



FIRST® Tech Challenge

Organizational Trays for REV FTC Starter Kit

Project to 3D print your own trays to organize and store parts in the Starter Kit

SUMMARY

The goal of this project was to create trays to help organize and store the parts in the REV FTC Starter Kit. While the kit includes zipper bags, this generally is not a good way to keep the parts long term. However, the kit comes in a very nice orange storage bin, and we wanted to continue to use that to store parts when not in use. As such, we aimed to design the trays such that everything—including both the parts and the trays, as well as larger parts that do not go in the trays—would fit in the orange storage bin.

ASSUMPTIONS

Our project is based on some assumptions. You should be able to use these instructions with minor adjustments to adapt to other equipment, materials, settings, etc.

First, the trays are designed for the contents of the **REV FTC Starter Kit V3** [Part # REV-45-1883] (<https://www.revrobotics.com/rev-45-1883/>). A **REV Orange Storage Tote** [Part # REV-41-1215] (<https://www.revrobotics.com/rev-41-1215/>) is included in the kit, and it was used to hold all of the trays in this guide.

Second, we used a **LulzBot SideKick 747** (<https://lulzbot.com/store/lulzbot-3d-printer-taz-sidekick-747-standard-boxed-for-retail-na-kt-pr0058na-bs1mlxx>) as our 3D printer. We also used the current version of the vendor recommended software for slicing and printing: **Cura LulzBot Edition** [Cura LE] (<https://lulzbot.com/support/cura>).

Here are some of the **printer specifications** and **settings** we used on the LulzBot SideKick 747:

- Printer Head: M175 v2 Tool Head [Model # SK175]
- Category: All
- Material: PolyLite PLA (Polymaker)

- Profile: High Speed “0.380mm”
- Infill: 10%
- Generate Support: Unchecked
- Build Plate Adhesion: Skirt

The filament we used was purchased on Amazon: **HATCHBOX ABS 3D Printer Filament, 1.75 mm Diameter, 1 kg Spool, Orange** (<https://www.amazon.com/dp/B00J0H4EVU/>).

IMPORTANT NOTE

Throughout this document, we refer to “squares”—and, although not described as “square,” the trays *appear* to be approximately square overall. They are, but they are not exact squares. The overall outside dimensions are approximately 6¼ inches (15.933 cm) in length (the left-to-right dimension when viewed from above in the tote) and approximately 5⅞ inches (14.900 cm) in width (the top-to-bottom dimension when viewed from above in the tote).

SOURCE FILES

We have published the following files:

- **Instructions** [this file], saved as a PDF file
 - This can be opened with Adobe Acrobat Reader, as well as most browsers and many other programs
- **CAD Drawings**, saved as STEP files
 - These can be opened with most any CAD software, including Fusion360, OnShape and SOLIDWORKS. As a reminder, these applications and others are available for free to FTC teams; instructions are on the **FIRST Tech Challenge Team Complimentary Software** page (<https://ftc-docs.firstinspires.org/en/latest/sponsors/software/software.html>).
- **3D Renderings**, saved as STL files
 - These files can be opened with the aforementioned Cura LulzBot Edition. Once opened in the application, the software will “slice” the file and prepare it for printing.
- **Print Files**, saved as G-code files
 - These are the output files. They also can be opened with the Cura LulzBot Edition and printed directly; however, you will lose some of the features (e.g., time required to print, etc). ***Our recommendation is to use the STL files, slice them in your preferred slicer application, and then print them from there.***
- **Photos**, saved as JPEG files
 - While included below in this file, we have published the original photos, too, in order to provide high quality images, as well as include some supplemental images not in the instructions.

