” button head cap screw (4)



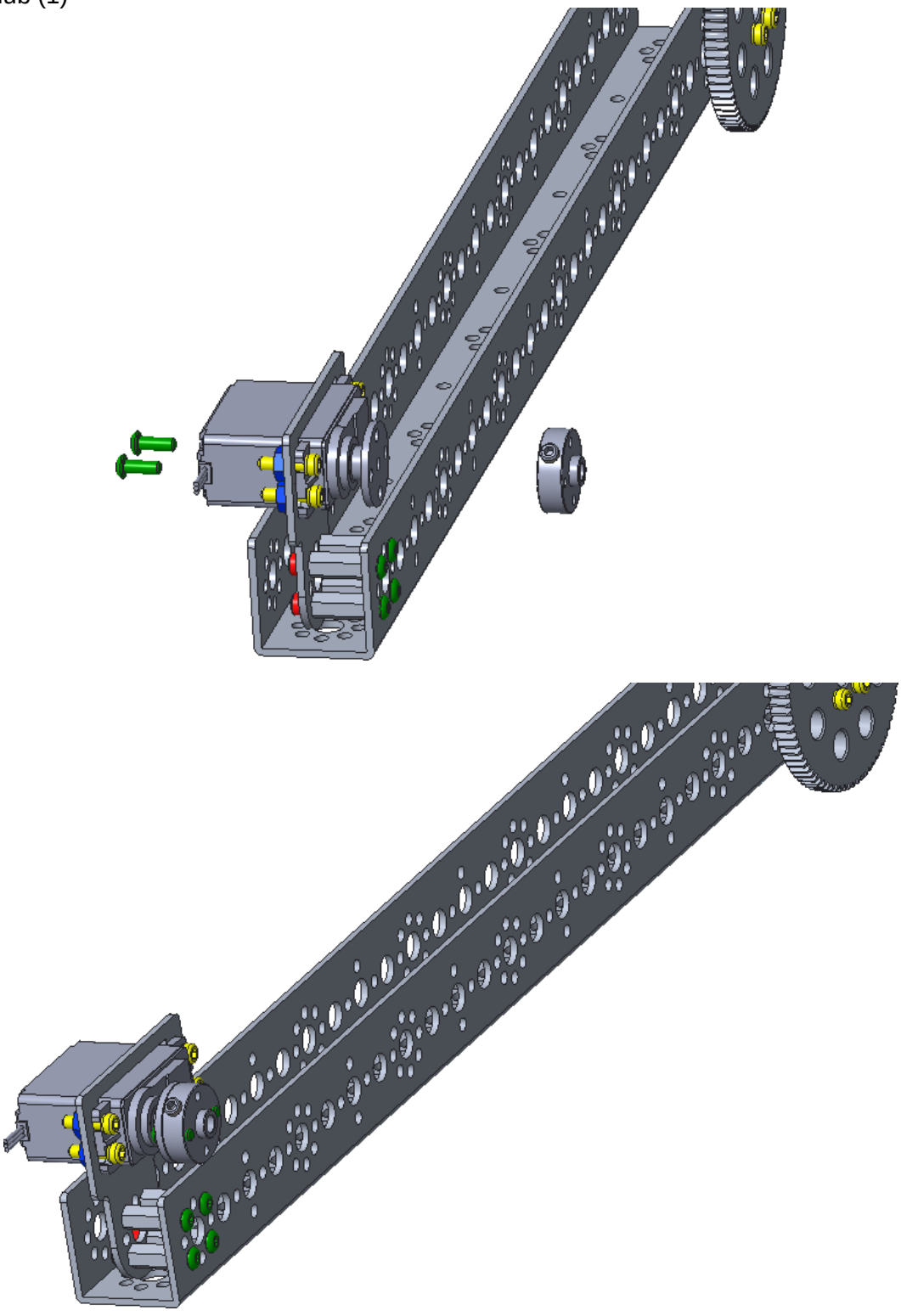
Step 4: Add the Servo to the Bracket

39094 - keps nut (4)
39197 - 180° standard scale servo motor (1)
39097 – 1/2" socket head cap screw (4)



Step 5: Add the Axle Hub to the Servo

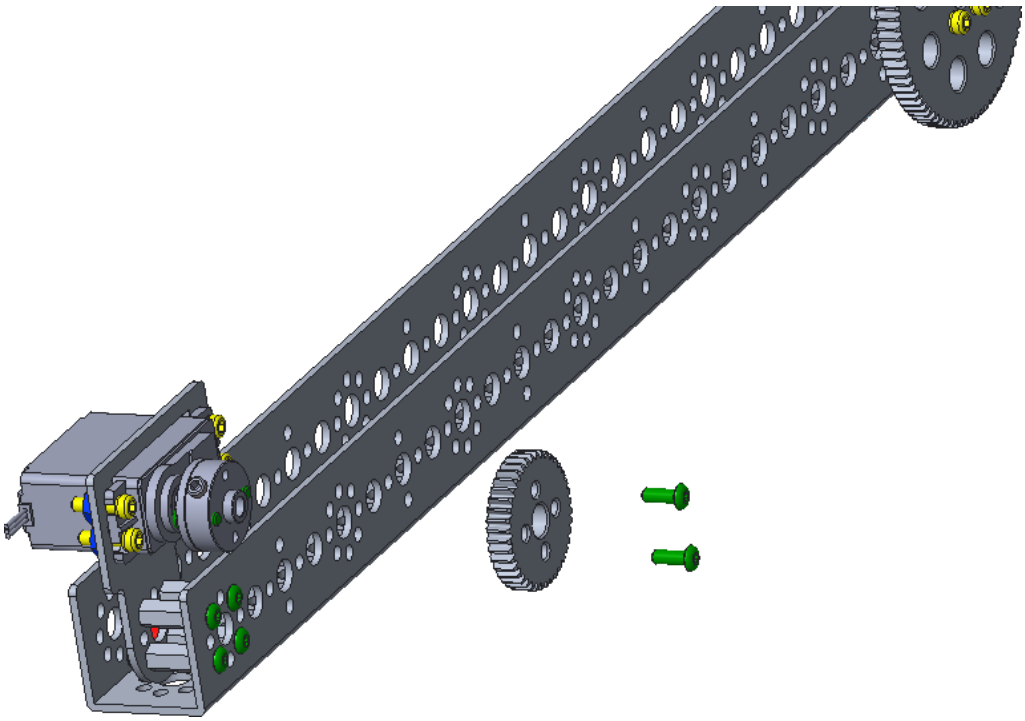
39111 - 3/8" button head cap screw (2)
39172 – axle hub (1)

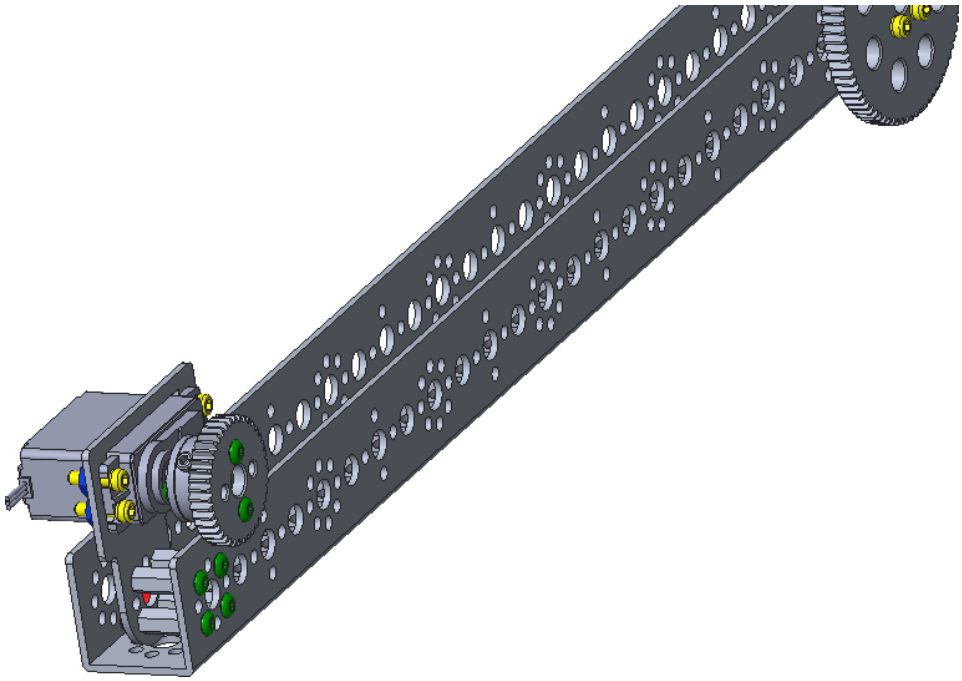


The small black screw that secures the horn onto the server is easily rounded-out. PRESS HARD on the screwdriver, but not so hard as to break the servo, to remove the socket horn. Attach the axle hub to the horn and replace the horn on the servo. PRESS HARD on the screwdriver to secure the horn onto the servo.

Step 6: Add the Gear to the Axle Hub

39111 - 3/8” button head cap screw (2)
39028 - 40-tooth gear (1)

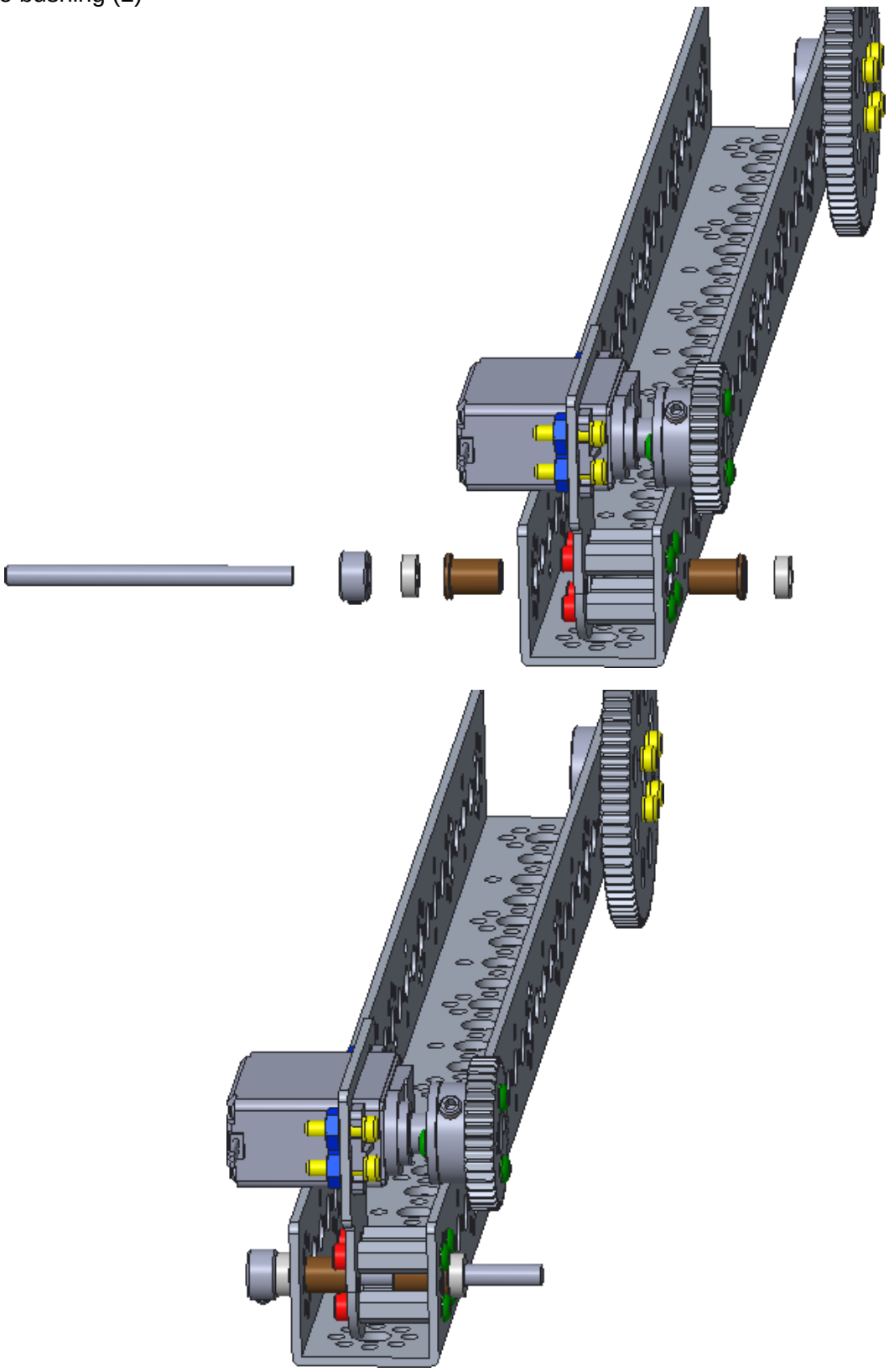




Use the two open holes of the axle hub.

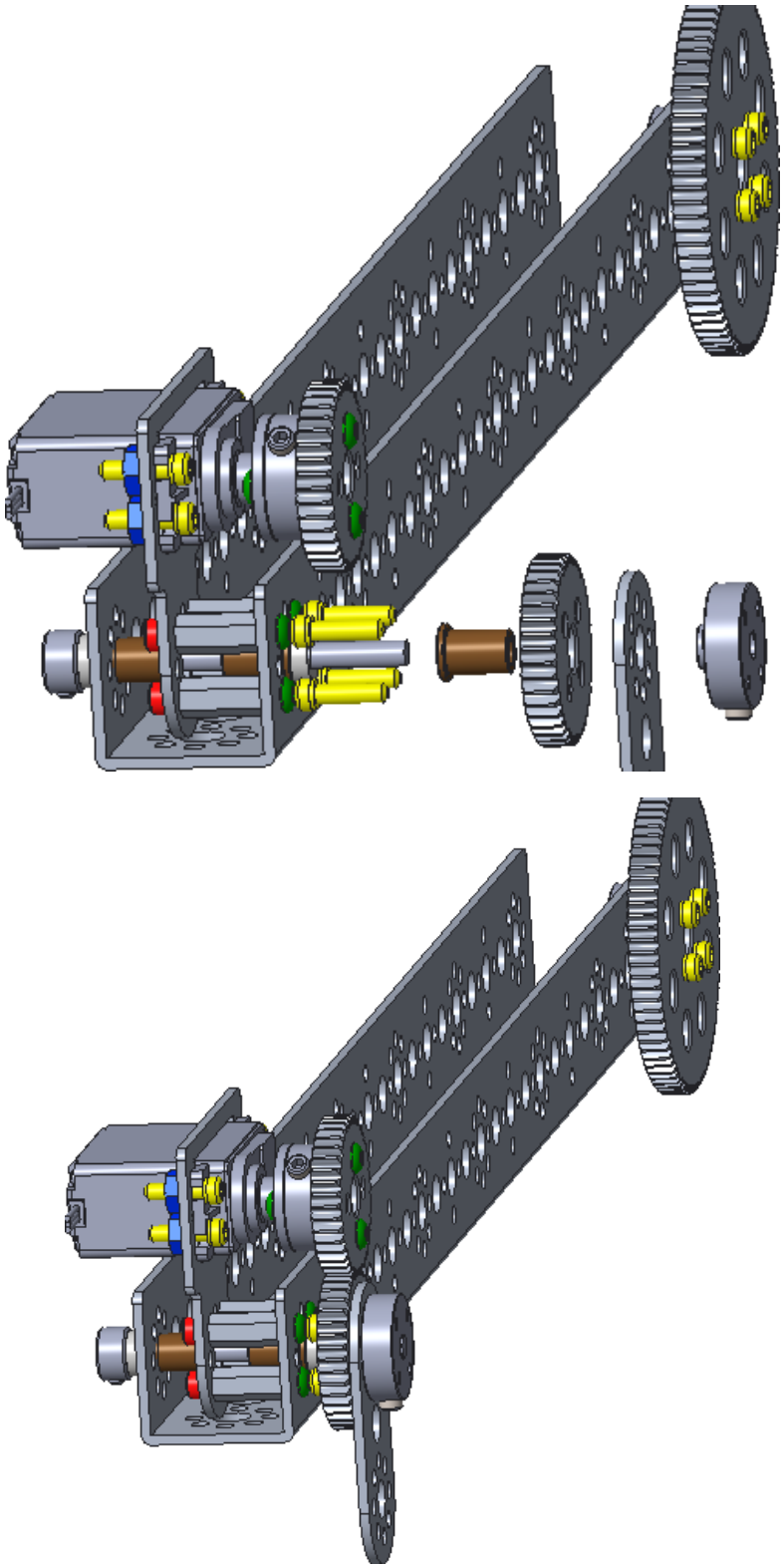
Step 7: Add the Axle to the Arm

41789 – the axle from the standard servo mounting kit (1) - see step 2: Add Support to the Servo Bracket.
39092 – axle set collar (1)
41665 – 6 mm plastic bushing spacer (2)
39091 – bronze bushing (2)



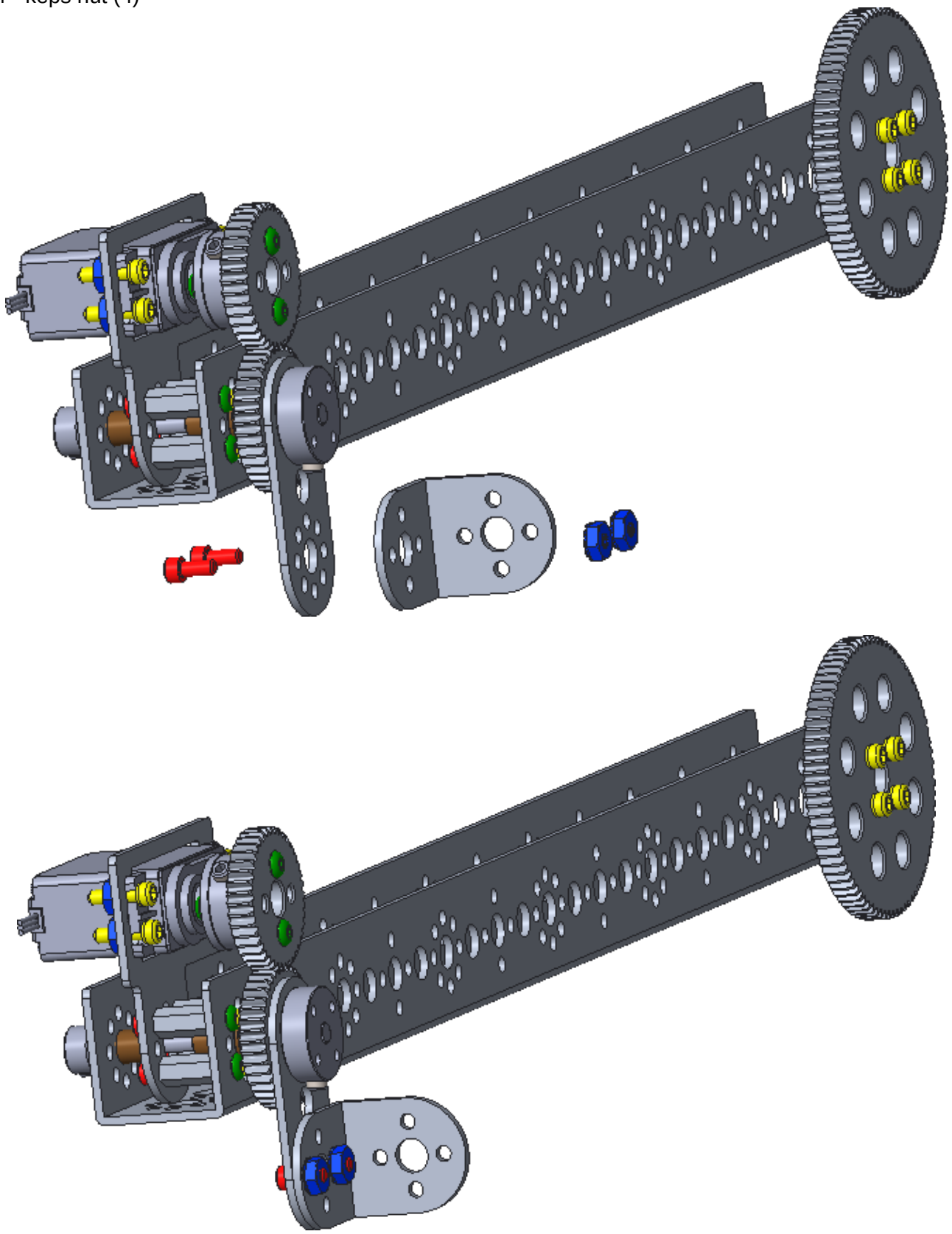
Step 8: Add the Basket Gear and Support

39097 – 1/2" socket head cap screw (4)
39091 – bronze bushing (1)
39028 - 40-tooth gear (1)
39274 - 64 mm X 27 mm flat
39172 – axle hub (1)



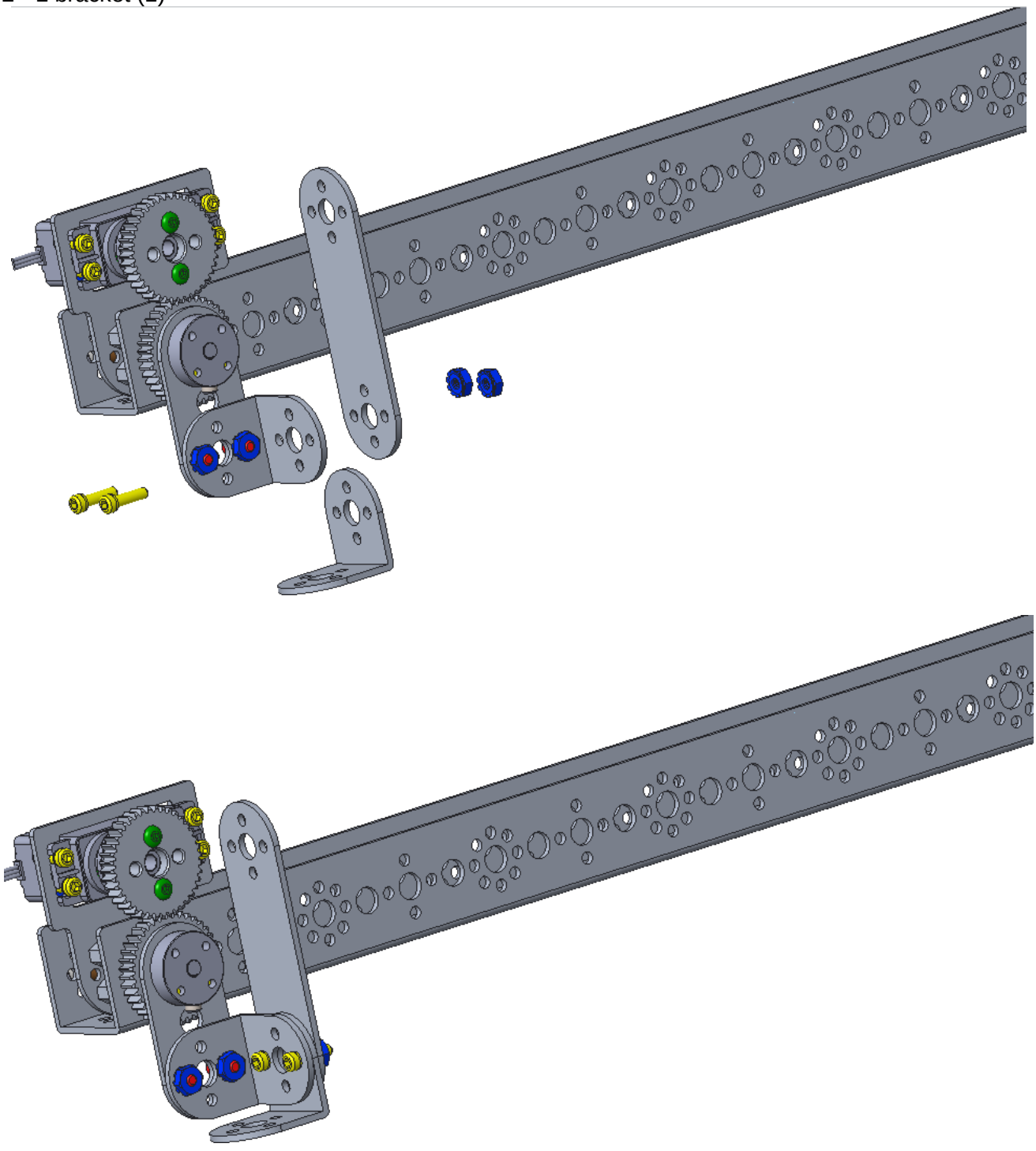
Step 9: Add Corner Brace

39098 – 15/16" socket head cap screw (2)
39062 - L bracket (1)
39094 - keps nut (4)



