3D Printing for TARC

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Doug Cullen
NAR 99106

https://tinyurl.com/tarc3d

Why 3D Printing?

Create parts that are not available from other sources

Make parts in less time than ordering them

Lower cost -especially shipping (if you don't count the cost of the printer, or your design time)

Pride of designing and making your own parts.

From Idea to Parts

Where do ideas come from?

You need a part that's not available.

You see a similar part.

You have a unique requirement.

https://gsablogs.gsa.gov/gsablog/files/2012/08/idea-1.jpg

Designing Parts

Has someone already designed the same part (or something similar)?

Check out the available repositories of 3D models.

Design your own. Most challenge, most rewarding.

Available 3D designs

These is a good chance that someone has already designed the part you are looking for.

Sources

Thingiverse (many parametric models available)

Grabcad

MyMiniFactory

Design Tools

Free 3D design tools

TinkerCad - part of the Autodesk Family

Autodesk Fusion 360 - free for students

Google Sketchup

Onshape

Open SCAD

Dimensional Data

You will often need to know the dimensions of parts such as body tubes.

Sources of data

- Apogee Rockets
- Estes
- Balsa Machining Service
- Ninfinger.org

Printer.

Do you have access to a 3D printer?

Many schools have 3D printers that can be used for school projects.

Get a grant or have a fundraiser to purchase a 3D printer

Find a volunteer to print your designs.

Materials

3D printers can use many different plastics to print parts.

PLA

ABS

PET (or PETG, Pet +)

Nylon

Polycarbonate

PLA

Easiest plastic for beginners.

Bio-plastic, no potentially hazardous fumes. Prints on an unheated print surface. Files, sands and paints very well. Rarely warps.

It is very rigid and tends to snap when bent. Low impact strength.

Low glass point temperature, not good for parts exposed to

ABS

Most common commercial thermoplastic.

High impact resistance. Somewhat flexible. Can be smoothed and bonded with acetone. Sands and paints very well.

Better heat resistance than PLA

Needs a heated print bed and/or enclosure

Higher shrinkage can change sizes or cause warping.

Fumes may cause coughing and nausea, needs ventilation.

PETG (An improved version of PET)

PETG offers many of the advantages of ABS without the drawbacks.

No noxious fumes and less shrinkage.

Heated bed not required, but is helpful.

May be a bit trickier to print than PLA.

Excellent bonding and impact resistance.

Nylon (Taulman, Weed Wacker Line)

Nylon can make very strong 3d printed parts.

Little or no odor.

All nylon is flexible, although flexibility varies with filament choice. Great abrasion resistance

Needs to be printed at high temperatures, usually requiring an all metal hot end.

Can be challenging to finish and glue.

Polycarbonate

Very strong and impact resistant plastic.

Require a very high printing temperatures and advanced techniques to print.

Very high temperature resistance.

Absorbs water, high tendency to warping.

Finishing

3D printed parts can often be used as printed, but often benefit from some post processing to create a smoother surface.

ABS can be vapor smoothed and perhaps strengthen the parts.

Tools

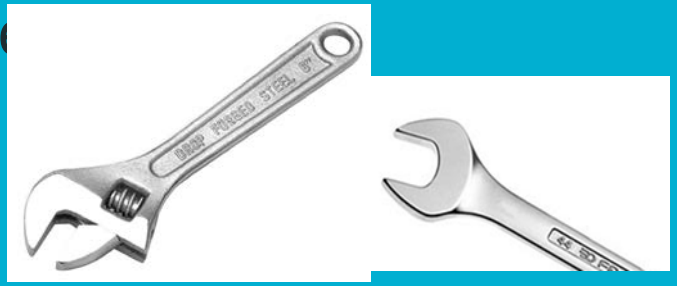
You may want a number of tools to make you printing faster, easier or just better looking.

You may want:

- Tools for the Printer
- Tools for Printing
- Tools for finishing

Tools for the printer

Ball End Hex Wrenches - many printers come with some low quality hex keys but a nice set of these are esse

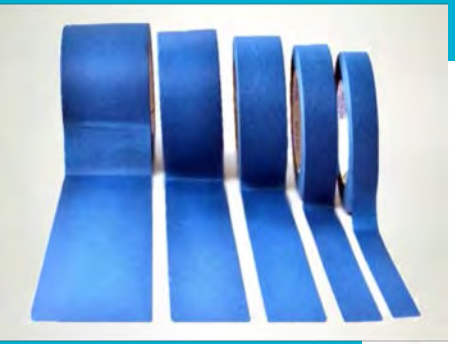


Open End and Adjustable wrenches for changing nozzles

Brass brush, used to clean up the exterior of the nozzle and hot end.