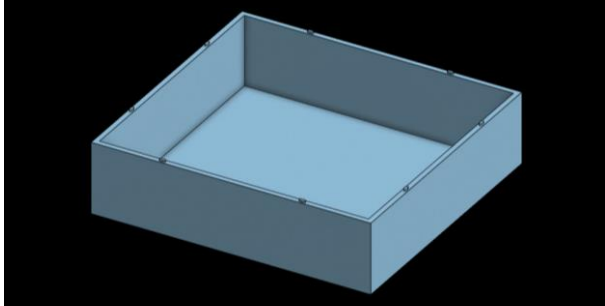
All of these files are shared in a Google Drive folder:

<https://drive.google.com/drive/folders/1wrmm5MblBMJn-qScOuJ4m3fOR5zBtK84?usp=sharing>

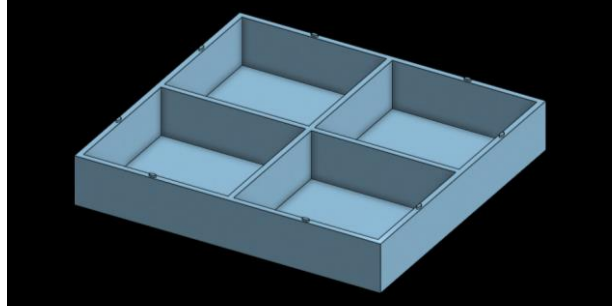
ITEMS TO PRINT

Here is a visual guide to the tray types:

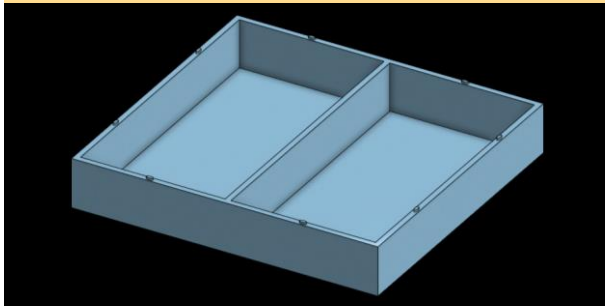
1 Square



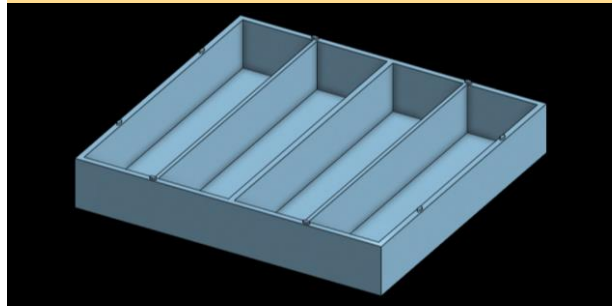
4 Square



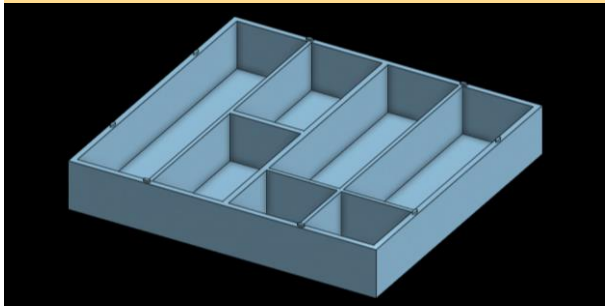
2 Rectangle



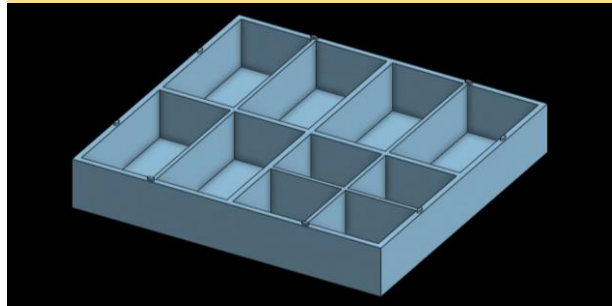
4 Rectangle



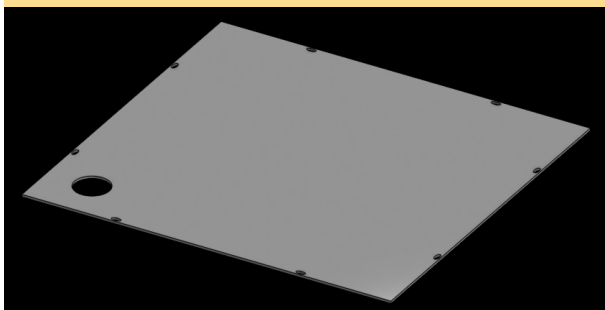
2 Square 5 Rectangle



4 Square 6 Rectangle



Lid



Please note that some trays are “tall” (approximately 1½ vs 1 inch, or 4.050 vs 2.550 cm) to accommodate larger and/or more numerous parts. These trays are on the 3rd and 4th layers.