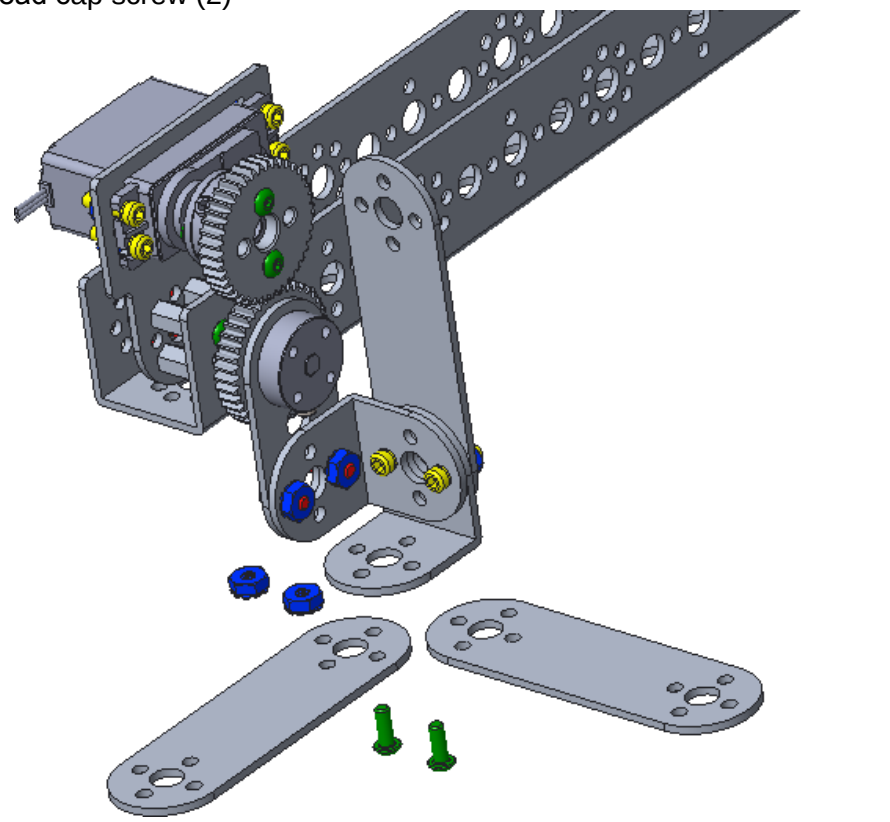
Step 10: Add Basket Back Right Support

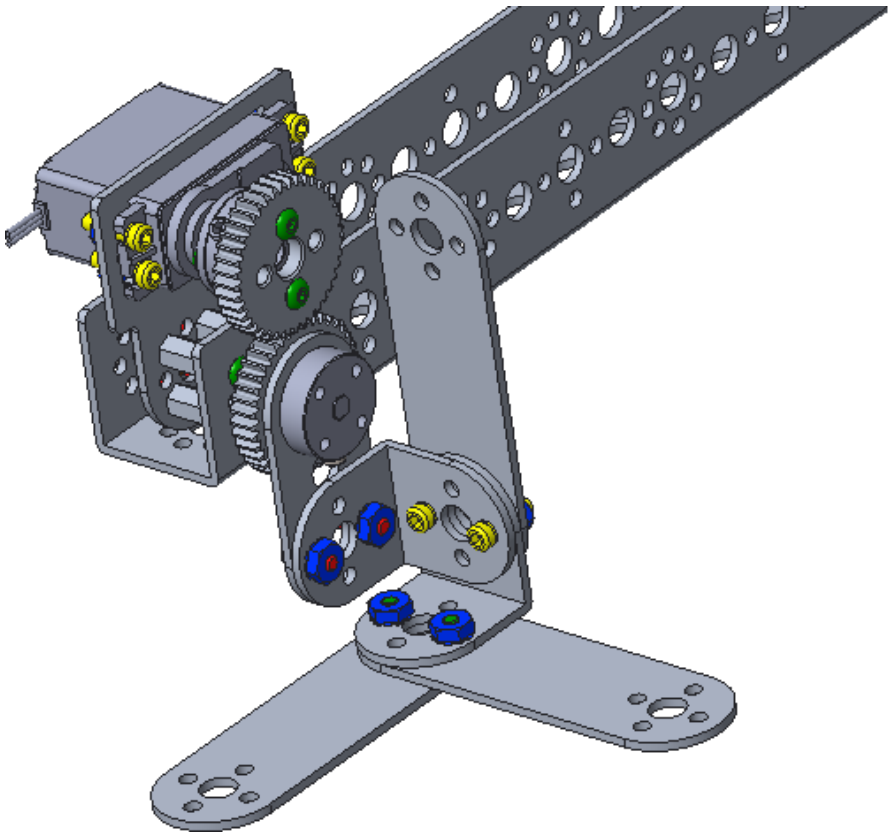
39097 – 1/2" socket head cap screw (2)
39094 - keps nut (2)
39061 - flat bracket (1)
39062 - L bracket (1)



Step 11: Add Basket Bottom Support

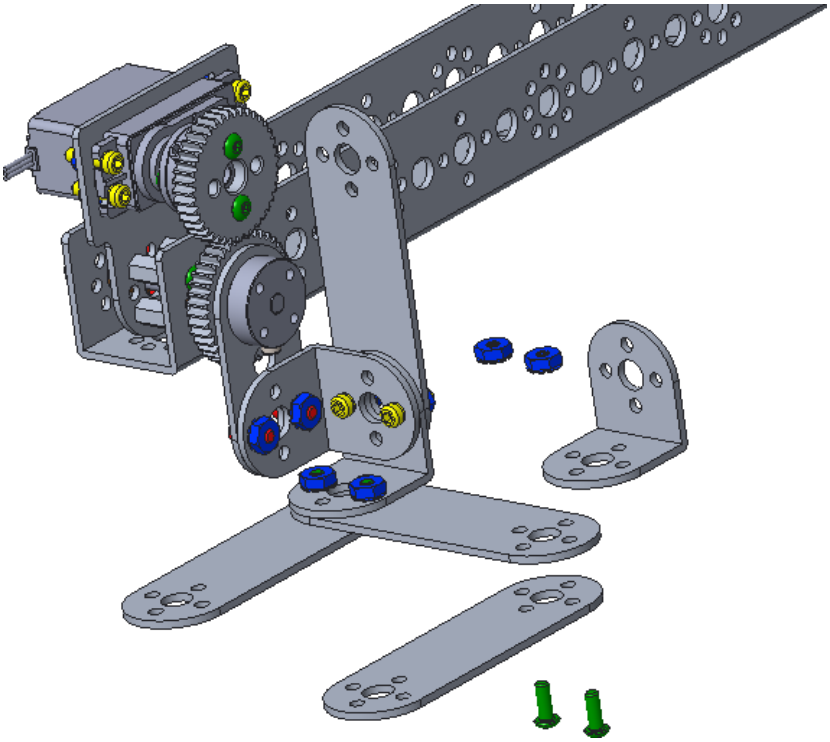
39061 - flat bracket (2)
39094 - keps nut (2)
39111 - 3/8” button head cap screw (2)

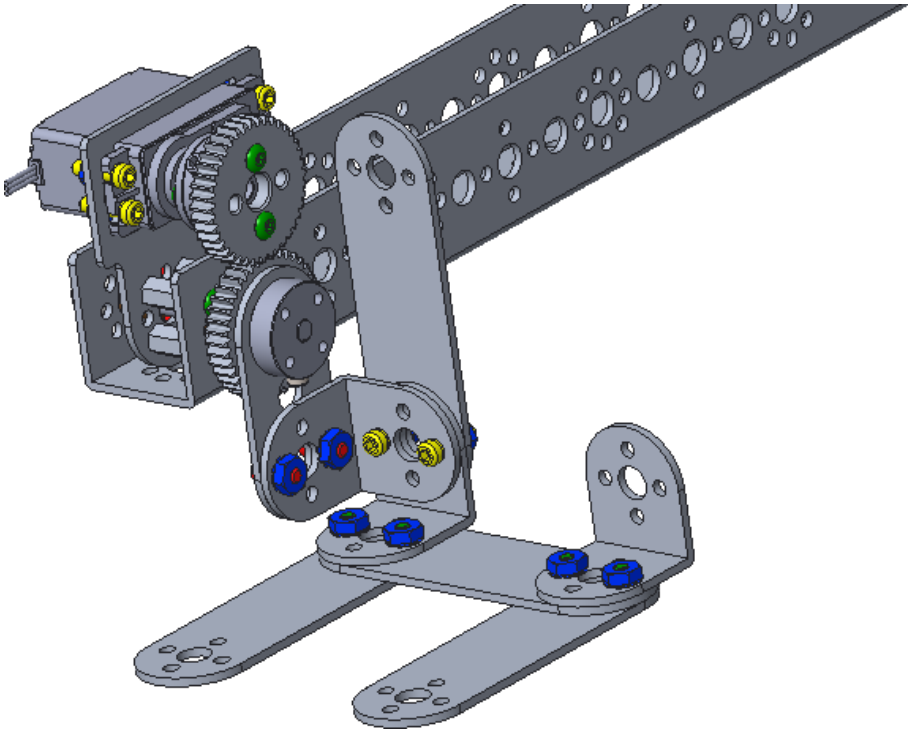




Step 12: Add More Basket Bottom Support

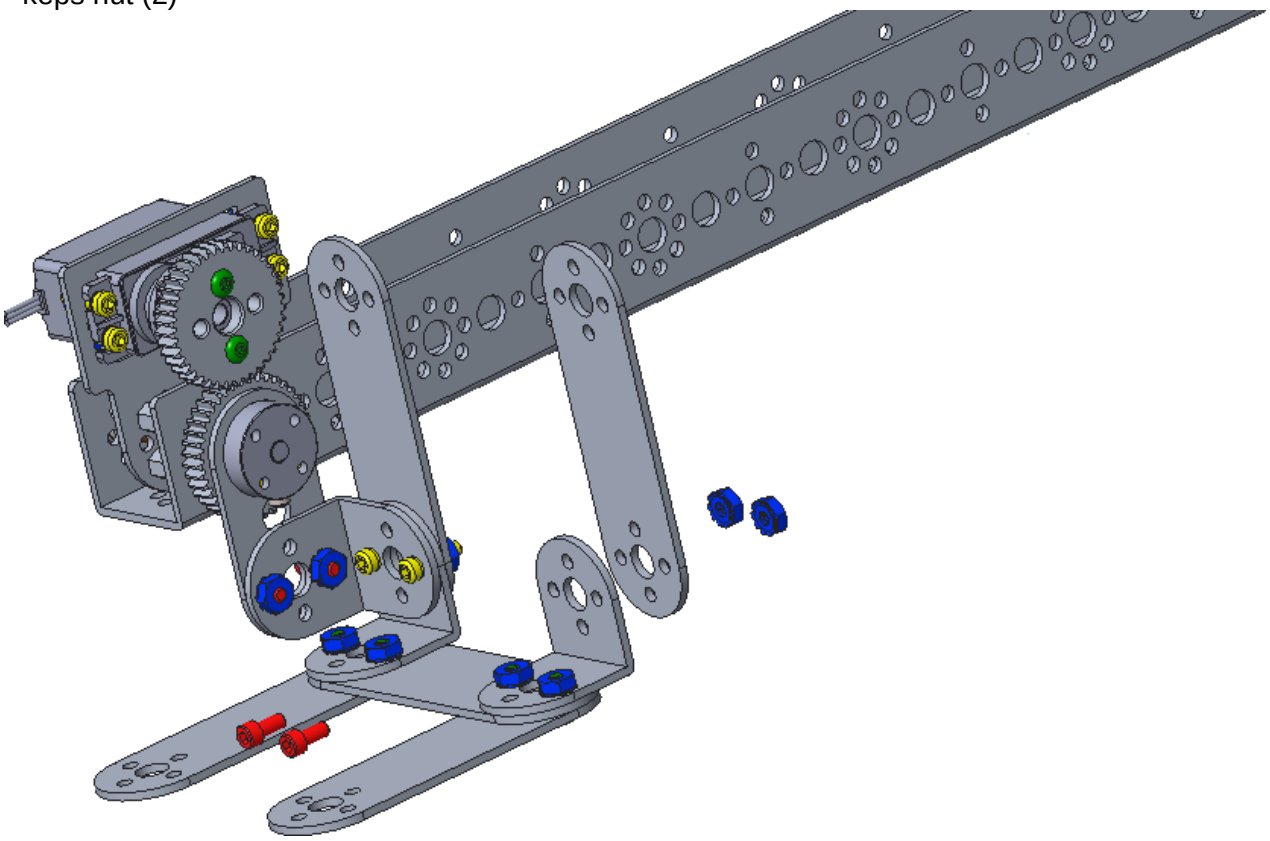
39061 - flat bracket (1)
39094 - keps nut (2)
39111 - 3/8” button head cap screw (2)
39062 - L bracket (1)

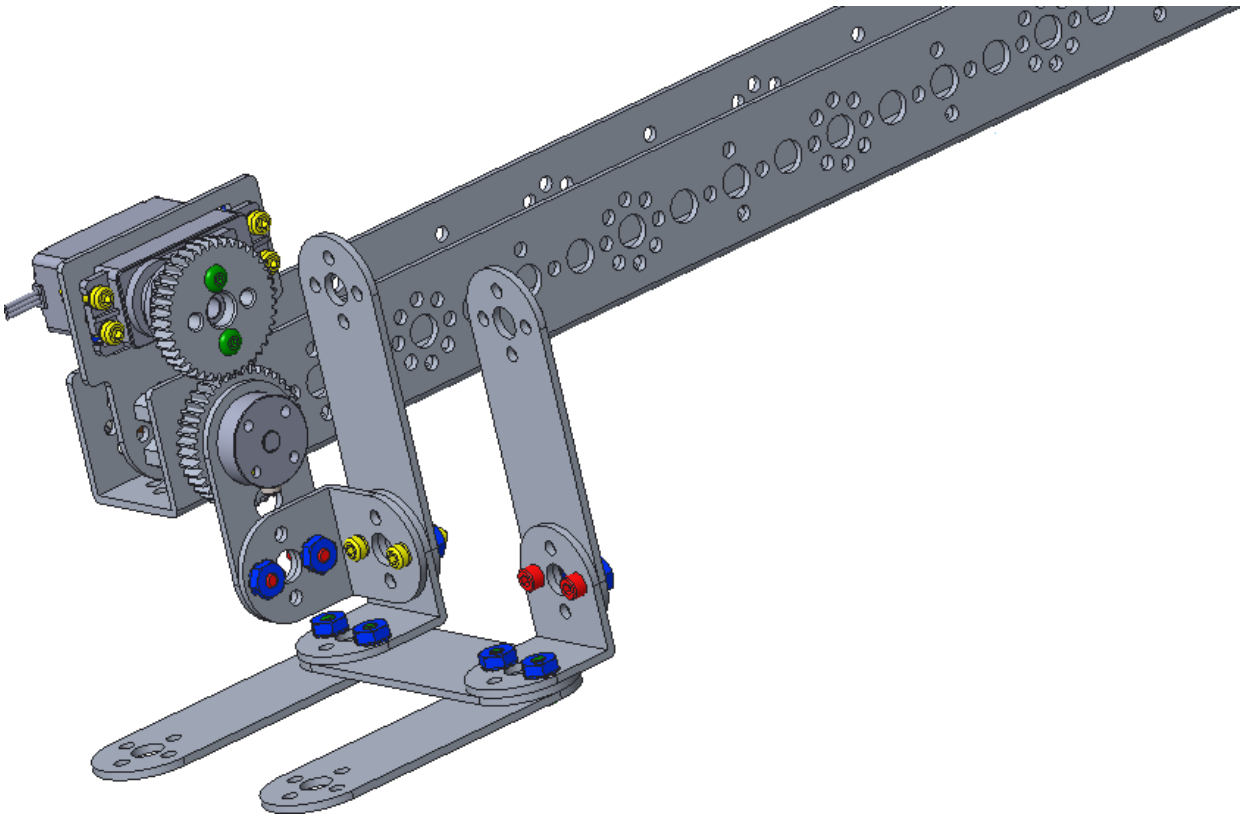




Step 13: Add Basket Back Support

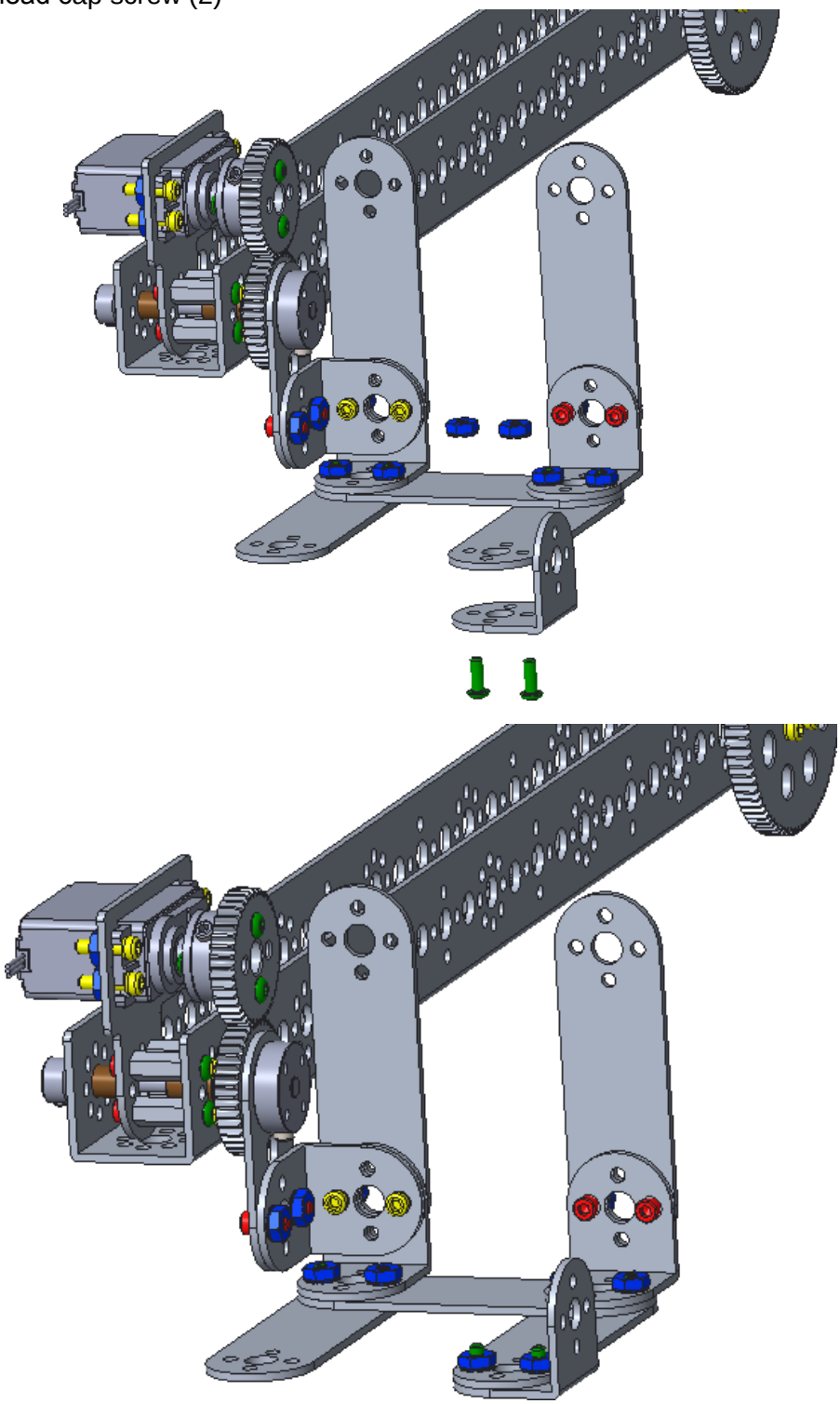
39061 - flat bracket (1)
39098 – 15/16" socket head cap screw (2)
39094 - keps nut (2)





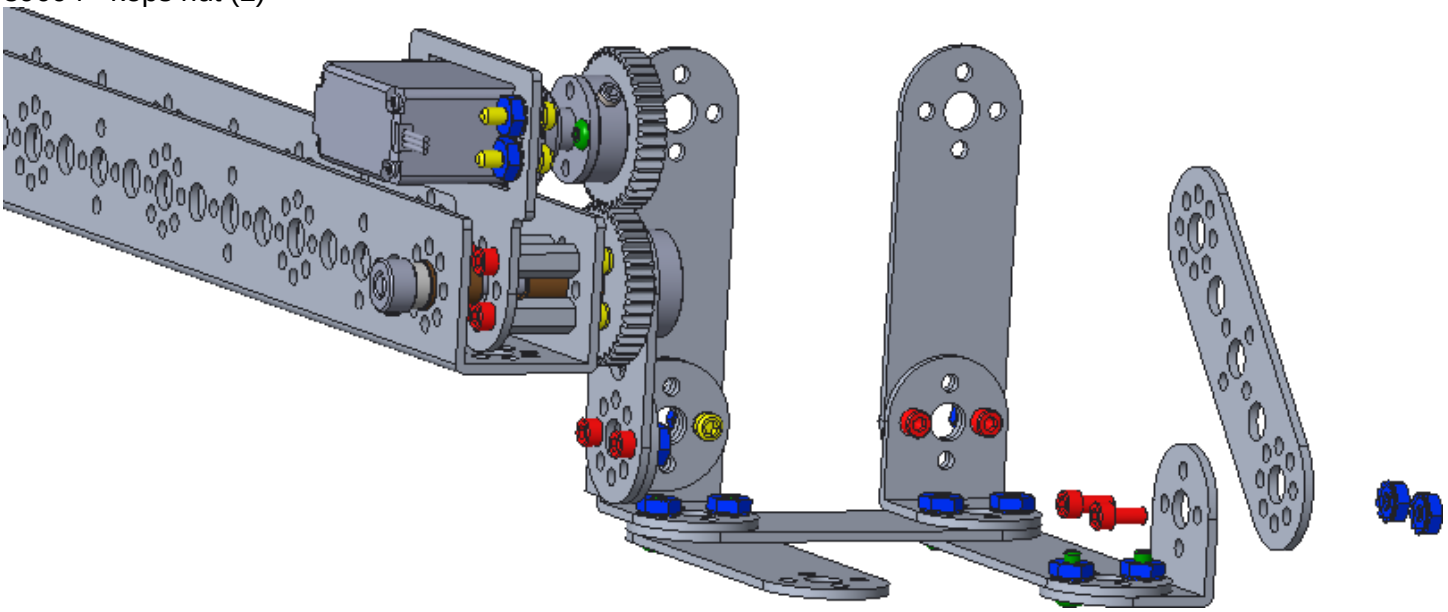
Step 14: Add Side Support

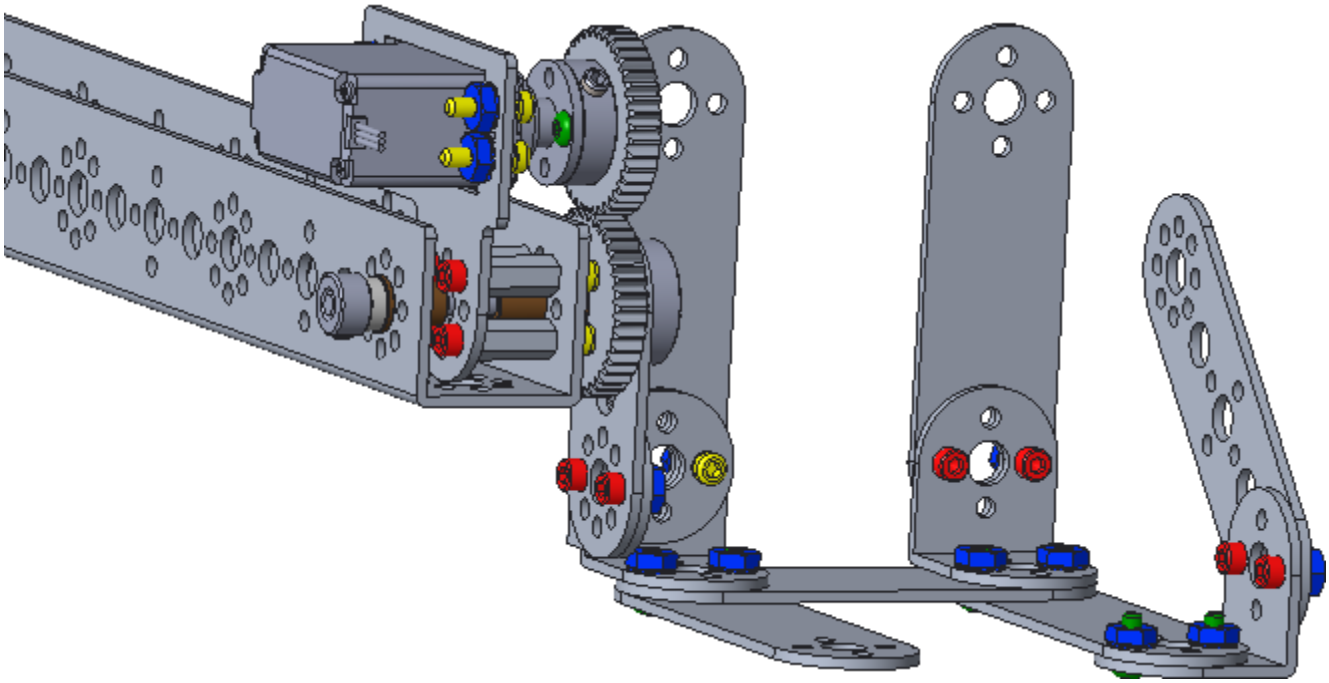
39062 - L bracket (1)
39094 - keps nut (2)
39111 - 3/8” button head cap screw (2)