Tools for Printing

Putty Knife, Spatula for removing prints from the print bed



Tape, Hair Spray, Glue Stick, ABS Surry or other products to ensure prints stay fixed to the bed

Tools for Printing

Cutters for trimming filament

Tweezers - for collecting loose bits of filament

Digital Calipers for measuring filament and test parts as well as for designing new projects

Tools for Finishing

Craft Knife - removing excess material

Deburring tool - removes excess material and smooths corners

Needle or diamond files. Removing excess or smoothing surfaces.

Tools for Finishing

Sandpaper - Smoothing surfaces, smoothing paint

Primer Filler - helps to remove layer lines and prepares the plastic for paint.

Printers

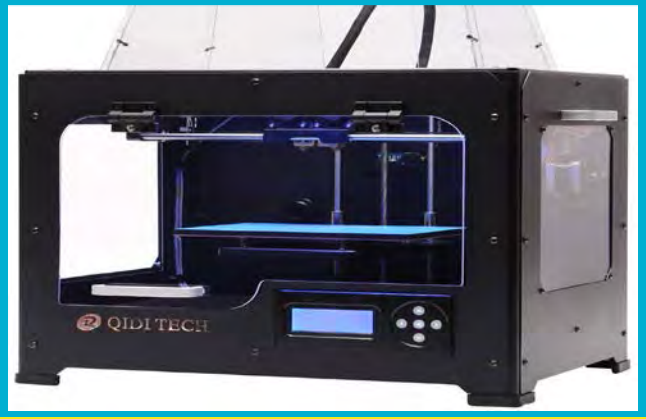
How much do you want to spend?

Prusa i3 designs - Very cost effective, available as kits or complete printers. I have a Wanhao Duplicator i3. It is a complete printer with an all metal frame.

There is a strong support community that is actively working to improve this machines. I have been able to print PLA, ABS, PetG and even Nylon

More Printers

Makerbot Replicator and Clones - Makerbot was one of the first commercially produced 3D printers for hobbiest. Today it has been largely eclipsed by clones that deliver better performance at lower cost.



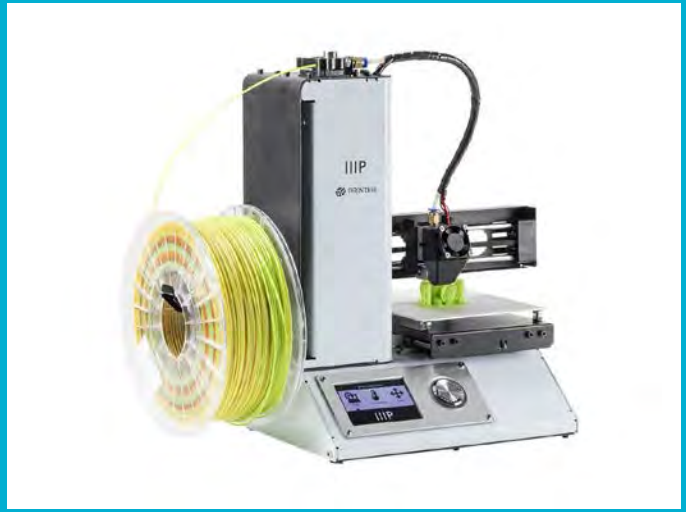
I have a QIDI Tech 1 clone with dual filament capabilities

More printers

I recently purchased a MonoPrice Select Mini for $165. A small but surprisingly good machine.

We have printed rail guides, transitions, nose cones and even hobby knives on this printer.

Using ABS



The Big Leagues

Machines I wish I could Afford

Some day, Maybe

Commercial Printers

What to print?

Tools -

Fin Guides and alignment Guides.

“Exacto” craft knives

Caps for craft knifes.

What to print?