Here is a summary of all the items you need to print:

1st Layer (Bottom)

	Quantity	Estimated Print... (each)			Estimated Print... (total)		
		Cost	Weight	Time	Cost	Weight	Time
2 Rectangle	1	\$1.68	70	3:32	\$1.68	70	3:32
2 Square 5 Rectangle	2	\$2.21	92	4:37	\$4.42	184	9:14
4 Square	3	\$1.90	79	4:00	\$5.70	237	12:00
Lid	6	\$0.79	33	2:00	\$4.74	198	12:00

2nd Layer (Middle)

	Quantity	Estimated Print... (each)			Estimated Print... (total)		
		Cost	Weight	Time	Cost	Weight	Time
4 Rectangle	2	\$2.06	86	4:19	\$4.12	172	8:38
4 Square	2	\$1.90	79	4:00	\$3.80	158	8:00
4 Square 6 Rectangle	2	\$2.40	100	5:02	\$4.80	200	10:04
Lid	6	\$0.79	33	2:00	\$4.74	198	12:00

3rd Layer (Middle)

	Quantity	Estimated Print... (each)			Estimated Print... (total)		
		Cost	Weight	Time	Cost	Weight	Time
1 Square - Tall	4	\$2.06	86	4:17	\$8.24	344	17:08
2 Rectangle - Tall	1	\$2.47	103	5:02	\$2.47	103	5:02
4 Square - Tall	1	\$2.97	119	5:43	\$2.97	119	5:43
Lid	6	\$0.79	33	2:00	\$4.74	198	12:00

4th Layer (Top)

	Quantity	Estimated Print... (each)			Estimated Print... (total)		
		Cost	Weight	Time	Cost	Weight	Time
1 Square - Tall	1	\$2.06	86	4:17	\$2.06	86	4:17
4 Rectangle - Tall	1	\$3.12	130	6:16	\$3.12	130	6:16
4 Square - Tall	2	\$2.97	119	5:43	\$5.94	238	11:26
Lid	4	\$0.79	33	2:00	\$3.16	132	8:00

	Quantity	Estimated Print... (total)		
		Cost	Weight	Time
TOTAL PRINT JOB	44	\$66.70	2,767 g	6:01:20

Thus, we estimate it will take **6 days 1 hour 20 minutes** of print time, cost **\$66.70** of filament and weigh **2,767 grams** (6.100 lbs). [In the above tables, time is stated as hh:mm or dd:hh:mm.]

We estimate it will take **3 filament spools** (1 kg each) to complete this project.

We used the **Prusa Research 3D Printing Price Calculator** (<https://blog.prusa3d.com/3d-printing-price-calculator-38905/>) for our estimates.

Here are the names of the print files you will find in the **3D Renderings (STL)** folder, listed as “**tray type - tray height** (if applicable) x **quantity to print**”:

- 1 Square - Tall x 5.stl
- 2 Rectangle - Tall x 1.stl
- 2 Rectangle x 1.stl
- 2 Square 5 Rectangle x 2.stl
- 4 Rectangle - Tall x 1.stl
- 4 Rectangle x 2.stl
- 4 Square - Tall x 3.stl
- 4 Square 6 Rectangle x 2.stl
- 4 Square x 5.stl
- Lid x 22.stl

TRAY CONTENTS

Once you have printed all of the items, you can place the contents of the REV FTC Starter Kit into the trays:

1st Layer | Top Left



Square

- 15mm Plastic Rod End Bracket, REV-41-1304
- 15mm Plastic 90 Degree Bracket, REV-41-1305 [in three compartments]

1st Layer | Top Middle



Square

- UltraPlanetary Outside Mounting Bracket, REV-41-1621 [3D printed reproduction of original metal part shown]
- UltraPlanetary Outside Mounting Bracket, REV-41-1623
- UltraPlanetary Flat Mounting Bracket, REV-41-1624
- 15mm Metal Bent Servo Bracket V2, REV-41-1485

1st Layer | Top Right



Square

- *empty*
- 15mm Plastic Lap Corner Bracket, REV-41-1321 [overflow]

Rectangle (small)

- 15mm Metal Bent Core Hex Motor Bracket V2, REV-41-1433
- High Strength Hex Hub, REV-41-1147

Rectangle (medium)

- Shaft Collar, REV-41-1327
- 15mm Plastic Lap Corner Bracket, REV-41-1321

Rectangle (large)

- End Cap Bearing, REV-41-1322

1st Layer | Bottom Left



Square

- 15mm Plastic 60 Degree Bracket, REV-41-1306
- 15mm Plastic 45 Degree Bracket, REV-41-1307
- 15mm Plastic 30 Degree Bracket, REV-41-1308
- 15mm Plastic Servo Bracket, REV-41-1319

1st Layer | Bottom Middle



Rectangle

- 15mm Plastic Motion Bracket, REV-41-1303
- 5.5mm Combination Wrench, REV-41-1374 and Allen Wrench Pack, REV-45-1882

1st Layer | Bottom Right



Square

- 15mm Spacer, REV-41-1323 [in two compartments]

Rectangle (small)

- M3 Standoff - 40mm, REV-41-1492
- Tensioning Bushing - 39mm, REV-41-1702

Rectangle (medium)

- 5mm x 75mm Hex Shaft, REV-41-1347
- 5mm x 90mm Hex Shaft, REV-41-1348

Rectangle (large)

- 5mm x 135mm Hex Shaft, REV-41-1349

2nd Layer | Top Left



Rectangle

- 15mm Plastic Inside Corner Bracket, REV-41-1320 [in four compartments]

2nd Layer | Top Middle



Rectangle

- 15mm Hex Bearing Pillow Block, REV-41-1317 [in three compartments, with overflow into fourth compartment, if needed]
- 15mm Hex Pillow Block, REV-41-1316 [in one compartment]

2nd Layer | Top Right



Square

- 15mm Plastic 120 Degree Bracket, REV-41-1311
- 15mm Plastic Indexable Motion Bracket, REV-41-1313
- 15mm Gearbox Motion Bracket, REV-41-1315
- 15mm Plastic Variable Angle Bracket, REV-41-1318

2nd Layer | Bottom Left



Square

- 5mm Hex Shaft Spacer - 3mm, REV-41-1324
- 5mm Hex Shaft Spacer - 1.5mm, REV-41-1325
- Servo Gear Adapter, REV-41-1364
- Motion Pattern Spacer, REV-41-1846

Rectangle

- Through Bore Bearing - Short, REV-41-1326
- Servo Shaft Adapter, REV-41-1328
- Through Bore Bearing - Long, REV-41-1329
- 15 Tooth Plastic Gear, REV-41-1331
- 10 Tooth Plastic #25 Sprocket, REV-41-1338
- UltraPlanetary Outside Mounting Bracket, REV-41-1621

2nd Layer | Bottom Middle



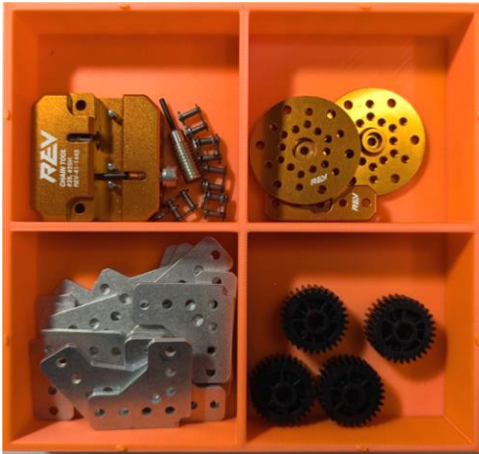
Square

- M3 x 8mm Button Head & M3 x 6mm Set Screw [from REV-41-1609], plus Shaft Collar Set Screws [used with REV-41-1327 and REV-41-1629]
- M3 x 10 mm Button Head [from REV-41-1609]
- M3 x 20 mm Button Head [from REV-41-1609]
- M3 x 30 mm Button Head [from REV-41-1609]

