

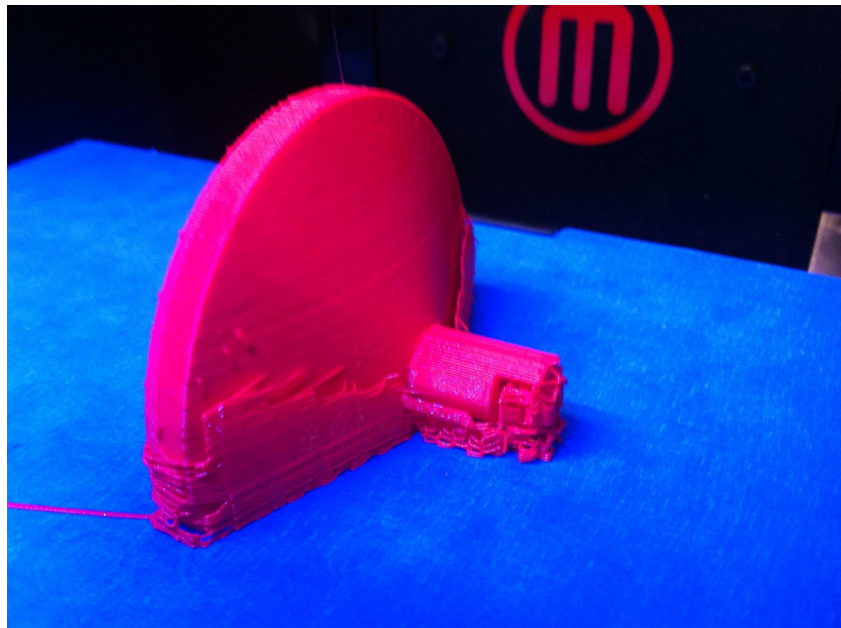
3D Printing for FRC

What are top teams printing and how can you be like them?

Travis Norris, FRC 2423



Printing in FRC has come a long way in 10+ years



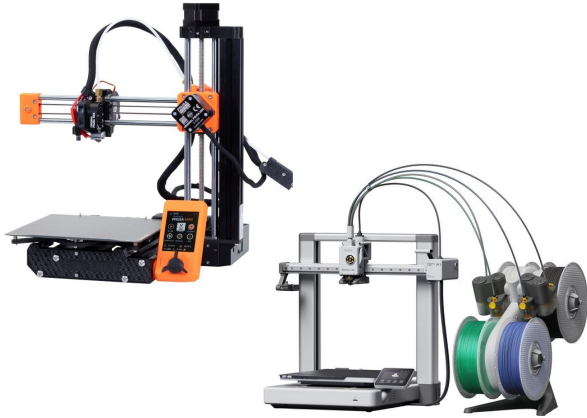
2013 Frisbee Indexing Device
2468 - *Team Appreciate*



2023 "Diff Swerve" on display at FormNext
88 - *TJ^2*

Where to Start

A reliable low-cost printer



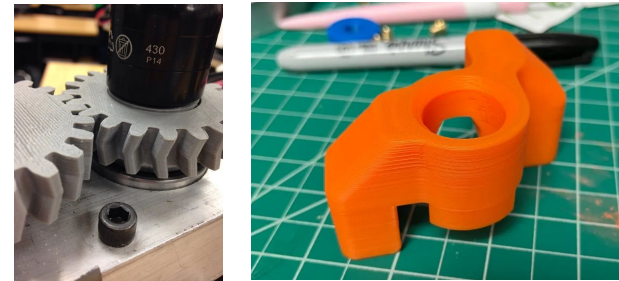
Prusa Mini
Bambu A1 / A1 Mini

A known good filament



PLA+, ProPLA, or similar

A few small parts



Spacers, Low torque gears,
pulleys, electronics
covers/mounts

Using the right material

PLA+ or ProPLA - The Standard

The best combination of fast printing, improved toughness, and affordability.

Brands vary, so find one you like and stick with it. (Polymaker PolyMax, eSun PLA+, Inland Tough PLA)

Why not PETG or regular PLA?

Faster than PETG and less brittle than PLA

TPU - Flexible

Flexible but can be fairly stiff based on infill percentage and part geometry.

