Studica FTC Docs

Release 0.0.1

Studica and FIRST® Robotics Canada

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Welcome to the Studica Robotics and *FIRST®* Robotics Canada documentation on the *FIRST®* Tech Challenge. Here you will find lots of information and tutorials on robotics related to FTC.

Note: These docs are a work in progress.

Rookies Start Here

Rookies that are new to FTC should choose this section to get started.

Official Docs

Link to the official docs from *FIRST®*

Building System

All of the gushy Studica Robotics components explained in more detail.

Electronics and Wiring

Want to learn about the electronics and how to wire your robot? Well look no further.

Camp Bot

Want to build the camp bot and program it? Get the build and program guides here!

Basic Bot

Looking for a bit more excitement? Get the build and program guides for the basic bot here!

Mechanisms

All you need to know about different drivetrains, arms, elevators, intakes, claws … and so on.

Software

You can build the mechanism but it won't do anything unless you program it. Learn how to program that arm or claw here.

Contributing

Want to contribute to this project? Check out this section.

Teacher Aid

FTC Class Pack "Getting Started" Guide for Teachers.

Report an Issue

Spotted an issue in these docs, click here!

CHAPTER

ONE

ROOKIES START HERE

CHAPTER

TWO

BUILDING SYSTEM

CHAPTER

THREE

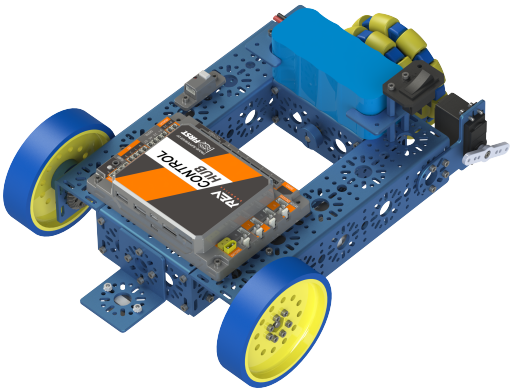
ELECTRONICS AND WIRING

CHAPTER

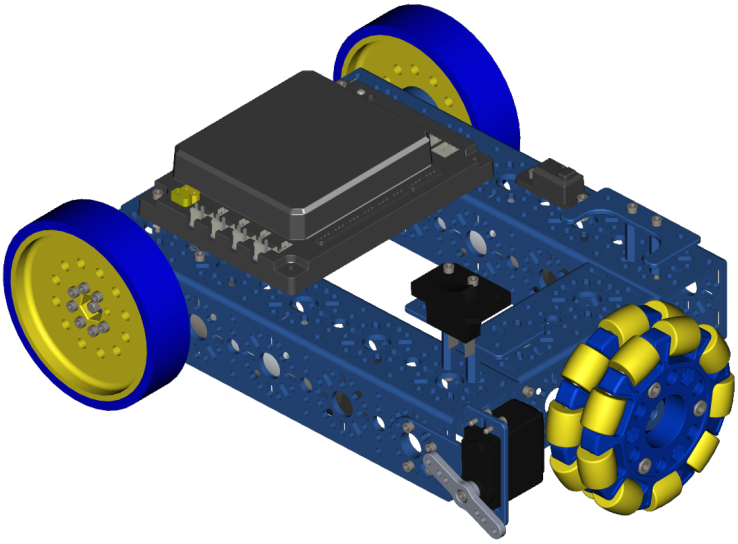
FOUR

CAMP BOT

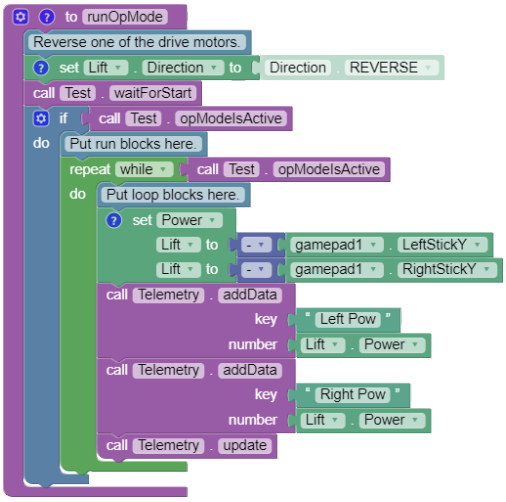
The Camp Bot is a simple robot that can built to teach the basics of robotics in FTC.



Build Guide



Programming Guide



4.1 Build Guide

The Camp Bot is a simple construction that should take around 10 min to 1 hour, based on skill level.

4.1.1 Tools Required

Hex Key Set

5.5mm Combination Wrench

Hint: It is recommended to take all the parts of the BOM out of the box for easy assembly.

BOM (click to open)

Table 1: BOM for Basic Bot Chassis

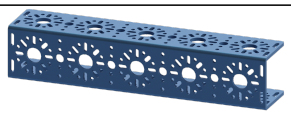
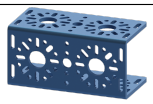
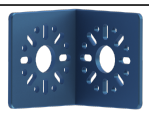
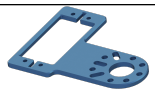
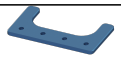
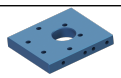
Name	Part #	Qty	Image
NeveRest Classic 40	am-4609b	2	
Multi-Mode Smart Servo	75002	1	
240mm U-Channel	76014	2	
96mm U-Channel	76017	2	
L Bracket	76087	1	
Servo Mount Offset Plate	76146	1	
Servo Arm	76151	1	
Battery Clip	76088	2	
Motor Mount Plate	76140	2	

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Table 1 – continued from previous page

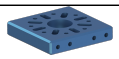
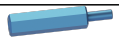
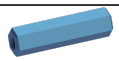
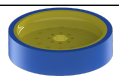
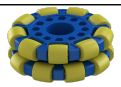
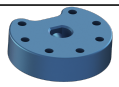
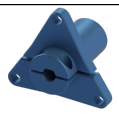
Name	Part #	Qty	Image
End Piece Plate	76015	4	
6mm x 96mm D-Shaft	76161	3	
25mm Male to Female Standoff	76184	2	
25mm Standoff	76182	5	
M3 x 10mm SHCS	76201	54	
M3 x 12mm SHCS	76202	14	
M3 x 20mm SHCS	76209	2	
M3 x 10mm BHCS	76203	28	
M3 Kep Nut	76204	10	
30 Tooth Bevel Gear	76219	4	
100mm Drive Wheel	76262	2	
100mm Omni Wheel	76260	1	
Light Weight Shaft Hub	76282	2	
Enhanced Wheel Hub Kit	76291	1	
14mm Flange Bearing	76302	4	
Bronze Bushing 6mm ID x 8mm OD	76300	2	
Collar Clamp	76320	3	
2mm Shaft Spacer	76306	12	

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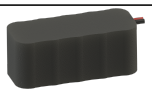
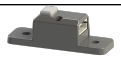
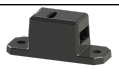
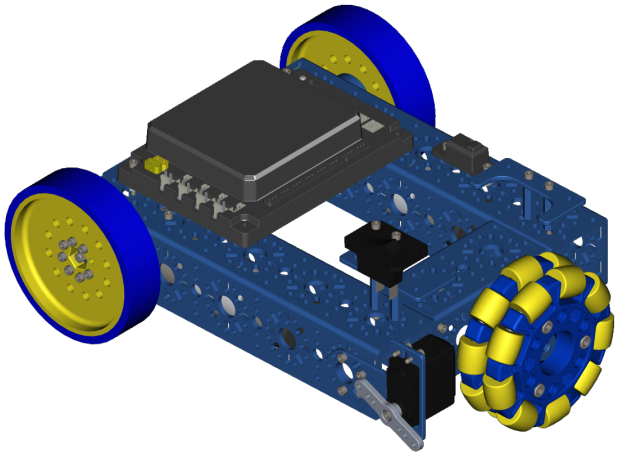
Table 1 – continued from previous page

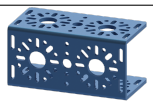
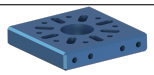
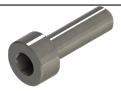
Name	Part #	Qty	Image
XT30 to Tamiya Adapter	70179	1	
12V 3000mAh Battery	39057	1	
Touch Sensor	REV-31-1425	1	
Colour Sensor	REV-31-1557	1	
Power Switch	REV-31-1387	1	
Control Hub	REV-31-1595	1	

Step 1: Start Build



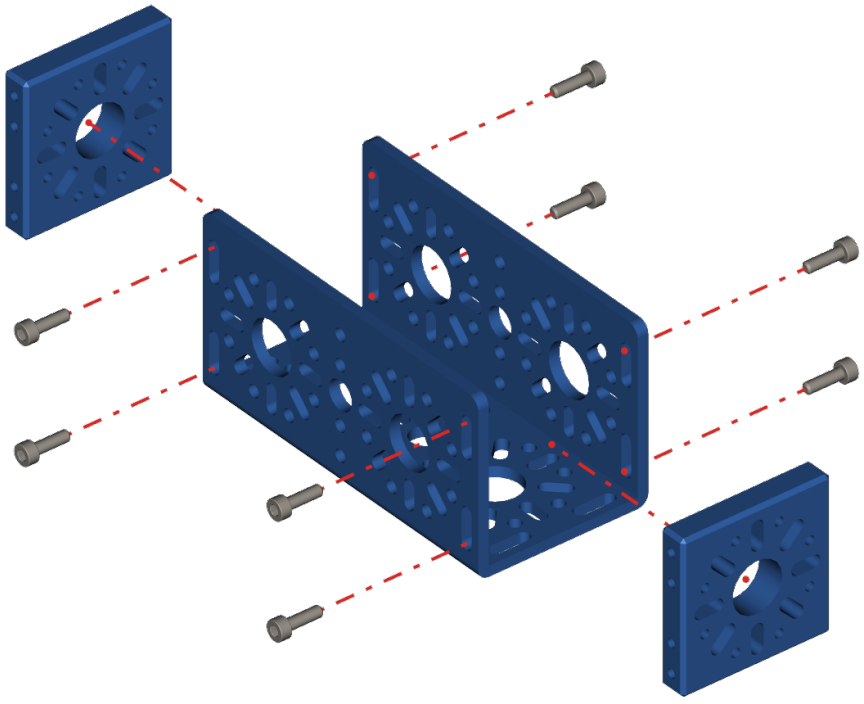
Step 1 - Start Build

Table 2: Parts Required for Step 1

Name	Part #	Qty	Image
96mm U-Channel	76017	2	
End Piece Plate	76015	4	
M3 x 10mm SHCS	76201	16	

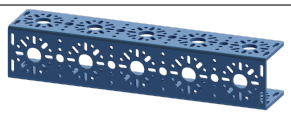
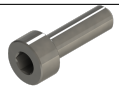
Instructions

- Slide the End Piece Plate into the end of the 96mm U-Channel.
- Using an M3 x 10mm SHCS screw from the outside of the 96mm U-Channel into the tapped holes of the End Piece Plates.
- Repeat for the other side.
- The End Piece Plate should sit flush on both ends of the channel.
- **Once one channel is complete, repeat the process with the other 96mm U-Channel and two other End Piece Plates.**



Step 2 - Frame Assembly

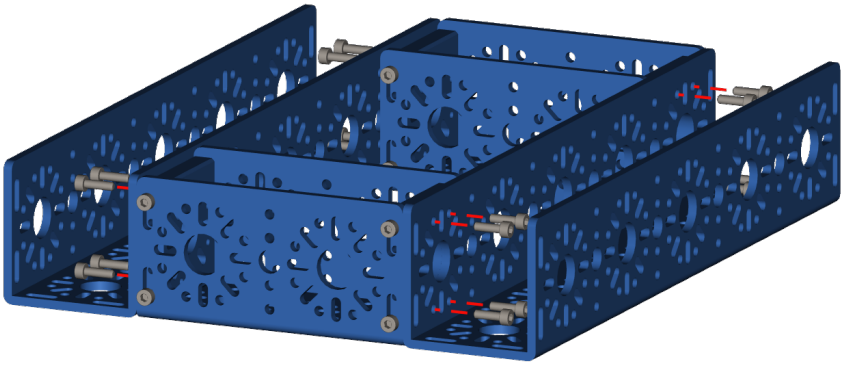
Table 3: Parts Required for Step 2

Name	Part #	Qty	Image
Completed Assembly from Part 1		2	
240mm U-Channel	76014	2	
M3 x 10mm SHCS	76201	16	

Instructions

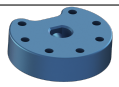
- Align the 96mm U-Channel with the 240mm U-Channel as shown below.
- Using M3 x 10mm SHCS, screw the 240mm U-Channel into the End Piece Blocks on the 96mm U-Channel. **Do not fully tighten the screws**
- Once all 16 screws have been put in, square up the frame so that everything is straight and level.
- Fully tighten all screws using a star pattern.

Note: NEED TO ADD AN IMAGE HERE SHOWING THE HEX KEY GOING THROUGH THE CHANNEL



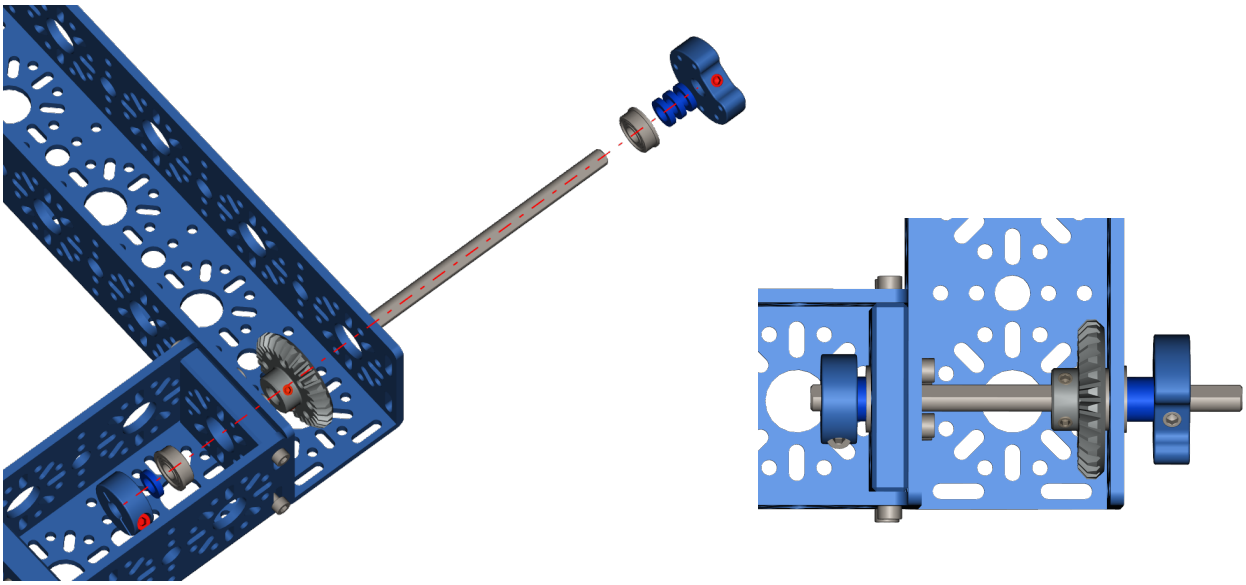
Step 3 - Drive Axle

Table 4: Parts Required for Step 4

Name	Part #	Qty	Image
Completed Assembly from Part 3		1	
Light Weight Shaft Hub	76282	2	
6mm x 96mm D-Shaft	76161	2	
30 Tooth Bevel Gear	76219	2	
14mm Flange Bearing	76302	4	
Collar Clamp	76320	2	
2mm Shaft Spacer	76306	8	

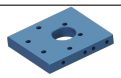
Instructions

- Pre-load the 5mm setscrew into the Light Weight Shaft Hub. **Be careful not to tighten the setscrew all the way**
- Pre-Load the 4mm setscrews into the 30 Tooth Bevel Gear. **Be careful not to tighten the setscrews all the way**
- Pre-load the M3 x 8mm SHCS into the Collar Clamp. **Be careful not to righten the screw**
- Slide the Collar Clamp onto the 6mm D-shaft and offset it about 2mm away from the edge of the shaft. **Using a 2mm spacer is an excellent way to get the spacing**
- Clamp the Collar clamp down to the D-shaft.
- Slide a single 2mm spacer onto the D-shaft and slide it down to the collar clamp.
- Slide a 14mm bearing down the D-shaft until it makes contact with the spacer. The flange should be touching the spacer.
- Slide the D-shaft through the End Piece Plate from inside the frame.
- Before sliding the shaft through, slide the 30 Tooth Bevel Gear onto the shaft with the setscrew side facing the inside of the frame. **Do not tighten the setscrews**
- Fully slide the D-Shaft through.
- Slide a 14mm bearing onto the D-shaft with the flange facing the outside.
- Slide 3 x 2mm spacers onto the D-shaft.
- Slide the Light Weight shaft hub onto the D-shaft and tighten the setscrew.
- The shaft should be able to spin freely. If there are any issues, loosen the Light Weight Shaft hub or the collar clamp and adjust.
- Repeat these steps for the other side.



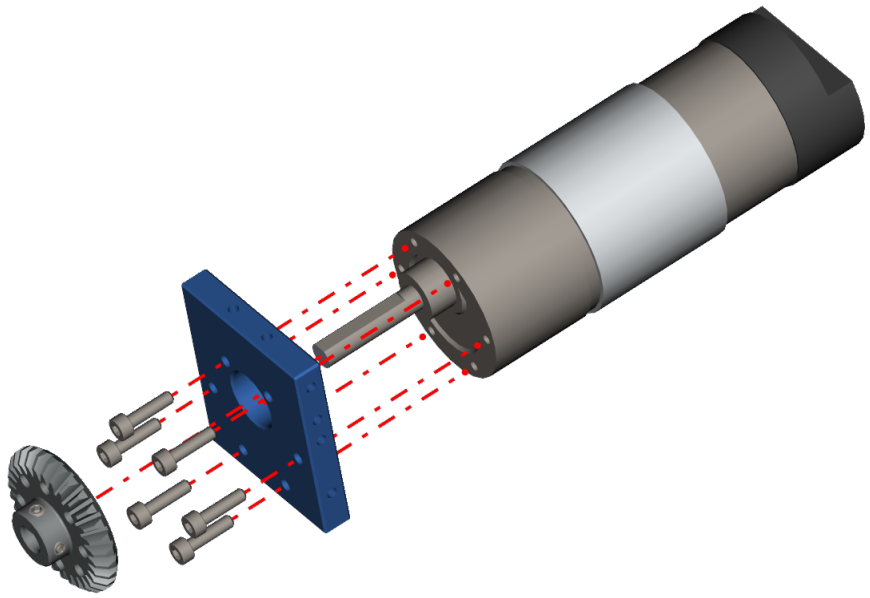
Step 4 - Motor Assembly

Table 5: Parts Required for Step 4

Name	Part #	Qty	Image
NeveRest Classic 40	am-4609b	2	
Motor Mount Plate	76140	2	
30 Tooth Bevel Gear	76219	4	
M3 x 10mm SHCS	76201	12	

Instructions

- Pre-Load the 4mm setscrews into the 30 Tooth Bevel Gear. **Be careful not to tighten the setscrews all the way**
- Slide the NeveRest Classic into the Motor Mount plate.
- Using M3 x 10mm SHCS, screw the NeveRest Classic into the Motor Mount Plate.
- Slide the 30 Tooth Bevel gear onto the NeveRest Classic Motor shaft. The set screws should face away from the motor, as shown below. **Do Not fully tighten the setscrews**.
- Repeat these steps for the other NeveRest Classic Motor.