Rectangle

- M3 x 40 mm Button Head [from REV-41-1609]
- M3 x 35mm Hex Cap Screws, REV-41-1125
- M3 x 8mm Hex Cap Screws, REV-41-1359
- M3 x 16mm Hex Cap Screws, REV-41-1360
- M3 Nyloc Nuts, REV-41-1361
- M3 x 8mm T-Slot Screw, REV-41-1907

2nd Layer | Bottom Right



Square

- 30 Tooth Plastic Gear, REV-41-1332
- #25 Chain Tool, REV-42-1442 & #25 Master Links, REV-41-1366
- Aluminum Double Servo Arm, REV-41-1820 & Aluminum Servo Horn V2, REV-41-1828
- 15mm Metal 90 Degree Bracket V2, REV-41-1480

3rd Layer | Top Left



Square

- 36" PWM Cable, REV-11-1130
- JST PH 4-pin Sensor Cables, REV-31-1408
- JST VH 2-pin Motor Cables, REV-31-1413
- Switch Cable and Bracket, REV-31-1387
- Plus various wires and cables that come with the hubs, sensors, motors, servos, etc

3rd Layer | Top Middle



Square

- Surgical Tubing - 3mm, REV-41-1163
- Battery Holder Plate, REV-41-1166
- 12V Slim Battery, REV-31-1302
- Hook and Loop Fastener – 13.5mm x 2m, REV-41-1373

3rd Layer | Top Right



Square

- SRS (Servo) Programmer, REV-31-1108
- 60 Tooth Plastic Gear, REV-41-1335
[overflow from 3rd Layer - Bottom Right tray, if needed]

3rd Layer | Bottom Left



Square

- 5.5mm Nut Driver, REV-41-1119
- Zip Ties - 160mm, REV-41-1161
- #25 Roller Chain - 10 ft., REV-41-1365

3rd Layer | Bottom Middle



Rectangle

- Smart Robot Servo, REV-41-1097, plus Servo Horn Assortment & Servo Horn Mounting Hardware [in two compartments]

3rd Layer | Bottom Right



Square

- 15 Tooth #25 Sprocket, REV-41-1339 & 20 Tooth #25 Sprocket, REV-41-1340
- 60 Tooth Plastic Gear, REV-41-1335
- 72 Tooth Plastic Gear, REV-41-1336
- 90 Tooth Plastic Gear, REV-41-1337

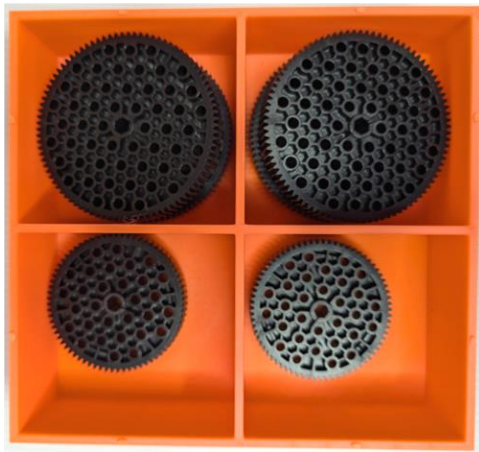
4th Layer | Top Left



Rectangle

- Core Hex Motor, REV-41-1300 [in two compartments]
- 45 Tooth Plastic Gear, REV-41-1334
- 30 mm Traction Wheel, REV-41-1353