Useful for shock absorption

Fiber Reinforced - Engineering Grade

Adds stiffness to a very tough material (Nylon or PET). Highly abrasive and more difficult to print



Finding the right printer



Fast - Printers have gotten significantly faster in the last 3 years

Reliable - A requirement for build season

Automated - Bed leveling, filament runout, etc

Connected - Print and monitor remotely

***Multi material** - Useful for filament backup (swapping if a spool runs out)

Adjusting your print settings

Increase outer walls, top/bottom layers instead of infill (5 of each)

- Most efficient way to add strength

Use the same layer height and preset on prototypes and final parts

- Tolerances will be different between “draft” and “quality” prints

You don't need to push the limit of speed

- Defaults are usually well tuned, slow them down for more complex prints

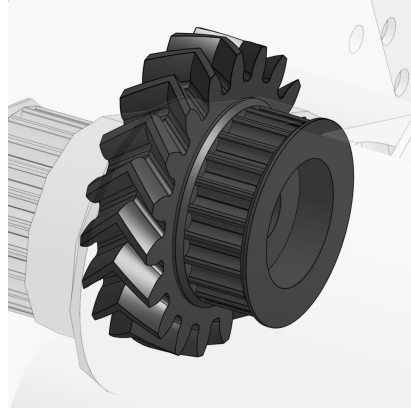
Be conscious of print orientation, because layer adhesion is always weaker

- The bond between layers is weaker than within a single layer



The easy wins

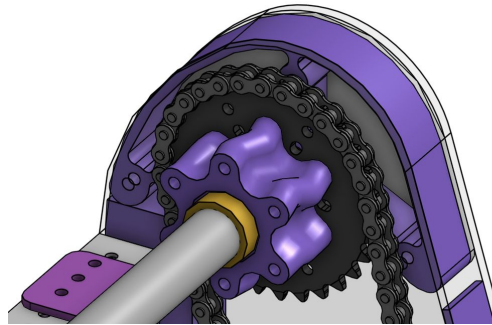
- Low torque gears
- Pulleys
- Electronics mounts
- Spacers



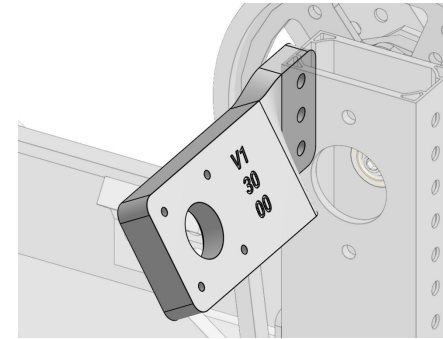
2024 Amp Mechanism
1678 - Citrus Circuits