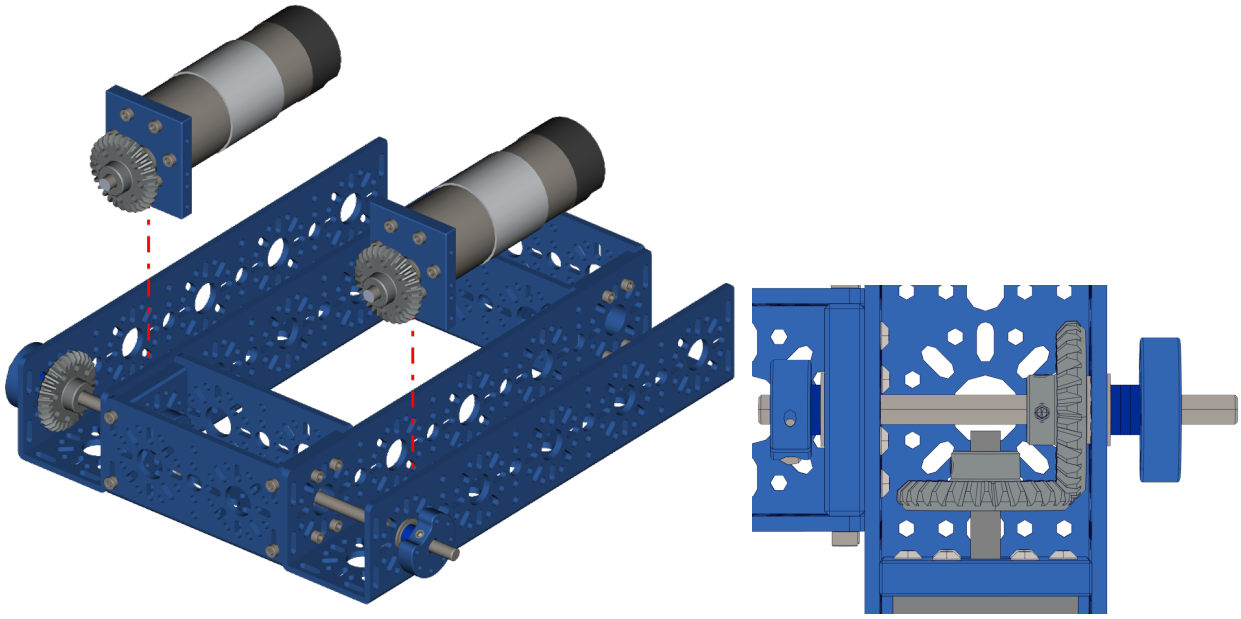
Step 5 - Inserting Motors

Table 6: Parts Required for Step 6

Name	Part #	Qty	Image
Completed Assembly from Part 3		1	
Completed Assembly from Part 4		2	

Instructions

- Slide the Motor Assemblies down into the chassis as shown in the pictures below.



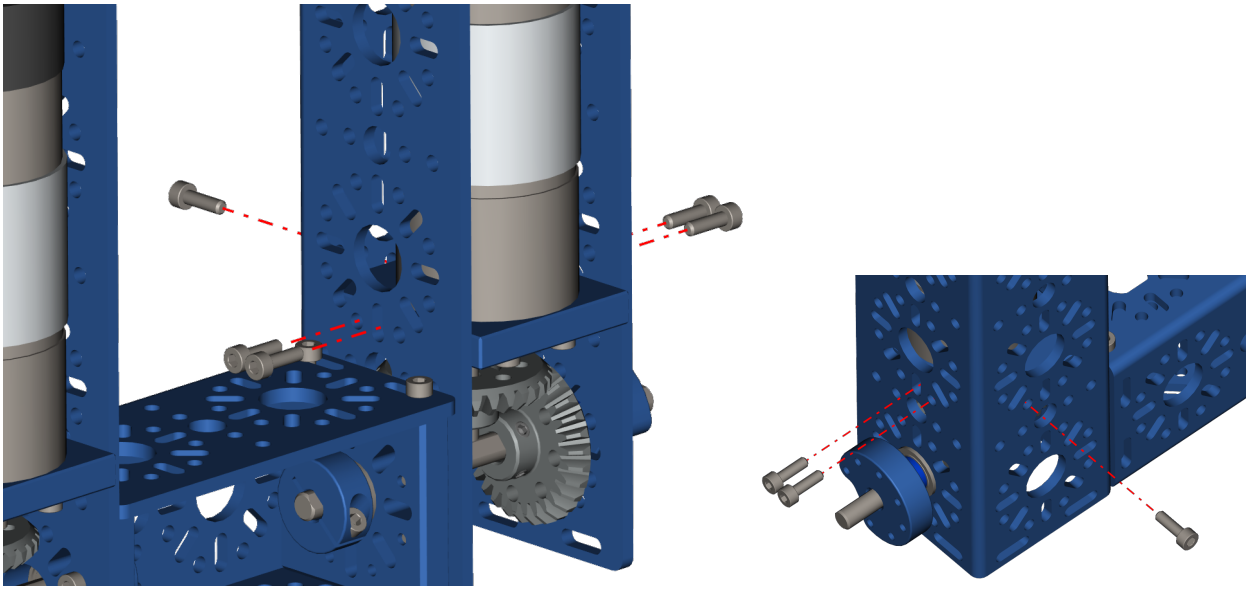
Step 6 - Securing the Motor Bracket

Table 7: Parts Required for Step 6

Name	Part #	Qty	Image
Completed Assembly from Part 7		1	
M3 x 10mm SHCS	76201	10	

Instructions

- Using the M3 x 10mm SHCS screw in the 5 screw points as shown in the pictures below.
- Repeat the process for the other side.



Step 7 - Bevel Gear Alignment

Table 8: Parts Required for Step 7

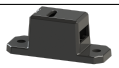
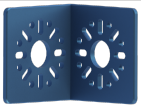
Name	Part #	Qty	Image
Completed Assembly from Part 6		1	

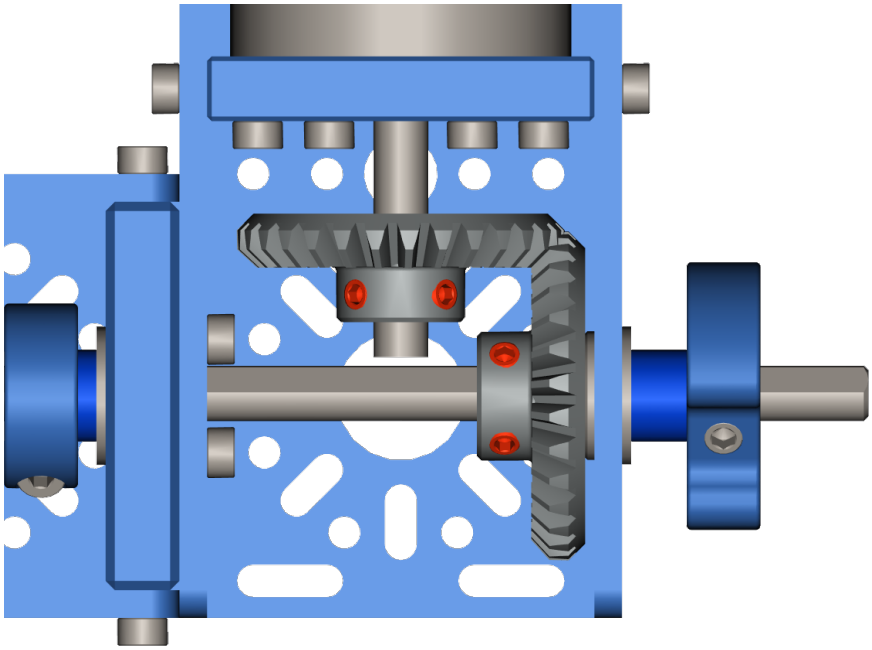
Instructions

- Mesh the two bevel gears and tighten the setscrews. **You may need to do one rotate the shaft and repeat to get all 4.**
- Repeat the process for the other side.

Step 8 - Colour Sensor Part 1

Table 9: Parts Required for Step 8

Name	Part #	Qty	Image
M3 x 10mm SHCS	76201	2	
Colour Sensor	REV-31-1557	1	
M3 Kep Nut	76204	2	
L Bracket	76087	1	



Instructions

- Using M3 x 10mm SHCS and Kep Nuts, attach the Colour sensor to an L Bracket.

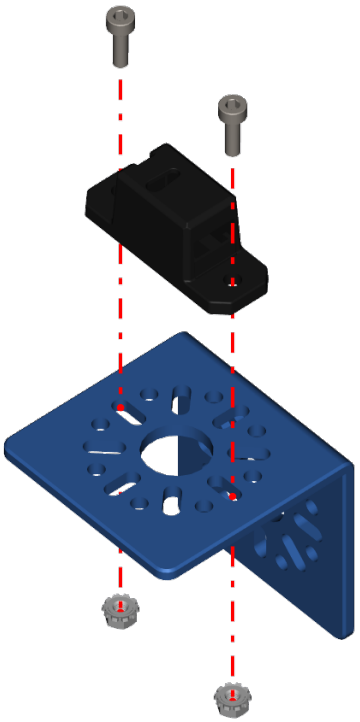
Step 9 - Colour Sensor Part 2

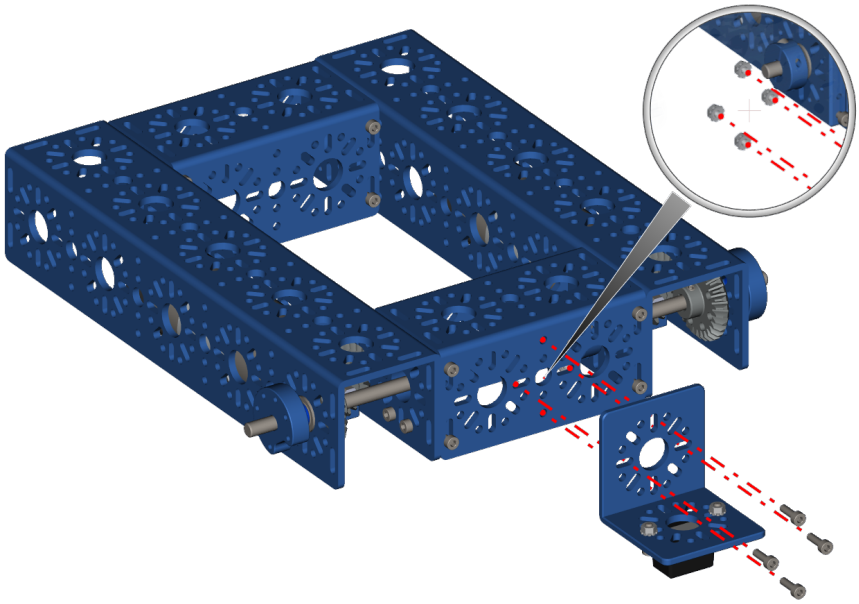
Table 10: Parts Required for Step 8

Name	Part #	Qty	Image
Completed Assembly from Part 7		1	
Completed Assembly from Part 8		1	
M3 x 10mm SHCS	76201	4	
M3 Kep Nut	76204	4	

Instructions

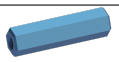
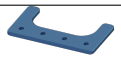
- Using M3 x 10mm SHCS and Kep Nuts, attach the L Bracket to the 96mm U-Channel on the drive wheel axle side.





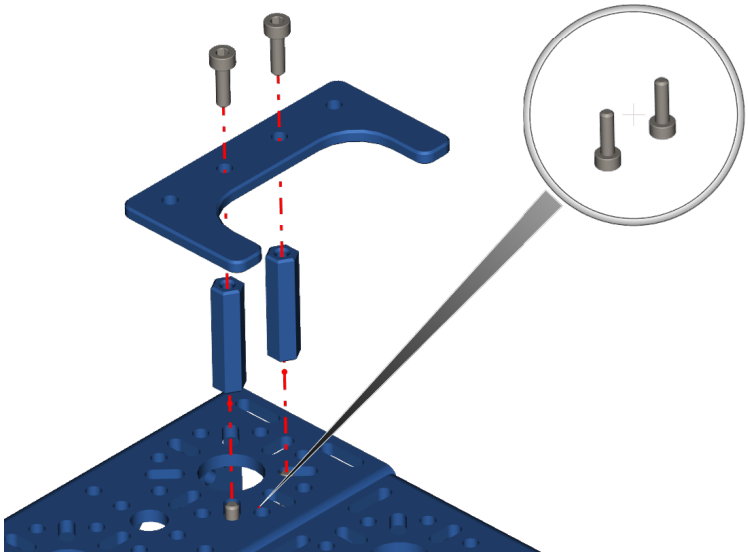
Step 10 - Battery Clip Part 1

Table 11: Parts Required for Step 10

Name	Part #	Qty	Image
Completed Assembly from Part 9		1	
M3 x 10mm SHCS	76201	4	
25mm Standoff	76182	2	
Battery Clip	76088	1	

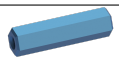
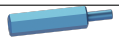
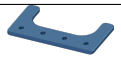
Instructions

- From inside the back 96mm U-Channel, use 2 M3 x 10mm SHCS to screw into 2 25mm Standoffs.
- Place the battery clip on top of the standoffs and screw them in with the other 2 M3 x 10mm SHCS.



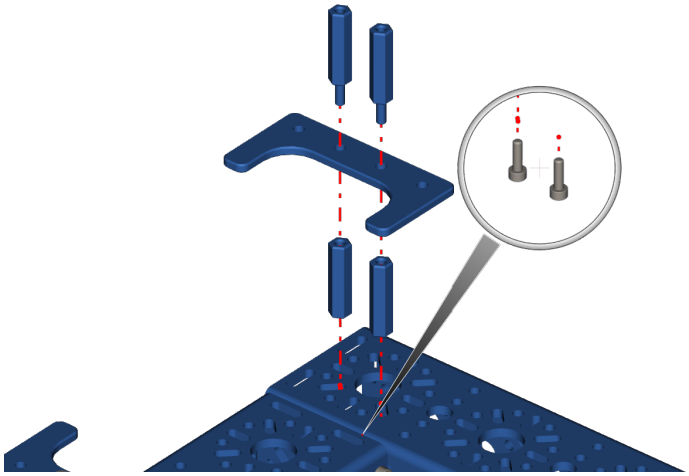
Step 11 - Battery Clip Part 2

Table 12: Parts Required for Step 11

Name	Part #	Qty	Image
Completed Assembly from Part 10		1	
M3 x 10mm SHCS	76201	2	
25mm Standoff	76182	2	
25mm Male to Female Standoff	76184	2	
Battery Clip	76088	1	

Instructions

- From inside the back 96mm U-Channel, use 2 M3 x 10mm SHCS to screw into 2 25mm Standoffs.
- Place the battery clip on top of the standoffs and screw them in with the 2 Male to Female standoffs.



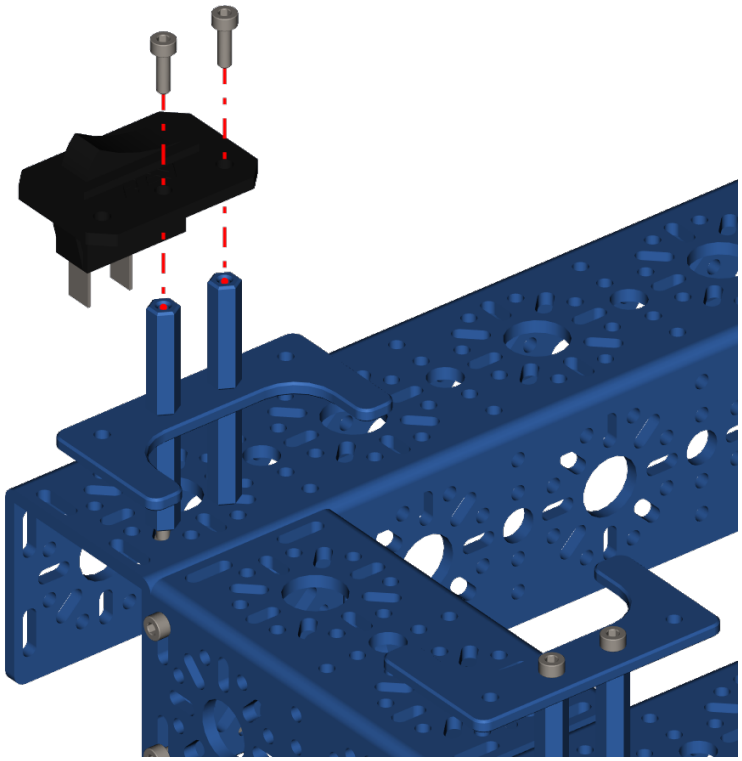
Step 12 - Power Switch

Table 13: Parts Required for Step 12

Name	Part #	Qty	Image
Completed Assembly from Part 11		1	
M3 x 10mm SHCS	76201	2	
Power Switch	REV-31-1387	1	

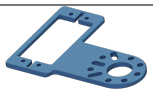
Instructions

- Screw the Power switch into the 2 standoffs using 2 M3 x 10mm SHCS.



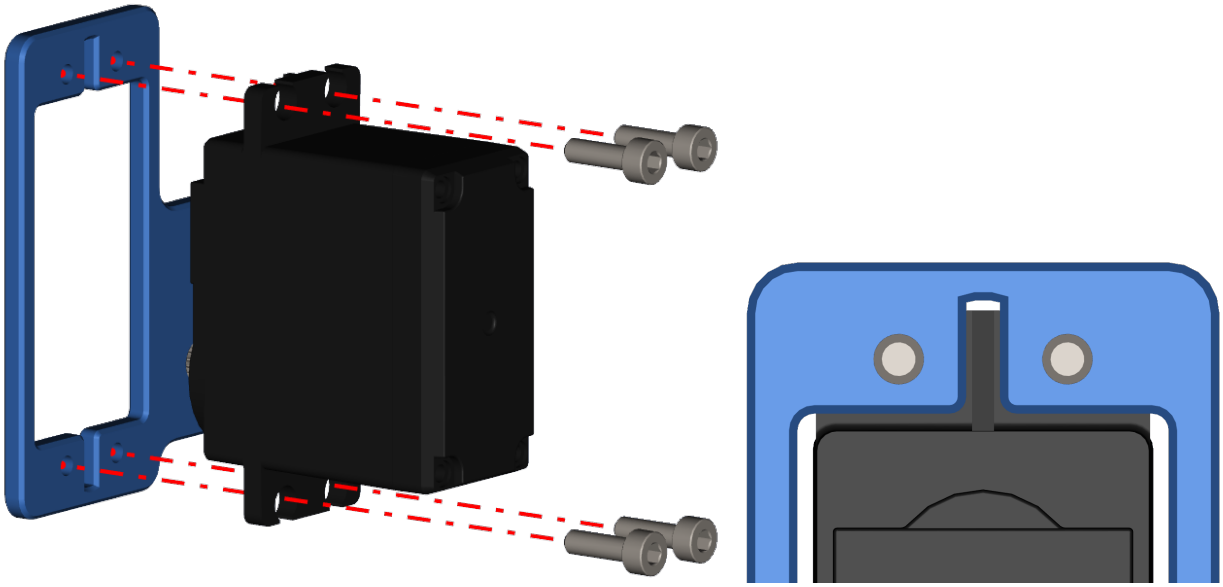
Step 13 - Servo Part 1

Table 14: Parts Required for Step 13

Name	Part #	Qty	Image
M3 x 10mm SHCS	76201	2	
Servo Mount Offset Plate	76146	1	
Multi-Mode Smart Servo	75002	1	

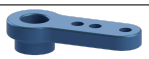
Instructions

- Screw the Servo into the offset plate using 4 M3 x 10mm SHCS.
- The Servo spline should be in line with the 14mm hole from the offset plate.
- Make sure the servo tab fits in the middle of the tab slot on the offset plate.