4th Layer | Top Right



Square

- 72 Tooth Plastic Gear, REV-41-1336 [shown in two compartments; overflow from 3rd Layer - Bottom Right tray, if needed]
- 90 Tooth Plastic Gear, REV-41-1337 [in two compartments]

4th Layer | Bottom Left



Square

- 125 Tooth Plastic Gear, REV-41-1333
- 40 Tooth #25 Sprocket, REV-41-1343

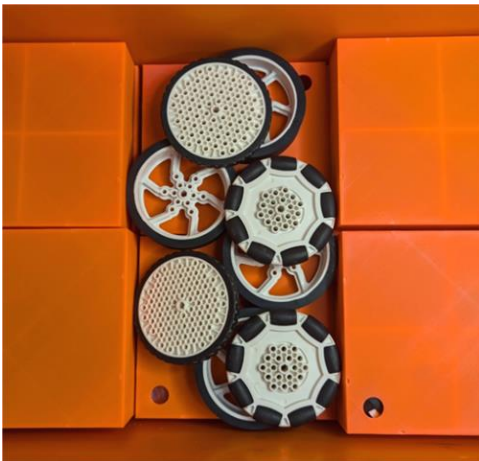
4th Layer | Bottom Right



Square

- HD Hex Motor, No Gearbox, REV-41-1291 [in two compartments]
- UltraPlanetary Cartridge - 3:1, REV-41-1601; UltraPlanetary Cartridge - 4:1, REV-41-1602 & UltraPlanetary Cartridge - 5:1, REV-41-1603
- UltraPlanetary Female 5mm Hex Output V2, REV-41-1615 & UltraPlanetary 550 Motor Plate, REV-41-1607

4th Layer | Loose on Top [Trays shown with Lids]



Tote

- 90mm Omni Wheel, REV-41-1190
- 90mm Grip Wheel, REV-41-1267
- 90mm Traction Wheel, REV-41-1354

5th Layer | Loose on Top



Tote

- Battery Charger, REV-31-1299
- 5mm x 400mm Hex Shaft, REV-41-1362
- 15mm Extrusion - 150mm - 45° Ends, REV-41-1430
- 15mm Extrusion - 225mm - 90° Ends, REV-41-1431
- 15mm Extrusion - 420mm - 90° Ends, REV-41-1432
- 15mm Extrusion - 120mm - 90° Ends, REV-41-1568
- 45mm x 15mm C Channel - 408mm, REV-41-1762
- 45mm x 15mm C Channel - 248mm, REV-41-1767

6th Layer | Loose on Top



Tote

- 450mm x 300mm x 4mm Corrugated Plastic Sheet, REV-41-1839
- Parts List
- FTC Starter Kit Guide

The final tray arrangement of trays as layers in the REV Orange Storage Tote is shown at the end of this document for reference.

Note that our proposed arrangement of parts in the compartments, trays and layers is just a suggestion. Please modify the arrangement in a way that works best for your circumstances.

CREDIT

This project was completed by **Angelo Morales**, Southern Nevada *FIRST* Senior Mentor, under the supervision of **Louis Rubbo**, FIRST Nevada Team Development and Education Specialist, and **Scot Duncan**, FTC Program Delivery Partner, for final documentation and review.

The project and its contents are freely available to all. You are welcome to download, use and share the material with others. *If shared, we ask that you credit **FIRST Nevada** as the source.* Additionally, if modified and shared, we ask that you *credit FIRST Nevada as a resource* used for your work.