2023 Electronics Strain Relief
2056 - OP Robotics



2024 Fun Sprocket Spacer
6329 - The Bucks' Wrath



2024 Camera Mount
3467 - Windham Windup

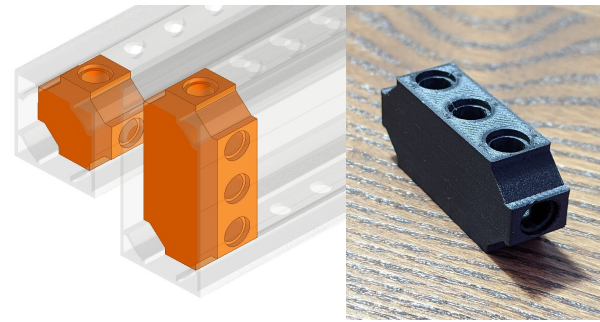


Intermediate additions

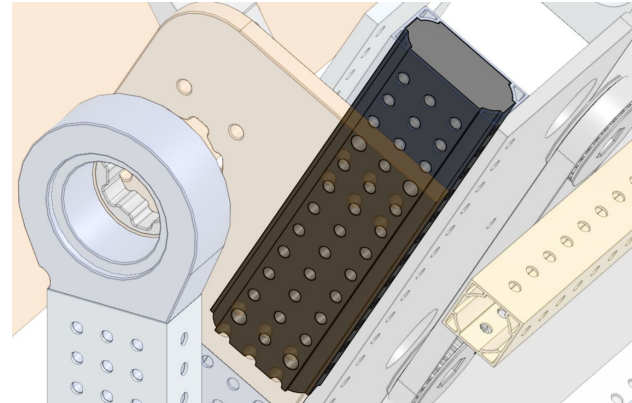
- Roller end caps
- Crush blocks



2024 Dead Axle Rollers
6328 - *Mechanical Advantage*

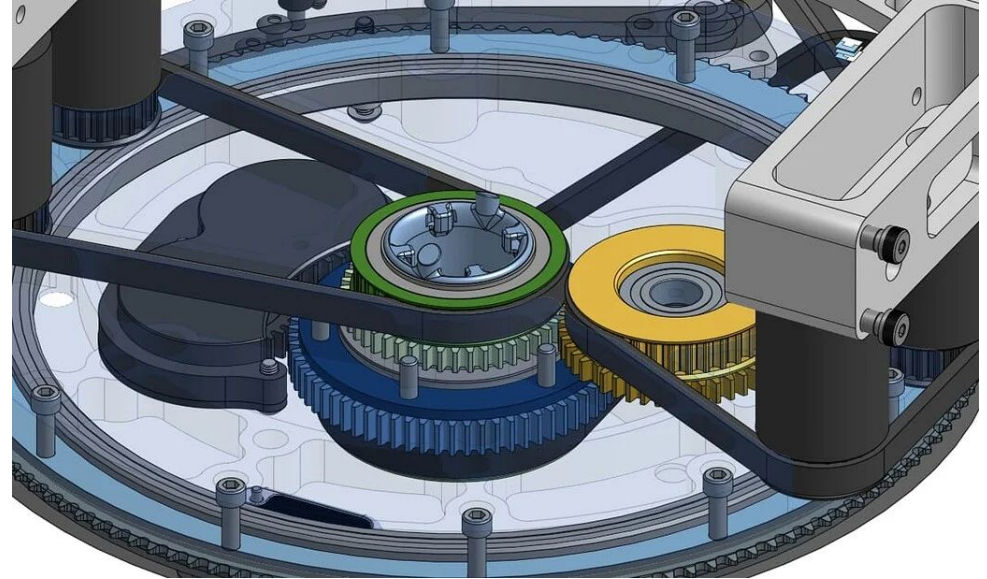
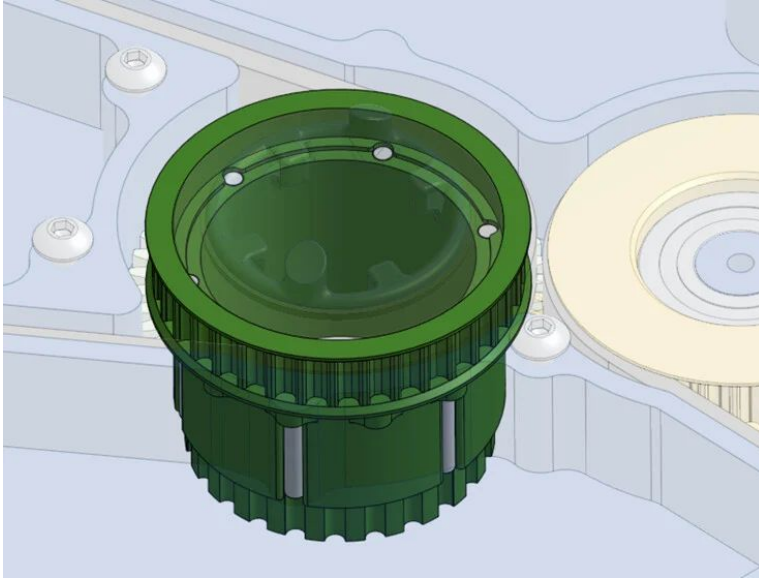


