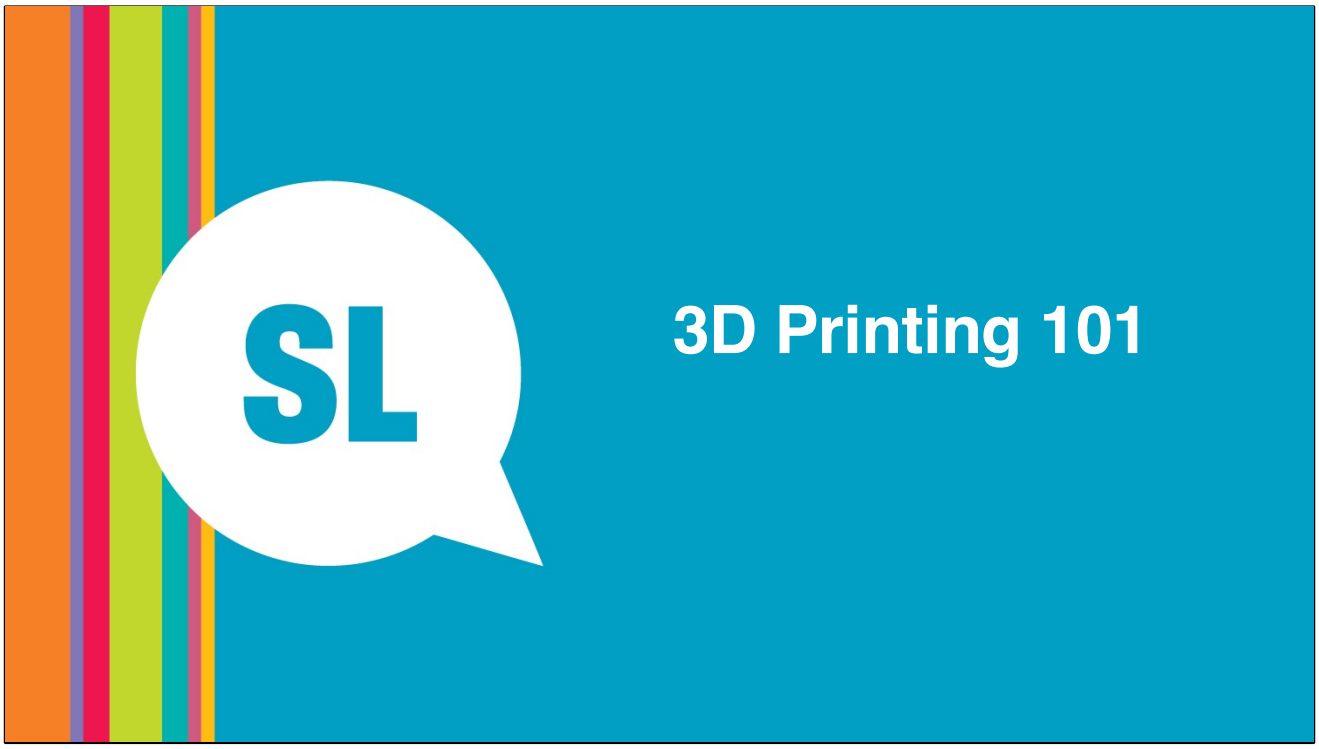


Before session:

- Email participants and ask them to sign up for a free Autodesk account
- Set up 3D printer with demo prints

Materials:

- Per participant:

Acknowledgement of Country

We acknowledge Aboriginal and Torres Strait Islander peoples and their continuing connection to land and as custodians of stories for millennia. We respectfully acknowledge the land on which we all meet today, and pay our respects to elders past, present and emerging.

Intros!

Why did you sign up?

Why do you want to know about 3D Printing?

What do you hope to get out of these sessions?

Session Overview

1. See The Edge's 3D printers at work.
2. Look at some software you can use to design a model
    - Fusion 360
    - Meshmixer
    - Tinkercad

Session Overview

3. Look at the software we use to slice our models.
4. Have a go at designing something to print

Why 3D printing?