Nose Cones - ABS or PetG

Transitions ABS or PetG

Altimeter Mounts. - PLA probably OK

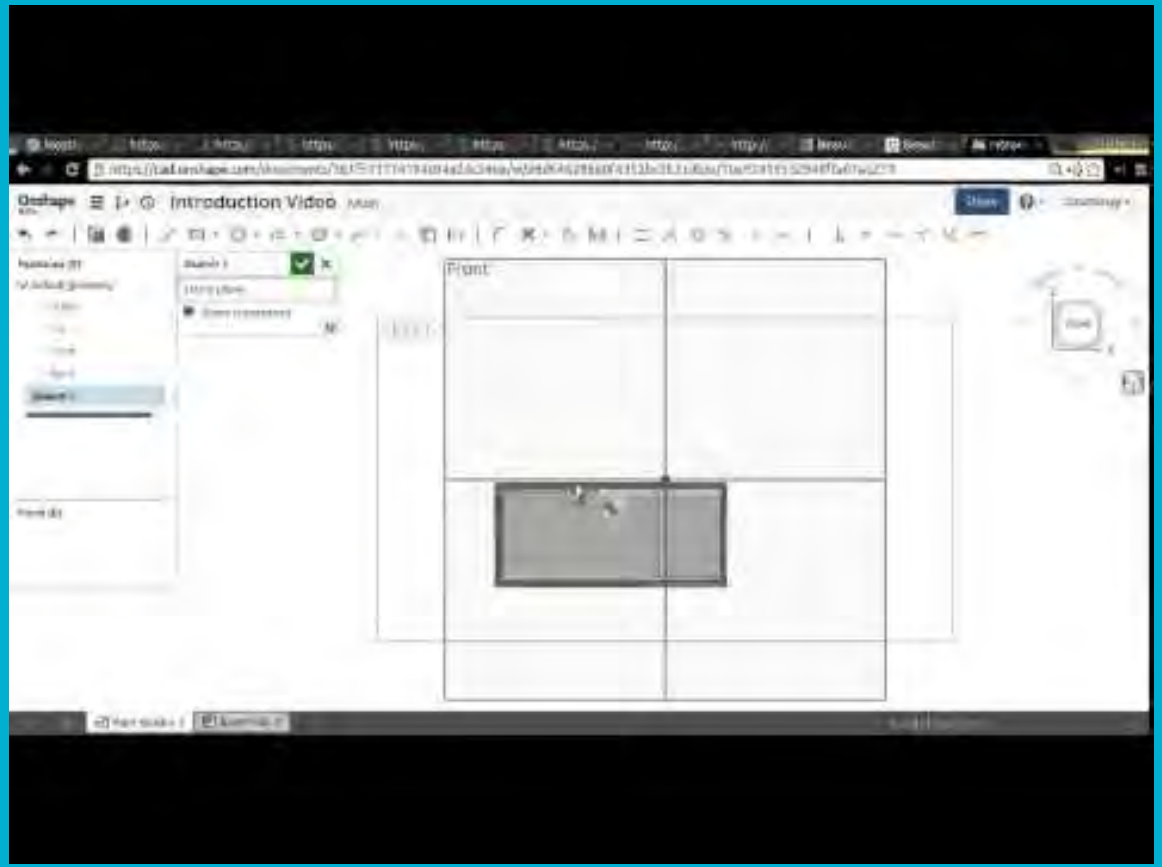
Centering Rings - maybe, PLA is NOT temperature stable

Motor Retainer - needs more testing - PLA = FAIL

Fins - Heavier and more fragile than balsa / lite ply.