2022 Max Tube Crush Blocks
5010 - *Tiger Dynasty*



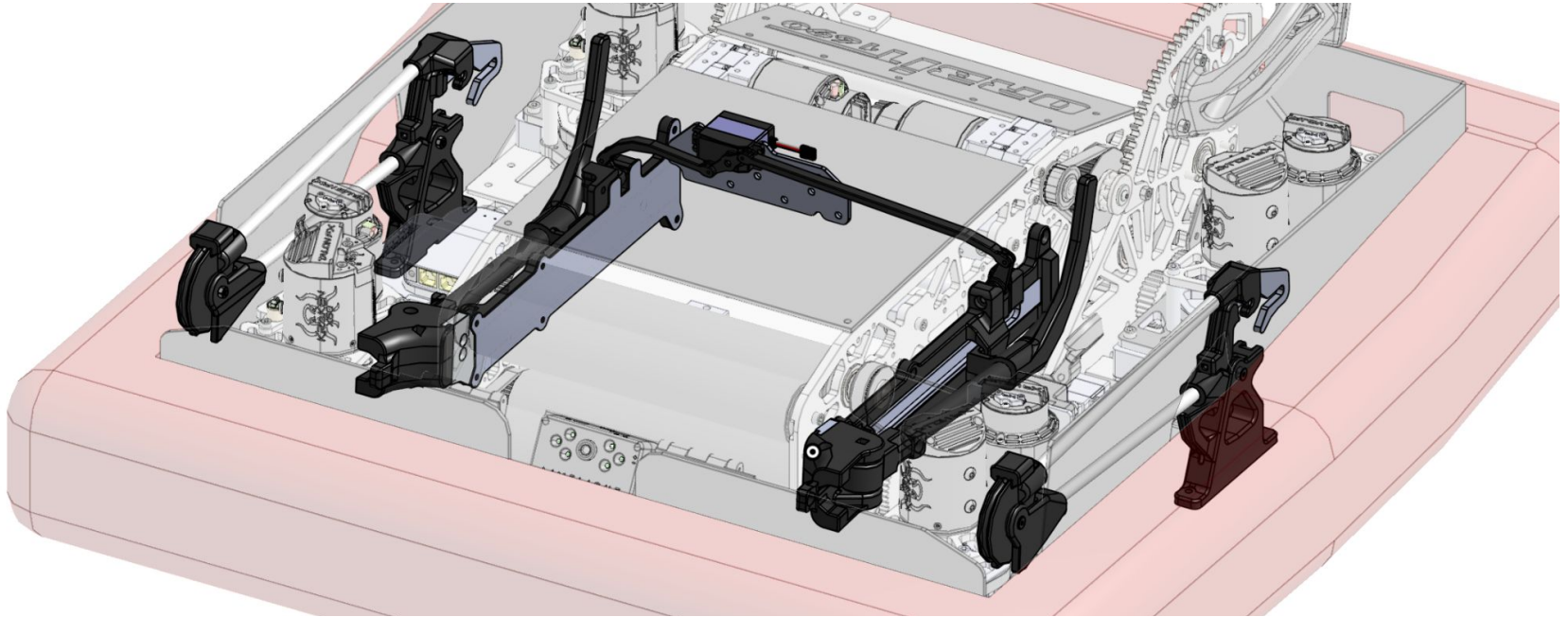
2024 Max Tube Crush Blocks
2423 - *The KwarQs*

Advanced components – 2910 Turret Core (2024)



2024 Turret and Teacup Rollers
2910 - Jack in the Bot

Advanced components - 1690 Climber (2024)



2024 Climber and Trap Mechanism
1690 - Orbit

Designing parts for 3D printing

Lightening is less needed

Since infill is already less dense than solid, lightening patterns aren't as beneficial

Design in cable management

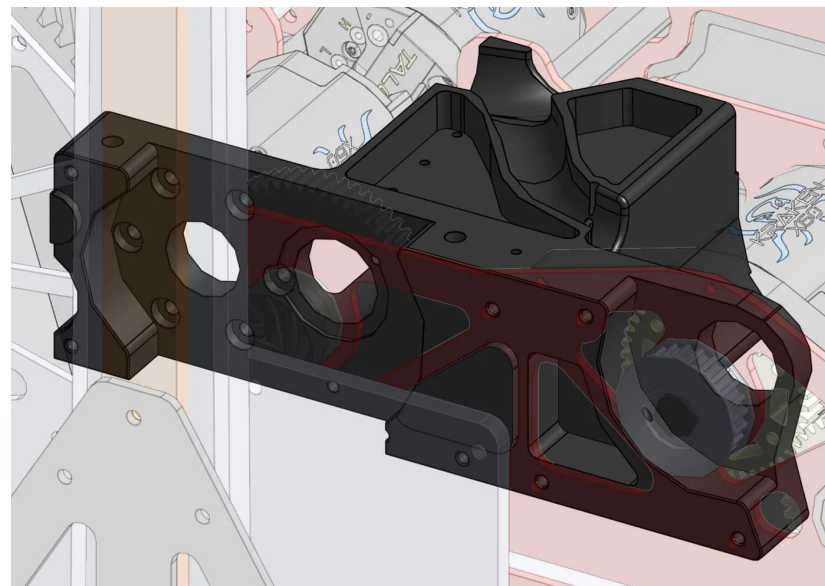
Add routes for cables, cut outs for zip ties