Step 14 - Servo Part 2

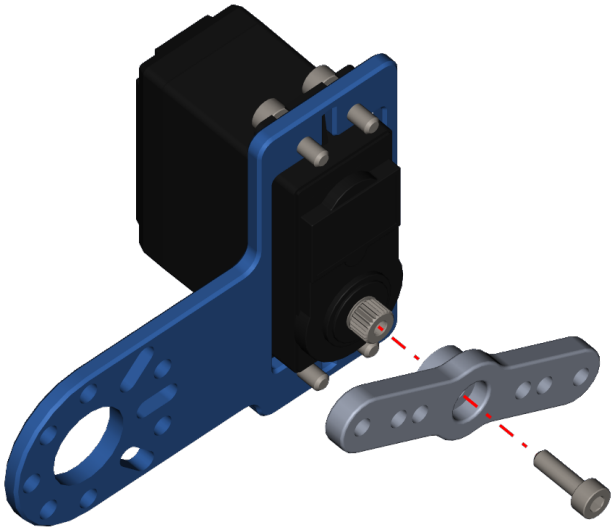
Table 15: Parts Required for Step 14

Name	Part #	Qty	Image
Completed Assembly from Part 13		1	
M3 x 8mm SHCS (in the bag)	75002	1	
Servo Arm	76151	1	

Instructions

- Screw the servo arm into the servo spline using an M3 x 8mm SHCS included with the servo.

Note: The picture below shows the double servo arm, but the single servo arm is included in the kit. There is no difference for the camp bot application.



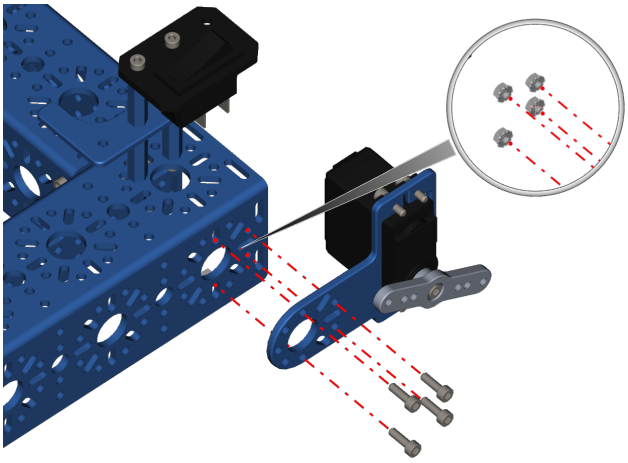
Step 15 - Servo Part 3

Table 16: Parts Required for Step 15

Name	Part #	Qty	Image
Completed Assembly from Part 12		1	
Completed Assembly from Part 14		1	
M3 x 10mm SHCS	76201	4	
M3 Kep Nut	76204	4	

Instructions

- Screw the servo offset plate into the 240mm U-Channel as shown in the picture below.



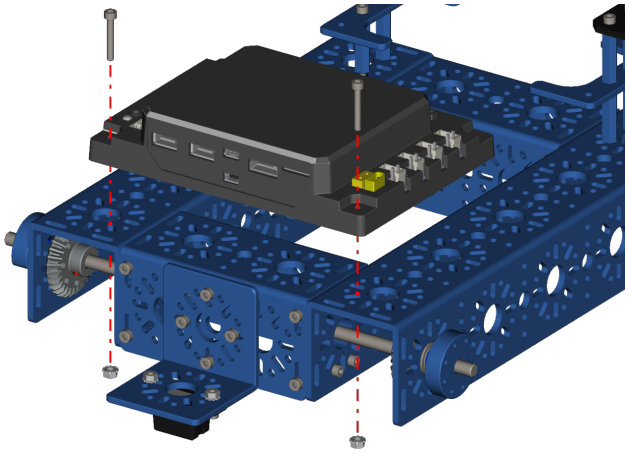
Step 16 - Control Hub Install

Table 17: Parts Required for Step 16

Name	Part #	Qty	Image
Completed Assembly from Part 15		1	
M3 x 20mm SHCS	76209	2	
M3 Kep Nut	76204	2	
Control Hub	REV-31-1595	1	

Instructions

- Place the Control Hub with the HDMI and USB ports facing the drive axles and away from the battery clips.
- Using the M3 x 20mm SHCS and M3 Kep Nuts, secure the Control Hub to the frame, as shown in the picture.



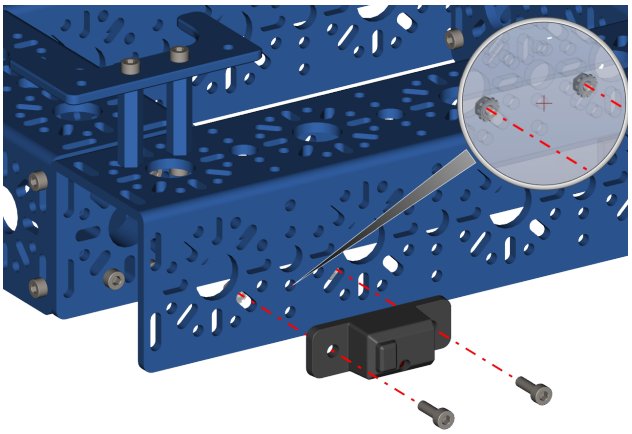
Step 17 - Touch Sensor

Table 18: Parts Required for Step 17

Name	Part #	Qty	Image
Completed Assembly from Part 16		1	
M3 x 10mm SHCS	76201	2	
M3 Kep Nut	76204	2	
Touch Sensor	REV-31-1425	1	

Instructions

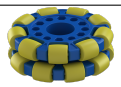
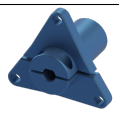
- On the back right side of the frame (battery clip side without power switch), install the touch sensor as shown.



Step 18 - Omni Wheel Part 1

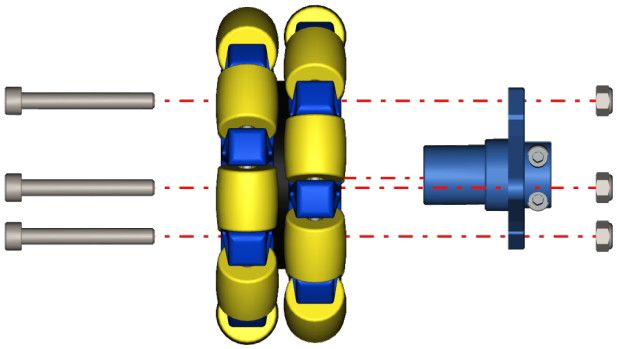
Important: This step requires pliers or an 8mm wrench.

Table 19: Parts Required for Step 18

Name	Part #	Qty	Image
100mm Omni Wheel	76260	1	
Enhanced Wheel Hub Kit	76291	1	

Instructions

- Using 3 of the M5 x 40mm SHCS, screw the Omni Wheel into the Enhanced Wheel Hub with the M5 Nyloc nuts on the other side of the Hub.
- The Nyloc nuts will need to be secured with pliers or an 8mm wrench. Otherwise, they will spin in place.
- Pre-install the M4 x 8mm SHCS into the Enhanced Wheel Hub. **DO Not Tighten the M4 Screws**
- Repeat for the other side.



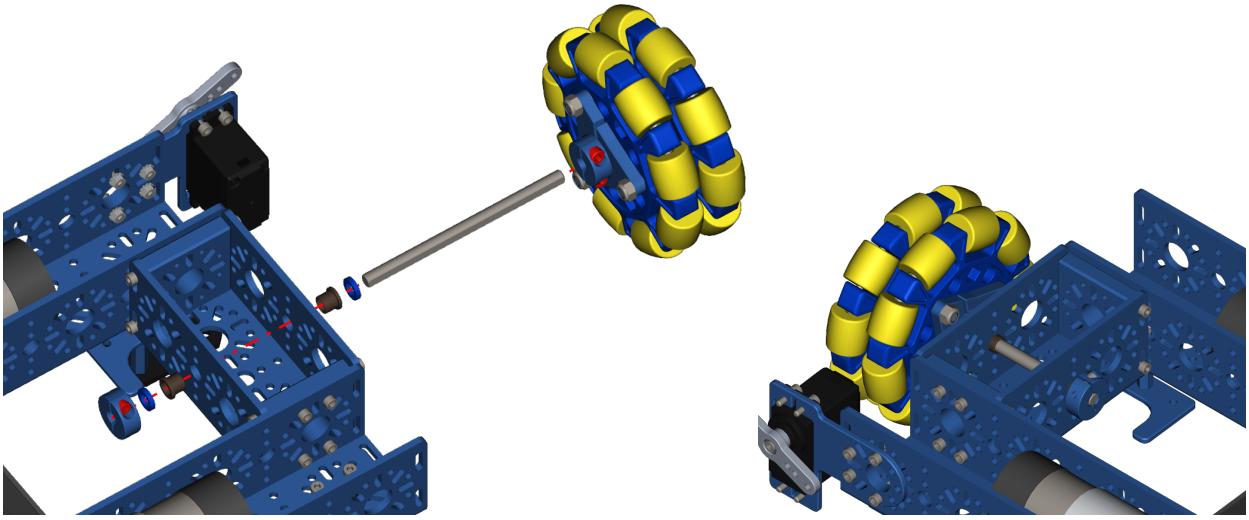
Step 19 - Omni Wheel Part 2

Table 20: Parts Required for Step 19

Name	Part #	Qty	Image
Completed Assembly from Part 17		1	
Completed Assembly from Part 18		1	
Bronze Bushing 6mm ID x 8mm OD	76300	2	
Collar Clamp	76320	1	
2mm Shaft Spacer	76306	2	
6mm x 96mm D-Shaft	76161	1	

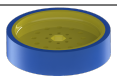
Instructions

- Place the Collar Clamp on the edge of the 6mm D-Shaft and fully tighten the M3 screw down to clamp the Collar Clamp to the D-Shaft. **Take note to ensure the Collar Clamp and Shaft are flush at one end**
- Slide a 2mm Spacer from the other end of the shaft down to the Collar Clamp.
- Slide the Bushing from the other end of the shaft down to the spacer. **The Flange of the bushing should be touching the spacer**
- Slide the Shaft into the 8mm hole in the middle of the 96mm U-Channel from the inside of the frame.
- Slide a Bushing from the outside of the 96mm U-Channel onto the shaft. **The Flange of the bushing should be facing outside**
- Slide a 2mm spacer on the shaft so that it makes contact with the bushing.
- Slide the Enhanced Wheel Hub onto the shaft and clamp it down using the 3mm Hex Key (Blue).
- The finished assembly should look like the picture on the right.
- Check to ensure you can spin the Enhanced Wheel hub without any issues. If there are issues, loosen the hub or the collar clamp and try again. The hub should be able to spin smoothly.



Step 20 - Drive Wheels

Table 21: Parts Required for Step 20

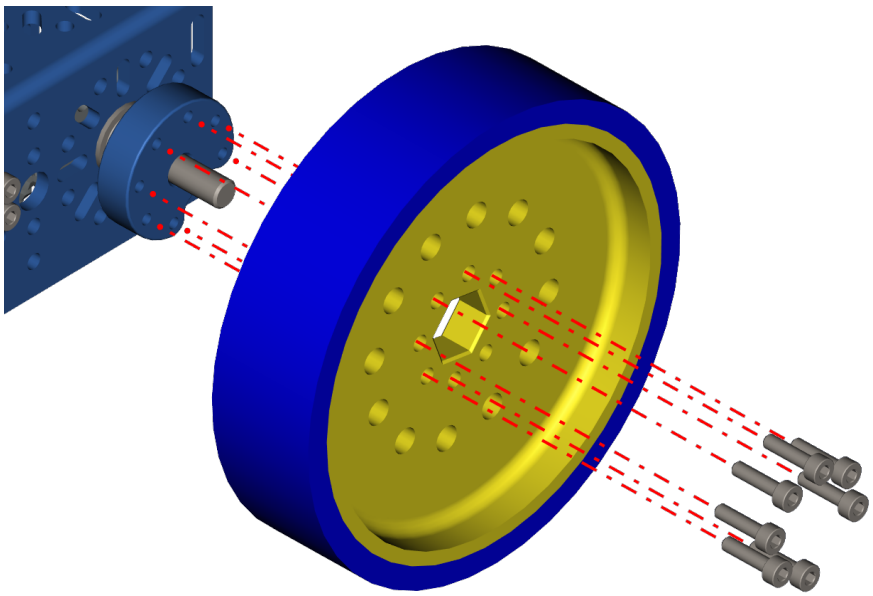
Name	Part #	Qty	Image
Completed Assembly from Part 19		1	
100mm Drive Wheel	76262	2	
M3 x 12mm SHCS	76202	14	

Instructions

- Using 7 M3 x 12mm SHCS, screw the drive wheel into the light Weight shaft hub.
- Repeat for the other side.

Step 21 - Wiring

4.2 Programming

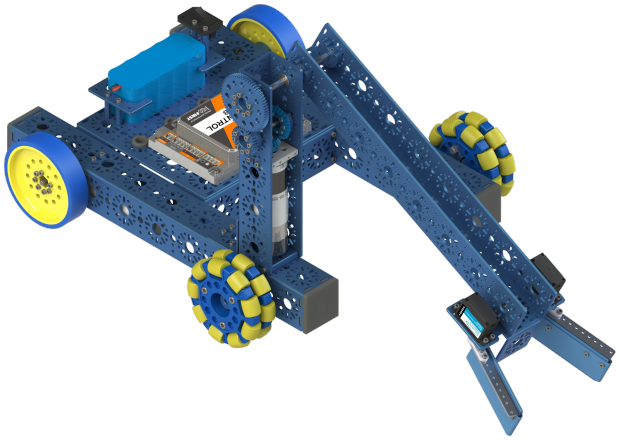


CHAPTER

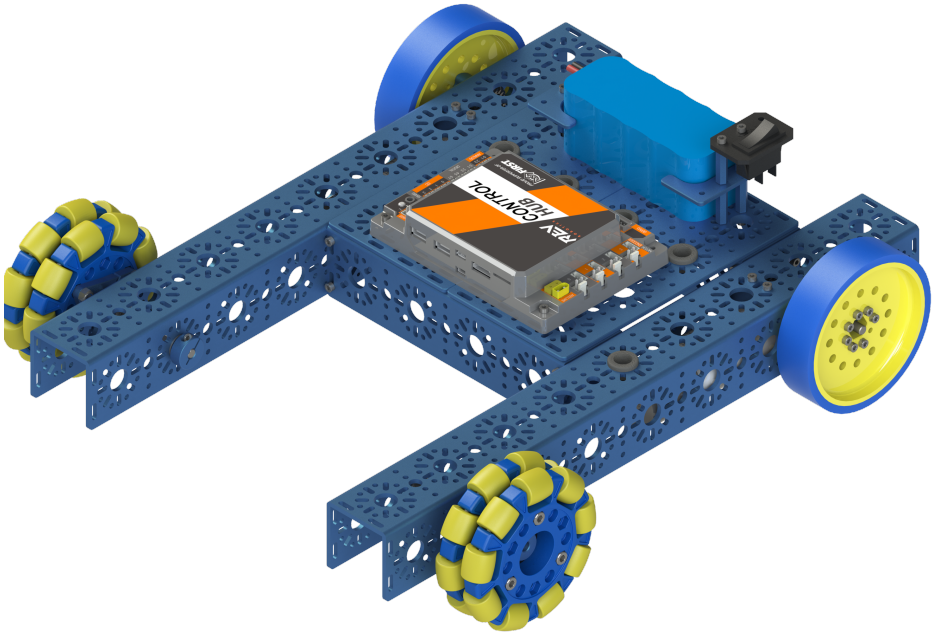
FIVE

BASIC BOT

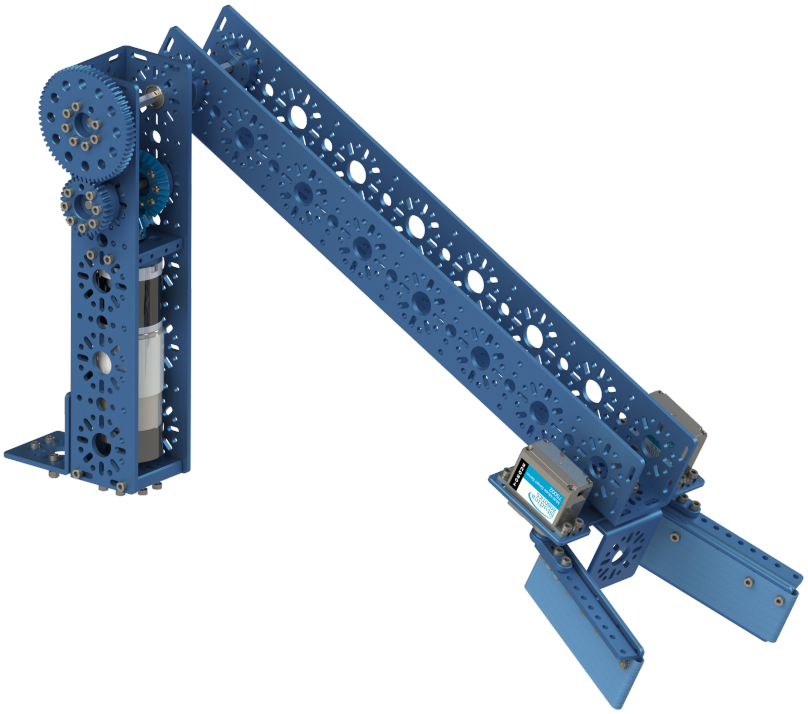
The basic bot is a simple robot that can built from the Studica Robotics FTC Starter Kit. The basic bot has two main parts, a chassis and an OMS (Object Management System). The chassis stays the same year after year however the OMS changes based on the years challenge.