Allows us to

- Rapid prototype
- Create elegant solutions to annoying problems… repair, invention, time or effort saving solutions
- Express our creative selves and beautify the places we spend our time.

- Also there are things you can do with a 3D printer (additive manufacturing) you cant do with subtractive processes

How does 3D printing work?

That depends…

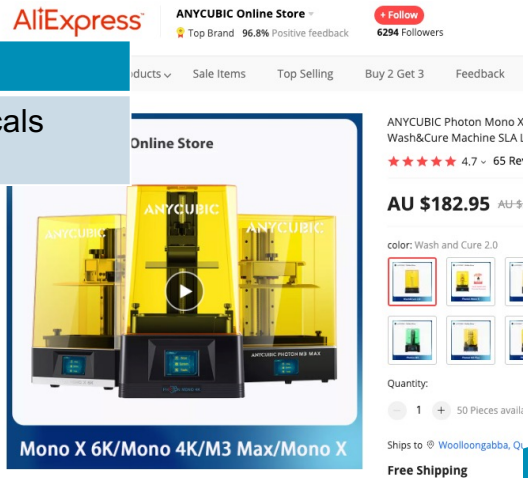
There’s 3 main types at the consumer/ prosumer level.

- UV Resin
- Laser cinter
- FDM

UV Resin

Layer by layer image exposes tank of UV activated resin UV light

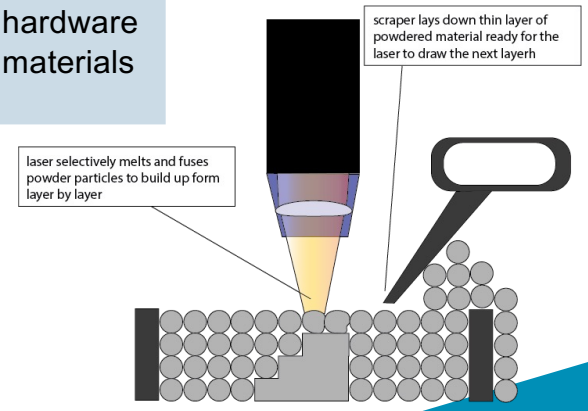
Pros	Cons
👍 Cheap hardware 👍 Hi Res	👎 Nasty chemicals



Selective Laser Sinter

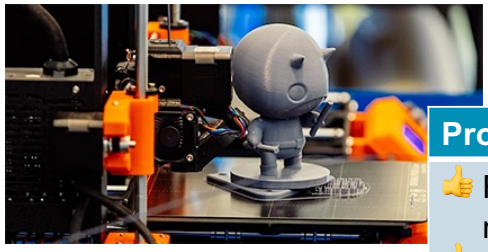
Laser draws an image layer by layer by selectively melting powdered material.

Pros	Cons
👍 Hi Res 👍 All sorts of great materials	👎 Expensive hardware 👎 Expensive materials



Fused Deposition Modeling

A hot nozzle draws a bead of melted thermoplastic layer by layer to create a model.



Pros	Cons
👍 Reasonably priced materials 👍 Reasonably priced hardware 👍 DIY kits and open source community	👎 Limited to a few types of plastics 👎 Limited resolution 👎 More plastic being used and potentially ending up in our environment

What can go wrong?

Safety

- Electricity
- Fire
- Respiratory
- Crush injury
- Brain explosions

Electricity – need to be aware that we are working with machines that are run off 240v
Fire- thermal run away can cause a fire this is why we do not leave printers running without general supervision
Respiratory- Fumes from the filament and particulate are harmful human health take ohs precautions
Crush injury- you can get fingers stuck in a machine
Brain explosions- if you start to get frustrated walk away.

Isopropyl used to clean printer bed also presents fire, inhalation and skin irritation risk please read and follow SOP located with equipment

Print failure modes
Machine failure and possible damage to the machine

- Birds nest - non adhesion/ print lift
- Z axis shift
- Delaminated layers
- Clogged nozzle or extrusion stepper errors
- GCode Encoding error
- Hot end runaway

Lets see a machine and how to start a job

Move to printers.