Step 15: Complete the Basket

39098 – 15/16" socket head cap screw (2)
39273 - 96 mm x 27 mm flat (1)
39094 - keps nut (2)

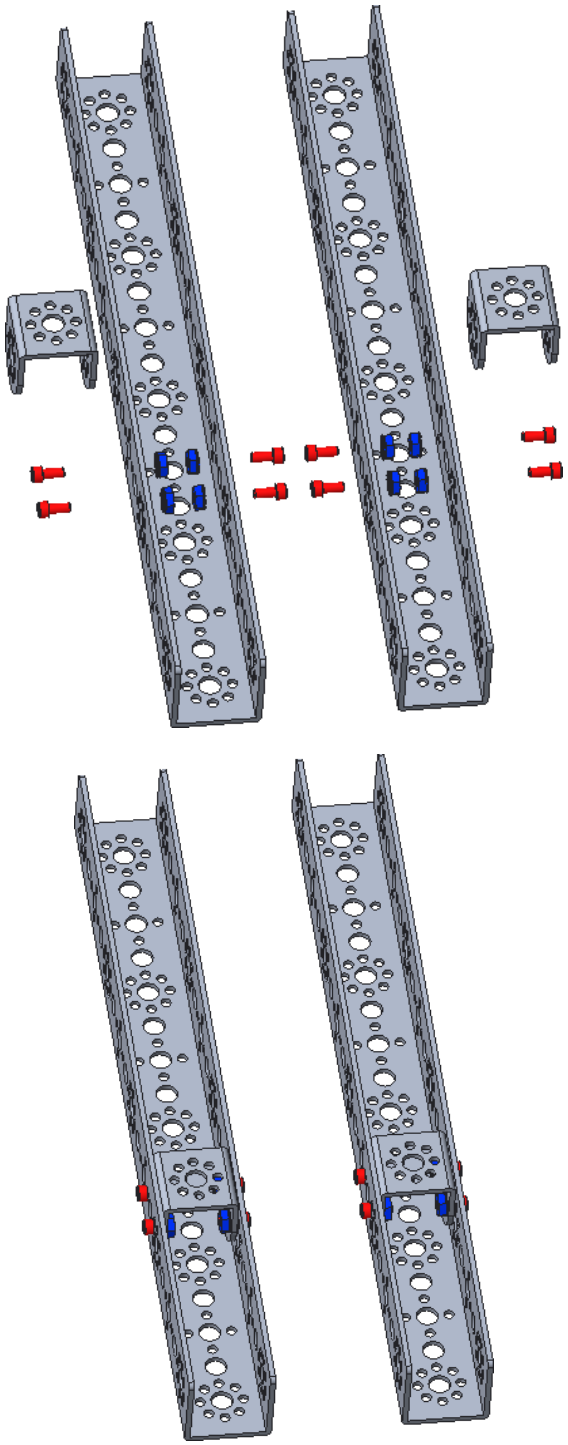




Build the Tower

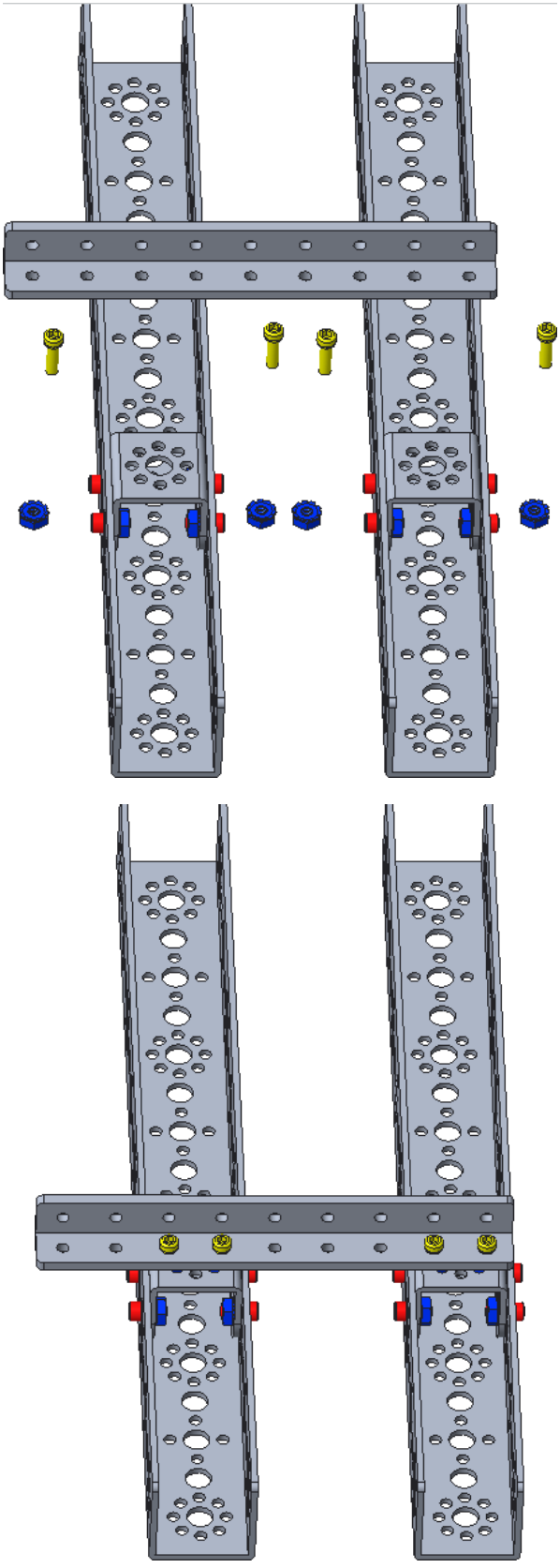
Step 1: Begin the Vertical Supports

39069 - 416 mm channel (2)
39270 - inside C connector (2)
39098 – 15/16" socket head cap screw (8)
39094 - keps nut (8)



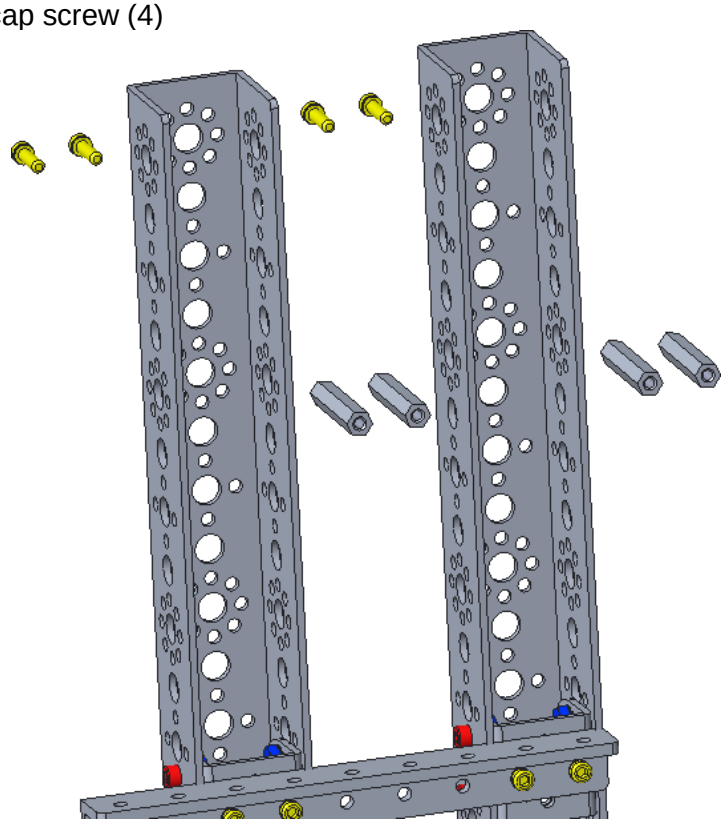
Step 2: Add Lower Horizontal Support

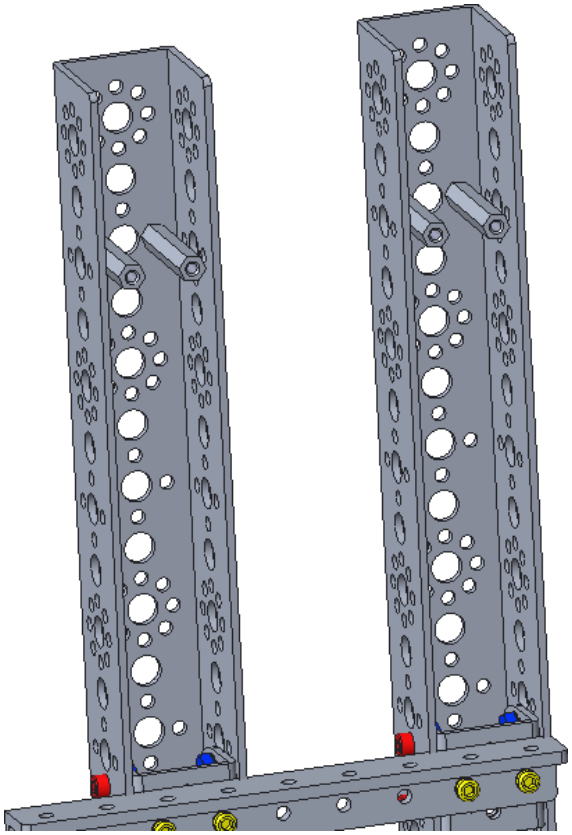
39072 - 288 mm flat bar
39097 – 1/2" socket head cap screw (4)
39094 - keps nut (4)



Step 3: Begin Upper Horizontal Support

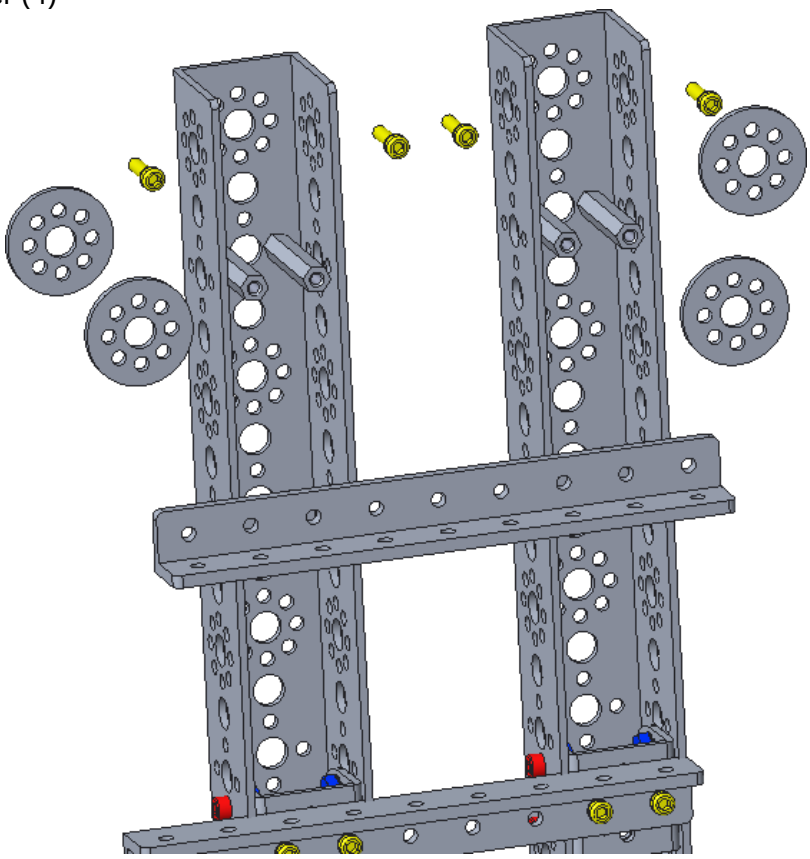
44707 - 6-32 x 28 mm stand-off post (4)
39097 – 1/2" socket head cap screw (4)

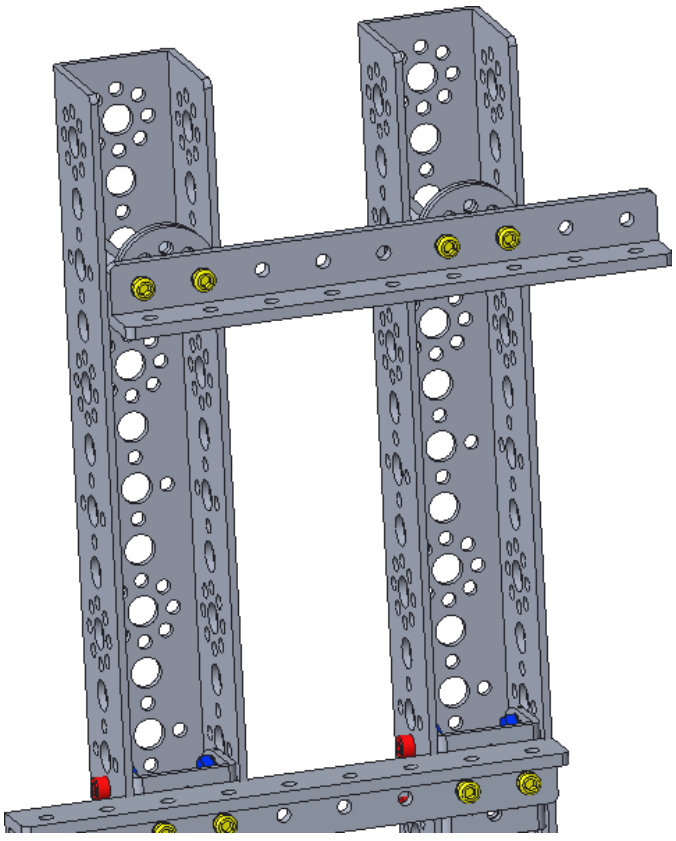




Step 4: Complete Upper Horizontal Support

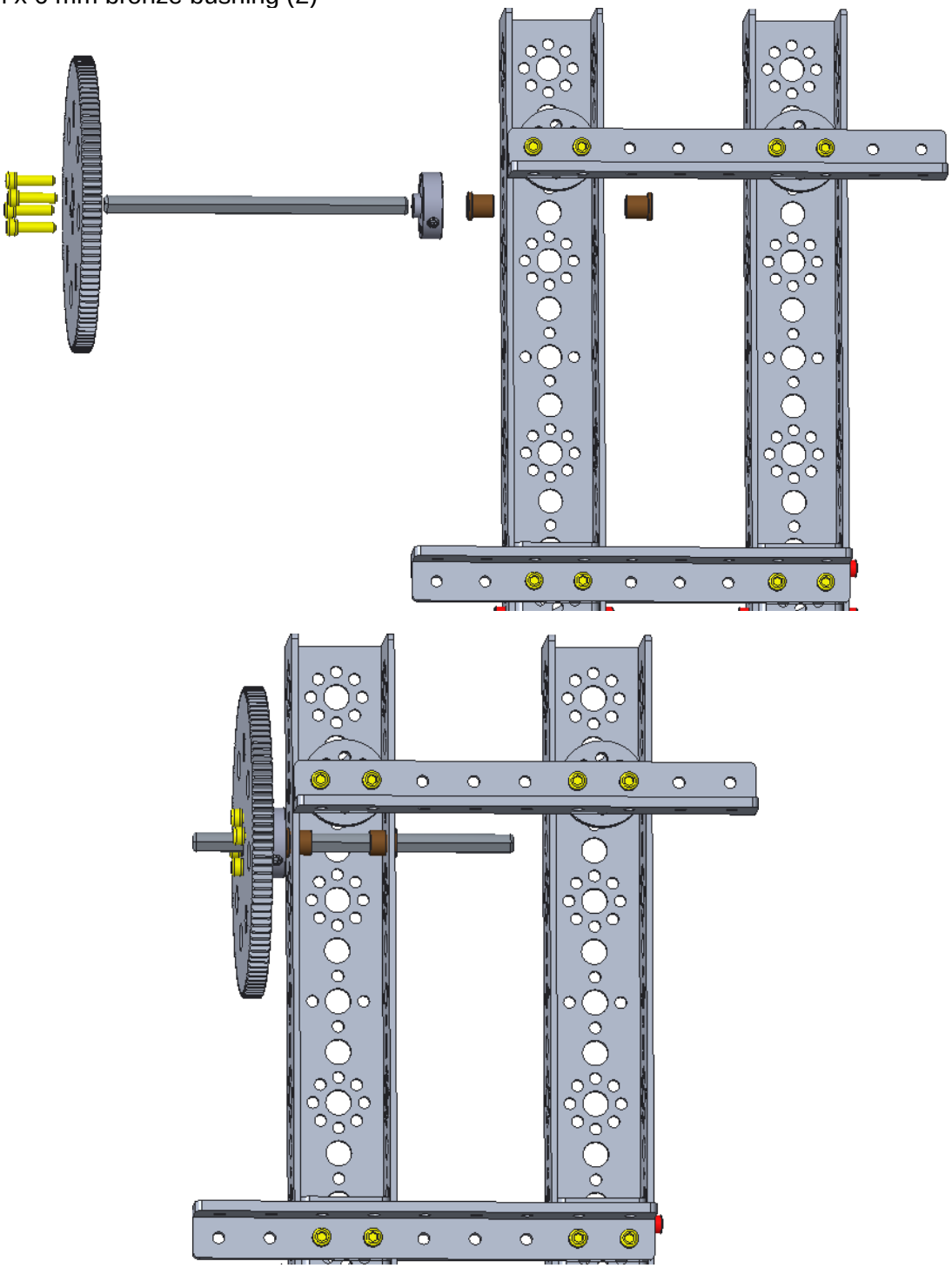
39097 – 1/2" socket head cap screw (4)
39387 - flat round spacer (4)





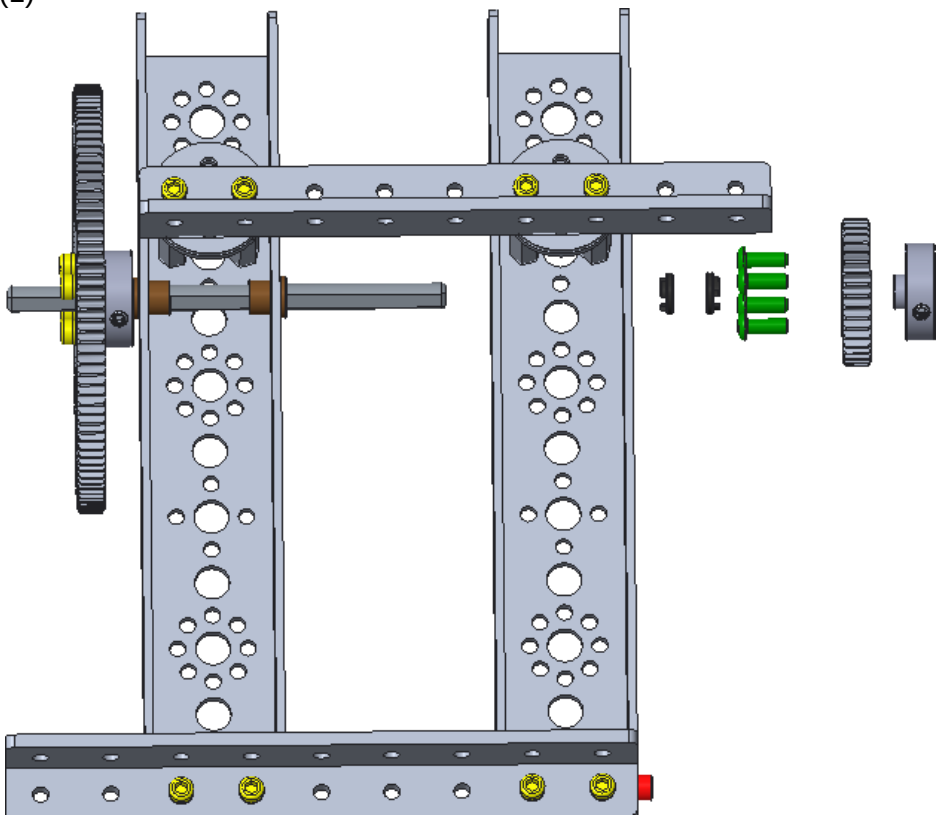
Step 5: Begin Upper Gear Assembly

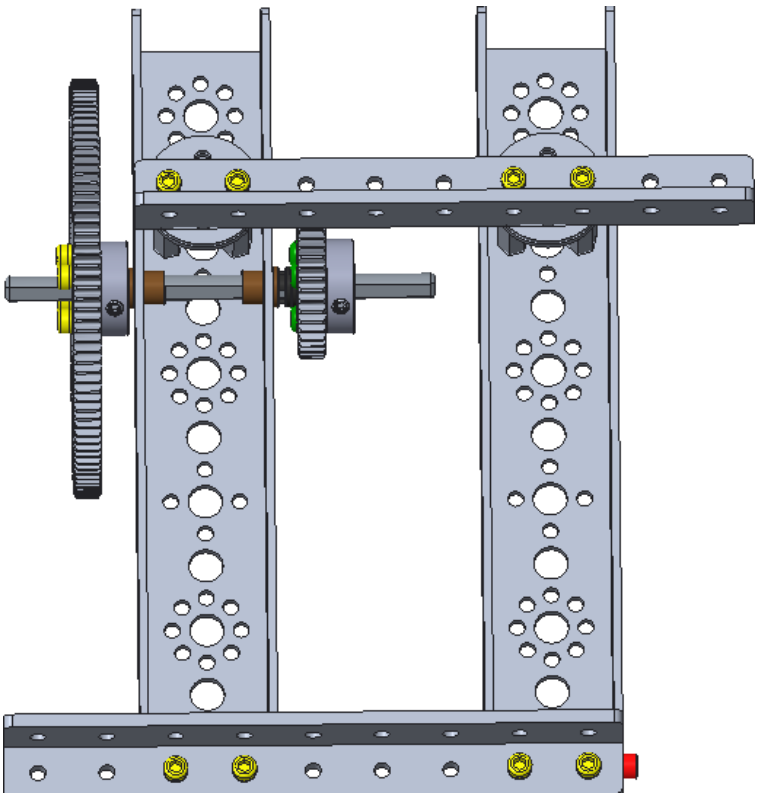
39097 – 1/2" socket head cap screw (4)
39085 - 120-tooth gear (1)
44708 - 100 mm x 6 mm axle (1)
39079 - motor hub (1)
40227 - 8 mm x 6 mm bronze bushing (2)