Chassis Build Guide



OMS Build Guide



Programming Guide

5.1 Chassis Build Guide

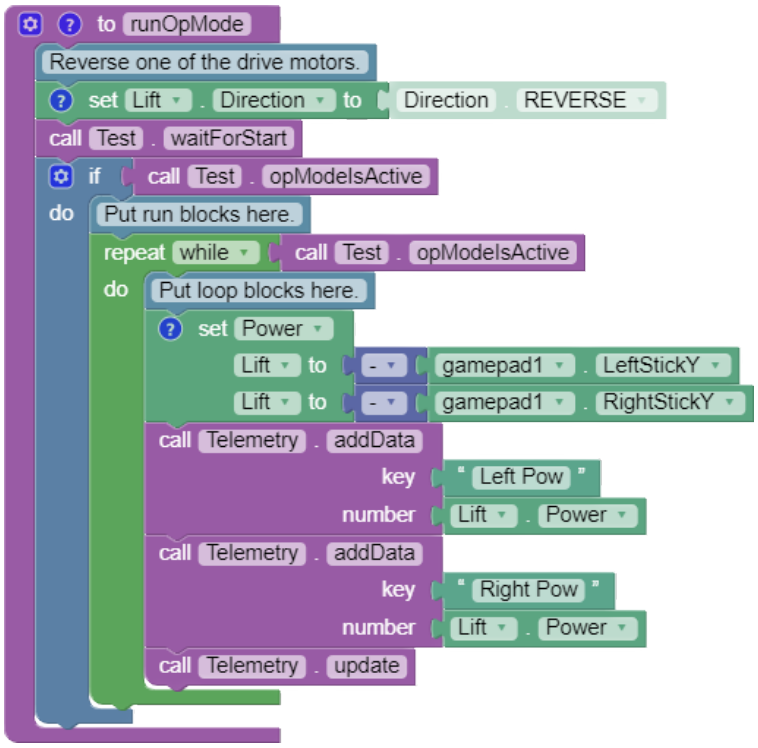
The Chassis of the basic bot is a simple construction. The assembly can take 10 min to 1 hour based on skill level.

5.1.1 Tools Required

Hex Key Set

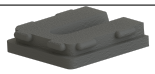
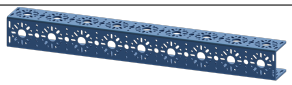
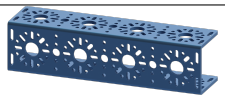
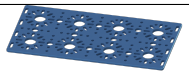
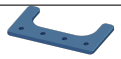
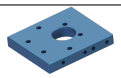
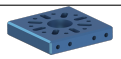
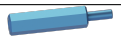
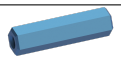
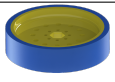
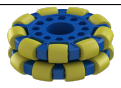
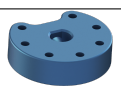
5.5mm Combination Wrench

Hint: It is recommended to take all the parts of the BOM out of the box for easy assembly.

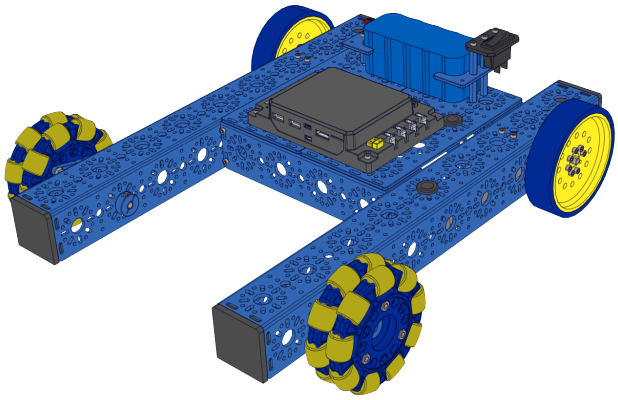

to runOpMode
Reverse one of the drive motors.
set Lift . Direction to Direction . REVERSE
call Test . waitForStart
if call Test . opModeIsActive
do Put run blocks here.
repeat while call Test . opModeIsActive
do Put loop blocks here.
set Power
Lift to - gamepad1 . LeftStickY
Lift to - gamepad1 . RightStickY
call Telemetry . addData
key " Left Pow "
number Lift . Power
call Telemetry . addData
key " Right Pow "
number Lift . Power
call Telemetry . update

BOM (click to open)

Table 1: BOM for Basic Bot Chassis

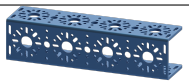
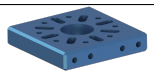
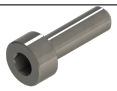
Name	Part #	Qty	Image
Rubber Grommet	76504	9	
U-Channel Bumper	76505	4	
NeveRest Classic 40	am-2964b	2	
432mm U-Channel	76010	2	
192mm U-Channel	76015	2	
192mm x 96mm Flat Bracket	76066	2	
Battery Clip	76088	2	
Motor Mount Plate	76140	2	
End Piece Plate	76015	4	
6mm x 96mm D-Shaft	76161	4	
25mm Male to Female Standoff	76184	2	
25mm Standoff	76182	5	
M3 x 10mm SHCS	76201	54	
M3 x 12mm SHCS	76202	14	
M3 x 20mm SHCS	76209	2	
M3 x 10mm BHCS	76203	28	
M3 Kep Nut	76204	2	
30 Tooth Bevel Gear	76219	4	
100mm Drive Wheel	76262	2	
100mm Omni Wheel	76260	2	
Light Weight Shaft Hub	76282	2	

Step 1: Start Build



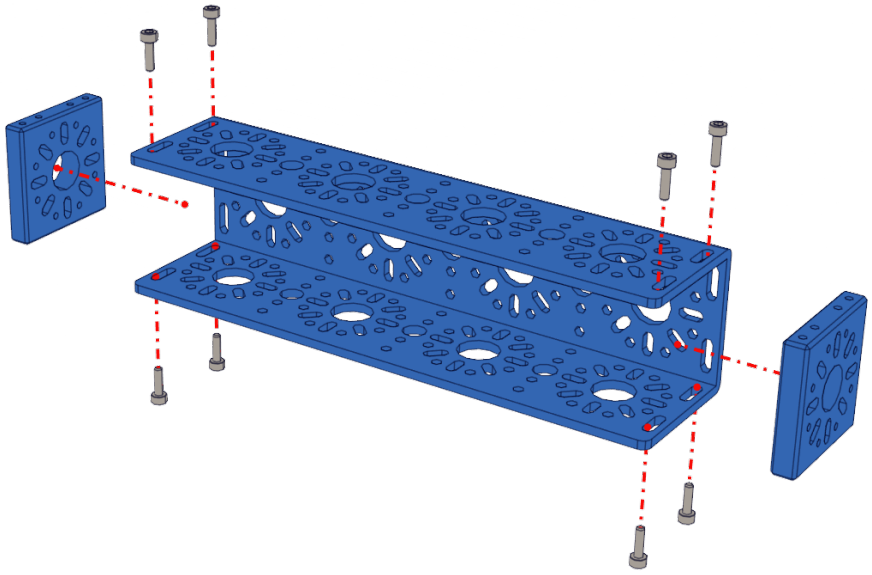
Step 1: Start Build

Table 2: Parts Required for Step 1

Name	Part #	Qty	Image
192mm U-Channel	76015	2	
End Piece Plate	76015	4	
M3 x 10mm SHCS	76201	16	

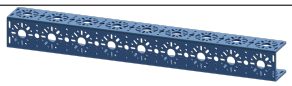
Instructions

- Slide the End Piece Plate into the end of the 192mm U-Channel.
- Using an M3 x 10mm SHCS screw from the outside of the 192mm U-Channel into the tapped holes of the End Piece Plate. The 2.5mm Hex Key (Green) is the tool to use here.
- Repeat this process for the other side of the 192mm U-Channel.
- The End Piece Plate should sit flush with both ends of the channel.
- **Once one channel is complete, repeat the process with the other 192mm U-Channel and two other End Piece Plates.**



Step 2 - Chassis Frame

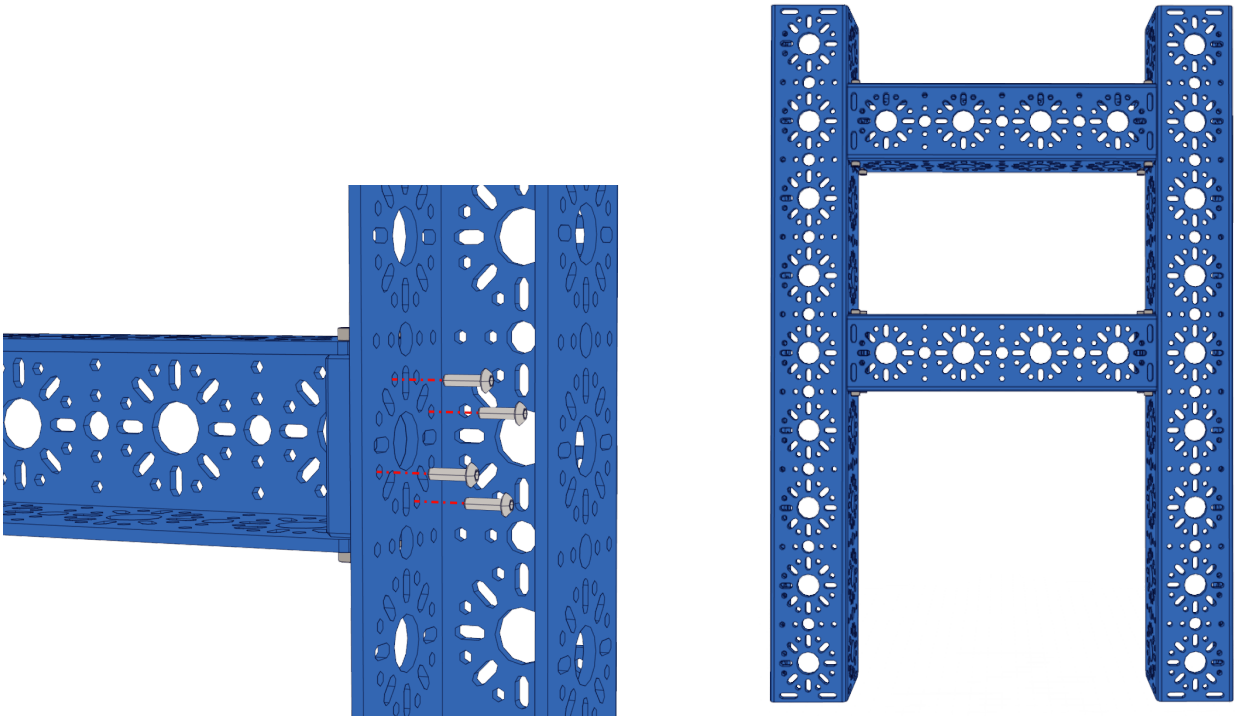
Table 3: Parts Required for Step 2

Name	Part #	Qty	Image
Completed Assembly from Part 1		2	
432mm U-Channel	76010	2	
M3 x 10mm BHCS	76203	16	

Instructions

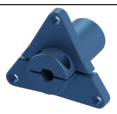
- Align the 192mm U-Channel with the 432mm U-Channel as shown in the picture on the right.
- Using 4 M3 x 10mm BHCS, screw the 432mm U-Channel into the End Piece Plate on the 192mm U-Channel, as shown in the left picture. M3 BHCS requires the 2mm Hex Key (Pink).
- Do not fully tighten the screws yet. They should be loose so the chassis can be straightened later.
- Repeat the process for the other three End Piece Plates connected to the 432mm U-Channel.
- Once everything is together, use the flattest surface to make all 4 channels as flat as possible.
- With all the channels flat and square to your liking, all 16 M3 x 10mm BHCS can be fully tightened. **Remember to use a star pattern when tightening to get even torque**

Note: NEED TO ADD AN IMAGE HERE SHOWING THE HEX KEY GOING THROUGH THE CHANNEL



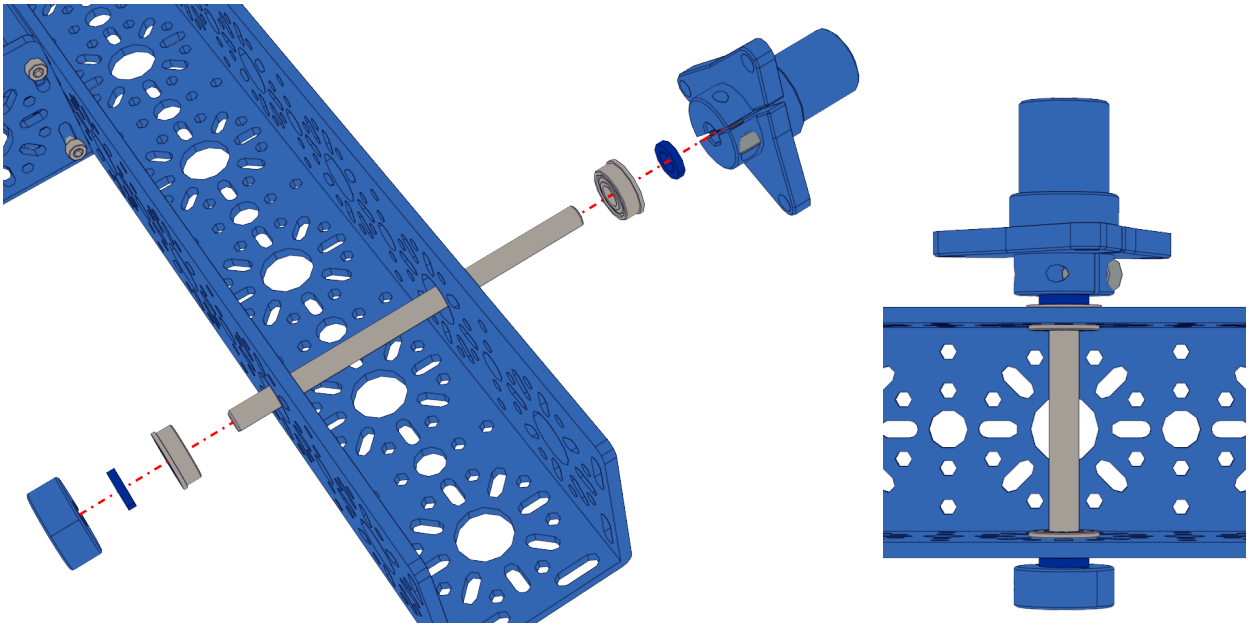
Step 3 - Front Idler Shaft

Table 4: Parts Required for Step 3

Name	Part #	Qty	Image
Completed Assembly from Part 2		1	
Enhanced Wheel Hub Kit	76291	2	
14mm Flange Bearing	76302	4	
Collar Clamp	76320	2	
2mm Shaft Spacer	76306	4	
6mm x 96mm D-Shaft	76161	2	

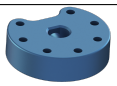
Instructions

- Pre-load the M4 x 8mm SHCS into the Enhanced Wheel Hub. **Be careful not to tighten the screws**
- Pre-load the M3 x 8mm SHCS into the Collar Clamp. **Be careful not to righten the screw**
- Place the Collar Clamp on the edge of the 6mm D-Shaft and fully tighten the M3 screw down to clamp the Collar Clamp to the D-Shaft. **Take note to ensure the Collar Clamp and Shaft are flush at one end**
- Slide a 2mm Spacer from the other end of the shaft down to the Collar Clamp.
- Slide the 14mm Bearing from the other end of the shaft down to the spacer. **The Flange of the bearing should be touching the spacer**
- Slide the Shaft into the 2nd 14mm hole on the 432mm U-Channel from the inside, as shown in the left picture. The Collar Clamp should be on the inside of the chassis frame.
- Slide a 14mm Bearing from the outside of the 432mm U-Channel onto the shaft. **The Flange of the bearing should be facing outside**
- Slide a 2mm spacer on the shaft so that it makes contact with the bearing.
- Slide the Enhanced Wheel Hub onto the shaft and clamp it down using the 3mm Hex Key (Blue).
- The finished assembly should look like the picture on the right.
- Check to ensure you can spin the Enhanced Wheel hub without any issues. If there are issues, loosen the hub or the collar clamp and try again. The hub should be able to spin smoothly.
- Repeat the process for the other side of the chassis. There should be two Enhanced Wheel Hubs on the front of the chassis. The Wheel hubs should be on the outside of the chassis.



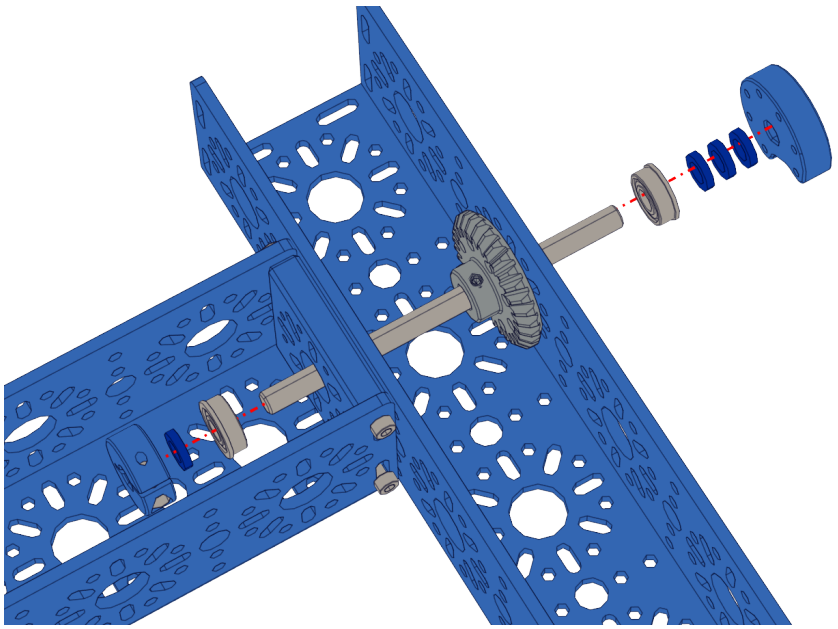
Step 4 - Drive Shaft

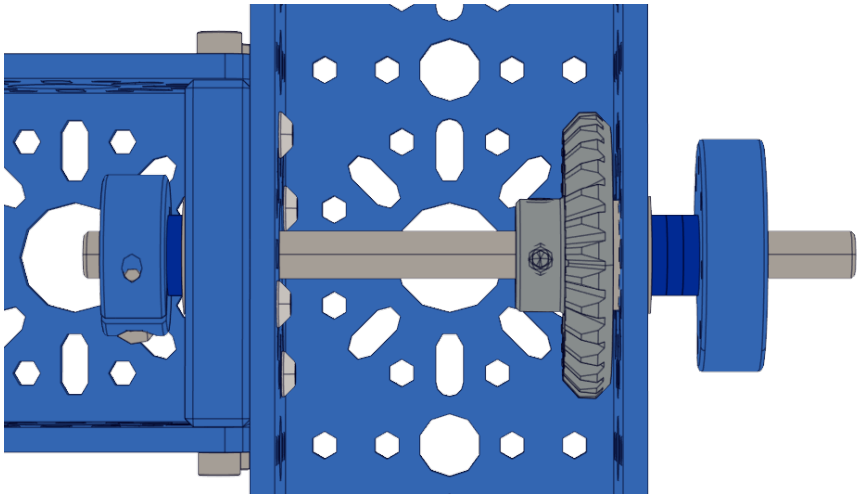
Table 5: Parts Required for Step 4

Name	Part #	Qty	Image
Completed Assembly from Part 3		1	
14mm Flange Bearing	76302	4	
Collar Clamp	76320	2	
2mm Shaft Spacer	76306	8	
6mm x 96mm D-Shaft	76161	2	
30 Tooth Bevel Gear	76219	2	
Light Weight Shaft Hub	76282	2	

Instructions

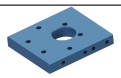
- Pre-load the 5mm setscrew into the Light Weight Shaft Hub. **Be careful not to tighten the setscrew all the way**
- Pre-Load the 4mm setscrews into the 30 Tooth Bevel Gear. **Be careful not to tighten the setscrews all the way**
- Pre-load the M3 x 8mm SHCS into the Collar Clamp. **Be careful not to righten the screw**
- Slide the Collar Clamp onto the 6mm D-shaft and offset it about 2mm away from the edge of the shaft. **Using a 2mm spacer is an excellent way to get the spacing**
- Clamp the Collar clamp down to the D-shaft.
- Slide a single 2mm spacer onto the D-shaft and slide it down to the collar clamp.
- Slide a 14mm bearing down the D-shaft until it makes contact with the spacer. The flange should be touching the spacer.
- Slide the D-shaft through the End Piece Plate from inside the chassis.
- Before sliding the shaft all the way through, slide the 30 Tooth Bevel Gear onto the shaft with the setscrew side facing the inside of the chassis. **Do not tighten the setscrews**
- Fully slide the D-Shaft through.
- Slide a 14mm bearing onto the D-shaft with the flange facing the outside.
- Slide 3 x 2mm spacers onto the D-shaft.
- Slide the Light Weight shaft hub onto the D-shaft and tighten the setscrew.
- The shaft should be able to spin freely. If there are any issues, loosen the Light Weight Shaft hub or the collar clamp and adjust.
- Repeat these steps for the other side.