Don't forget tolerances

Printed parts need $>0.1\text{mm}$ for a close fit

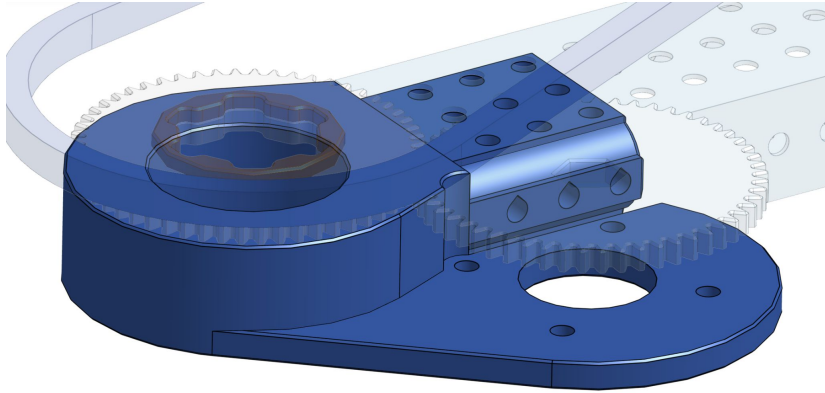
Reduce the need for supports

You no longer need to eliminate them entirely but less support = less time and material



2024 Shooter Gearbox
125 - NUTRONS

Designing parts for 3D printing (pt. 2)



2024 Shoulder Mount
2423 - The KwarQs

Teardrop horizontal holes

No supports required inside horizontal holes.

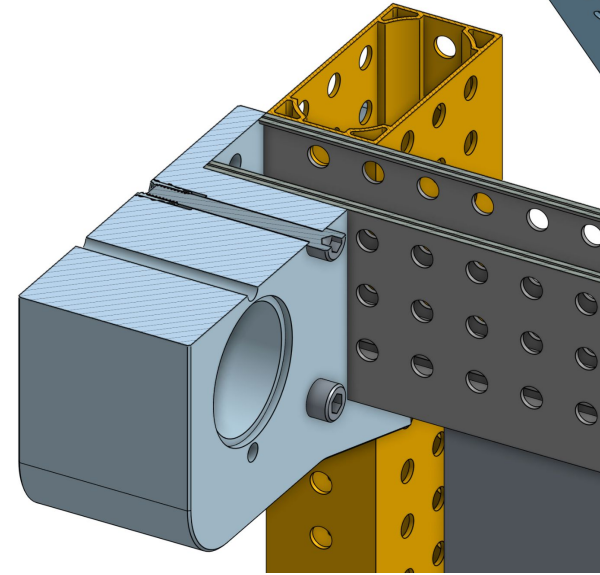
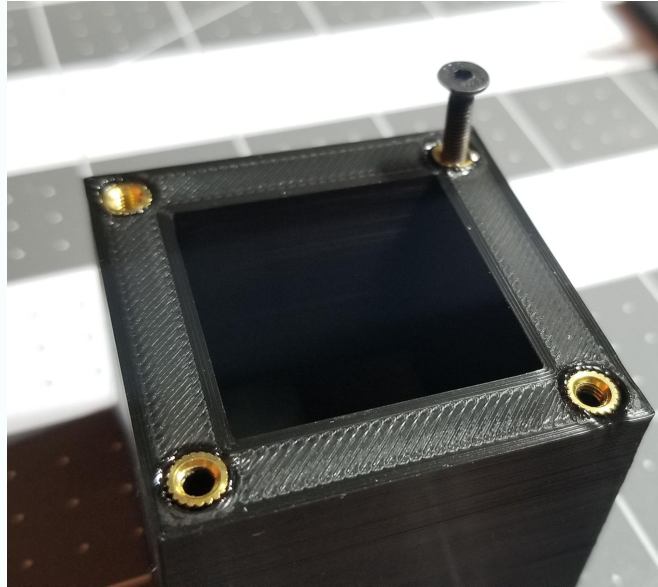
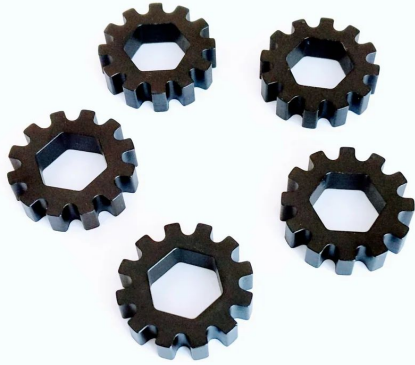
Precision in the plane of the build plate

Printers are more precise in XY than Z.