Step 6: Complete Upper Gear Assembly

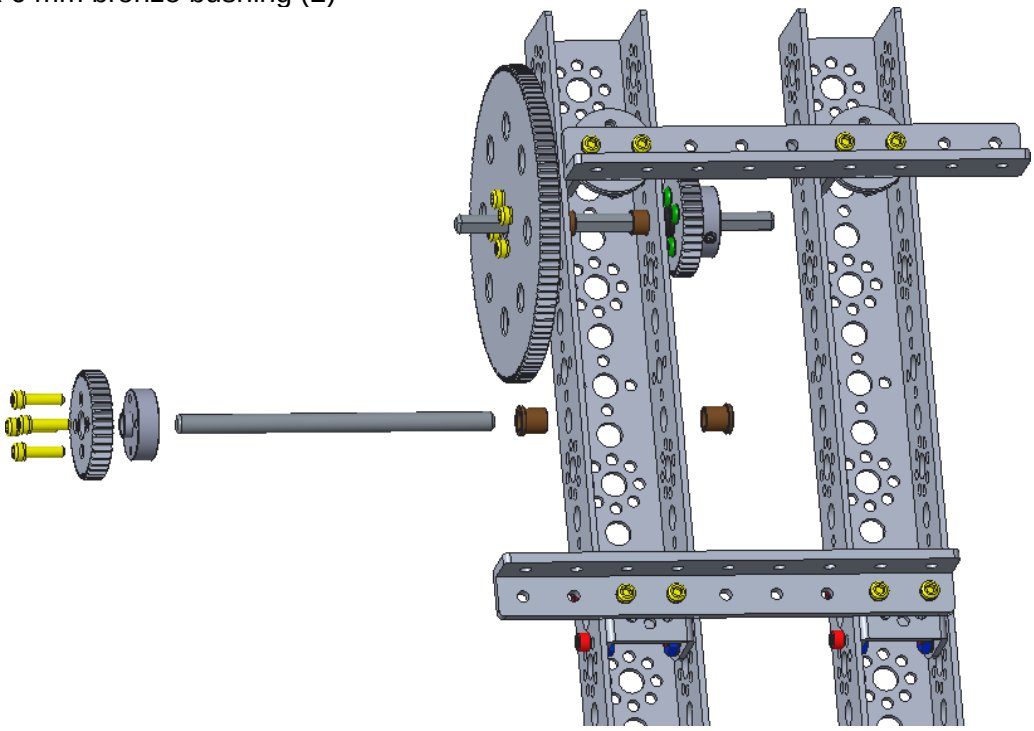
41665 - 6 mm plastic bushing spacer (2)
39111 - 3/8” button head cap screw (4)
39028 - 40-tooth gear (1)
39079 - motor hub (1)

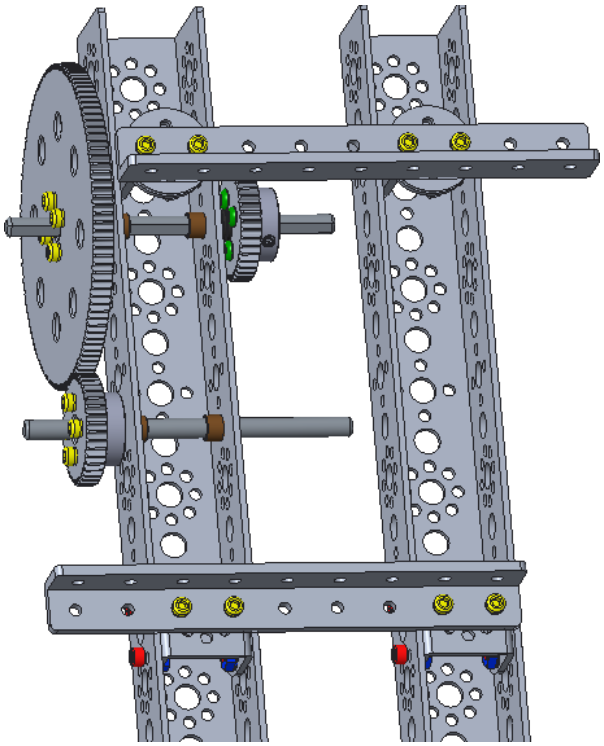




Step 7: Begin Lower Gear Assembly

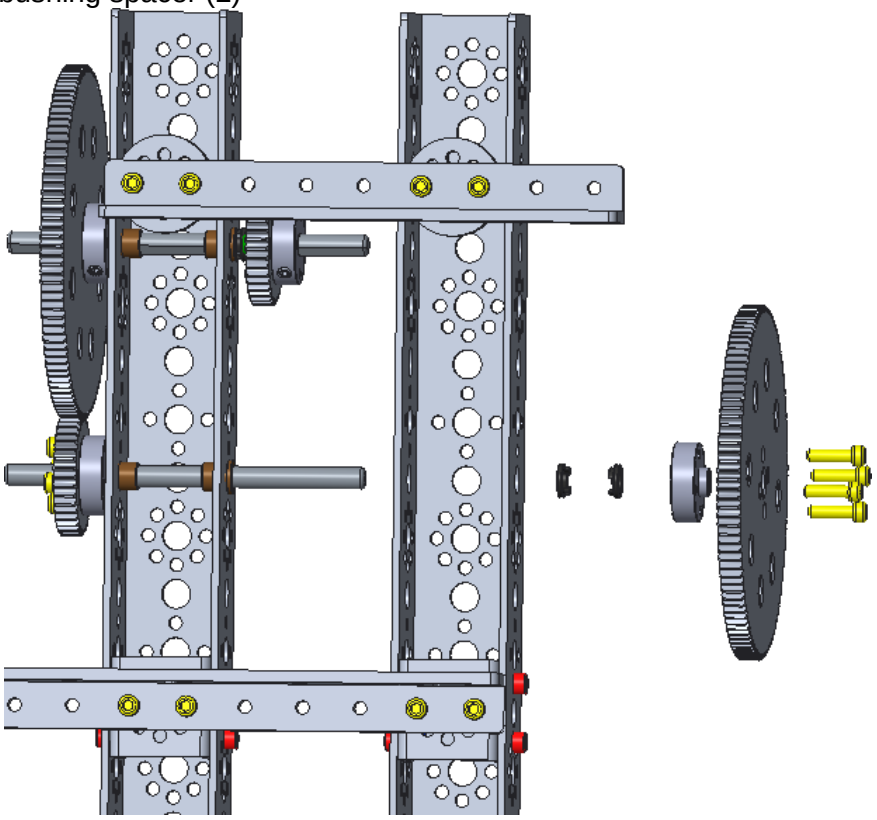
39097 – 1/2" socket head cap screw (4)
39028 - 40-tooth gear (1)
44708 - 100 mm x 6 mm axle (1)
39079 - motor hub (1)
40227 - 8 mm x 6 mm bronze bushing (2)

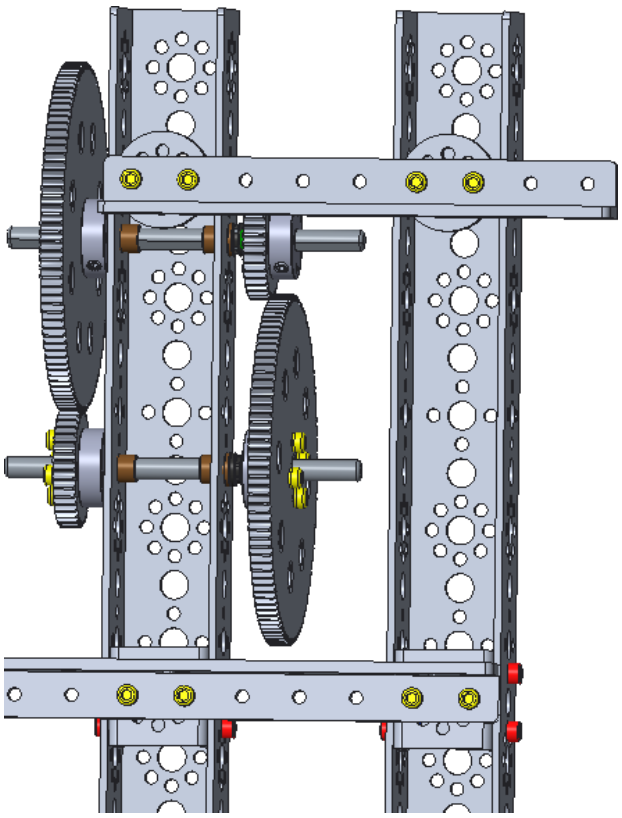




Step 8: Complete Lower Gear Assembly

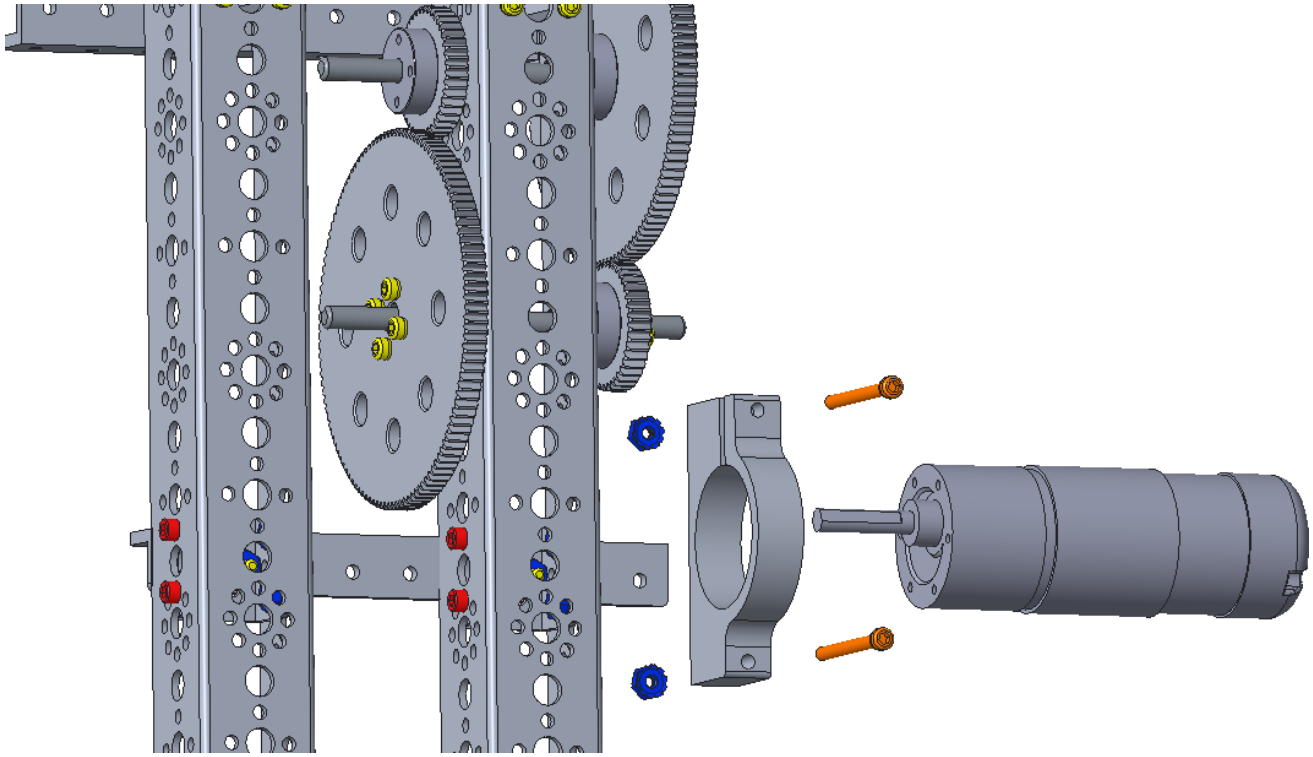
39097 – 1/2" socket head cap screw (4)
39085 - 120-tooth gear (1)
39079 - motor hub (1)
41665 - 6 mm plastic bushing spacer (2)



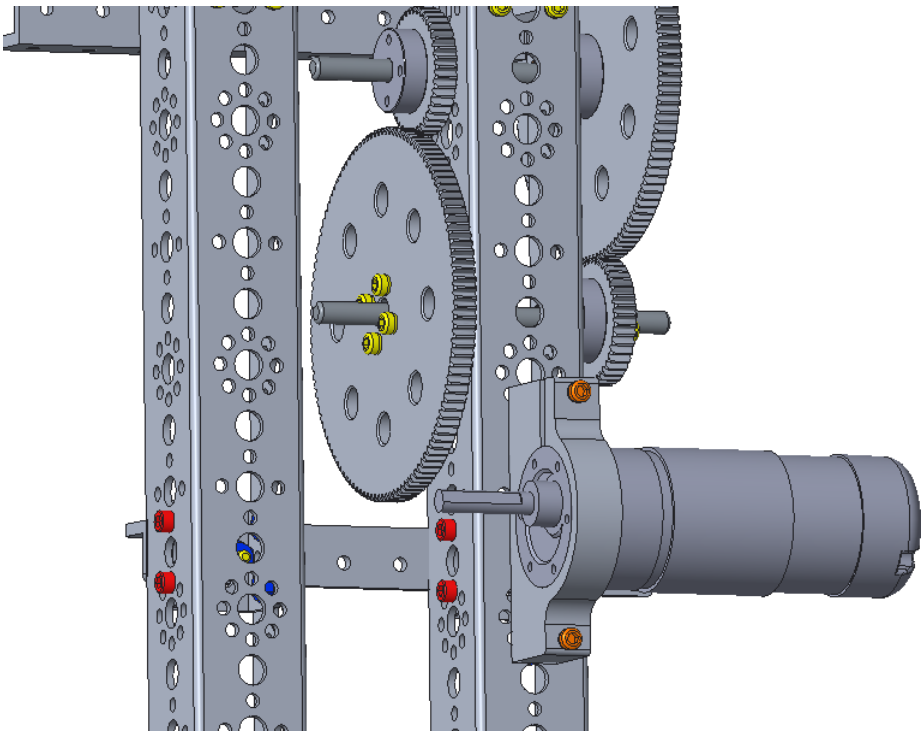


Step 9: Add the Arm Motor

39089 – motor mount with included screws and nuts (1)
44260 - TorqueNADO Motor (2) with included wire wraps (1)

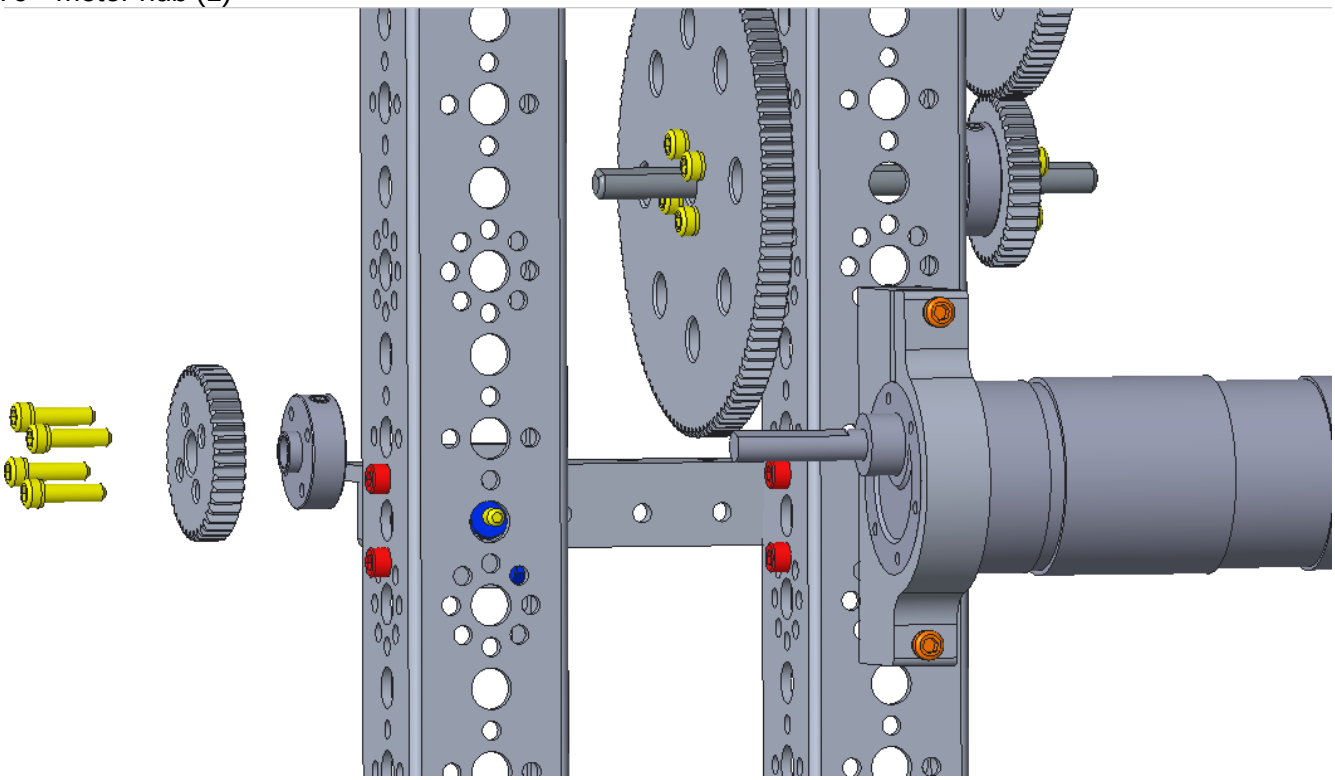


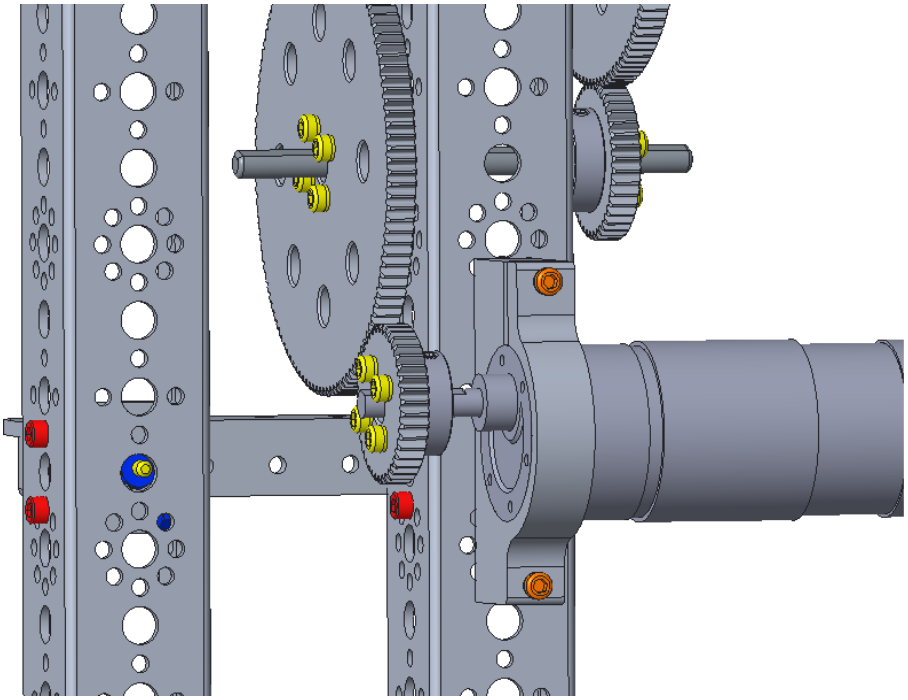
Note: Do not tighten the motor mount bolts that control the clamp (i.e. the gap on one side of the mount) until the gear has been attached to the axle (next step). When this bolt is tightened, the motors can't be inserted into the mount.



Step 10: Complete the Arm Motor

39097 – 1/2" socket head cap screw (4)
39028 - 40-tooth gear (1)
39079 - motor hub (1)





Rotate the motor until the teeth mesh.

Tighten the motor mount bolt (lower bolt in the above image), so the motor will not rotate.

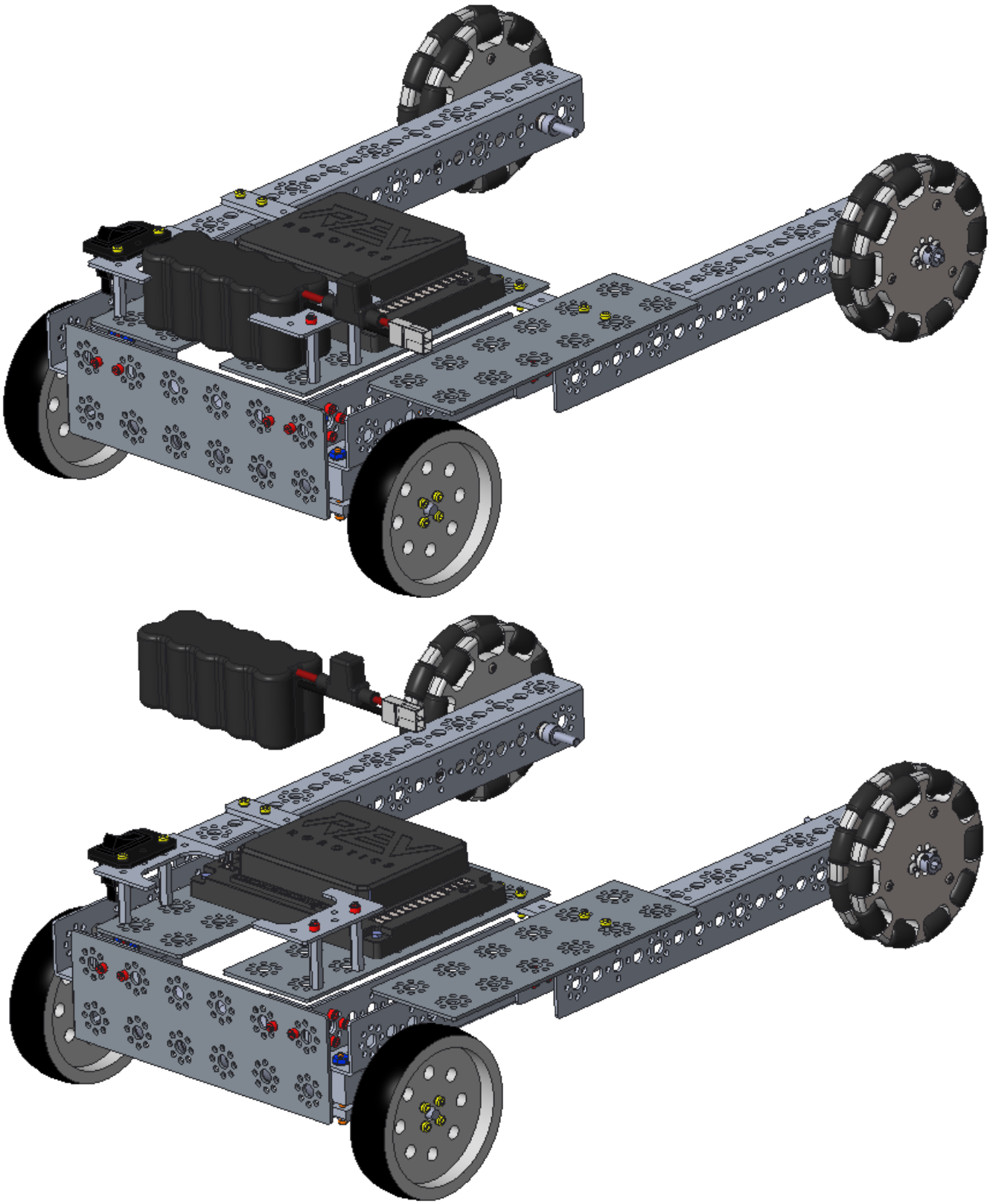
Remove Electronics

Remove Battery

Step 1: Disconnect the Battery from the Switch

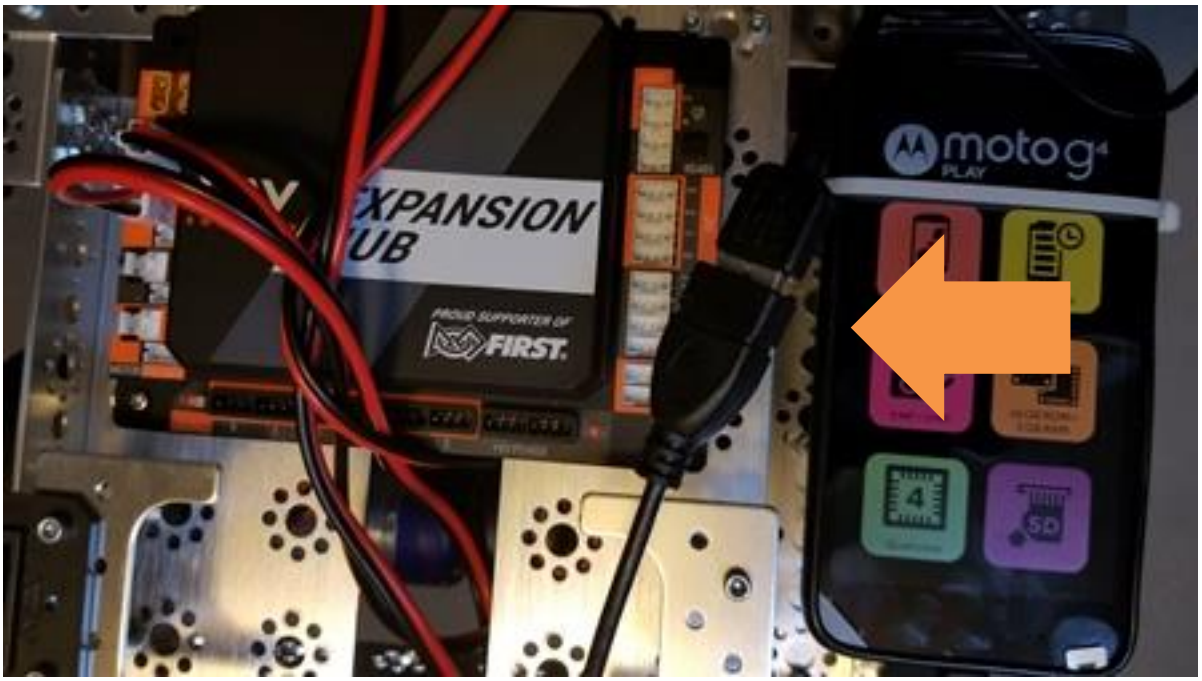
Step 2: Remove the Battery from the Chassis

39057 - battery



Remove the Robot Controller

Step 1: Disconnect the Robot Controller from the Expansion Hub (Part 1)
USB On The Go Adapter (OTG) Cable (1)



Unplug the USB-A plug (of the phone) from the USB-A plug (of the Expansion Hub).