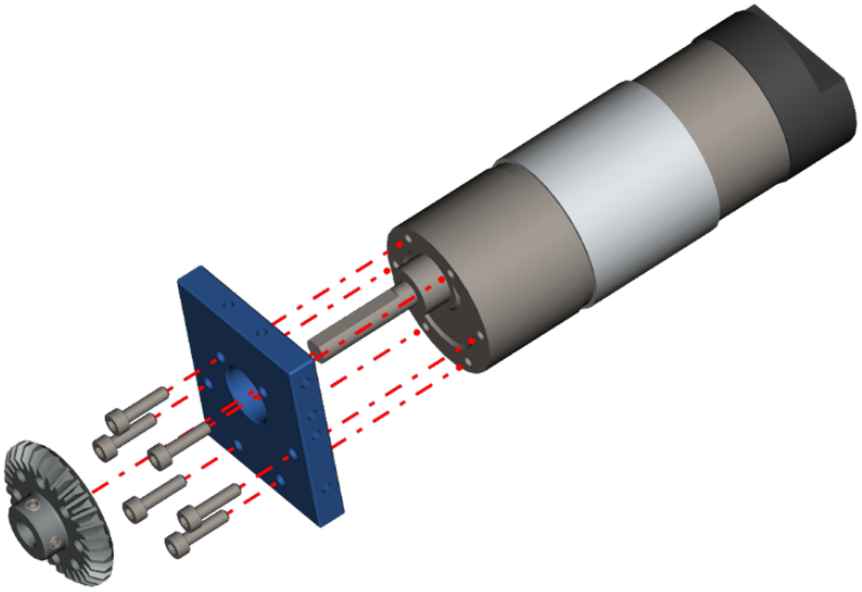
Step 5 - Motor Assembly

Table 6: Parts Required for Step 5

Name	Part #	Qty	Image
NeveRest Classic 40	am-4609b	2	
Motor Mount Plate	76140	2	
30 Tooth Bevel Gear	76219	4	
M3 x 10mm SHCS	76201	12	

Instructions

- Pre-Load the 4mm setscrews into the 30 Tooth Bevel Gear. **Be careful not to tighten the setscrews all the way**
- Slide the NeveRest Classic into the Motor Mount plate.
- Using M3 x 10mm SHCS, screw the NeveRest Classic into the Motor Mount Plate.
- Slide the 30 Tooth Bevel gear onto the NeveRest Classic Motor shaft. The set screws should face away from the motor, as shown below. **Do Not fully tighten the setscrews**.
- Repeat these steps for the other NeveRest Classic Motor.



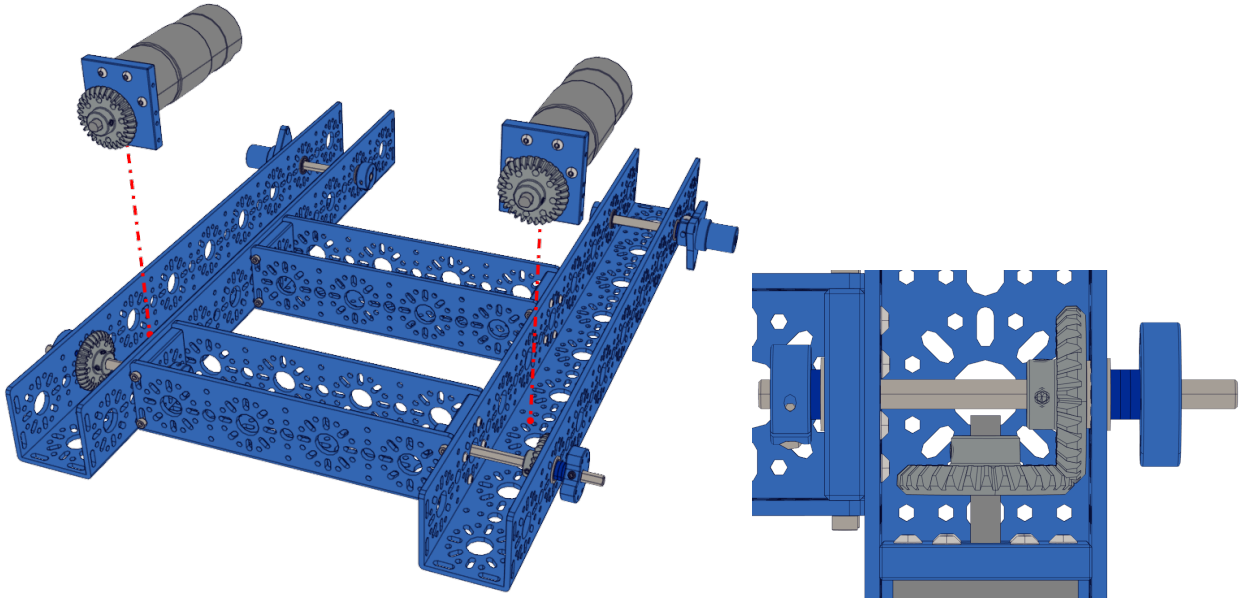
Step 6 - Inserting Motors

Table 7: Parts Required for Step 6

Name	Part #	Qty	Image
Completed Assembly from Part 4		1	
Completed Assembly from Part 5		2	

Instructions

- Slide the Motor Assemblies down into the chassis as shown in the pictures below.



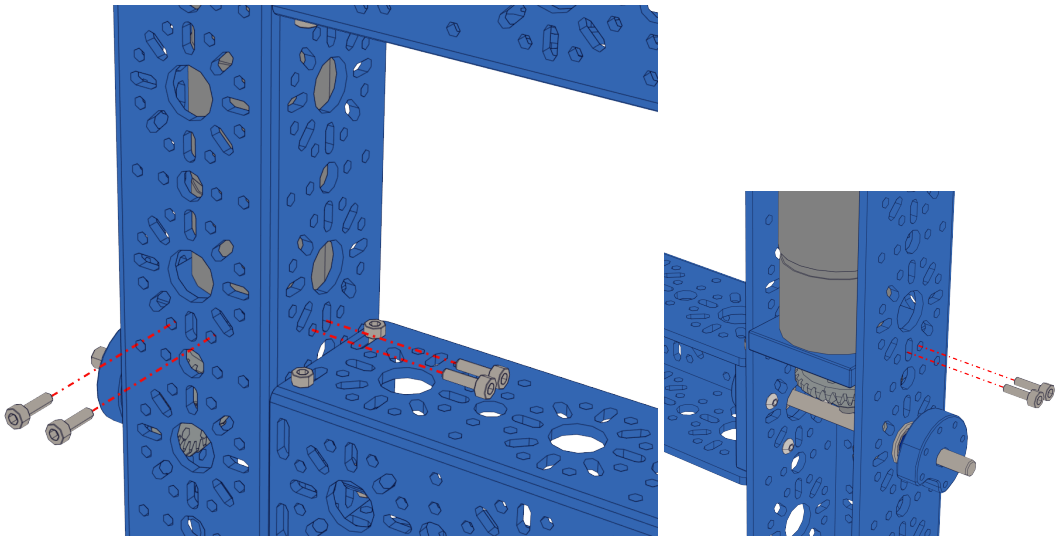
Step 7 - Securing the Motor Bracket

Table 8: Parts Required for Step 7

Name	Part #	Qty	Image
Completed Assembly from Part 6		1	
M3 x 10mm SHCS	76201	12	

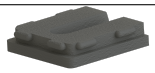
Instructions

- Using the M3 x 10mm SHCS screw in the 6 screws points as shown in the pictures below.
- Once fully tightend, mesh the two bevel gears and tighten the setscrews. **You may need to do one rotate the shaft and repeat to get all 4.**
- Repeat the process for the other side.



Step 8 - Bumpers

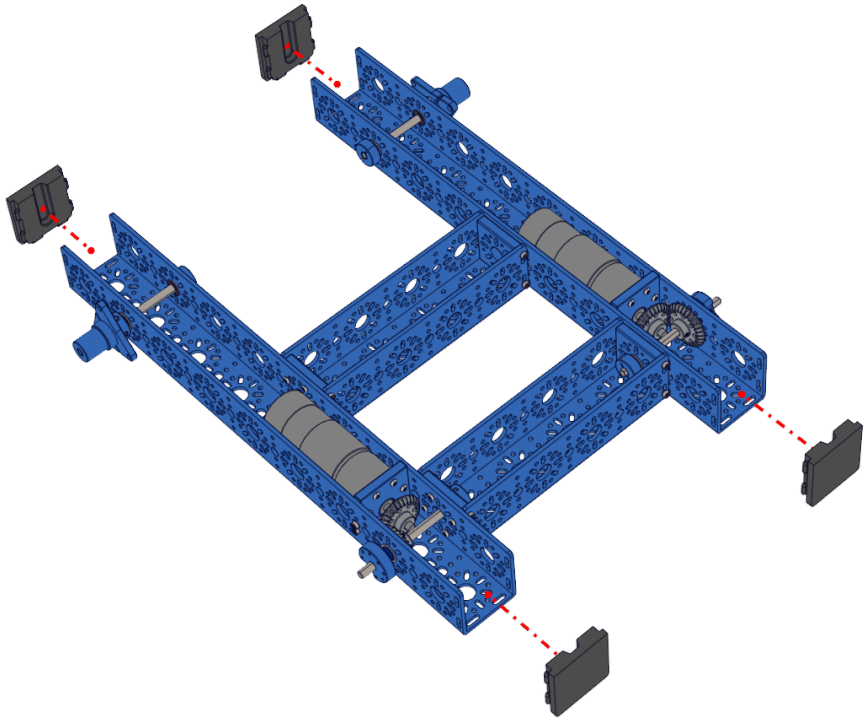
Table 9: Parts Required for Step 8

Name	Part #	Qty	Image
Completed Assembly from Part 7		1	
U-Channel Bumper	76505	4	

Instructions

- Press the U-Channel Bumper into the end slots of the 432mm U-Channel

Hint: Sometimes, bending the bumper can help get it in.



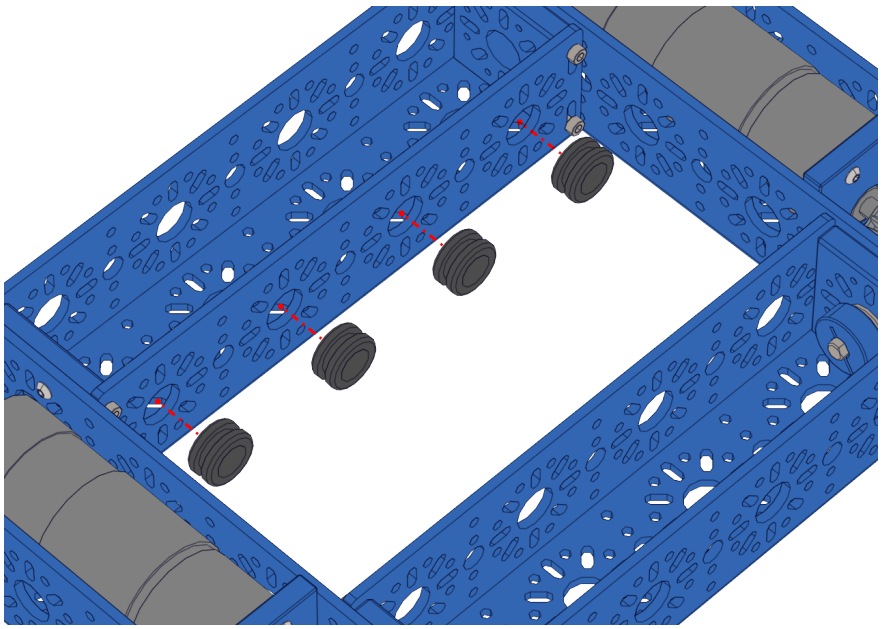
Step 9 - Wire Grommets 1

Table 10: Parts Required for Step 9

Name	Part #	Qty	Image
Completed Assembly from Part 8		1	
Rubber Grommet	76504	4	

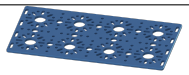
Instructions

- Press four wire grommets into the large holes as shown in the picture below.



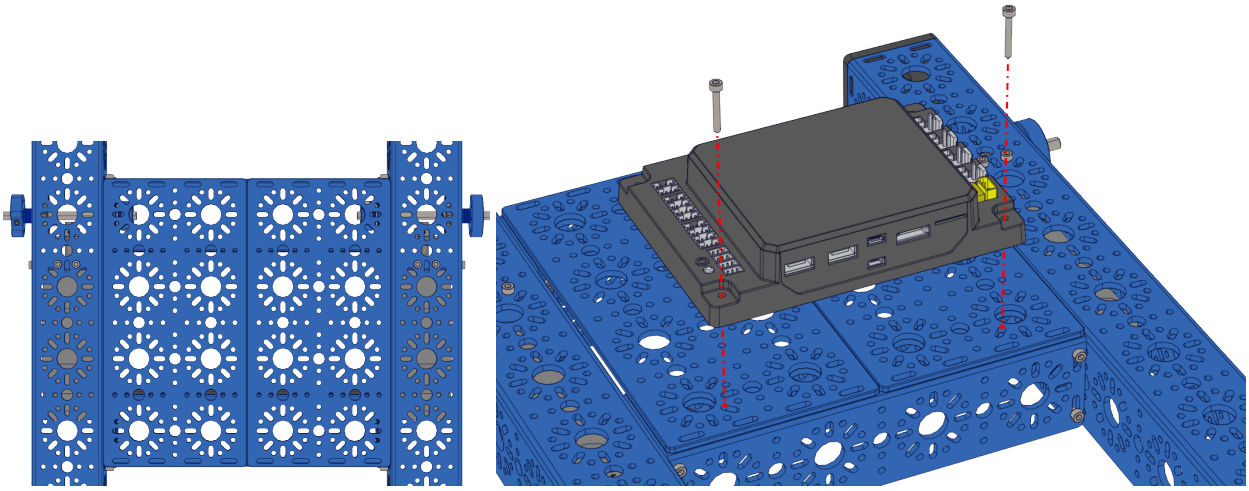
Step 10 - Control Hub Install

Table 11: Parts Required for Step 10

Name	Part #	Qty	Image
Completed Assembly from Part 9		1	
192mm x 96mm Flat Bracket	76066	2	
M3 x 20mm SHCS	76209	2	
M3 Kep Nut	76204	2	
Control Hub	REV-31-1595	1	

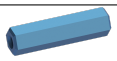
Instructions

- Place the two 192mm x 96mm Flat Brackets onto the 192mm U-Channels as shown on the left.
- Place the Control Hub with the HDMI and USB ports facing the front of the chassis.
- Using the M3 x 20mm SHCS and M3 Kep Nuts, secure the Control Hub and 192mm x 96mm Brackets to the chassis as shown in the right picture.



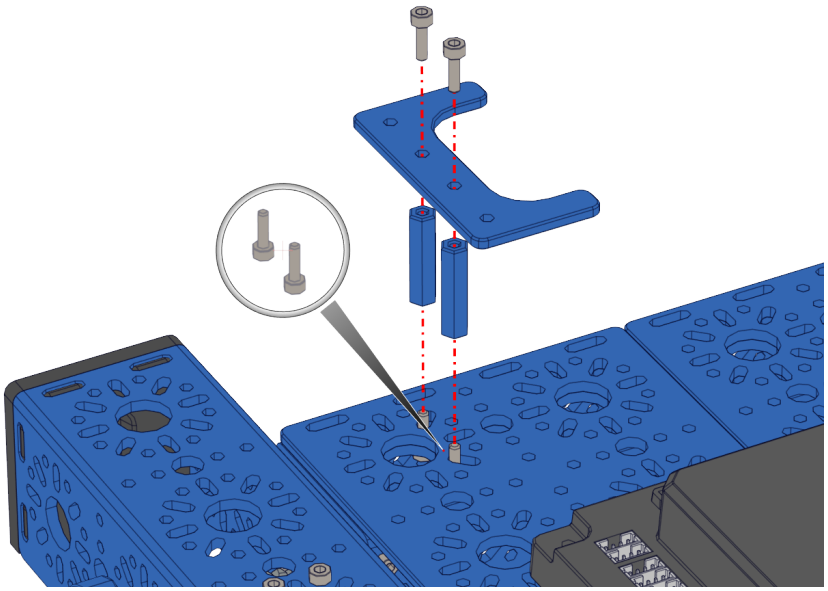
Step 11 - Battery Clip 1

Table 12: Parts Required for Step 11

Name	Part #	Qty	Image
Completed Assembly from Part 10		1	
M3 x 10mm SHCS	76201	4	
25mm Standoff	76182	2	
Battery Clip	76088	1	

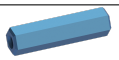
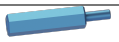
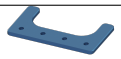
Instructions

- From inside the back 192mm U-Channel, use 2 M3 x 10mm SHCS to screw into 2 25mm Standoffs.
- Place the battery clip on top of the standoffs and screw them in with the other 2 M3 x 10mm SHCS.