CONTACT

If you have any questions about this project, please contact FIRST Nevada:

FIRST Nevada
PO Box 33565
Las Vegas, NV 89133-3565

TEL (702) 888-3673
EMAIL info@firstnevada.org

1ST LAYER (BOTTOM)



2ND LAYER (MIDDLE)



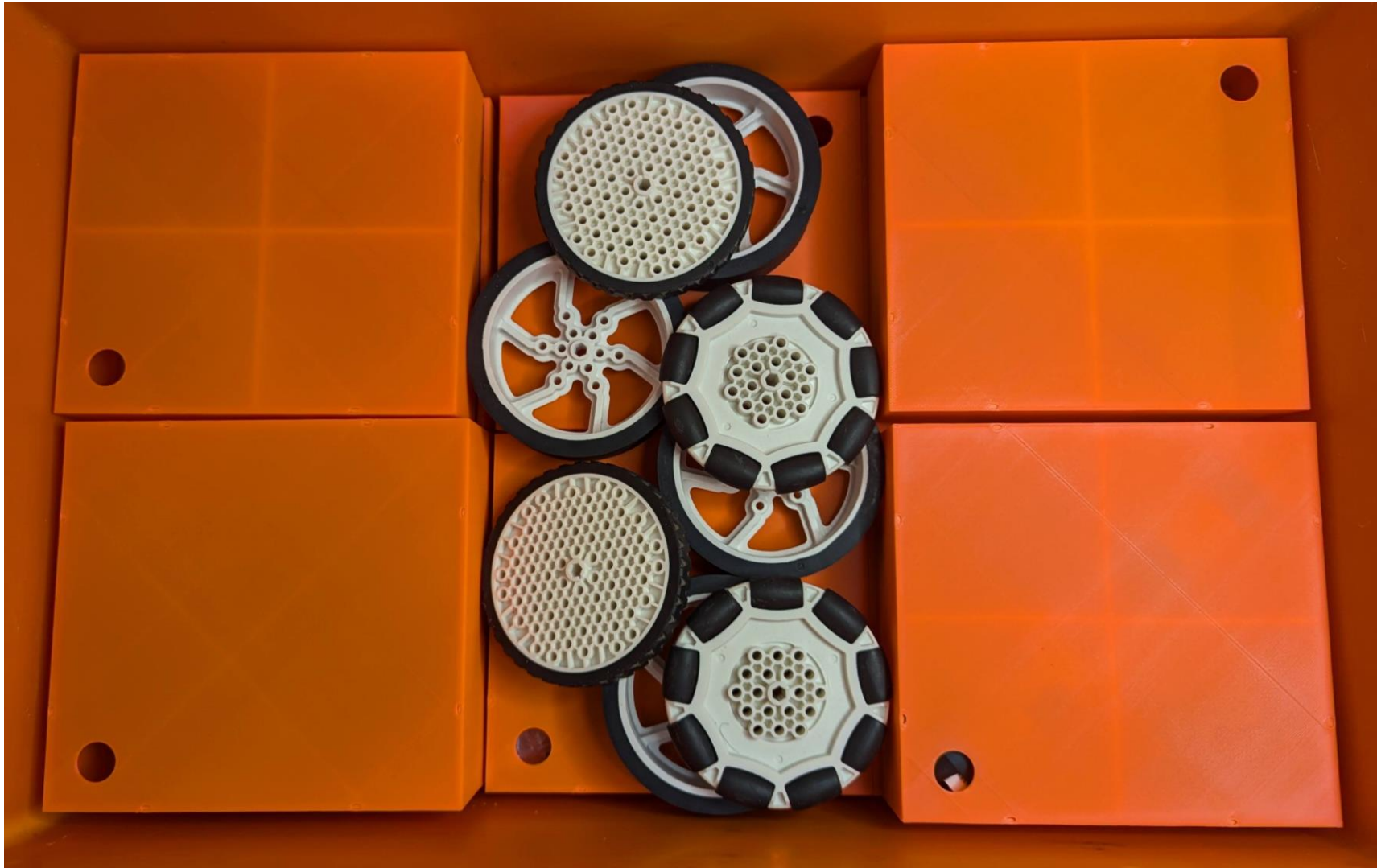
3RD LAYER (MIDDLE)



4TH LAYER (TOP)



4TH LAYER (TOP) [WITH LIDS AND WHEELS SHOWN]



5TH LAYER (LARGE PARTS – EXTRUSIONS, CHANNELS, LONG AXLES & BATTERY CHARGER)



6TH LAYER (CORRUGATED PLASTIC SHEET, PARTS LIST & GUIDE)