How to Print

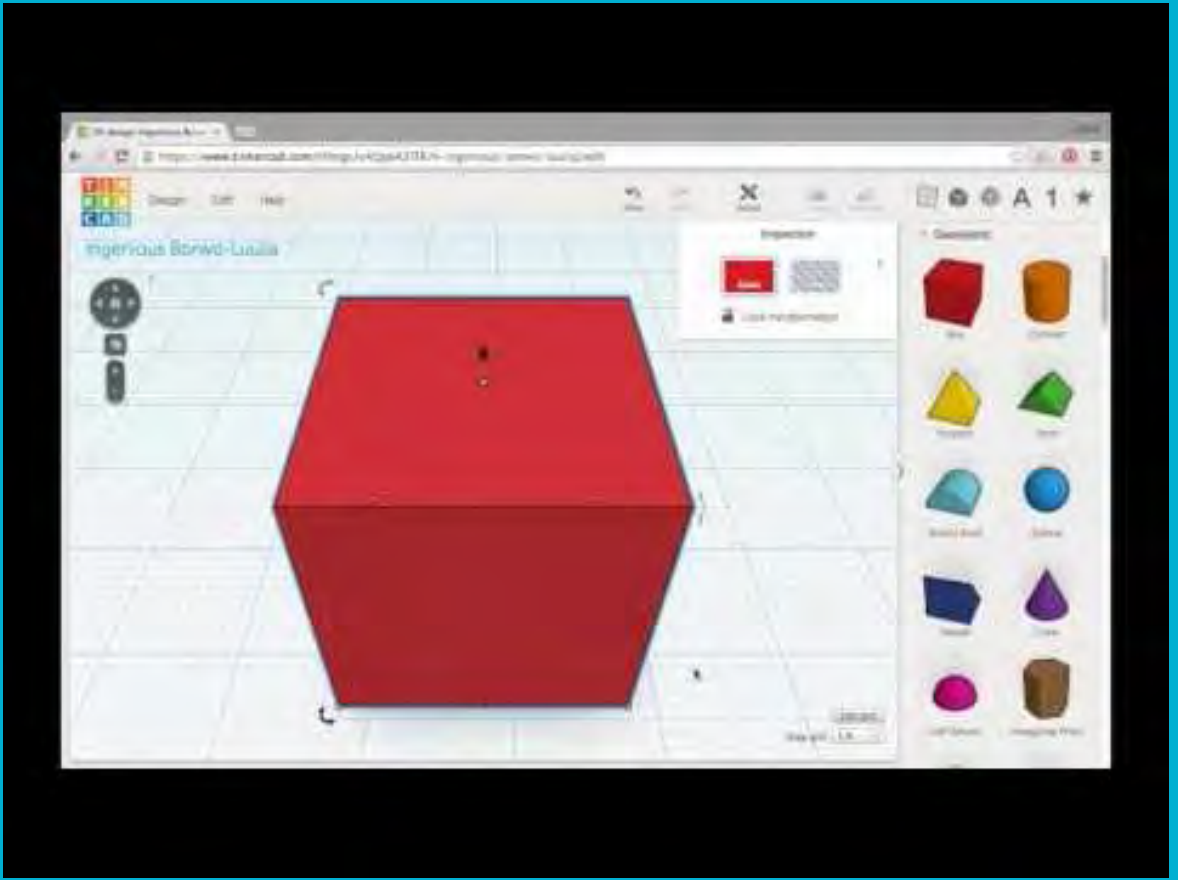
Creating Your Design in OnShape



Or

Tinkercad

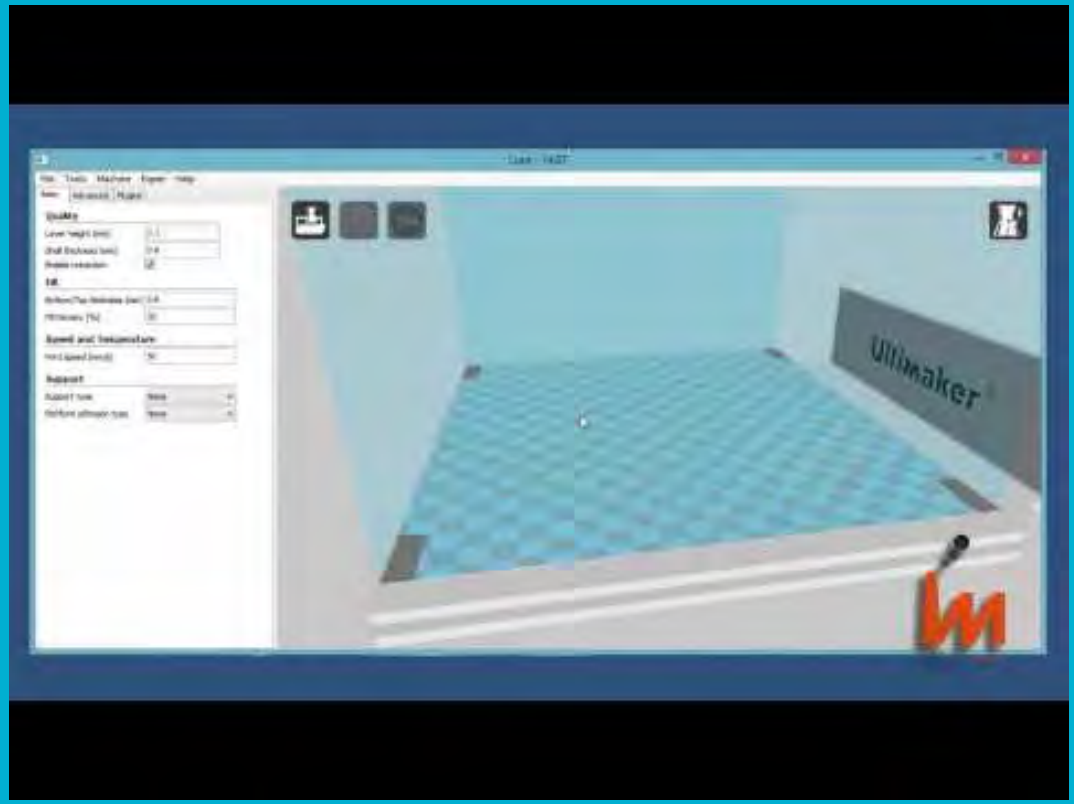
Build with 3D primitives



Convert 3D model to Printer Instructions

This process is called “Slicing”