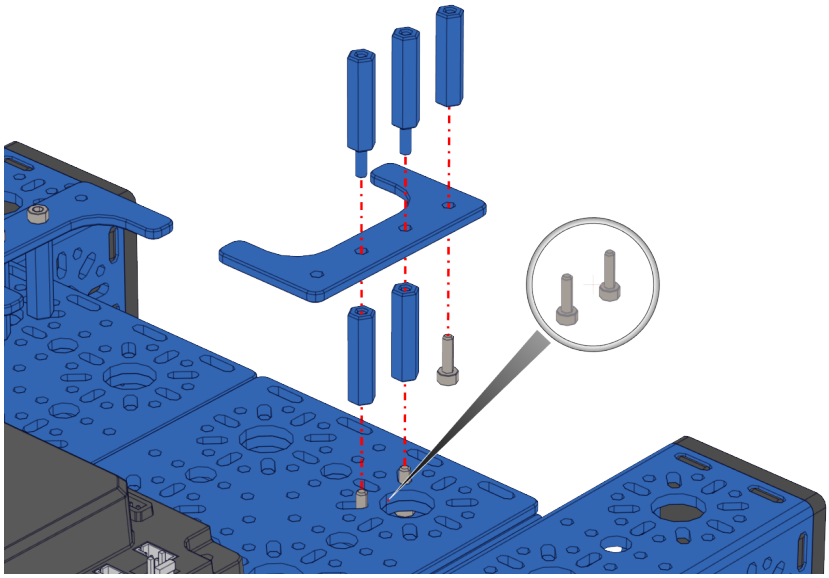
Step 12 - Battery Clip 2

Table 13: Parts Required for Step 12

Name	Part #	Qty	Image
Completed Assembly from Part 11		1	
M3 x 10mm SHCS	76201	3	
25mm Standoff	76182	2	
25mm Male to Female Standoff	76184	2	
Battery Clip	76088	1	

Instructions

- From inside the back 192mm U-Channel, use 2 M3 x 10mm SHCS to screw into 2 25mm Standoffs.
- Place the battery clip on top of the standoffs and screw them in with the 2 Male to Female standoffs.
- Screw the last Standoff into one of the remaining holes on the battery clip with an M3 x 10mm SHCS.



Step 13 - Power Switch

Table 14: Parts Required for Step 13

Name	Part #	Qty	Image
Completed Assembly from Part 12		1	
M3 x 10mm SHCS	76201	3	
Power Switch	REV-31-1387	1	

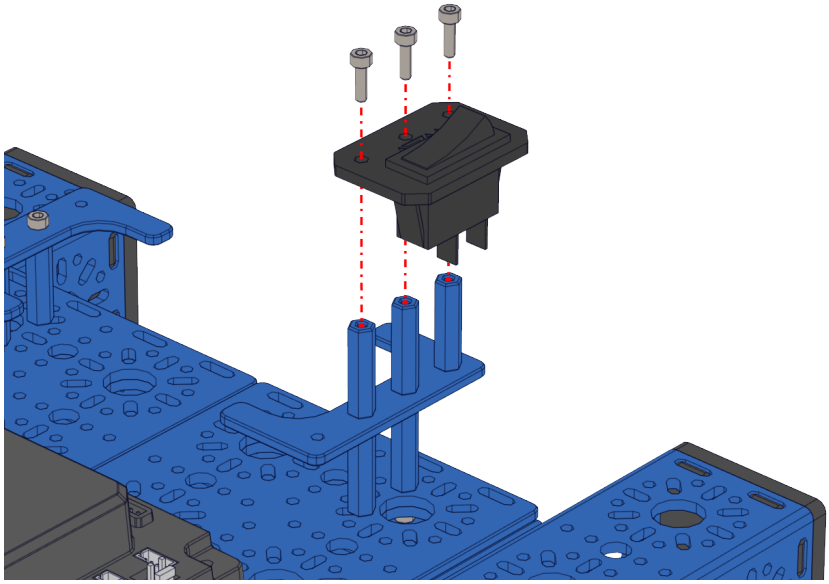
Instructions

- Screw the Power switch into the 3 standoffs using 3 M3 x 10mm SHCS.

Step 14 - Wire Grommets 2

Table 15: Parts Required for Step 14

Name	Part #	Qty	Image
Completed Assembly from Part 13		1	
Rubber Grommet	76504	5	

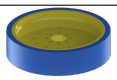


Instructions

- Press five wire grommets into the large holes as shown in the picture below.

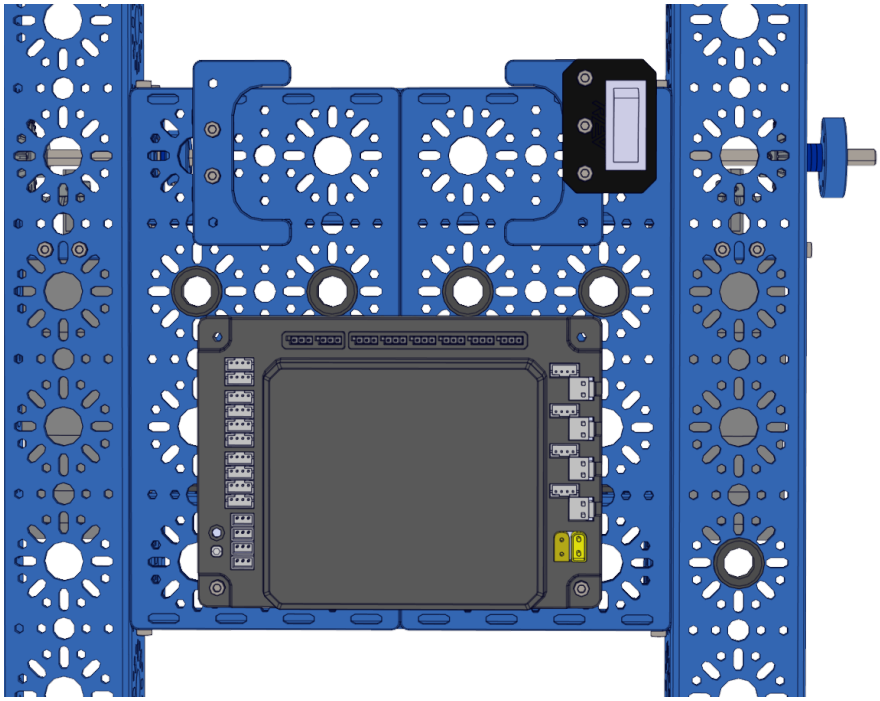
Step 15 - Drive Wheels

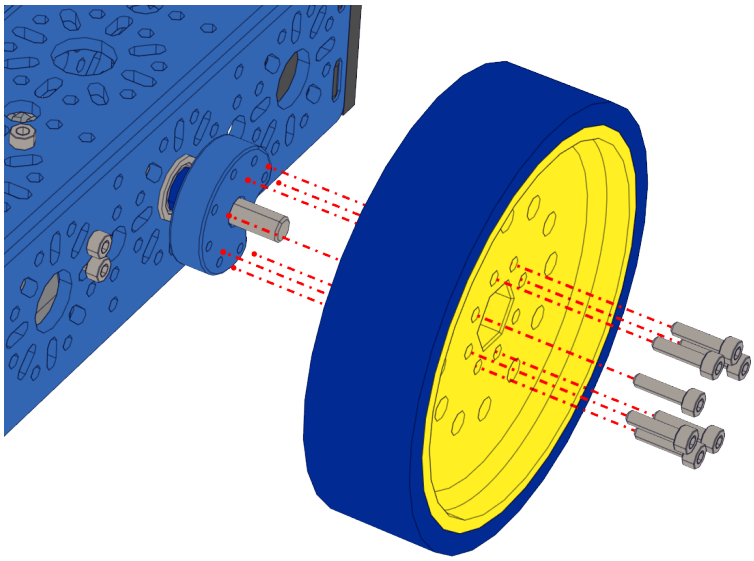
Table 16: Parts Required for Step 15

Name	Part #	Qty	Image
Completed Assembly from Part 14		1	
100mm Drive Wheel	76262	2	
M3 x 12mm SHCS	76202	14	

Instructions

- Using 7 M3 x 12mm SHCS, screw the drive wheel into the light Weight shaft hub.
- Repeat for the other side.

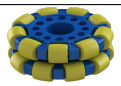
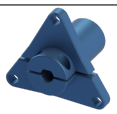




Step 16 - Omni Wheels

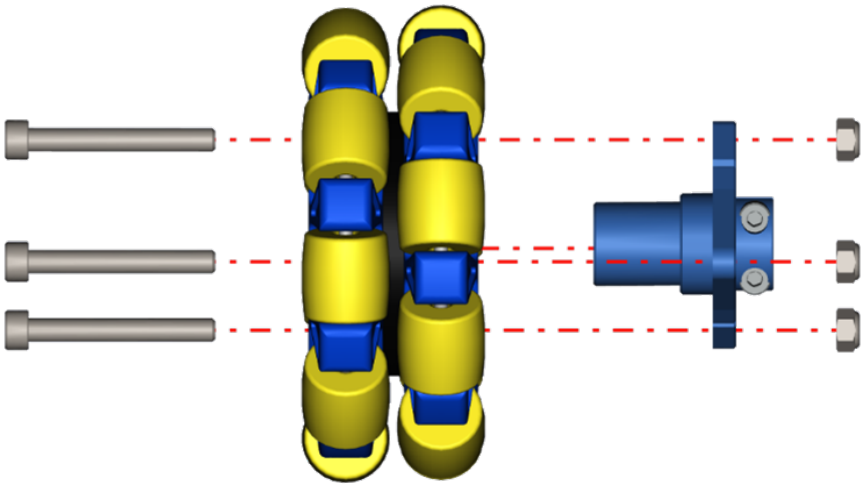
Important: This step requires pliers or an 8mm wrench.

Table 17: Parts Required for Step 15

Name	Part #	Qty	Image
Completed Assembly from Part 14		1	
100mm Omni Wheel	76260	2	
Enhanced Wheel Hub Kit	76291	2	

Instructions

- Using 3 of the M5 x 40mm SHCS, screw the Omni Wheel into the Enhanced Wheel Hub with the M5 Nyloc nuts on the other side of the Hub.
- The Nyloc nuts will need to be secured with pliers or an 8mm wrench. Otherwise, they will spin in place.
- Repeat for the other side.



Step 17 - Wiring

5.2 OMS Build Guide

The basic bot's OMS (object management system) or arm is a simple construction. The assembly can take 10 min to 1 hour, based on skill level.

5.2.1 Tools Required

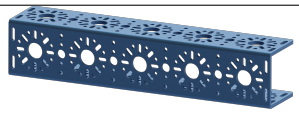
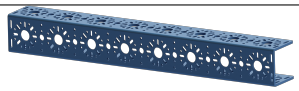
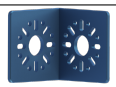
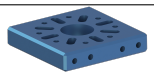
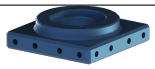
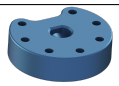
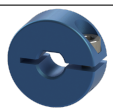
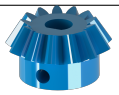
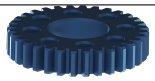
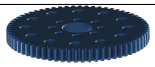
Hex Key Set

5.5mm Combination Wrench

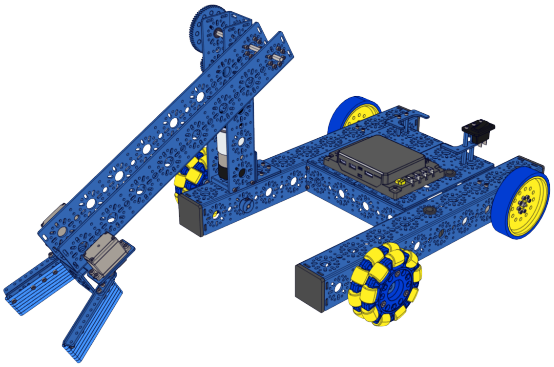
Hint: It is recommended to take all the parts of the BOM out of the box for easy assembly.

BOM (click to open)

Table 18: BOM for Basic Bot OMS

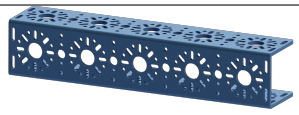
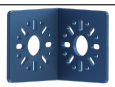
Name	Part #	Qty	Image
240mm U-Channel	76014	1	
384mm U-Channel	76011	1	
L Bracket	76087	2	
End Piece Plate	76015	1	
Orbital Motor Mount	76138	1	
Lightweight Shaft Hub	76282	5	
Collar Clamp	76320	2	
26 Tooth Bevel Gear	76224	1	
13 Tooth Bevel Gear	76223	1	
32 Tooth Spur Gear	76220	1	
64 Tooth Spur Gear	76221	1	
14mm Flange Bearing	76302	4	
1mm Shaft Spacer	76305	4	
5mm Shaft Spacer	76307	1	
6mm x 70mm D-Shaft	76160	1	
6mm x 140mm D-Shaft	76164	1	
NeveRest 51	am-4609b	1	
Servo Mount Offset Plate	76146	2	
Smart Servo Torque	75002	2	
Servo Arm	76151	2	

Step 1: Start OMS Build



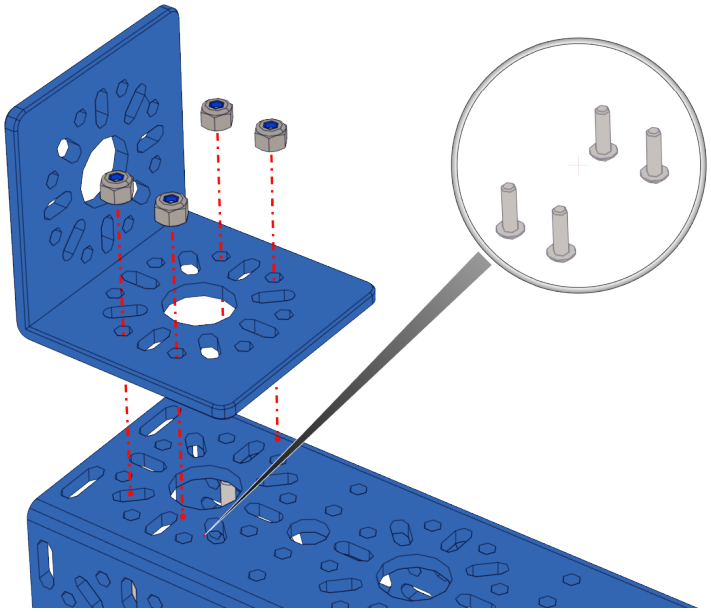
Step 1: Start OMS Build

Table 19: Parts Required for Step 1

Name	Part #	Qty	Image
240mm U-Channel	76014	1	
L Bracket	76087	1	
M3 x 10mm BHCS	76203	4	
M3 Nyloc	76205	4	

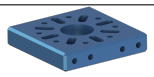
Instructions

- Mount the L Bracket on the outside center end of the 240mm U-Channel.
- 4 x M3 Button Head Cap Screws are required along with 4 M3 Nyloc nuts.
- The L Bracket and the edge of the 240mm U-Channel should be flush.



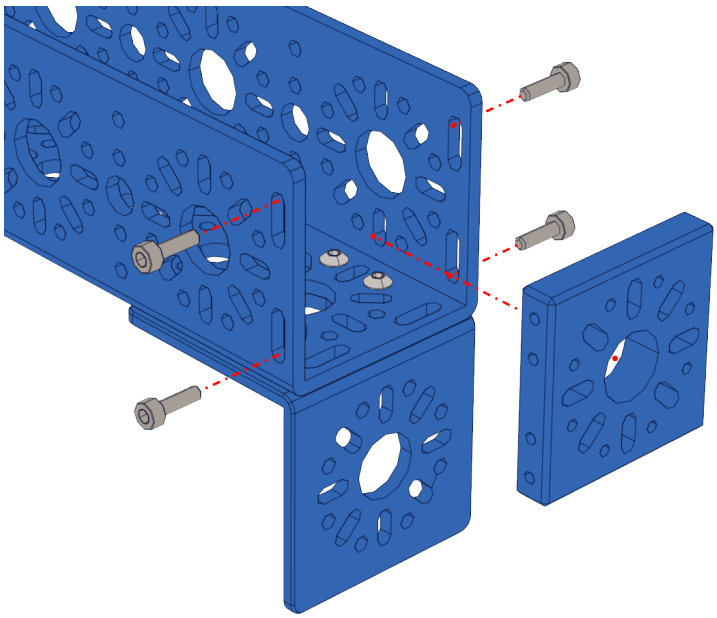
Step 2:

Table 20: Parts Required for Step 2

Name	Part #	Qty	Image
Completed Assembly from Part 1		1	
End Piece Plate	76015	1	
M3 x 10mm SHCS	76201	4	

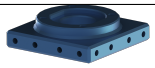
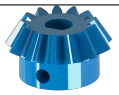
Instructions

- Slide the End Piece Plate into the bottom of the 240mm U-Channel.
- Using 4 x M3 SHCS, screw the End Piece Plate into the channel.
- The End Piece Plate should be flush with the channel and the L Bracket.



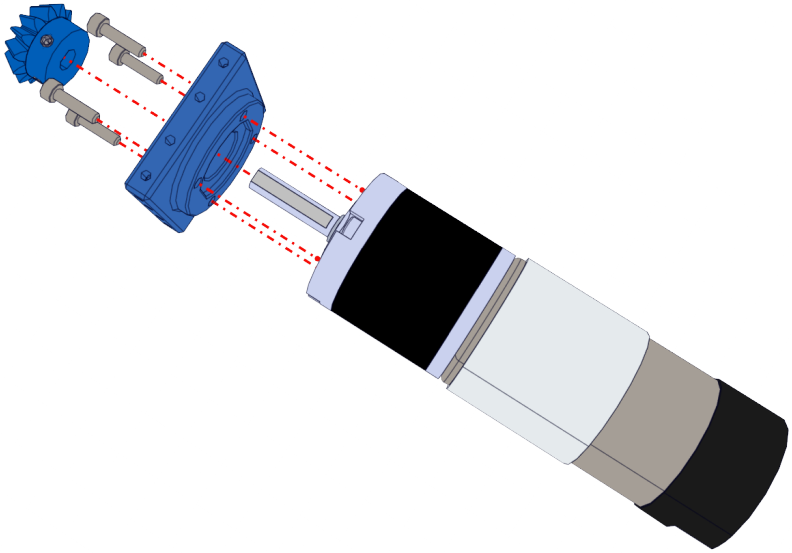
Step 3:

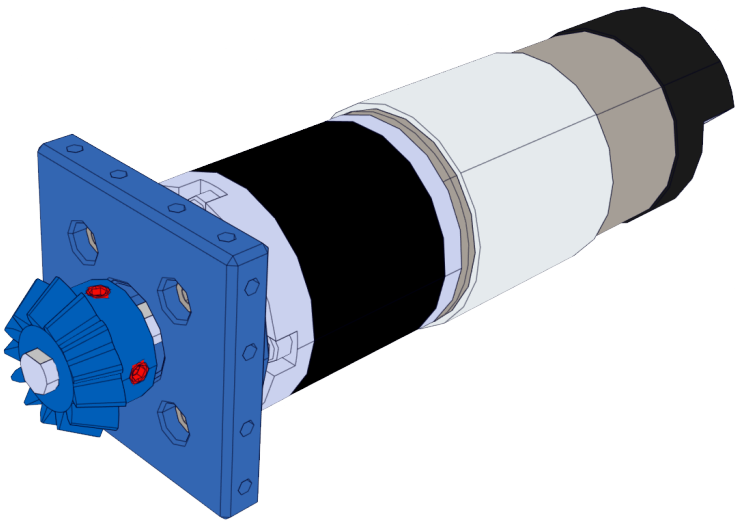
Table 21: Parts Required for Step 3

Name	Part #	Qty	Image
NeveRest 51	am-4609b	1	
Orbital Motor Mount	76138	1	
13 Tooth Bevel Gear	76223	1	
M3 x 12mm SHCS	76202	4	

Instructions

- Slide the Orbital Motor Mount onto the NeveRest 51 Motor.
- Using 4 x M3 SHCS, screw the motor mount into the motor.
- Slide the 13 Tooth Bevel Gear onto the D-Shaft of the motor.
- Try to keep it loose by only tightening a little bit. Set screws are highlighted in red. Use the pink hex key(2mm) to tighten.