Step 2: Disconnect the Robot Controller from the Expansion Hub (Part 2)

USB On The Go Adapter (OTG) Cable (1)

Unplug the Micro USB plug from the bottom of the cell phone.

Step 3: Remove the Robot Controller Cell Phone from the Holder

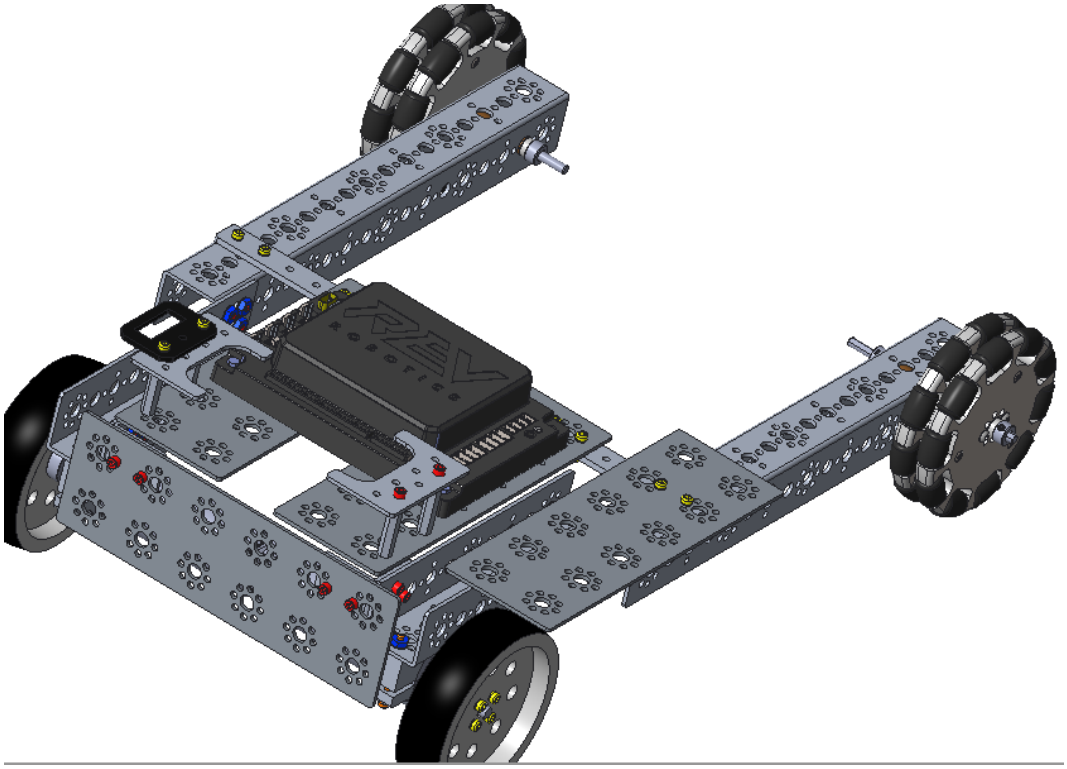
31902 - zip tie (1)

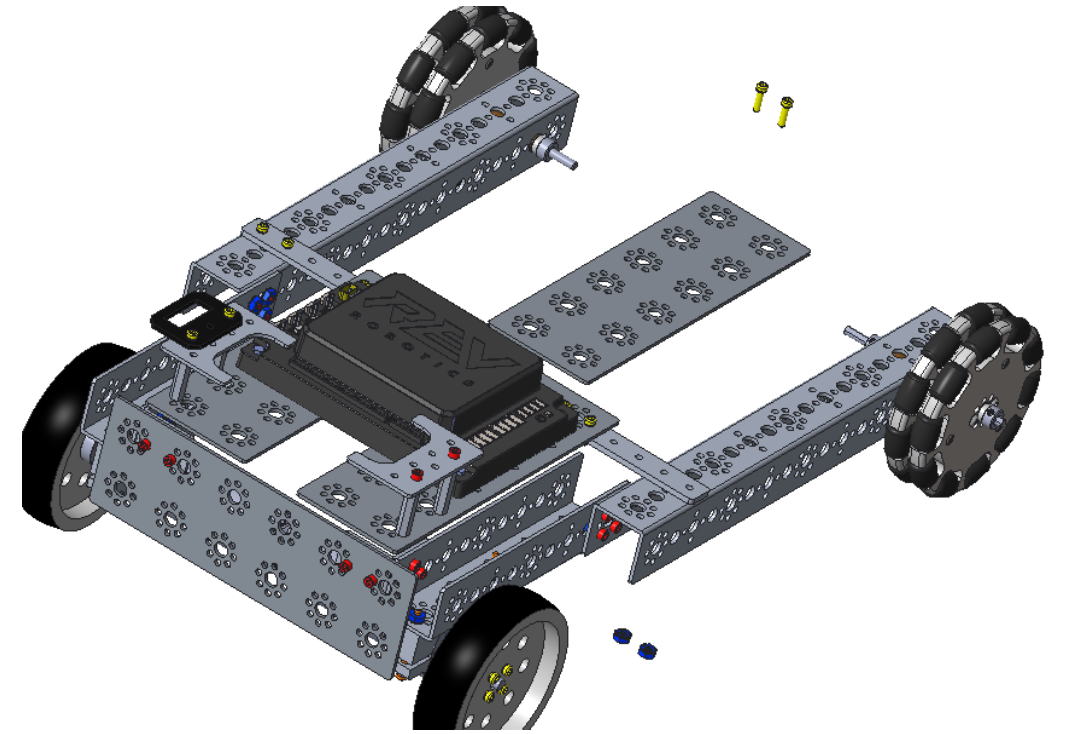
Cell phone configured as the robot controller

Slide the zip tie and phone off the holder – the zip tie will need to be retained.

Step 4: Remove the Phone Support Plate

39073 - flat building plate (1)

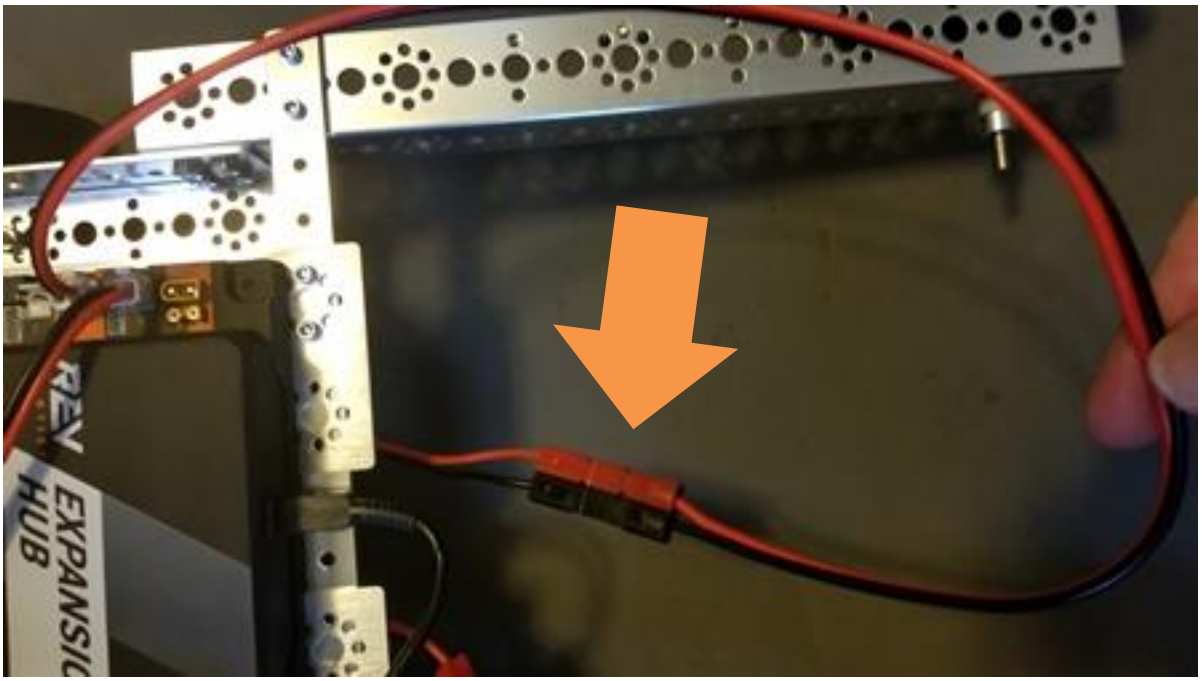




Note: Replace the two screws that hold the right rail onto the chassis.

Remove the Motor and Sensor Controller

Step 1: Unplug the Left and Right Drive Motor Power Cables
REV-31-1381 JST to Anderson Power Pole Cable (2)

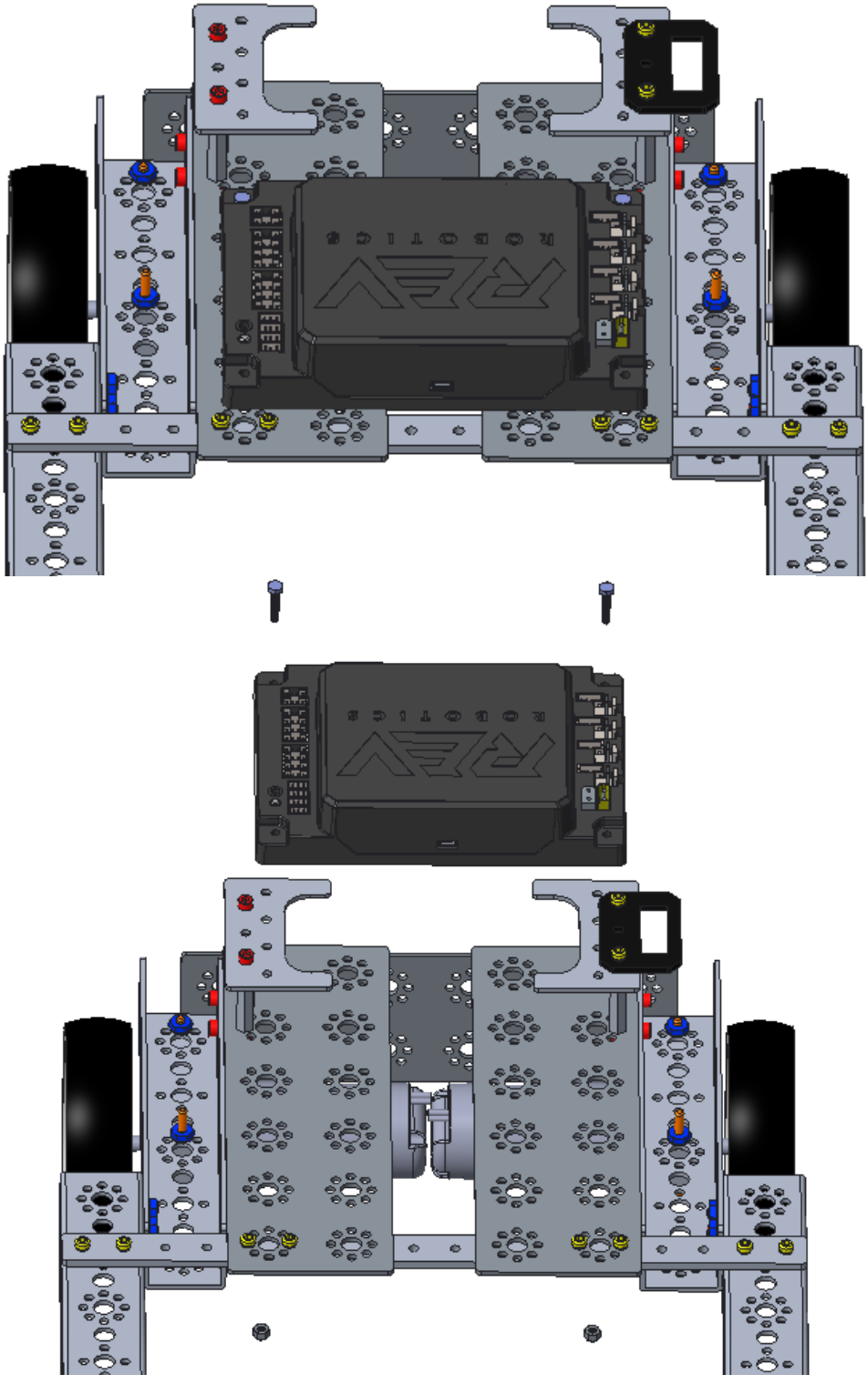


Unplug both cables at the Anderson Power Pole Connections.

Leave the cables attached to the Expansion Hub.

Step 2: Remove the Rev Robotics Expansion Hub

REV-31-1153 expansion hub (1)
REV-41-1360 screws (2)
REV-41-1361 M3 Nyloc nuts (2)

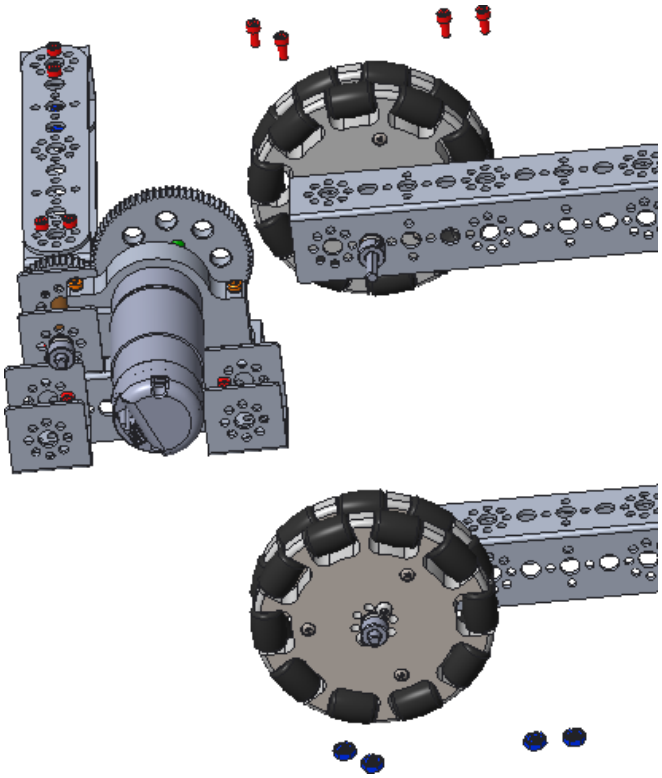


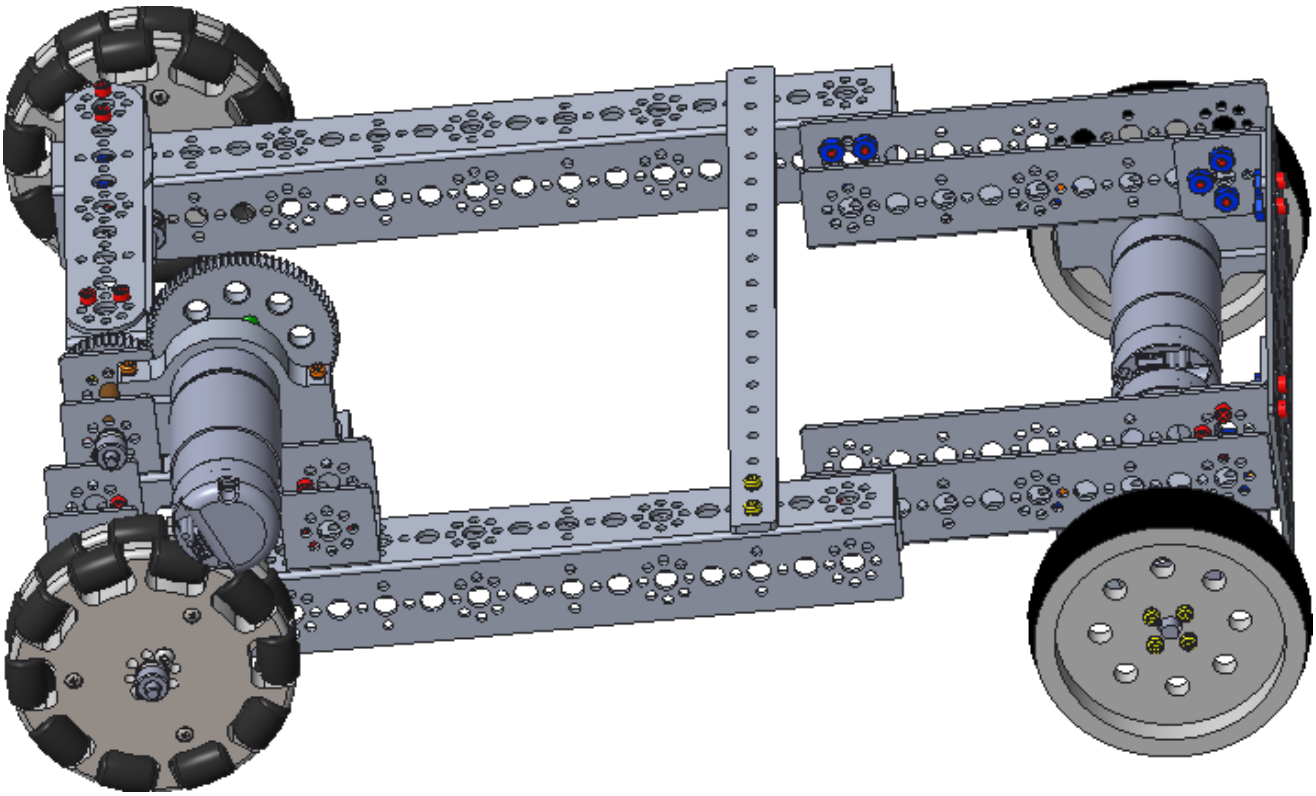
Please note: The pictures above do not show the cables that should still be attached to the Expansion Hub.

Attach the Sweeper to the Chassis

Step 1: Add the Sweeper

39098 – 15/16" socket head cap screw (4)
39094 - keps nut (4)





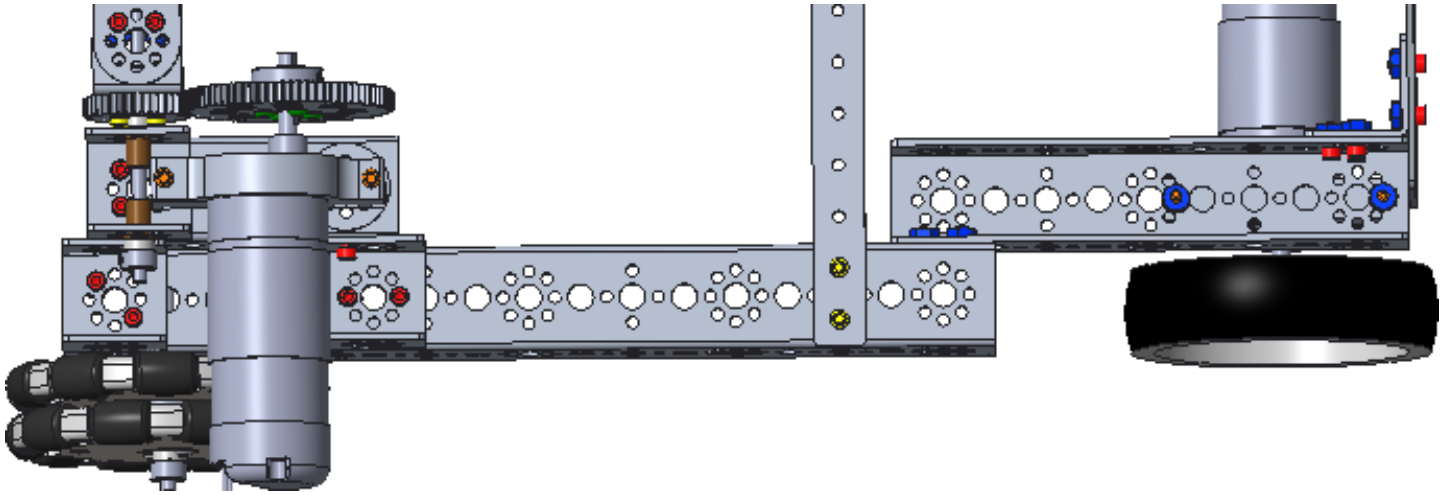
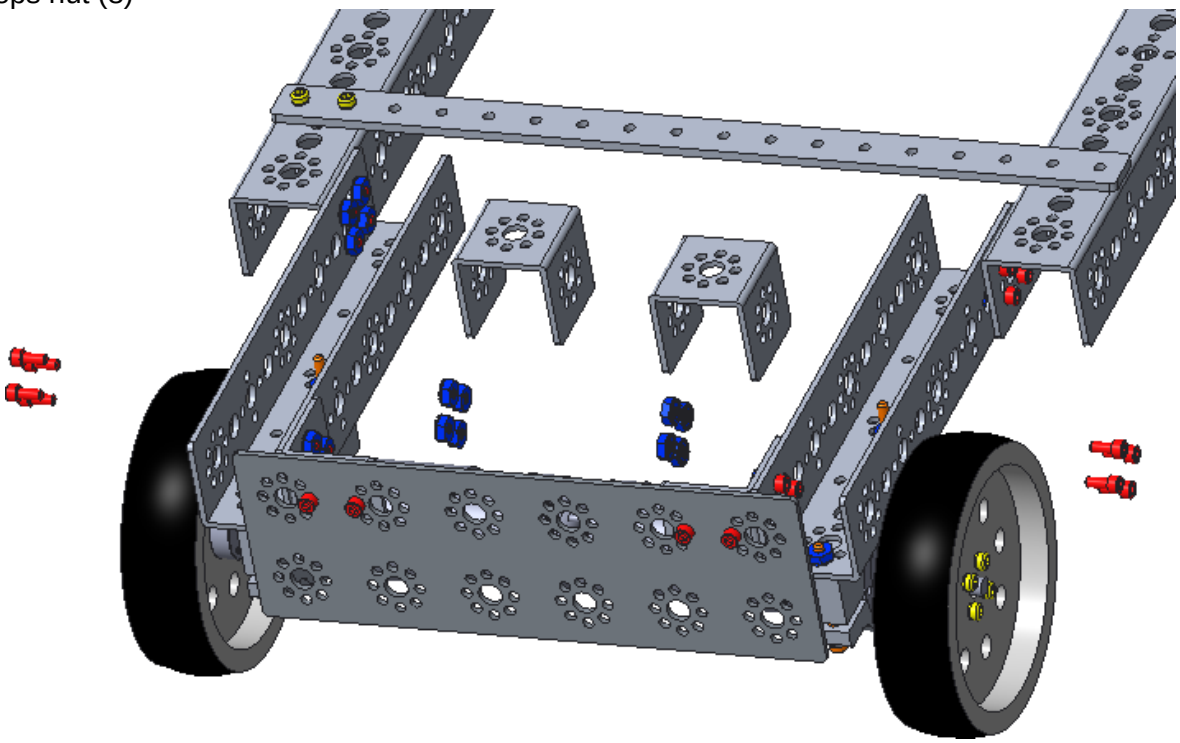