Some printers use “G-Code”, a generic language for CNC



Complex Processes

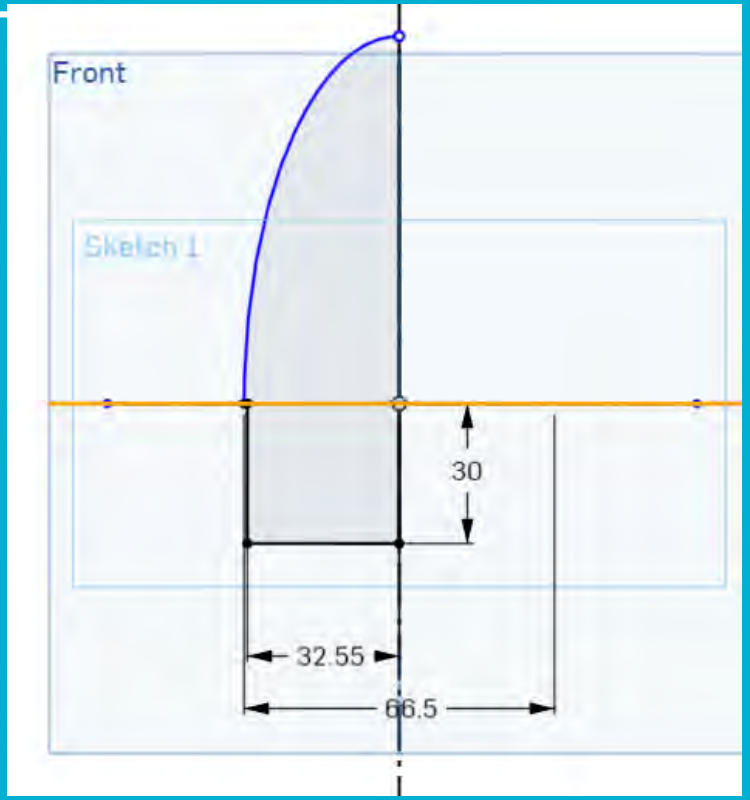
Some models can present challenge to printing well. The shoulders of nose cones and transitions can be problematic