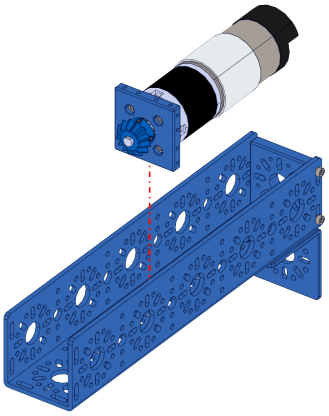
Step 4:

Table 22: Parts Required for Step 4

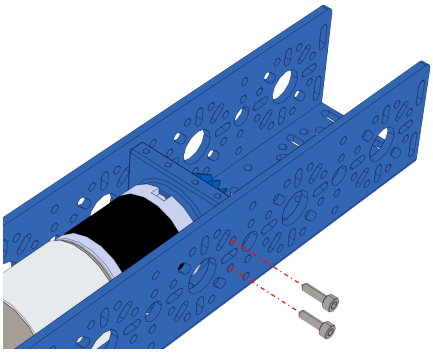
Name	Part #	Qty	Image
Completed Assembly from Part 2		1	
Completed Assembly from Part 3		1	
M3 x 10mm SHCS	76201	6	

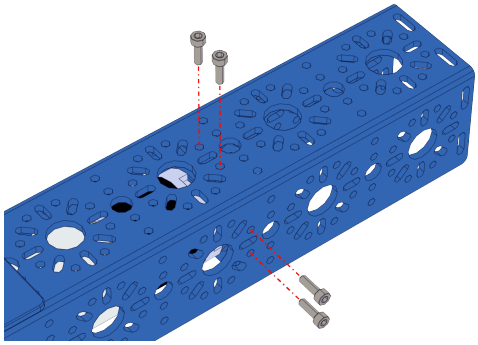
Instructions

- Slide the Motor Assembly from step 3 into the 240mm U-Channel assembly. The bevel gear should be facing away from the End Piece Plate and L Bracket.



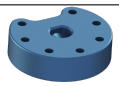
- Using 6 x M3 SHCS, screw the Orbital Motor Mount to the 240mm U-Channel.





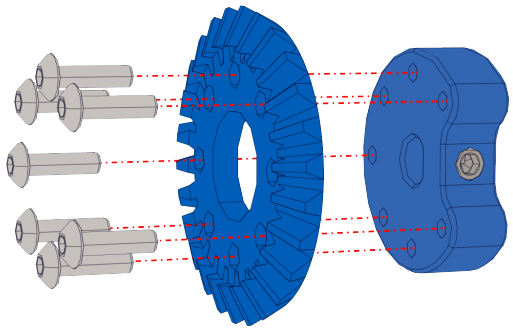
Step 5:

Table 23: Parts Required for Step 5

Name	Part #	Qty	Image
M3 x 10mm BHCS	76203	7	
26 Tooth Bevel Gear	76224	1	
Lightweight Shaft Hub	76282	1	

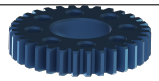
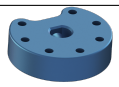
Instructions

- Using 7 x M3 BHCS, screw the 26 Toot Bevel Gear into the Lightweight Shaft Hub.



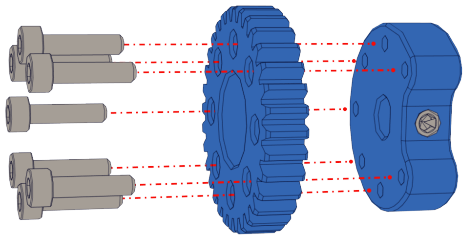
Step 6:

Table 24: Parts Required for Step 6

Name	Part #	Qty	Image
M3 x 12mm SHCS	76202	7	
32 Tooth Spur Gear	76220	1	
Lightweight Shaft Hub	76282	1	

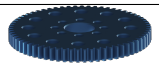
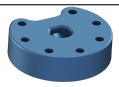
Instructions

- Using 7 x M3 SHCS, screw the 32 Toot Spur Gear into the Lightweight Shaft Hub.



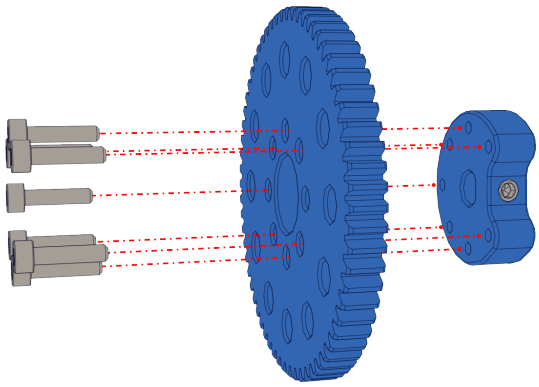
Step 7:

Table 25: Parts Required for Step 7

Name	Part #	Qty	Image
M3 x 12mm SHCS	76202	7	
64 Tooth Spur Gear	76221	1	
Lightweight Shaft Hub	76282	1	

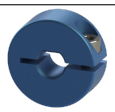
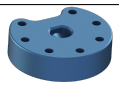
Instructions

- Using 7 x M3 SHCS, screw the 64 Toot Spur Gear into the Lightweight Shaft Hub.



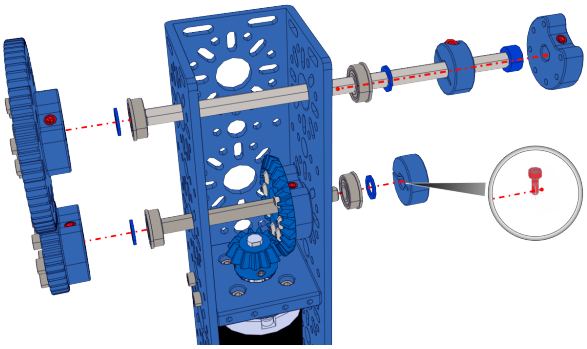
Step 8:

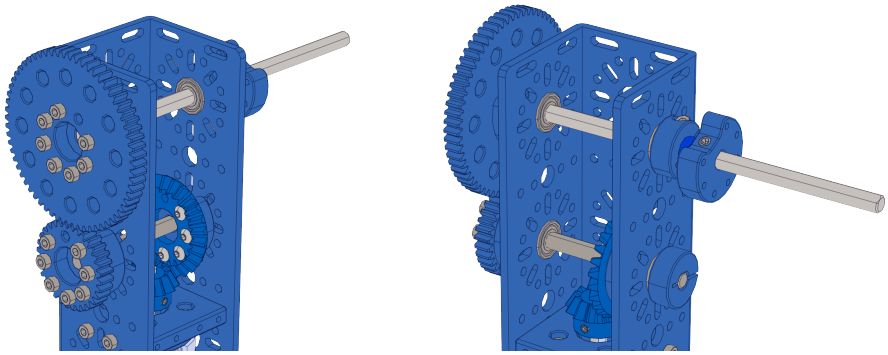
Table 26: Parts Required for Step 8

Name	Part #	Qty	Image
Completed Assembly from Part 4		1	
Completed Assembly from Part 5		1	
Completed Assembly from Part 6		1	
Completed Assembly from Part 7		1	
14mm Flange Bearing	76302	4	
1mm Shaft Spacer	76305	4	
5mm Shaft Spacer	76307	1	
6mm x 70mm D-Shaft	76160	1	
6mm x 140mm D-Shaft	76164	1	
Collar Clamp	76320	2	
Lightweight Shaft Hub	76282	1	

Instructions

- Assemble all the assemblies as shown.
- Tighten the set screws and collar clamps fully **EXCEPT FOR THE SET SCREW WITH THE 26 TOOTH BEVEL GEAR**.

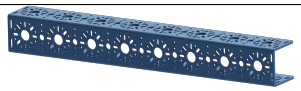
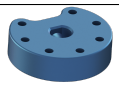




- With the assembly complete, as shown above, align the bevel gears so they are meshing and tighten the setscrews.

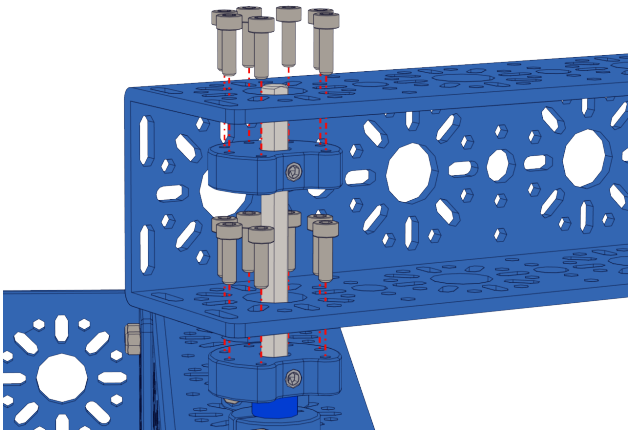
Step 9:

Table 27: Parts Required for Step 9

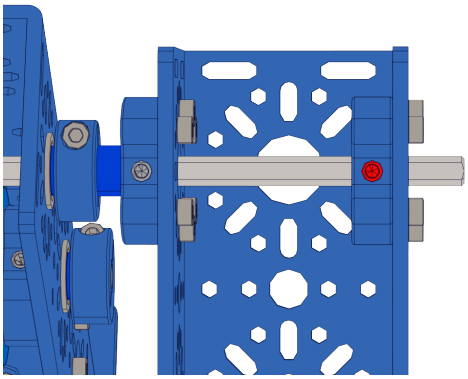
Name	Part #	Qty	Image
Completed Assembly from Part 8		1	
384mm U-Channel	76011	1	
Lightweight Shaft Hub	76282	1	
M3 x 10mm SHCS	76201	14	

Instructions

- Mount the 384mm U-Channel onto the 140mm D-Shaft. The inside of the U-Channel should be facing upwards.
- Using 7 x M3 SHCS, screw the 384mm U-Channel into the Lightweight Shaft hub already on the 140mm D-Shaft.
- Using another Lightweight Shaft Hub and 7 x M3 SHCS, screw down the other side of the 384mm U-Channel.



- Tighten all set screws



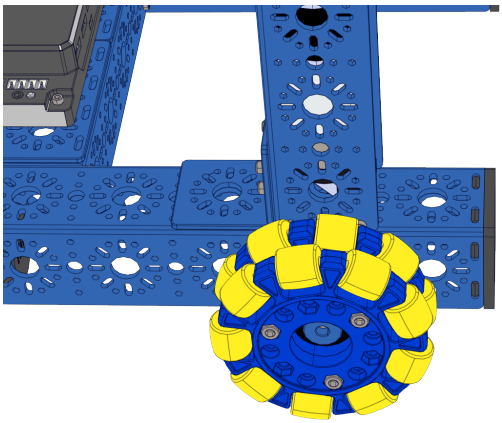
Step 10:

Table 28: Parts Required for Step 10

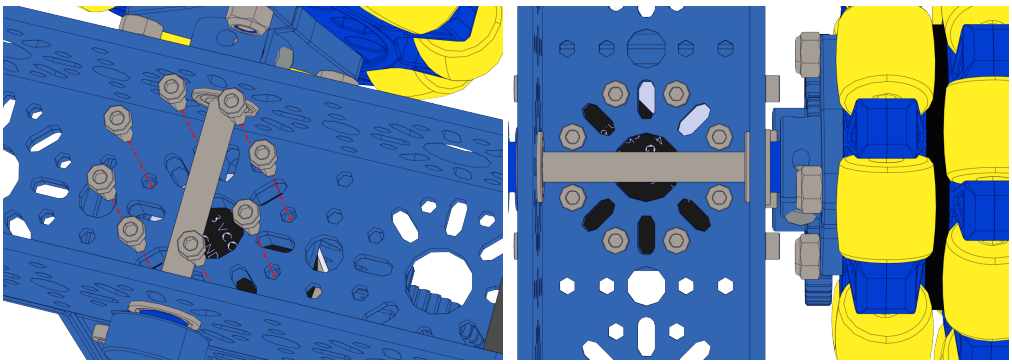
Name	Part #	Qty	Image
Completed Chassis Assembly		1	
Completed Assembly from Step 9		1	
M3 x 10mm SHCS	76201	8	

Instructions

- Place the arm assembly as shown on the right side of the basic bot chassis.



- From the bottom inside of the chassis, screw the chassis to the End Piece Plate of the arm assembly using 8 x M3 SHCS.



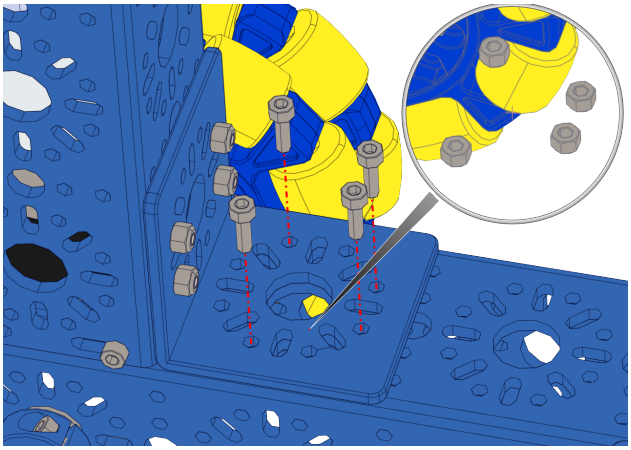
Step 11:

Table 29: Parts Required for Step 11

Name	Part #	Qty	Image
Completed Assembly from Step 10		1	
M3 x 10mm SHCS	76201	4	
M3 Nyloc	76205	4	

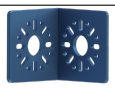
Instructions

- Using 4 x M3 SHCS and 4 x M3 Nyloc Nuts, screw the L Bracket of the arm assembly to the basic bot chassis. The nyloc nuts should be on the inside of the chassis U-Channel.



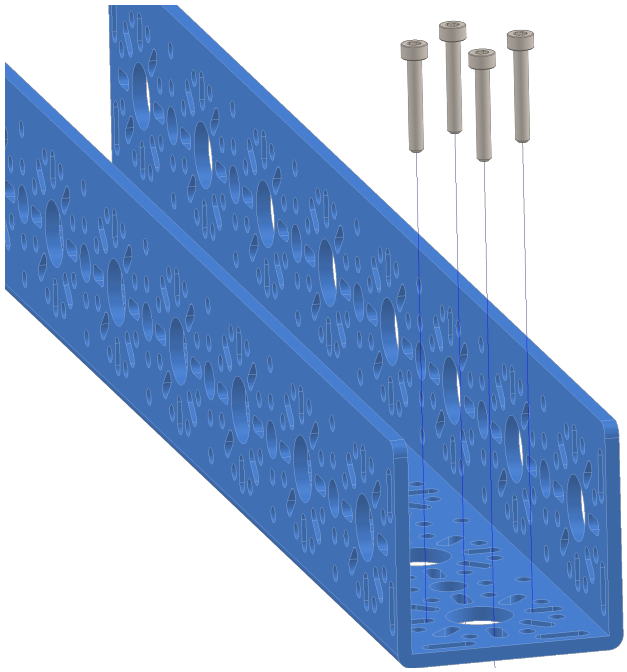
Step 12:

Table 30: Parts Required for Step 12

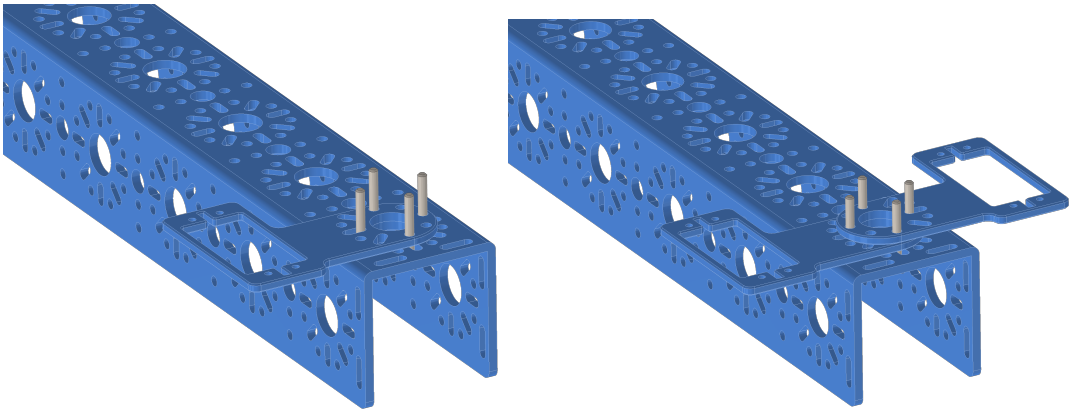
Name	Part #	Qty	Image
Completed Assembly from Step 11		1	
M3 x 20mm SHCS	76209	4	
Servo Mount Offset Plate	76146	2	
L Bracket	76087	1	
M3 Nyloc	76205	4	

Instructions

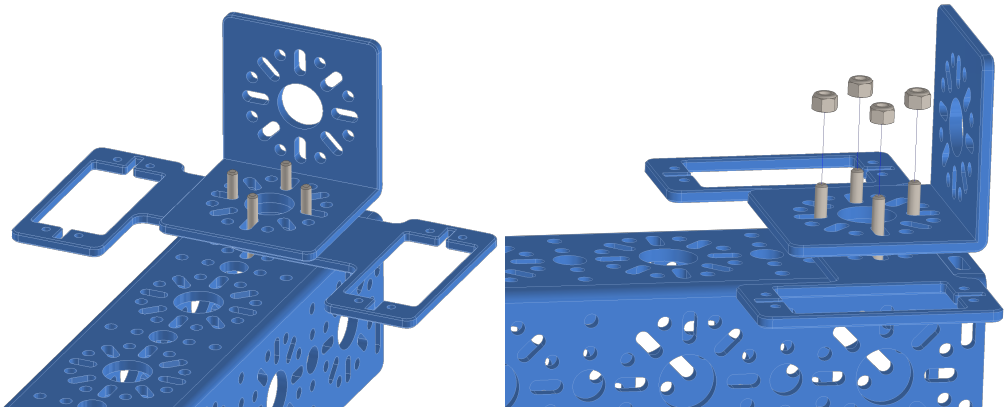
- Prep the claw mounting by inserting 4 x M3 SHCS in the holes on the end of the 384mm U-Channel.



- Place the Servo Offset Mounts on the M3 SHCS.



- Place an L Bracket on top of the servo mounts.
- Screw everything down using the M3 SHCS and 4 x Nyloc nuts.