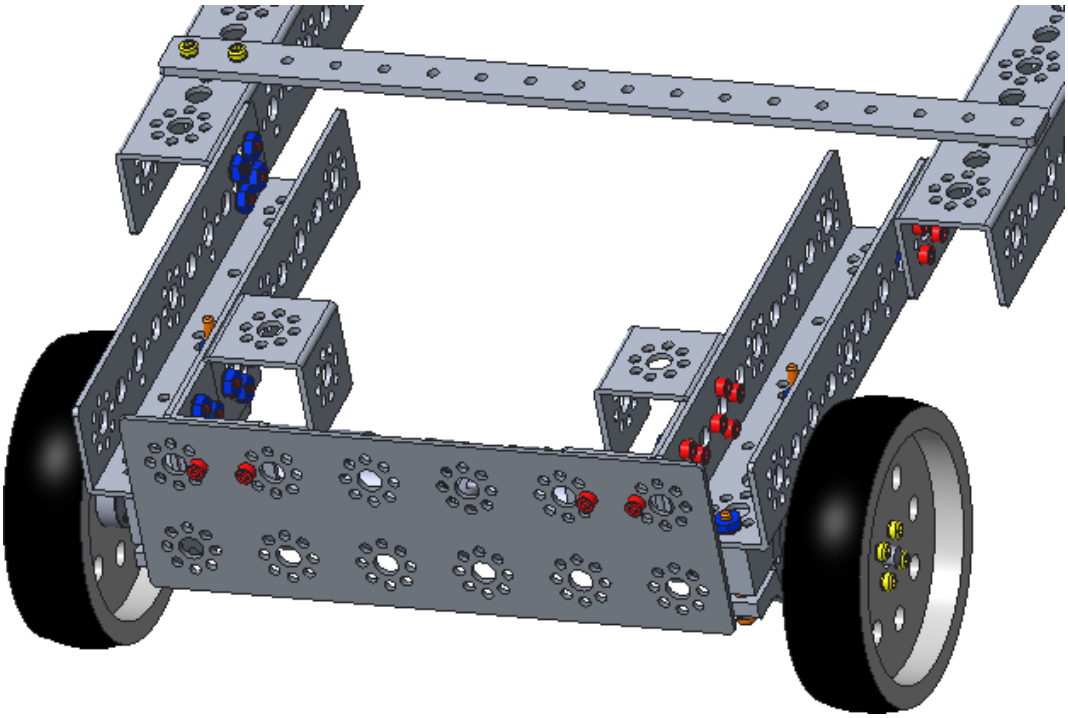
Figure 7 A view from above the robot from the step on the previous page

Attach the Tower to the Robot

Step 1: Add Tower Base

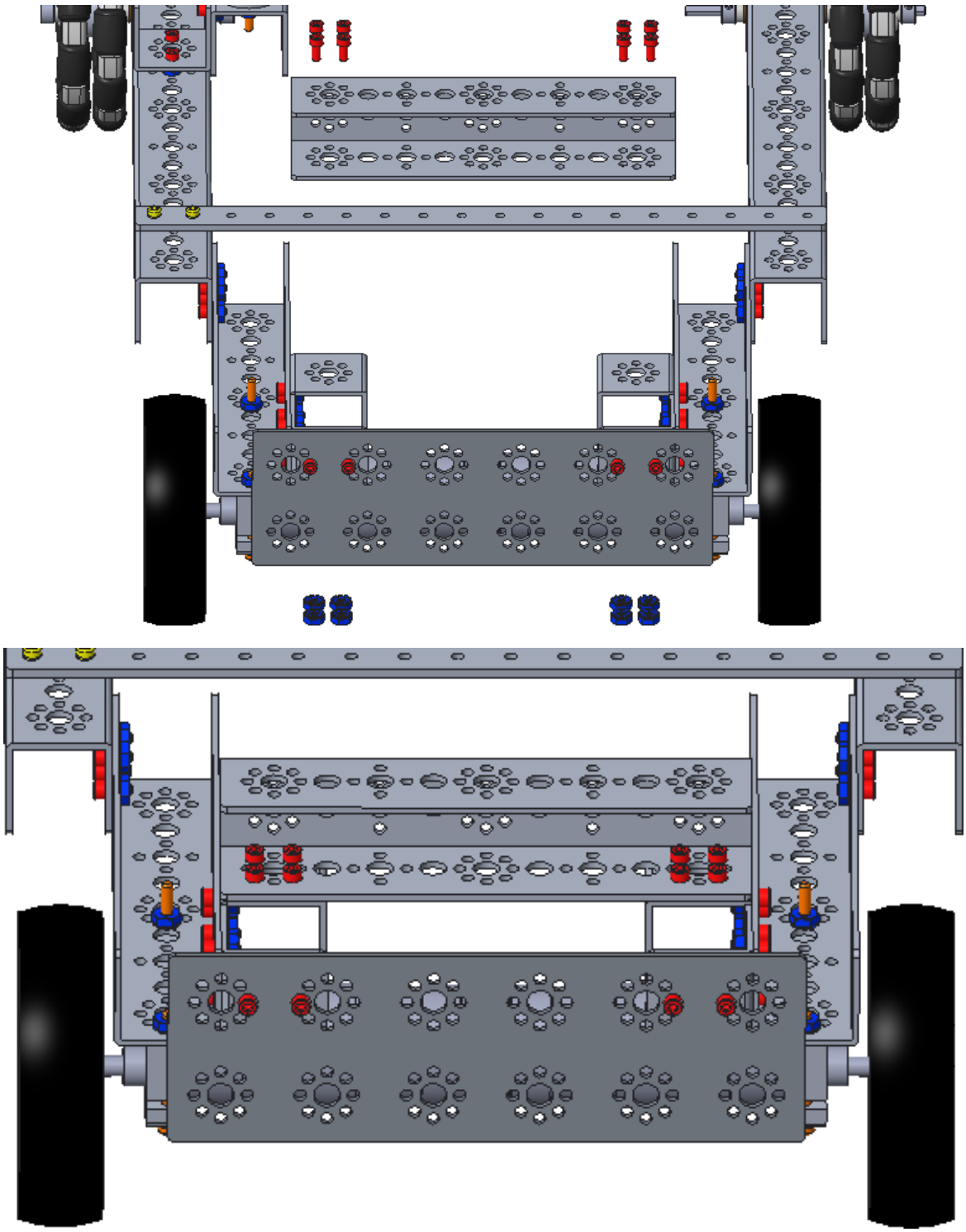
39065 - 32 mm channel (2)
39098 – 15/16" socket head cap screw (8)
39094 - keps nut (8)





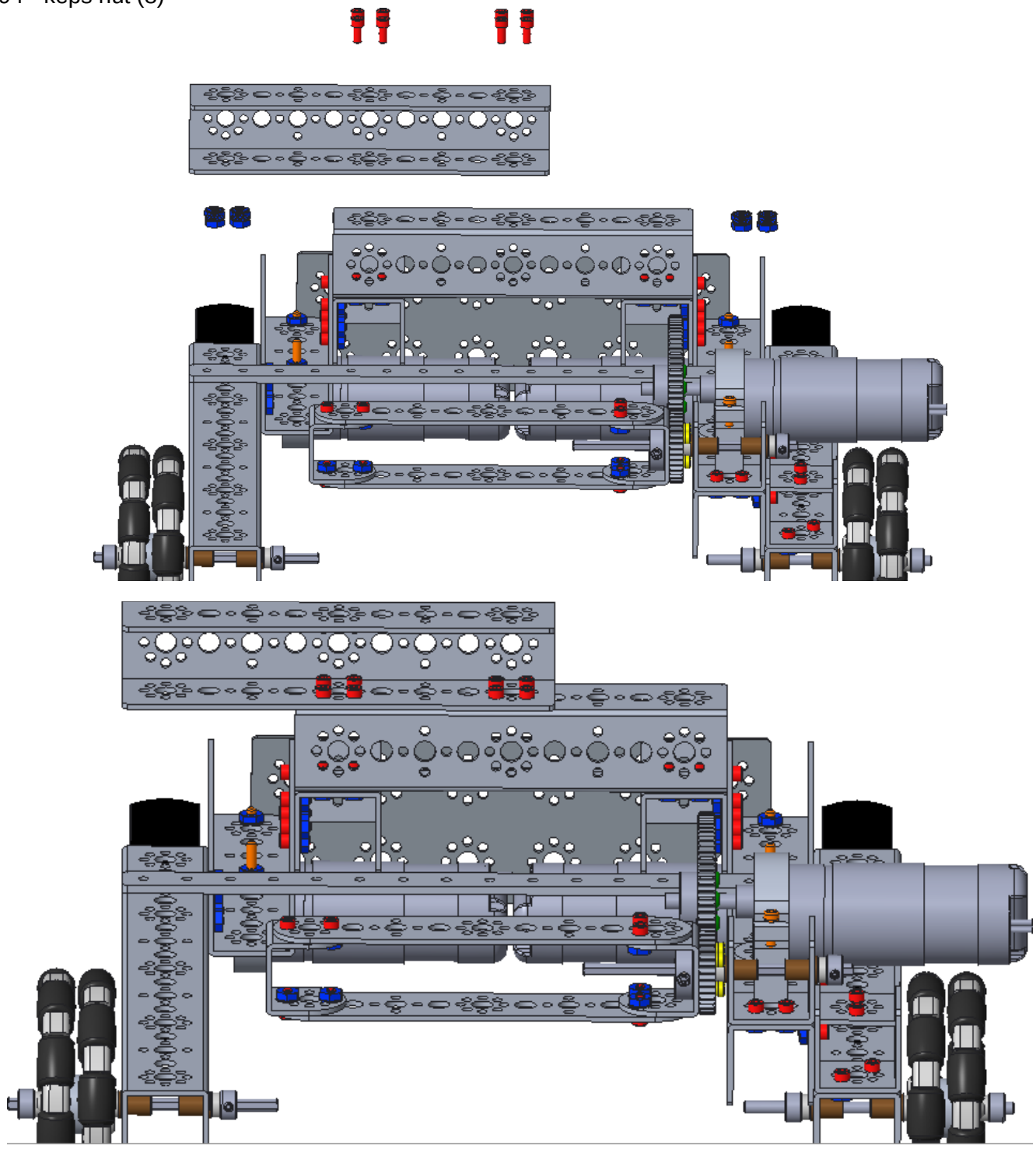
Step 2: Add Lower Support Channel

39067 - 160 mm channel (1)
39098 – 15/16" socket head cap screw (8)
39094 - keps nut (8)



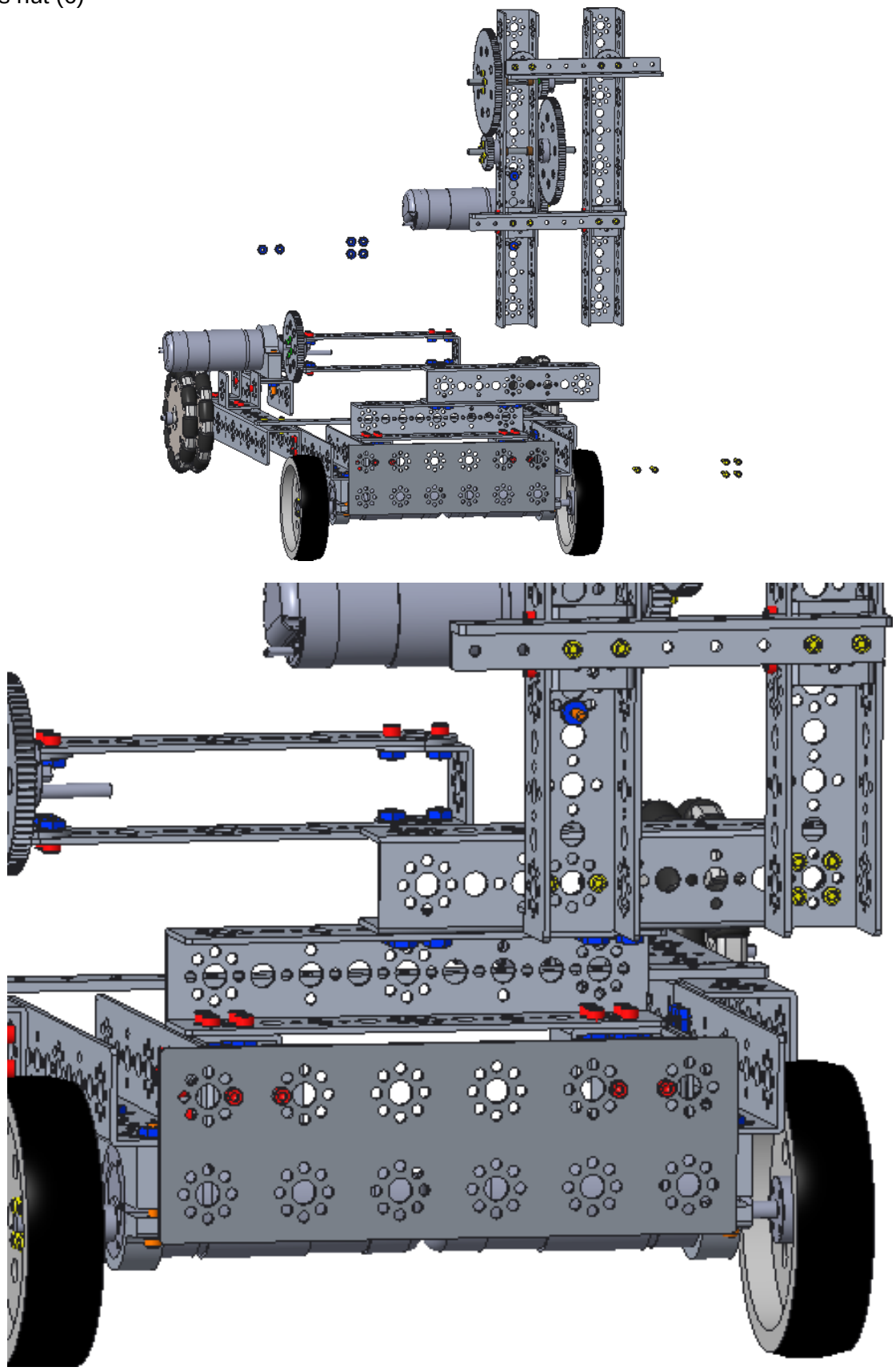
Step 3: Add Upper Support Channel

39067 - 160 mm channel (1)
39098 – 15/16" socket head cap screw (8)
39094 - keps nut (8)



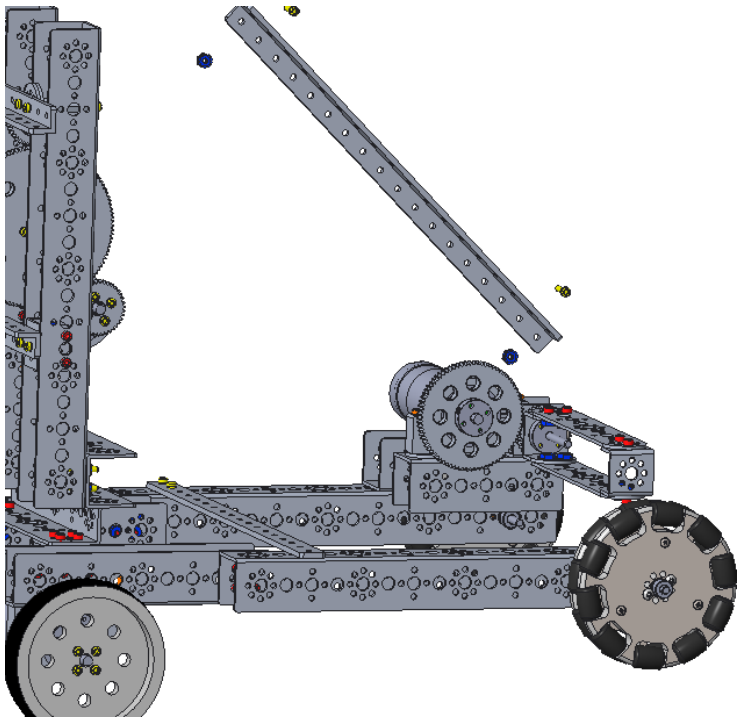
Step 4: Attach Tower to Upper Support Channel

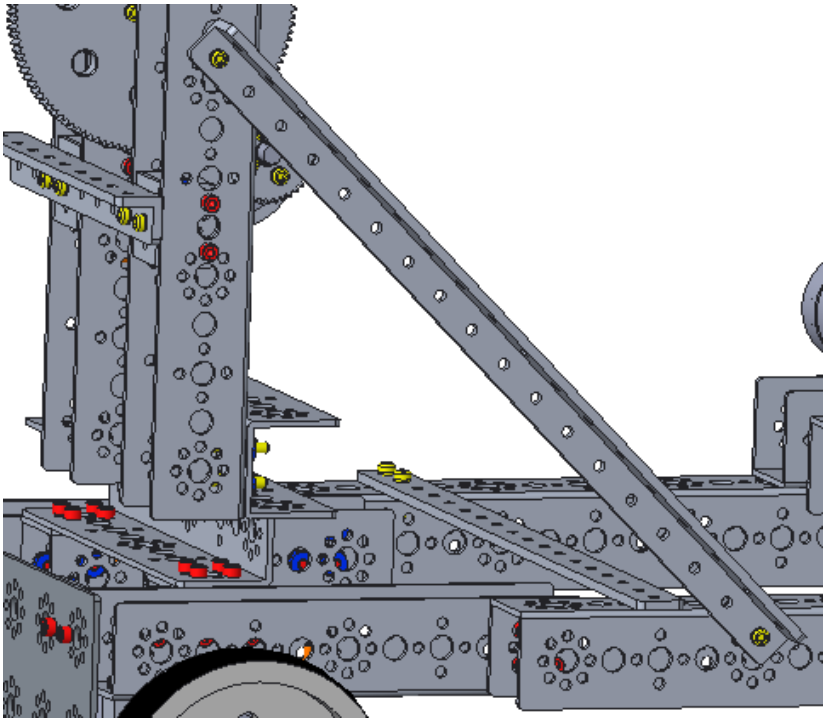
39097 – 1/2" socket head cap screw (6)
39094 - keps nut (6)



Step 5: Add Side Support

39071 - 288 mm angle
39097 – 1/2" socket head cap screw (6)
39094 - keps nut (6)

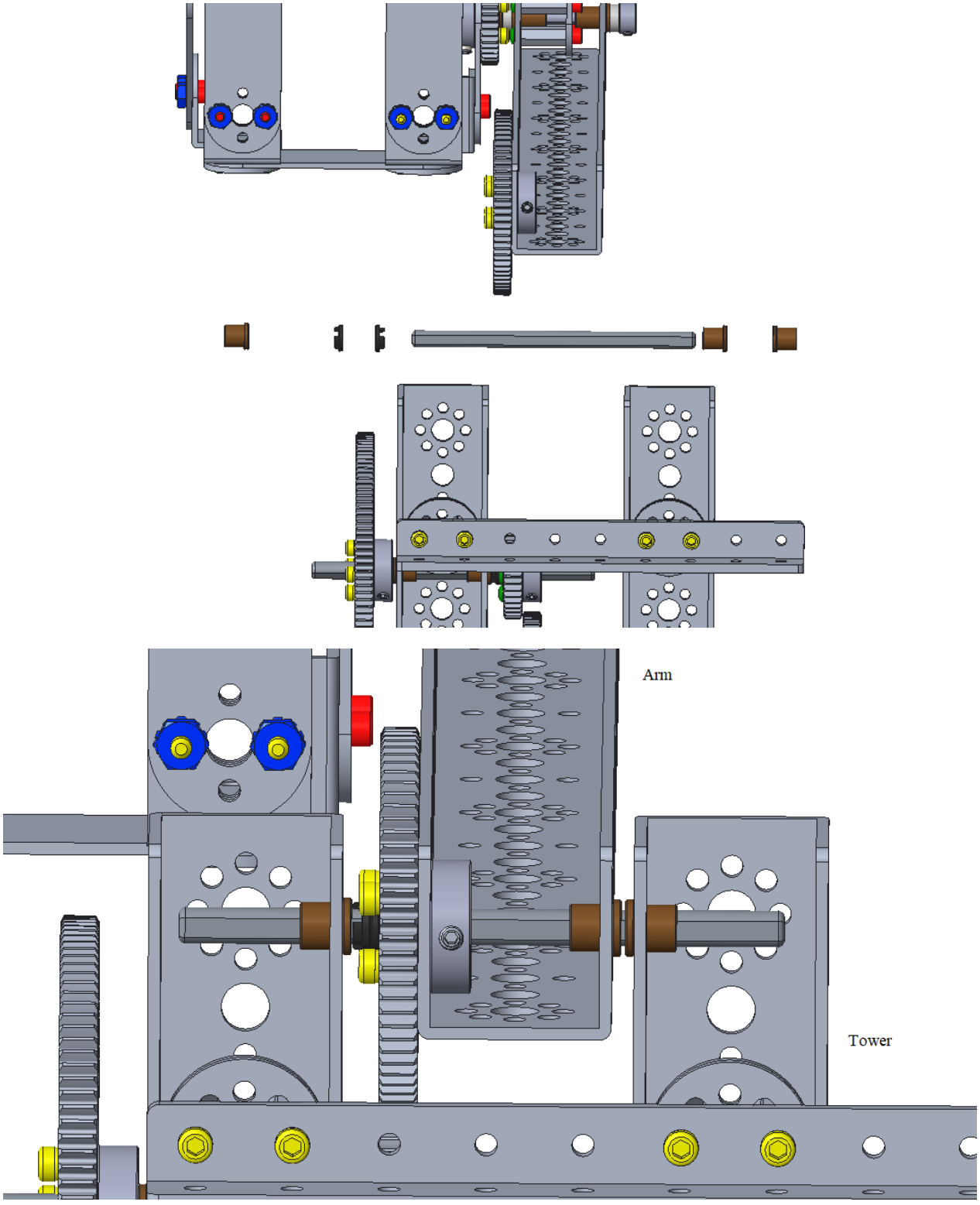




Attach the Arm to the Tower

Step 1: Add Connecting Axle

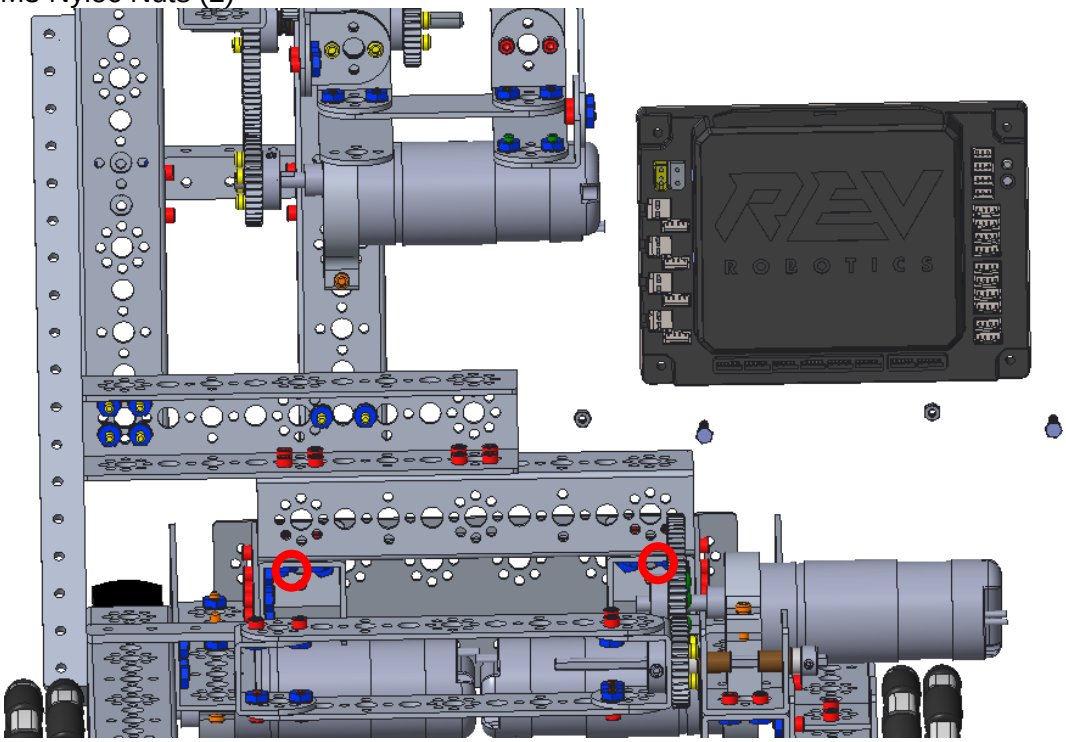
40227 - 8 mm x 6 mm bronze bushing (2)
41665 - 6 mm plastic bushing spacer (2)
40227 - 8 mm x 6 mm bronze bushing (2)
44708 - 100 mm x 6 mm axle (1)