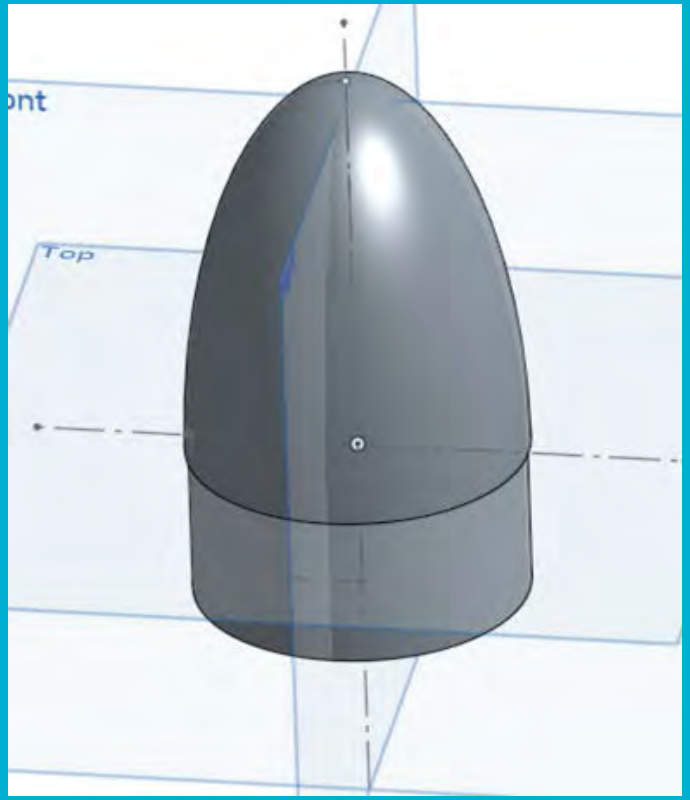
An Example of Complex Operations

BT 80 Eliptical Nose Cone

Challenges include the step in the diameter at the shoulder and what happens when you try to print horizontal surfaces in space

Onshape Design Process

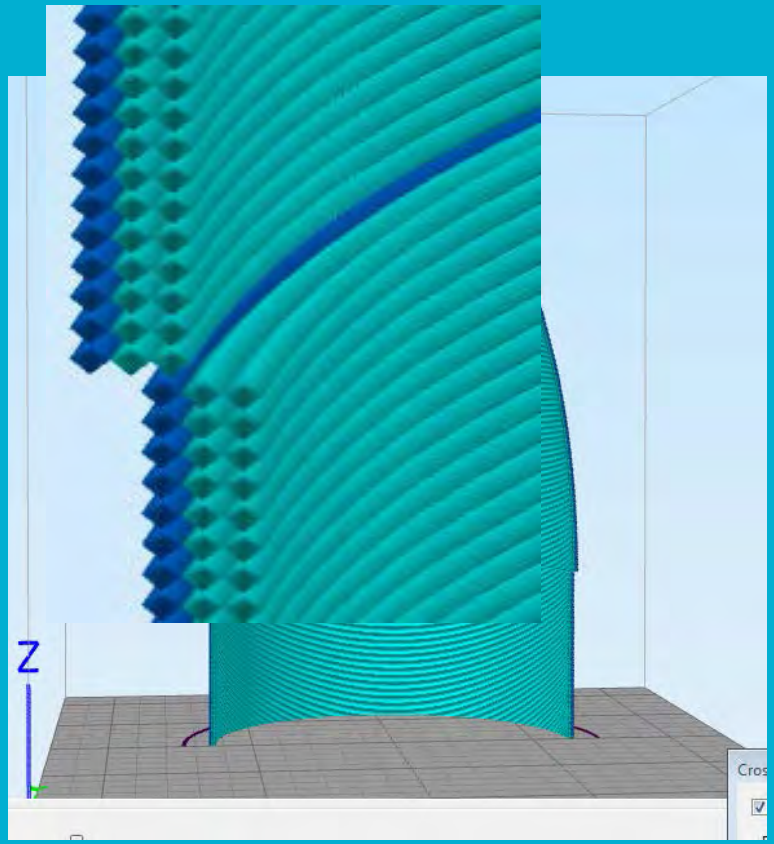




The Shoulder Problem

Nice looking print that will FAIL.

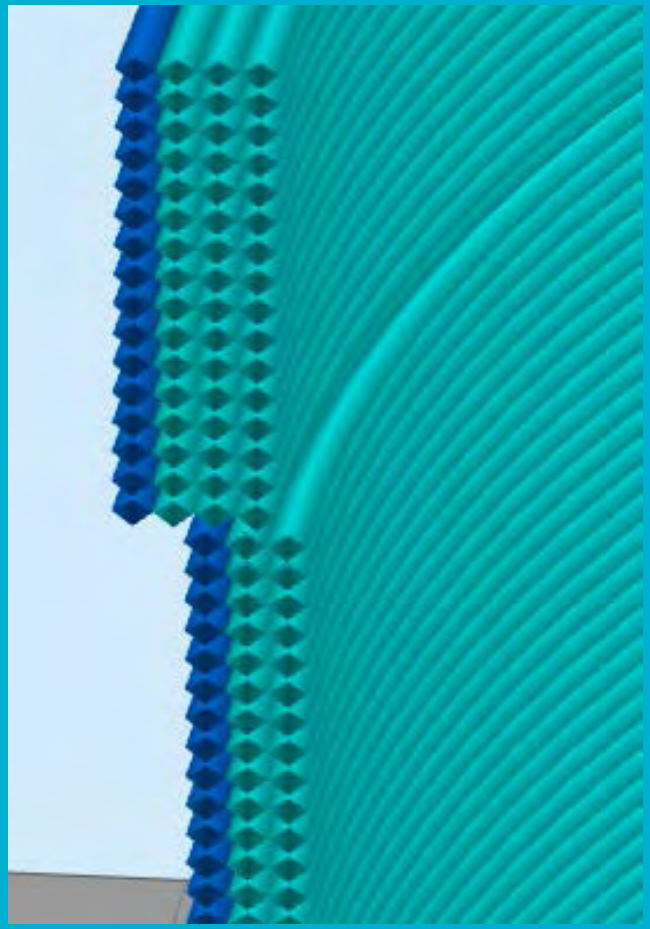
It will break at the shoulder because the layers don't stack up