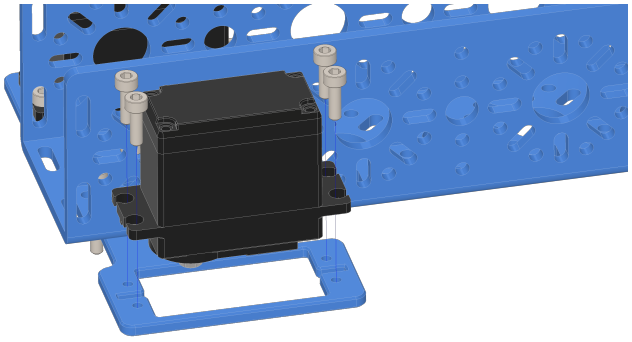
Step 13:

Table 31: Parts Required for Step 13

Name	Part #	Qty	Image
Completed Assembly from Step 12		1	
M3 x 10mm SHCS	76201	8	
Smart Servo Torque	75002	2	

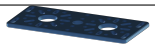
Instructions

- Screw the 2 servos into their mounting plates using M3 SHCS. The spline of the servo should be facing the end of the 384mm U-Channel.



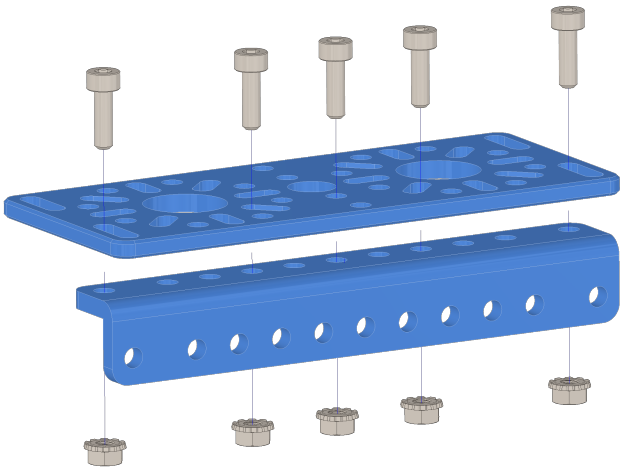
Step 14:

Table 32: Parts Required for Step 14

Name	Part #	Qty	Image
96mm L Beam	76117	2	
M3 x 10mm SHCS	76201	10	
96mm x 40mm Flat Bracket	76065	2	
M3 Kep Nut	76204	10	

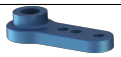
Instructions

- Using 5 x M3 SHCS and 5 x Kep Nuts, assemble the claw finger as shown.
- Repeat for the other finger. There should be two claw fingers.



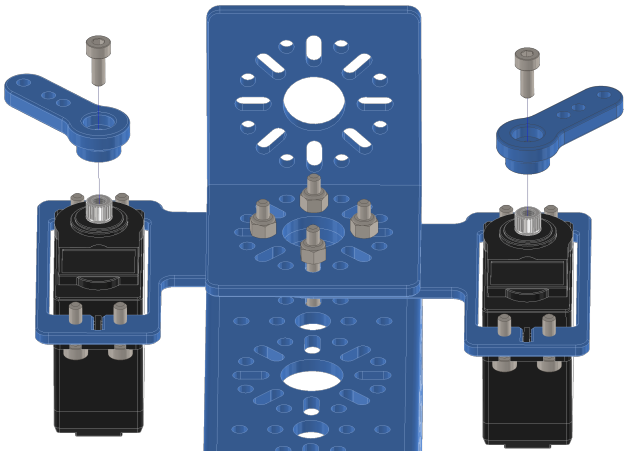
Step 15:

Table 33: Parts Required for Step 15

Name	Part #	Qty	Image
Completed Assembly from Step 13		1	
M3 x 8mm SHCS	76200	2	
Servo Arm	76151	2	

Instructions

- Using 2 x M3 SHCS, screw the servo arms into the servo splines.



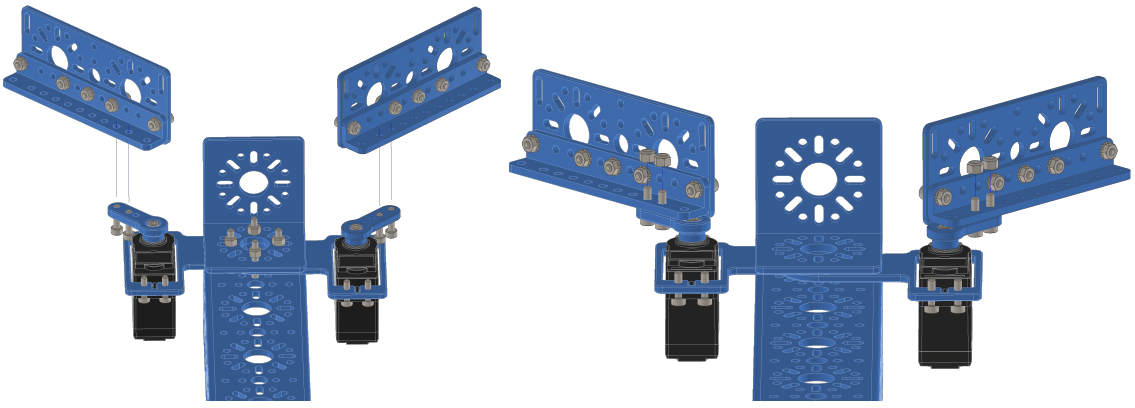
Step 16:

Table 34: Parts Required for Step 16

Name	Part #	Qty	Image
Completed Assembly from Step 14		2	
Completed Assembly from Step 15		1	
M3 x 12mm SHCS	76202	4	
M3 Nyloc	76205	4	

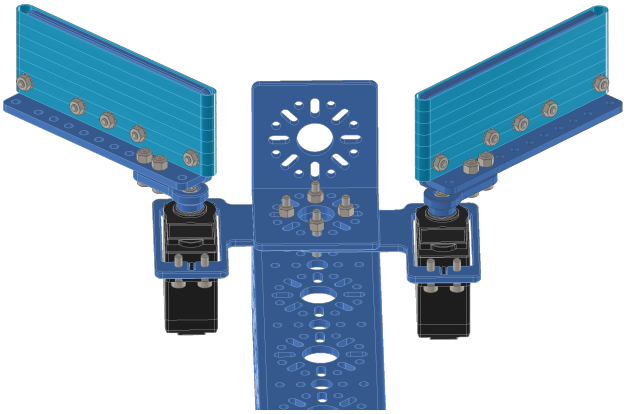
Instructions

- Using 2 x M3 SHCS and 2 x M3 Nyloc nuts, screw the claw fingers onto the servo arms.



Optional

Rubber bands can be added around the fingers to grip an object better.



CHAPTER

SIX

MECHANISMS

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SEVEN

SOFTWARE

CHAPTER

EIGHT

STYLE GUIDE

8.1 Filenames

Only lowercase alphanumeric characters, - (minus) symbol and the `.rst` extension should be used.

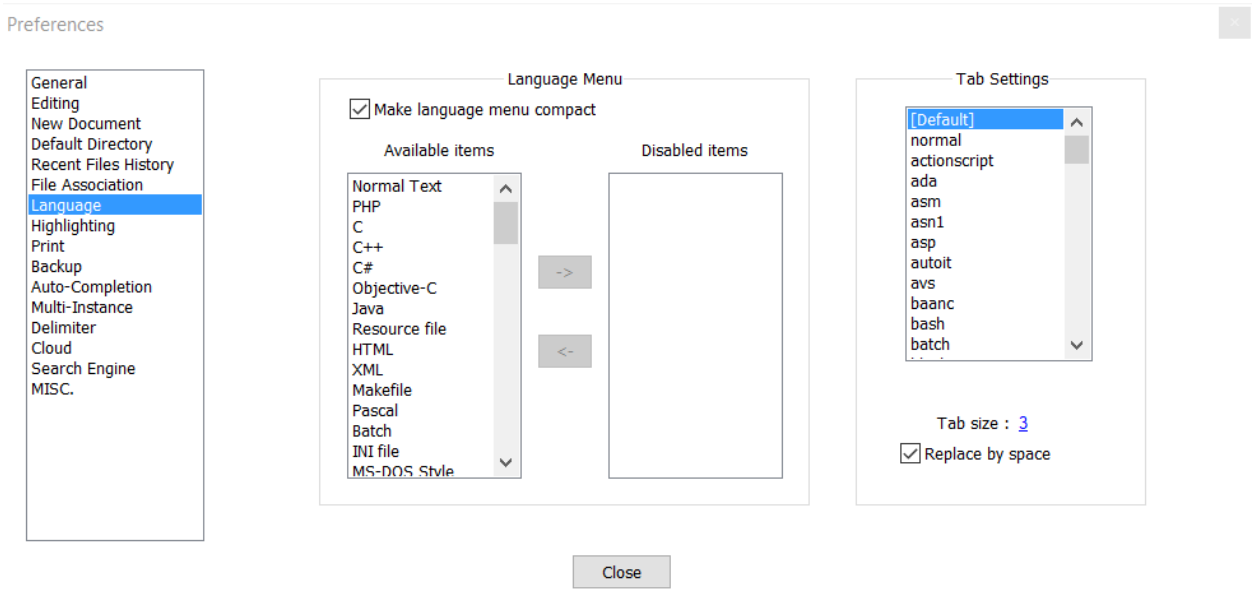
Examples:

- `style-guide.rst`
- `index.rst`
- `a-super-long-filename-that-is-to-long.rst`

8.2 Preferred Editor

It is preferred to use Notepad++ as the text editor for creating files. When creating a `.rst` file **tabs** need to be replaced with a **space indentation** of 3.

This can be accomplished easilly with Notepad++ by going to `Settings/Preferences/Language`. In Language look to the right side for `Tab Settings`, select `[Default]` then check `Replace by space` and set the **Tab size:** to 3. An example image is shown below.



Important: All text should be on the same line. To make it easier to read turn on text wrap. In Notepad++ this feature is enabled by going to `View/Word wrap`

8.3 Indentation and Blank Lines

Indentations should **always** match the previous level of indentation unless a new content block is created.

There should always be 1 blank line between everything. Except for lists.

```
.. tabs:: Example

   some stuff

   .. note:: some other stuff

   .. image:: images/fake-image-1.png
      :align: center
```

Note: The highlight lines are the 1 blank line. Also note how there is no blank line between `.. image::` and `:align:` as they are related and not seperate blocks.

8.4 Naming Conventions

To match other documentation use the following case for these terms exactly:

- roboRIO
- LabVIEW
- myRIO
- Visual Studio Code or VS Code
- macOS
- Linux
- VMXpi

8.5 Images

Images are easy to add and give a visual aspect to the user.

```
.. image:: images/example-image.png
```

Images should always be aligned to the center.

```
.. image:: images/example-image.png
   :align: center
```

If an image is to big or needs to be resized options such as width can be used to scale the image.

```
.. image:: images/example-image.png
   :align: center
   :width: 1000
```

8.5.1 Image Files

Location

Images should be stored in the same directory as the file using the image, located in a sub-directory `images`.

```
docs/Contributing/style-guide <- is the file
docs/Contributing/images/style-guide-1.png <- image location
```

File Types

Supported image types:

- `.png`
- `.jpg`
- `.gif`

Note: If including a `.gif` image a `.png` static version of the same name is required to be included in the `images` folder. This is required for a proper `pdf` build.

If using a `.gif` the format for the image would be this:

```
.. image:: images/example-image.*
   :align: center
```

Naming Conventions

Images should be named corresponding to the name of the file using it and incremented with a number enumerated to the end. Examples are shown below.

Filename `style-guide.rst` would have the images

- `style-guide-1.png`
- `style-guide-2.png`

Filename `another-example.rst` would have the images

- `another-example-1.gif`
- `another-example-1.png`

8.6 Headings

Headings are signified with an underline with a specific symbol along with the heading character length. The following are the symbol levels to create heading:

1. = used for document titles and should only be used once

```
Document Title
==============
```

2. - signifies the chapters or sections

```
Chapter or Section
------------------
```

3. ^ signifies a new sub-section

```
New Sub-Section
^^^^^^^^^^^^^^^
```

4. ~ signifies a sub-sub-section

```
Sub-Sub-Section
~~~~~~~~~~~~~~~
```

Note: If a heading more than a **sub-sub-section** is required then in most cases it should be written another way

---

8.7 Links

Links should be formated to be anonymous hyperlinks. The format of which is shown below.

```
`Link <https://google.com>`__
```

This will come out as: Link

Note: The anonymous link has a few sections. First the `, then the text the link will attach to in this case `Link`, the link itself in <>, another `, and finally at the end there are **TWO** underscores __.

8.8 Code Blocks

To create a block of code, use the `code-block` directive.

Important: Line numbers are required for any block of code that contatains code. This is shown below. An exception for not having line numbers is when the code-block is just used for unformated text.

```
.. code-block:: (language)
   :linenos:

       Source code
```

Here is a simple Java example.

```
.. code-block:: java
   :linenos:

   System.out.println("Hello to whomever is reading this.");
```

Will come out as:

```
1 System.out.println("Hello to whomever is reading this.");
```

To higlight certain lines to stand out the `:emphasize-lines:` is used.

```
.. code-block:: java
   :linenos:
   :emphasize-lines: 2,4

   System.out.println("Hello to whomever is reading this.");
   System.out.println("I hope you learn something.");
   System.out.println("Its real important.");
   System.out.println("For success.");
```

Will come out as:

```
1 System.out.println("Hello to whomever is reading this.");
2 System.out.println("I hope you learn something.");
3 System.out.println("Its real important.");
4 System.out.println("For success.");
```

Hint: The use of `2,3,4` is useful for single lines but for ranges `2-4` would work better. They can also be joined I.E. `2,4,6-10,12`.

8.9 Lists

There are two types of lists and they are easy to use.

```
- This is
- a simple
- bullet lists

1. This is
2. a simple
3. numeric list
```

- This is

- a simple
- bullet lists

1. This is
2. a simple
3. numeric list

Note: List's don't require the 1 line blank space in-between like the other functions

8.10 Tabs

Tabs are a useful tool with many uses.

A common use case in this documentation is Java and C++ tabs.

```
.. tabs::

   .. tab:: Java

      .. code-block:: java
         :linenos:

         System.out.println("Hello World!");

   .. tab:: C++

      .. code-block:: c++
         :linenos:

         std::cout << "Hello World!";
```

Would come out looking like:

Java

```
1 System.out.println("Hello World!");
```

C++

```
1 std::cout << "Hello World!";
```

For more information, vist Sphinx tabs.

8.11 Admonitions

Admonitions are a popup to indicate a warning or important information. The following are the possible admonitions; attention, caution, danger, error, hint, important, note, tip and warning. To utilize a admonition use the keywords admonition as a directive.

For ease of use place descriptions on the same line as the admonition.

Yes

```
.. attention:: Description
```

No

```
.. attention::

   Description
```

Examples of each:

Attention: This is the attention admonition

Caution: This is the caution admonition

Danger: This is the danger admonition

Error: This is the error admonition

Hint: This is the hint admonition

Important: This is the important admonition

Note: This is the note admonition

Tip: This is the tip admonition

Warning: This is the warning admonition

CHAPTER

NINE

TEACHER INSTRUCTION AID

FIRST® Robotics Canada introduces: **FTC Class Pack "Getting Started" Guide for Teachers** - Helping teachers to get started through the Provincial FTC Class Pack program. The goal is to provide teachers and students with easy entry to STEM robotics through our "getting started activity" based on the Class Pack Kit to build two simple robots instead of one advanced robot. Here is a complete list of parts and basic instructions for the teacher and students for building a T-bot in 3-4 hours of class time. This activity allows teachers to introduce students to an incredible STEM Advanced Robot Kit. It provides enough equipment to engage groups of 6 students, split into pairs to quickly build and operate a robot. Each class receives five robot kits, which can be used to build two T-bots for each group. A Time Challenge game activity follows the activity.

9.1 Key Points:

1) Overview of T-bot and extension activities/robots below are intended for in-class.
2) *FIRST®* Canada educational staff have worked to double the number of robots built when initially engaging their students with the FTC Class Pack.
3) The activities can be organized to fit easily into the period length of time for both elementary and secondary students.
4) The structure of the T-bot introductory robot building activity focuses on getting the teacher and students started quickly to build two robots per kit in less than 4 hours of class time. Students thereby experience the build phase, adding a robot control system phase and operating/practice driving/operating phase where students quickly can see and experience the excitement of STEM in their classrooms.
5) Key to the T-bot is to actively engage every student in the class in **Hands-On Learning, working collaboratively as a team** in each group and each sub-group to contribute to building and operating the robots.
6) **Teachers can be flexible** when each part of the activities is delivered in 30-minute or 76-minute classes, serving both elementary and secondary school students.
7) **Extension activities** are added with all the robot activities to provide **meaningful learning for all learner levels** regardless of their prior knowledge and experience.

9.2 Basic T-bot Outline

Table 1: Basic T-bot Outline

Tasks	# of Students	Time to Build	Details
Prior Teacher Training		(120 mins)	Teacher learns to download code and preload onto Control Hub and Driver Station configuration.
In-class kit orientation, inventory, safety		30 - 60 mins	Intro to FTC, robot kit, understanding & managing inventory, safety tips & tool use.
Control Hub Assembly and Battery Mount Component System	2	60 mins	1/3 of student group = 3 subgroups working simultaneously.
Omni Wheel and U-Channel Assembly	2	30 mins	1/3 of student group = 3 subgroups working simultaneously.
Drive Wheel and U-Channel Assembly	2	30 mins	1/3 of student group = 3 subgroups working simultaneously.
Full robot system integration/assembly	6	30 mins	Groups all work together to make two full robots.
Teacher intro Time Challenge & Field set up		60 mins	Students take turns driving robots - moving single control hub assembly from one robot to another in the group.
Time Challenge with 5 x 3 attempts / group		60 mins	Whole class was given time practice trials, recording and averaging time for the group, announcing the fastest robot winner.
Total class time		240 - 300 mins	4-5 classes; depends on the elementary or secondary class period length.
Total student engagement for T-bot activity	30	300 mins	Getting started T-bot activity achieves early success for teachers and students.

9.3 FTC Class Pack Extension Activities

Each scenario below is based on groups of six students, five groups per class with five FTC robot kits.

Robot	# of Robots	# of Students	Time to Build	Details
T-Bot +	2 robots / Group	6	300 mins	• Can be extended by adding Intro to OnShape, • Online block/java coding using FTC-SIM. Rotate • Rotate subgroups to include adding 3 x 60 mins • Total of 180 mins with build, CAD, and coding/sim • Lessons, videos, photos, teacher IAS: • Intro to CAD via OnShape • Intro to using FTC-SIM for virtual coding • Learning REV Client Hardware to configure Control Hub and Driver Station
Camp Bot	1 robot	6	480 mins	• More advanced than T-bot • Includes sub-group activities for build, CAD, and coding/sim • Building a total of one advanced robot / group of 6 students • Lessons, videos, photos, teacher IAS: • Intro to CAD via OnShape • Intro to using

CHAPTER

TEN

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