- Explain operation - feed stock passed into hot end driven by extruder stepper motor, movements controlled by the gcode instructions and actuated by x & y Stepper motors, draws out model on layer a a time and then Z axis stepper moves the layer and the machine then draws the next layer.
- Show components
- Prep build plate with Isopropyl
- Insert SD card and navigate to job.
- Start job

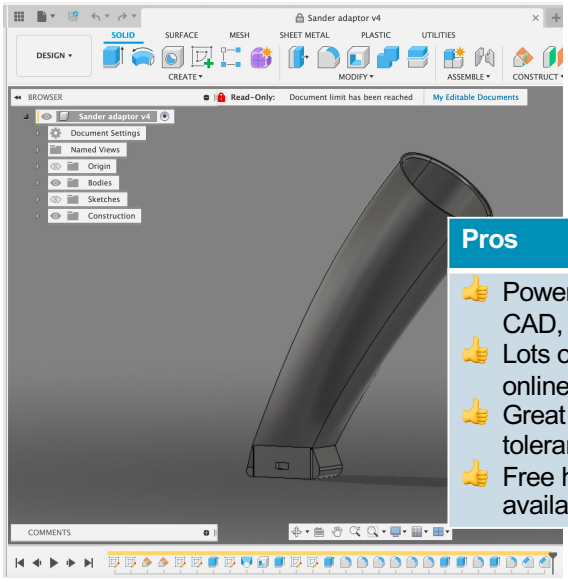
- Look at ½ done jobs on other printers:
    1. Add insert to paused job
    2. Look at internal infill
    3. Discuss support

Move to back to computers.