The Simplify 3D Solution

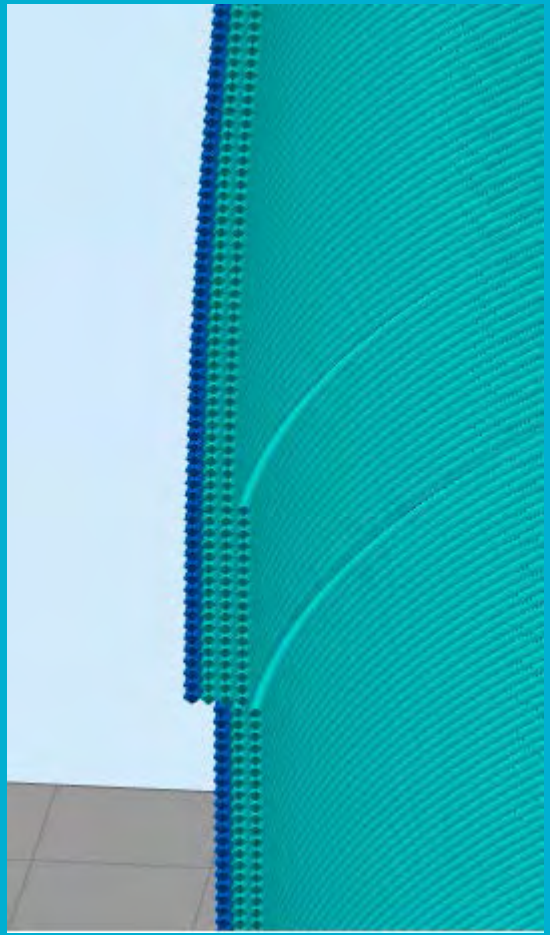
Simply increase the number of perimeters at the shoulder to increase the amount of overlap.