Chamfer the bottom edge

Reduced print quality defects (elephant's foot) and easier to remove from some build plates

Hex inserts, heat set inserts, and reinforcement



Hardware can reinforce weaknesses in printed parts.

Hex inserts available through Thrifty Bot and WCP. Heat set inserts sold widely

Common pitfalls

Plastic Creep - over time, printed parts will deform if left under tension/compression

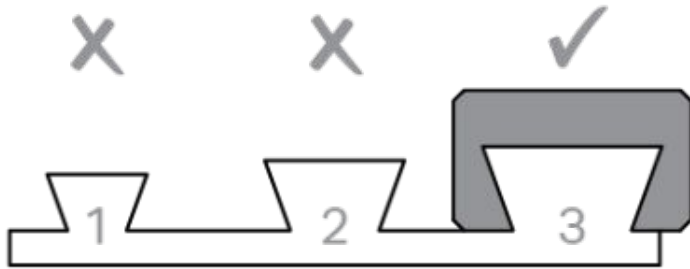
Overestimating stiffness - Plastic is much less stiff than aluminum. Be careful with cantilevered forces, gearbox plates, etc.

We can just print a replacement - Have at least 1 on hand, don't just print it at competition

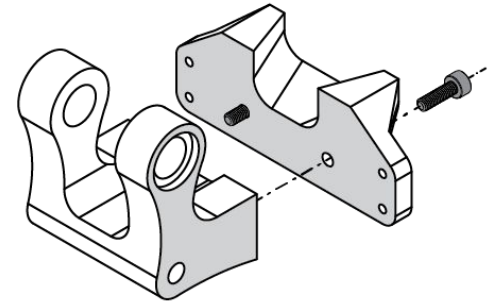
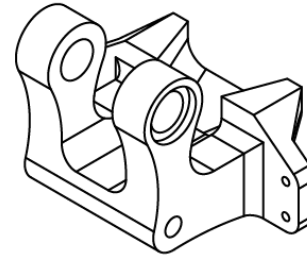


Plastic creep example - new (left) vs used (right)

Avoid re-printing the whole part



Unit test important fits



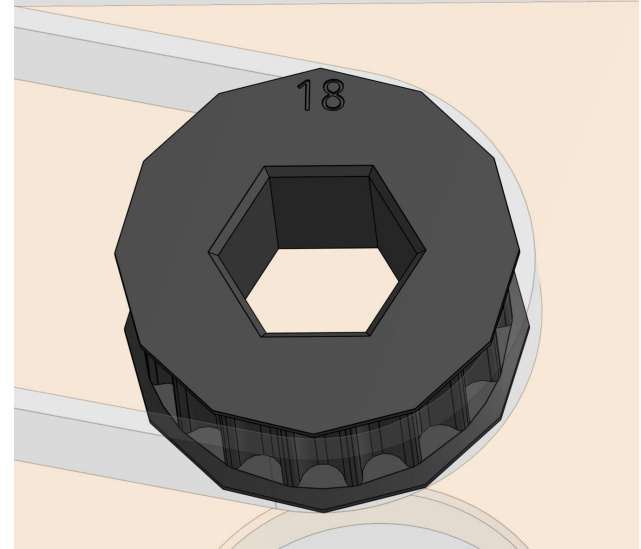
Split up large parts

Managing Printed Parts

Label them in CAD - emboss/engrave a part number, tooth count, or version

Keep track of your print files - Save your print files (.3mf) for each part so that you know the exact settings that were used

Mark “NOT FOR ROBOT USE” - If you print a test part with less strength, label it (different filament color or with a sharpie)



18T HTD Pulley
Robot Belt FeatureScript

Additional Resources

- [“What are your favorite 3D printed parts for FRC”?](#)
- [Spectrum’s 3D printed parts presentation](#)
- [2056 Strain Relief Parts](#)
- [Markforged Composite Design Guide](#)
- Youtube channels
 - [CNC Kitchen](#)
 - [Made with Layers \(Thomas Sanladerer\)](#)
 - [Maker’s Muse](#)
 - [Teaching Tech](#)

Prototyping

Hype Blocks

<https://www.chiefdelphi.com/t/team-5254-3d-printed-prototyping-resources/33559>

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