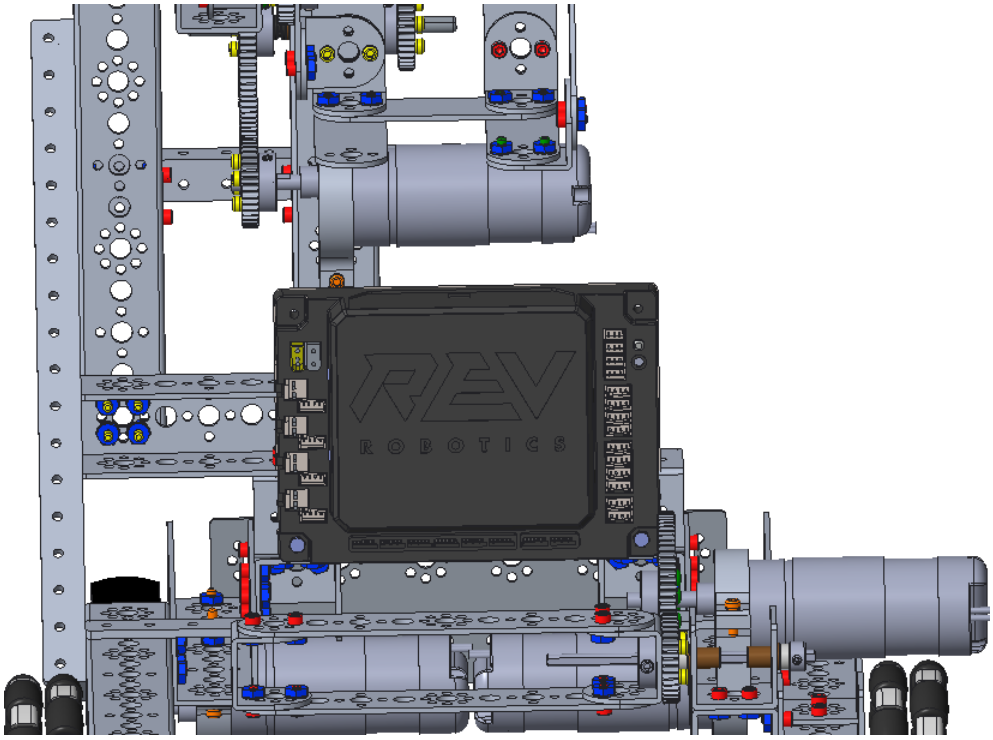


Add the Electronics

Step 1: Add the Motor and Sensor Controller

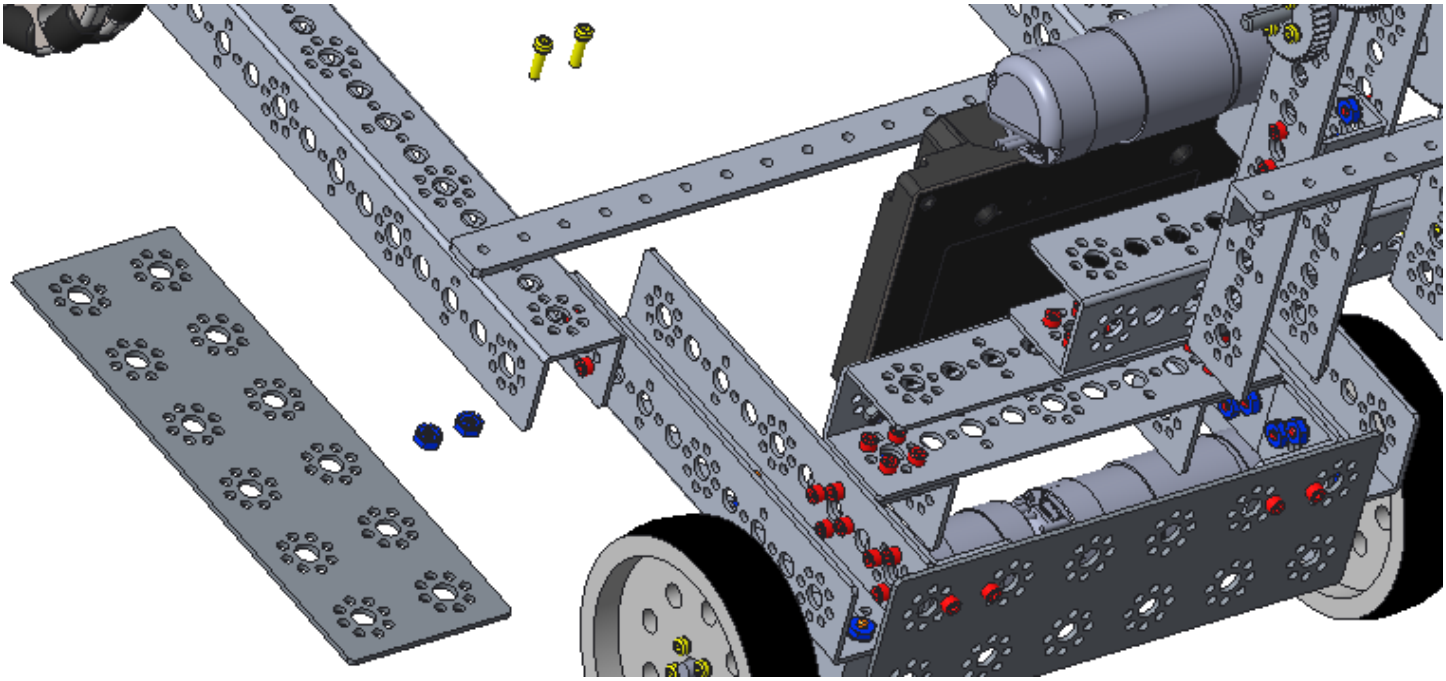
REV-31-1153 expansion hub (1)
REV-41-1360 screws (2)
REV-41-1361 M3 Nyloc Nuts (2)

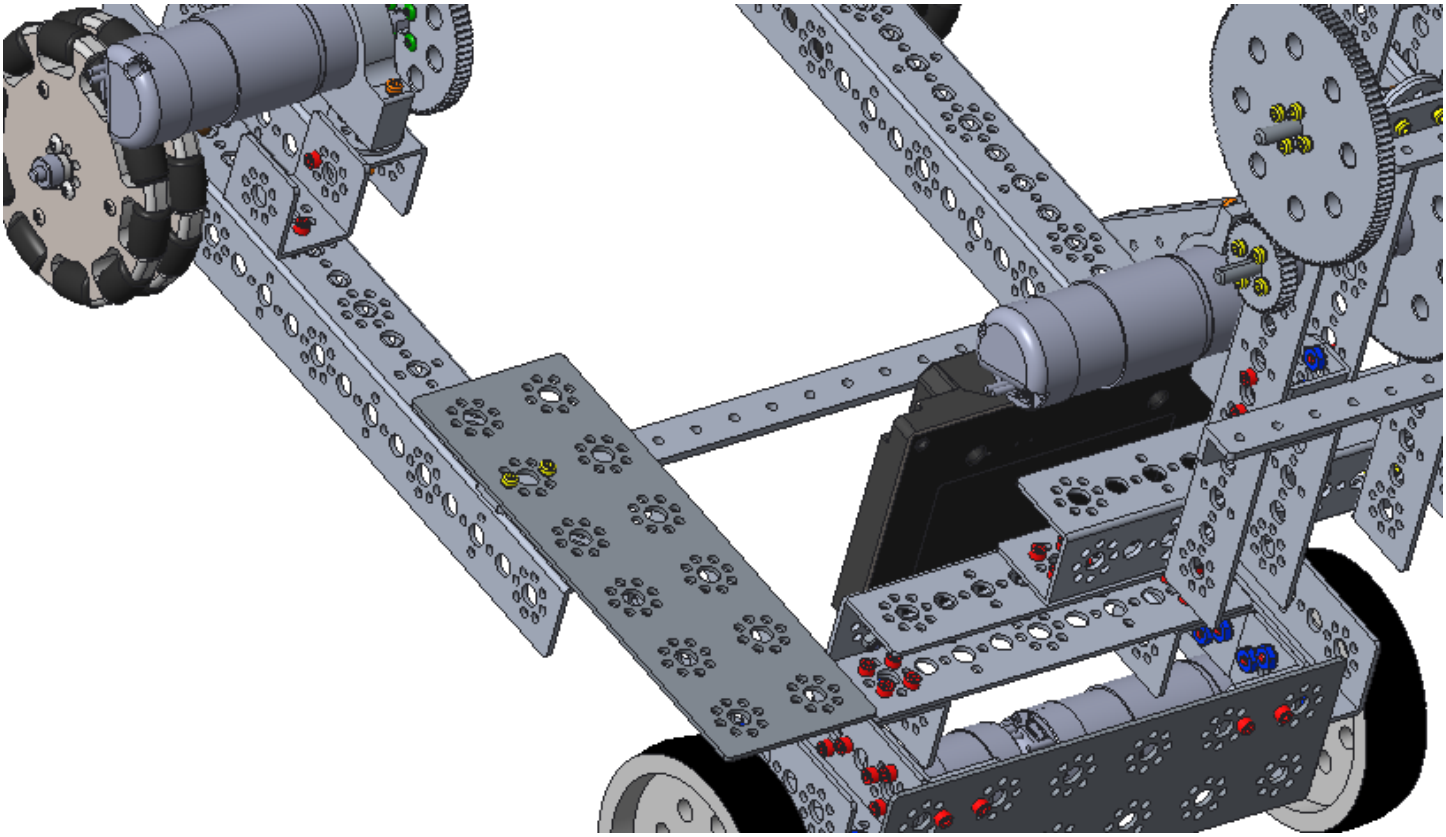




Step 2: Add Robot Controller Support Plate

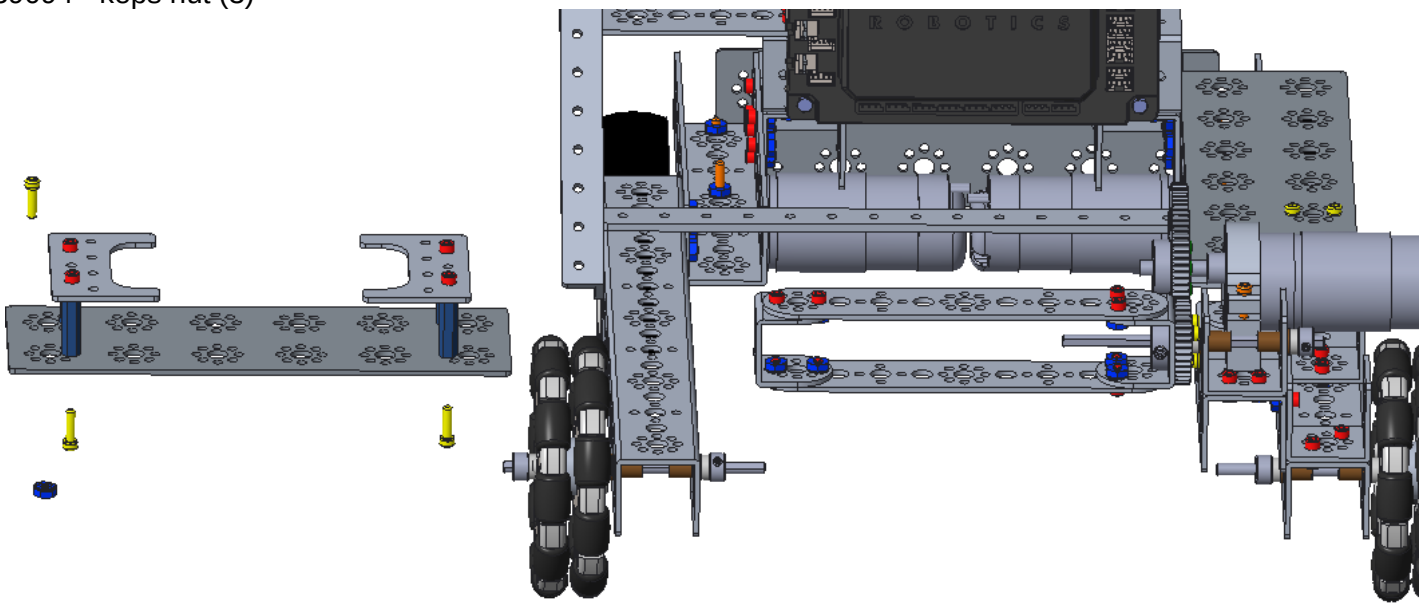
39073 - flat building plate (1)
39097 – 1/2" socket head cap screw (2); remove the two existing 5/16” socket head cap screws
39094 - keps nut (0); use the existing nuts

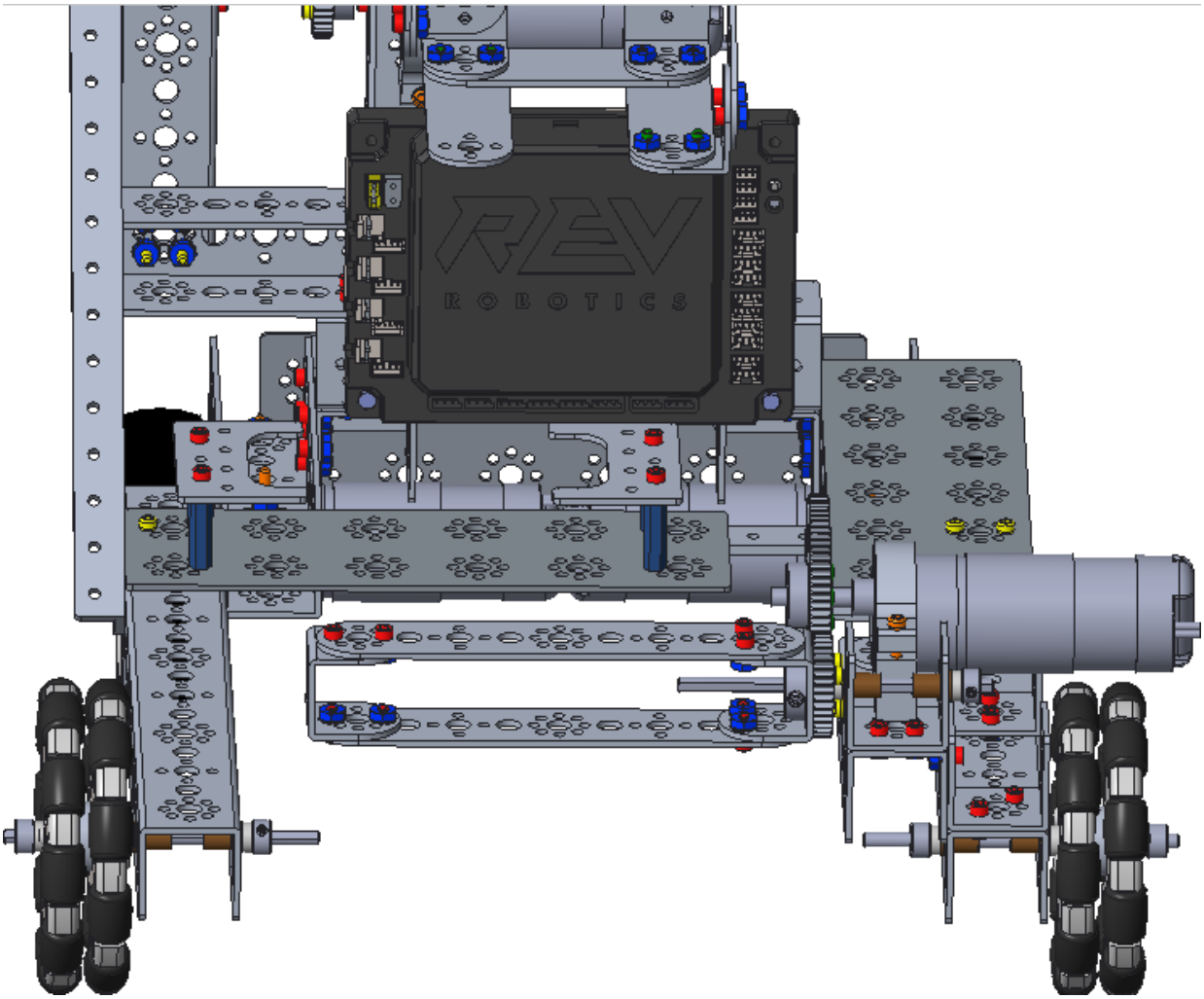




Step 3: Add the Battery Container

39097 – 1/2" socket head cap screw (3)
39094 - keps nut (3)





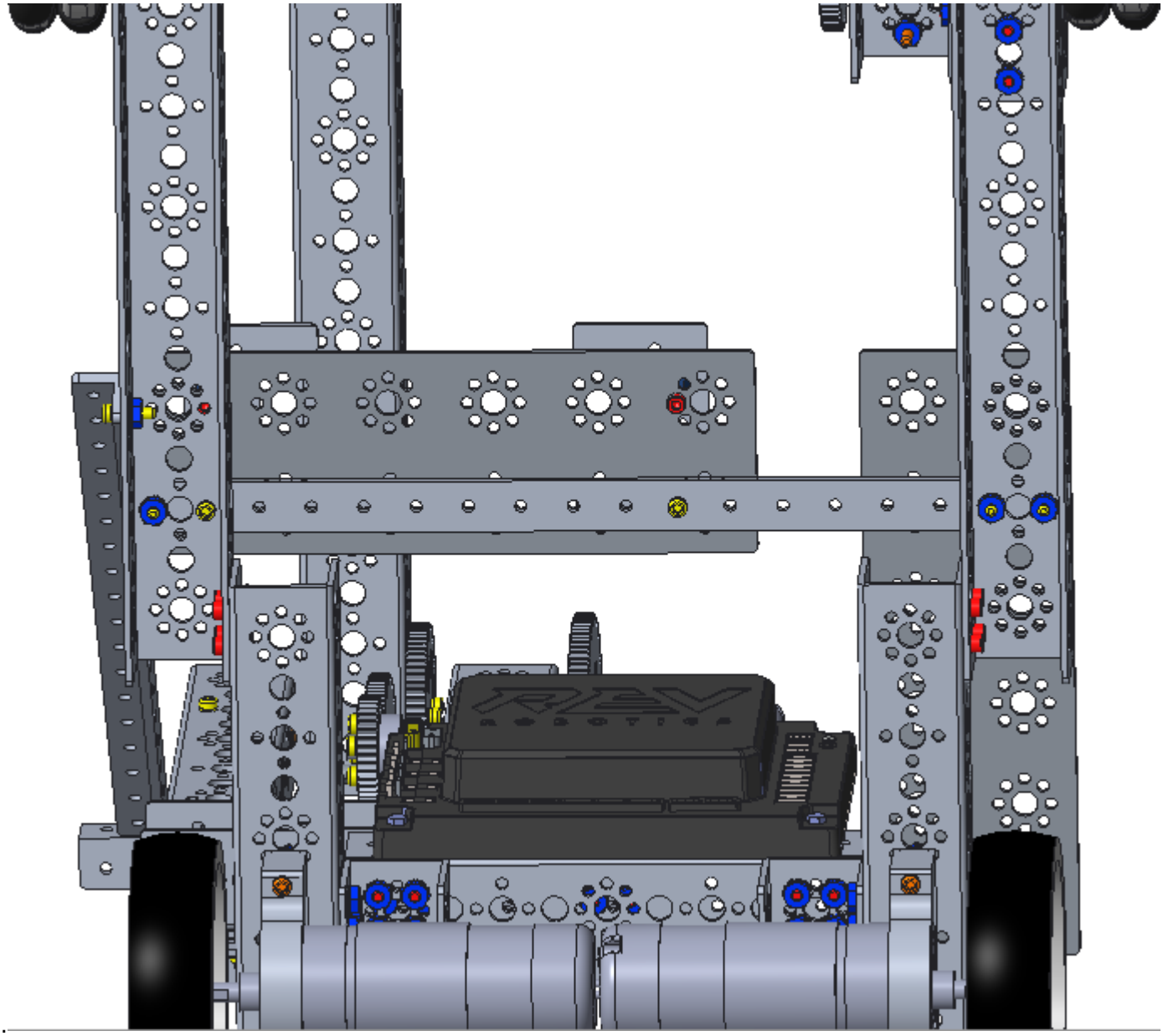
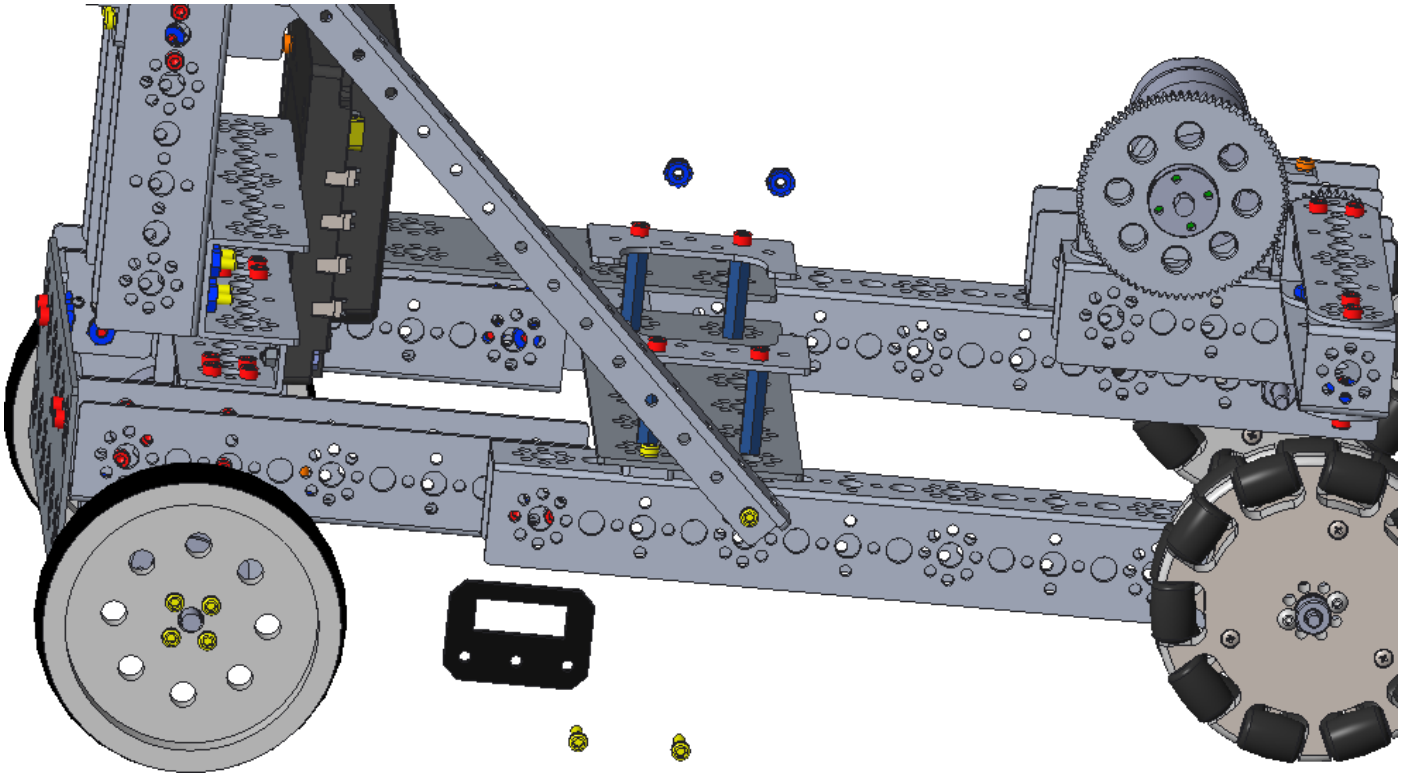
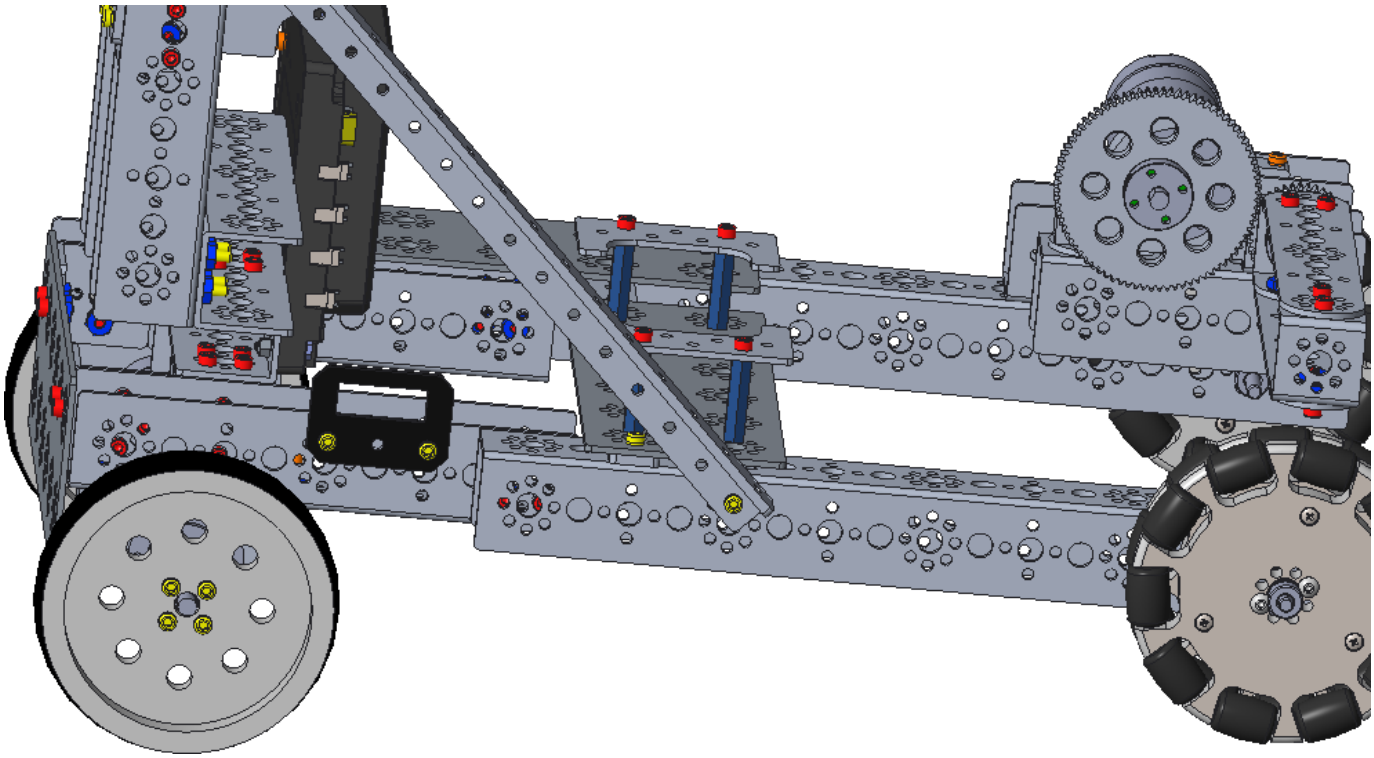