You could make the whole thing at 4 perimeters but it would be 30% heavier



Shoulder Fix

Create a belt of 4 perimeters

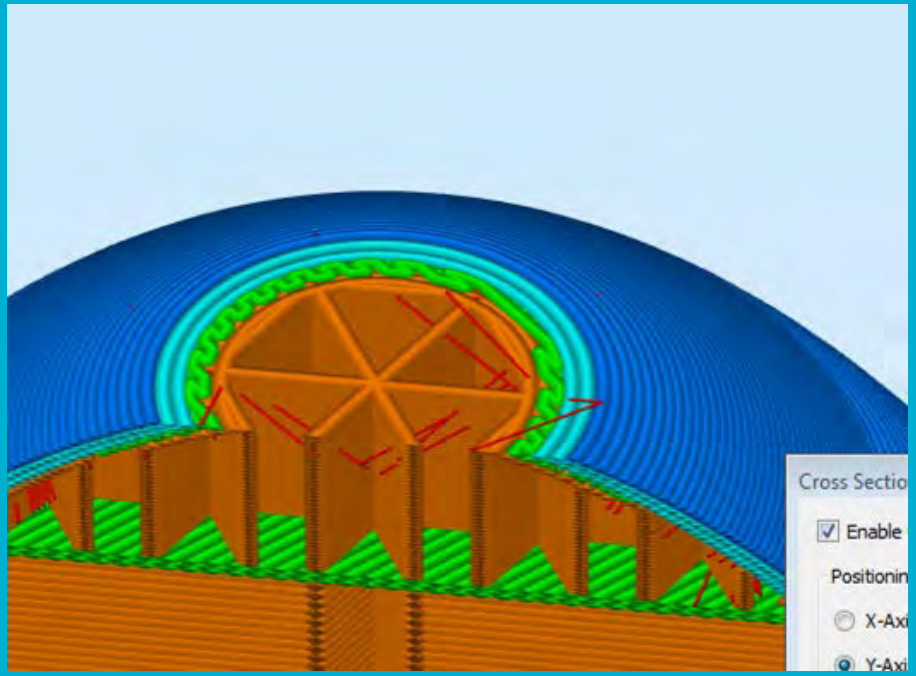


Printing the NC Tip

Add Tops and Bottom layers to support the more horizontal layers

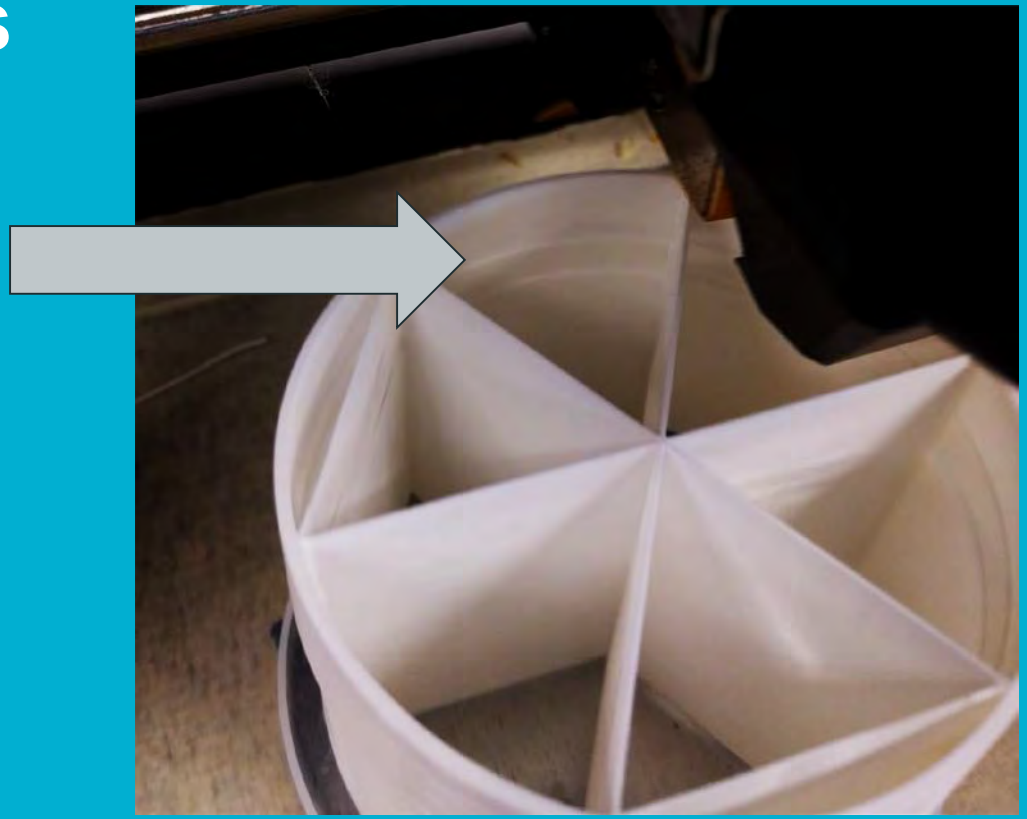
Add Infill to reduce bridge and create a better surface. AND

Reduce the Layer Height to create a smoother surface.



Printing Progress

Notice the step for the belt area



3D Printing as a Part of Larger Processes

Consider 3D printing as a step to creating your parts.

Need parts that are stronger or that can be created more quickly?

Use a 3D print as a pattern for molded parts. Use a silicone molding compound and casting resin.

Vacuum Forming Parts

3D Printed bucks can be used to create vacuum formed parts quickly and efficiently.
Vacuum formed parts can be total clear, not possible with 3D printing today.

Fiberglass and Carbon Fiber

3D printed parts can be used a molds to create parts using Fiberglass, Kevlar or Carbon Fiber fabrics and Resin

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