Figure 8 View from bottom of the robot during step 3

Step 4: Add the Switch Plate

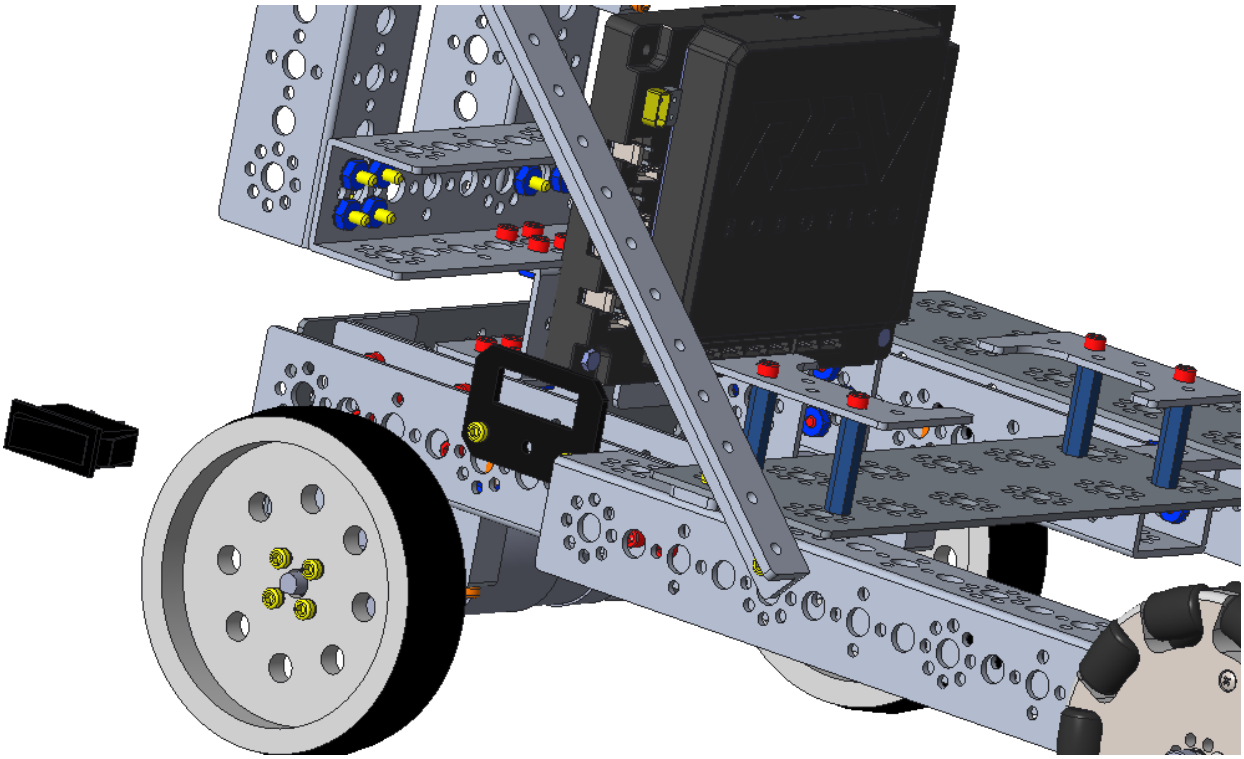
38009 - battery clip (1) [inside the electronics kit] (half of the package)
39097 – 1/2" socket head cap screw (2)
39094 - keps nut (2)



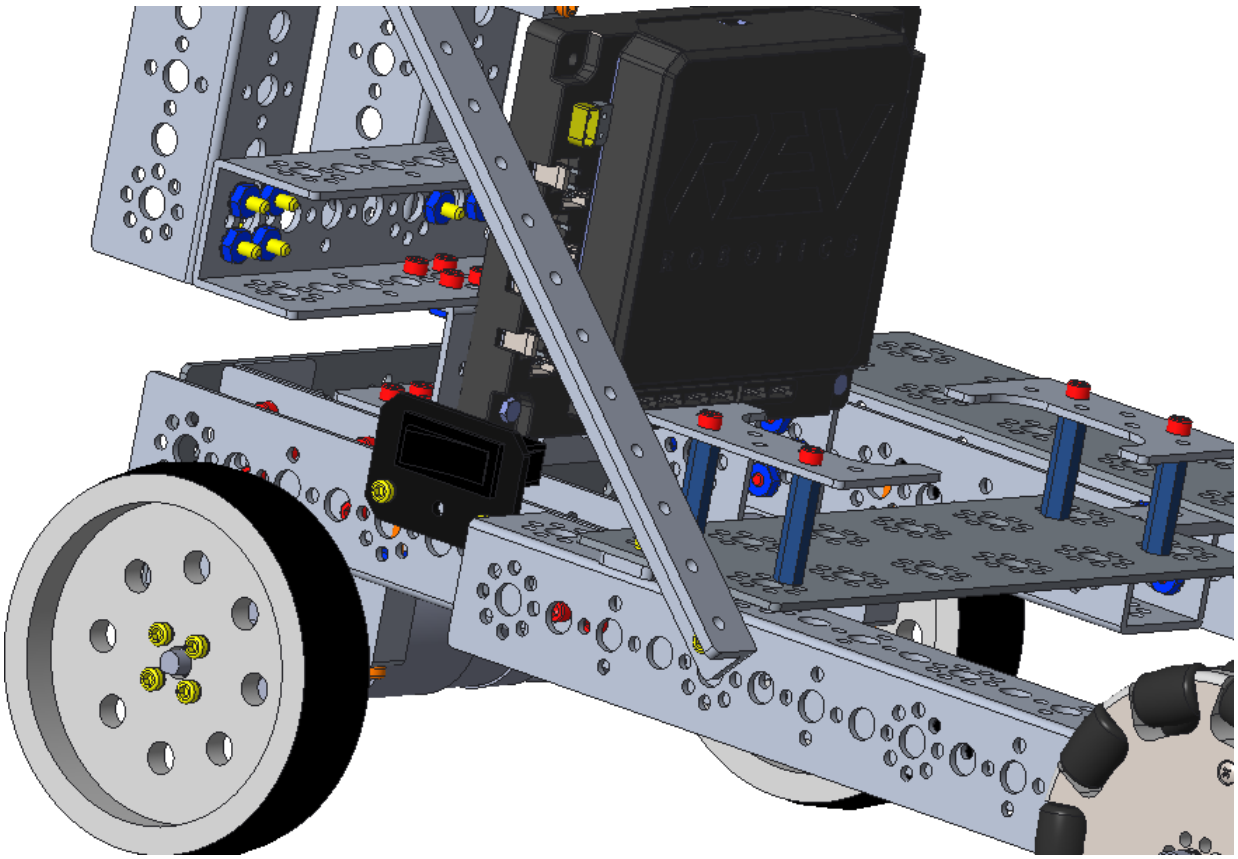


Step 5: Add the Switch

REV-31-1387 Switch

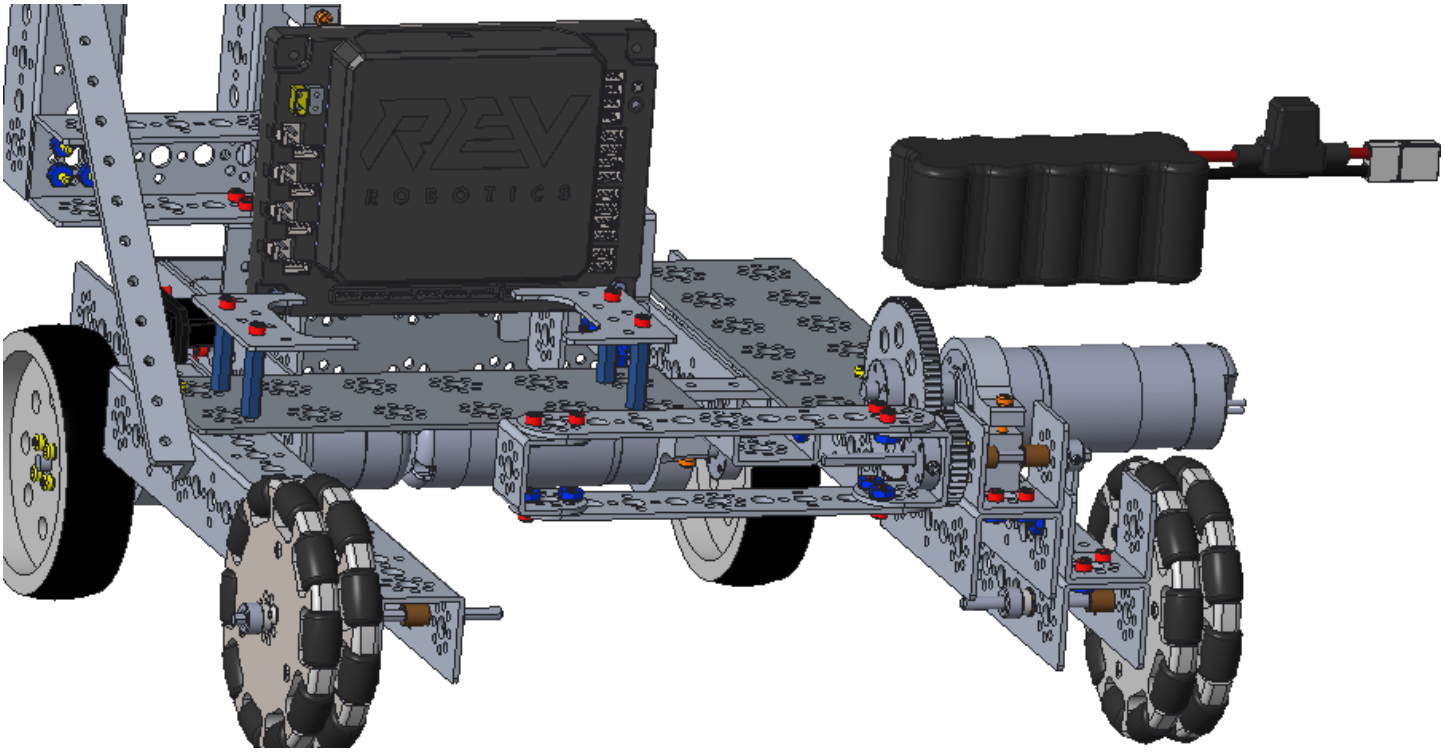


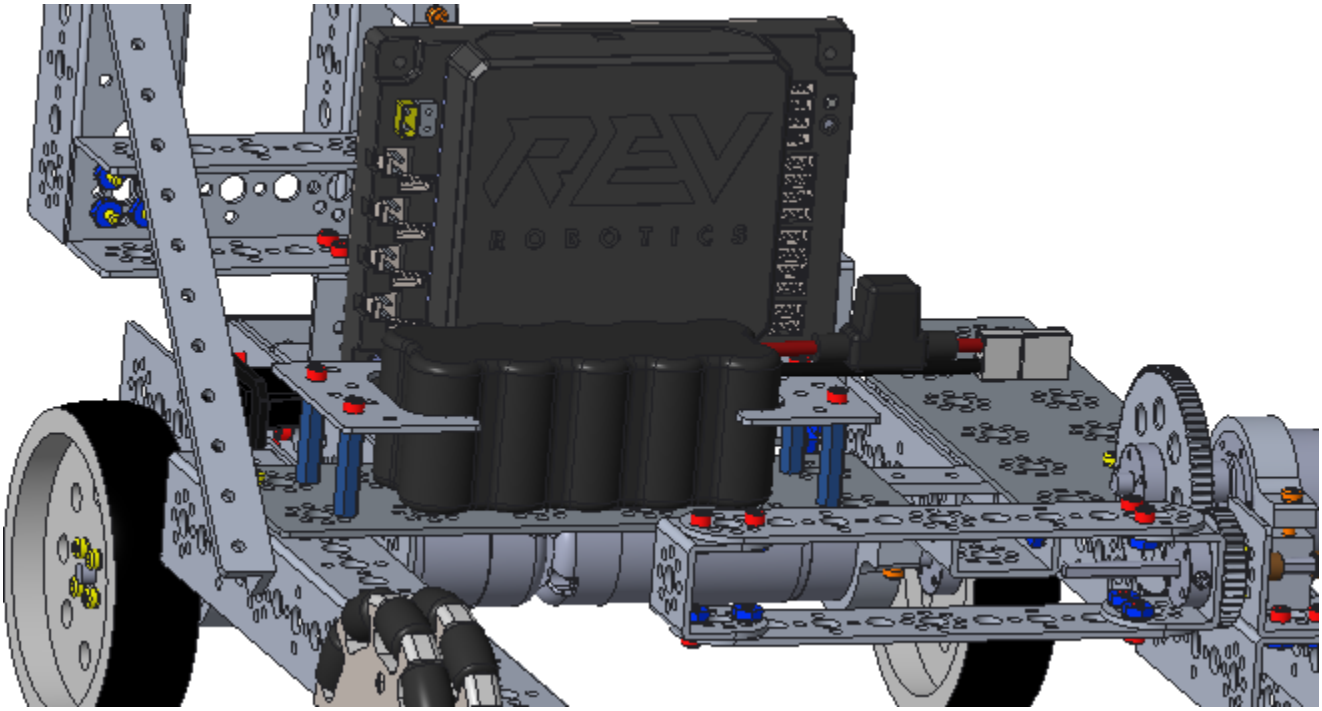
If the switch was removed from the plate, then insert it into the plate at this time.



Step 6: Add the Battery

39057 - battery (1)





Step 7: Complete the Wiring

Refer, if necessary, to the instructions in the Chassis Guide for more details on how to wire a DC motor.

1. Plug the left drive motor into port 0 of the motor controller.
2. Plug the right drive motor into port 1 of the motor controller.
3. Plug the arm motor into port 2 of the motor controller.
4. Plug the sweeper motor into port 3 of the motor controller.
5. Plug the servo motor into servo extension wire.
6. Plug the servo extension wire into SERVO port 0 of the motor controller.
7. Connect the motor controller to the robot controller.
8. Connect the motor controller to the switch.
9. Connect the robot controller to the motor controller.
10. Connect the switch to the battery.

As always, be careful when wiring, do not allow any wire to catch between two gears or two moving parts of the robot (ex. arm and tower).

SECURE all wiring! Use zip ties, plastic covered wire (ex. sandwich bread ties, garbage bag ties, etc.) to secure wire to a channel or other support surfaces.

Final Steps

The armature has been built. 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.

Special Thanks and Best Wishes

FIRST® Tech Challenge would like to sincerely thank the creators of this document **David and Lydean Spangler**. The Spangler's have worked tirelessly over many years and seasons to create, update and improve this document to give teams a "how to" guide for building the robot chassis to build upon and improve. We are forever grateful for their help and support in this endeavor.

David and Lydean would also like to send a special shout out to Jeff Tjiputra, a former Maryland *FIRST* Tech Challenge Affiliate Partner, for reeling them in: hook, line, and sinker! Or was that hockey pucks, ramps, and rollers! They visited a FIRST Tech Challenge Open House early in the season and took a LEGO 'Bot. He thought that was a bit humorous. He helped them (and all the Maryland and DC teams) through their first season. He has since retired from the Affiliate Partner position, but he's as hooked as the Spangler's are; he's now a Maryland Judge Advisor and they look forward to seeing him next year.

Please direct any questions or comments about this guide to: firsttechchallenge@firstinspires.org and put "Questions about the Basic Bot Guide for TETRIX-Part 2 Game Specific" in the subject line and we will redirect the emails to the appropriate responders.

Appendix A – Resources

Game Forum Q&A

http://ftcforum.usfirst.org/forum.php
Anyone may view questions and answers within the *FIRST*® Tech Challenge Game Q&A forum without a password. To submit a new question, you must have a unique Q&A System User Name and Password for your team.

Volunteers that apply for a specific volunteer role will receive an email from FTCTrainingSupport@firstinspires.org with their username and password to the forum. You will receive access to the forum thread specific to your role.

FIRST Tech Challenge Game Manuals

Part 1 and 2 - https://www.firstinspires.org/resource-library/ftc/game-and-season-info

FIRST Headquarters Pre-Event Support

Phone: 603-666-3906
Mon – Fri
8:30am – 5:00pm
Email: Firsttechchallenge@firstinspires.org

FIRST Websites

FIRST homepage – www.firstinspires.org

FIRST Tech Challenge Page – For everything *FIRST* Tech Challenge.

FIRST Tech Challenge Volunteer Resources – To access public Volunteer Manuals.

FIRST Tech Challenge Event Schedule – Find *FIRST* Tech Challenge events in your area.

FIRST Tech Challenge Social Media

FIRST Tech Challenge Twitter Feed - If you are on Twitter, follow the *FIRST* Tech Challenge Twitter feed for news updates.

FIRST Tech Challenge Facebook page - If you are on Facebook, follow the *FIRST* Tech Challenge page for news updates.

FIRST Tech Challenge YouTube Channel – Contains training videos, Game animations, news clips, and more.

FIRST Tech Challenge Blog – Weekly articles for the *FIRST* Tech Challenge community, including Outstanding Volunteer Recognition!

FIRST Tech Challenge Team Email Blasts – contain the most recent *FIRST* Tech Challenge news for Teams.

Feedback

We strive to create support materials that are the best they can be. If you have feedback about this manual, please email firsttechchallenge@firstinspires.org. Thank you!

Appendix B: Bill of Material (BoM) List

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

Qty	Common Name	CAD Name
4	288 mm Channel	39068_TXM-288MMCHANNEL
4	160 mm Channel	39067_TXM-160MMCHANNEL
82	6-32 x 5/16” SHCS	39098_TXM_SHCS_6-32_0_3125
109	Kep Nut	39094_KEP_NUT
1	288 mm Flat Bar	39070_TXM-288MM_FLAT_BAR
2	Inside Corner Bracket	39281_TXM-INSIDECORNERBRACKETS
3	Flat Building Plate	39073_TXM-FLATBUILDINGPLATES
4	Motor Mount	39089_TXM-MOTORMOUNT
8	6-32 x 1 1/2” SHCS	39195_TXM-SHCS_6-32_X_1_5
9	Motor Hub	39079_TXM-MOTOR-SHAFT-HUB
2	4” Wheel	39055_TXM-4_INCH_WHEEL
69	6-32 x 1/2” SHCS	39097_SHCS_6-32_X_0_5
9	Bronze Bushing	39091_TXM-BRONZE_BUSHING
10	1/8” Axle Spacer	39100_TXM-AXLESPACERS_0_125
6	Axle Set Collar	39092_TXM-AXLESETCOLLARS
3	100 mm Axle	39088_TXM-STEEL_AXLE_100MM

2	4” Omni Wheel Pack	36466_TXM-4_INCH_DUAL_OMNI_WHEEL
1	96 mm Channel	39066_TXM-96MMCHANNEL
5	32 mm Channel	39065_TXM-32MMCHANNEL
5	Flat Round Spacer	39387_TX-FLAT_2MM_SPACER
6	40 Tooth Gear	39028_TXM-GEAR40-TOOTH
4	Inside C Connector	39270_TXM-INSIDECCONNECTORS
3	Axle Hub	39172_TXM-AXLE_HUB
2	80 Tooth Gear	39086_TXM-GEAR80-TOOTH
22	Button Head Cap Screw	39111_BHCS_6-32_X_0_375
2	160 mm x 27 mm Flat	39272_TXM-FLAT160MMX26MM
2	144 mm Angle	39072_TXM-144MMANGLE
4	6-32 x 32 mm Stand-Off Post	39107_TXM-STAND-OFF-6-32X32MM
7	8 mm x 6mm Bronze Bushing	40227_TXP-6MM_IDX8MM_OD_BRONZE
3	100 mm x 6 mm Axle	44708_TXM-6MM_X_100MM_AXLE
2	120-Tooth Gear	39085_TXM-GEAR120-TOOTH
6	6 mm Plastic Bushing Spacer	41665_TXP_6MM_PLASTIC_BUSHING
1	288 mm Angle	39071_TXM-288MMANGLE
1	416 mm Channel	39069_TXM_416MMCHANNEL
4	6-32 x 16 mm Stand-Off Post	41253_TXM-16MM_LENGTH_POST
1	Standard Servo Mounting Kit	41789_TXM-SERVO_PLATE

1	180° Standard-Scale Servo Motor	39197_TETRIX_485HB_STANDARD_SER
1	64 mm x 27 mm Flat	39274_TXM-FLAT64MMX26MM
4	L Bracket	39062_TXM-LBRACKETS
5	Flat Bracket	39061_TXM-FLATBRACKETS
1	96 mm x 27 mm Flat	39273_TXM-FLAT96MMX26MM
1	Expansion Hub	REV-31-1153
2	M3 Screw for Expansion Hub	REV-M3X16MM
2	M3 Nyloc Nut	M3_LOCKNUT
4	6-32 x 16 mm Stand-Off Post	44707_TX-STAND-OFFPOSTS6-32X28M
2	Battery Clip	38009_TXM-BATTERY-CLIP
1	Switch Bracket	ACRYLIC_SWITCH_BRACKET
1	Switch	SWITCH
1	Battery	39057_TXM-12V_3000MAH_BATTERY