Designing for 3D printing

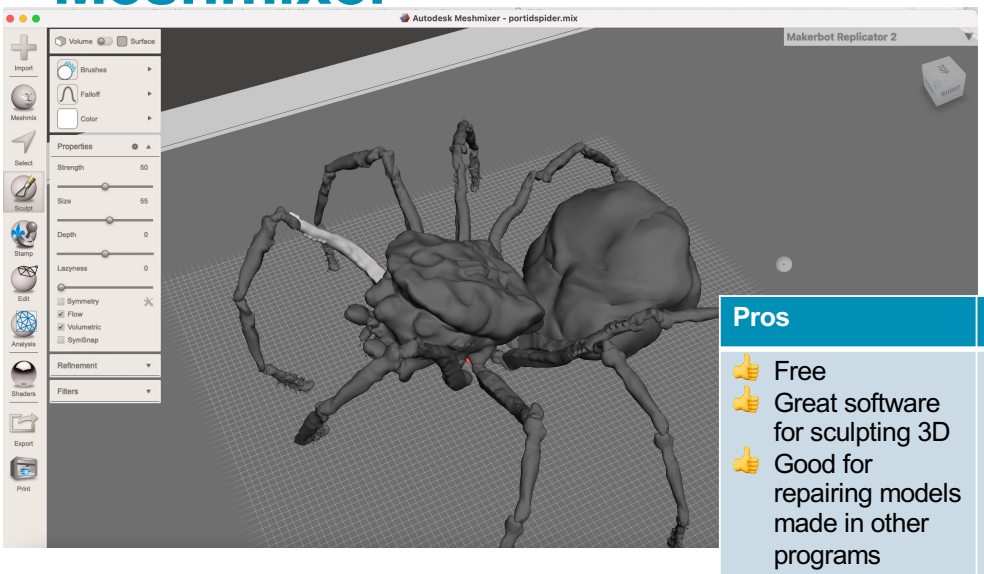
CAD software

Fusion 360



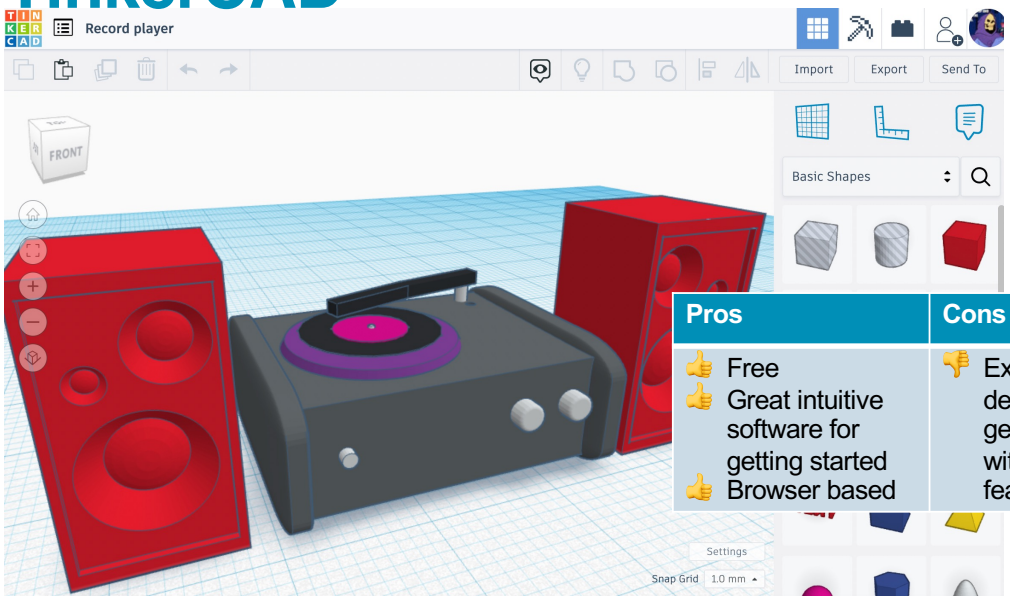
Pros	Cons
👍 Powerful professional CAD, CAM, CAE software. 👍 Lots of good tutorials online 👍 Great for design hi tolerance mechanical parts 👍 Free hobbist license available	👎 A lot to get your head around when starting 👎 Full version relatively expensive (but not as expensive as others)

Meshmixer



Pros	Cons
👍 Free 👍 Great software for sculpting 3D 👍 Good for repairing models made in other programs	👎 Probably want try something more intuitive first to get your head around the concepts

TinkerCAD



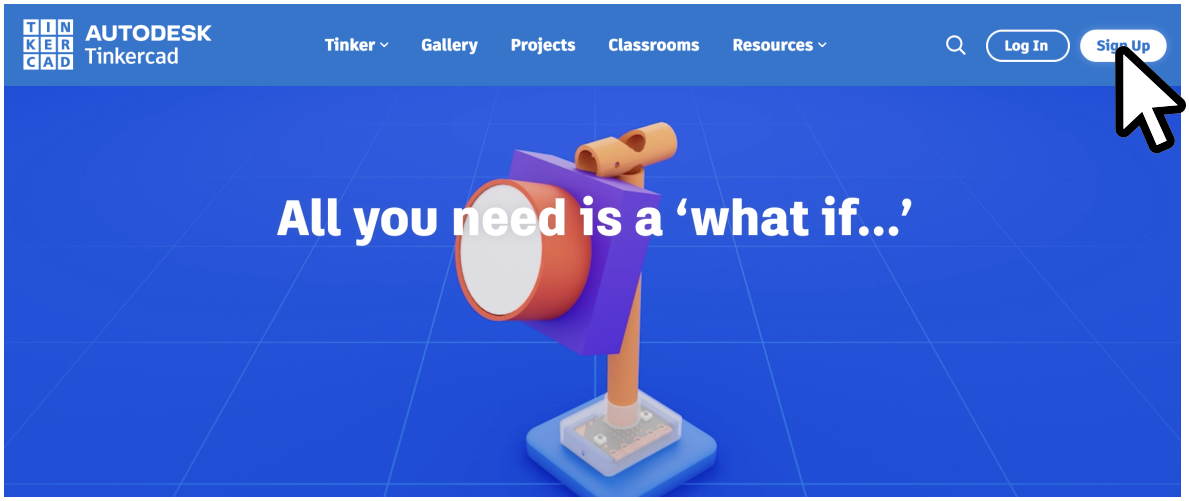
Pros	Cons
👍 Free 👍 Great intuitive software for getting started 👍 Browser based	👎 Experienced designers might get frustrated with the lack of features

Lets have a go!

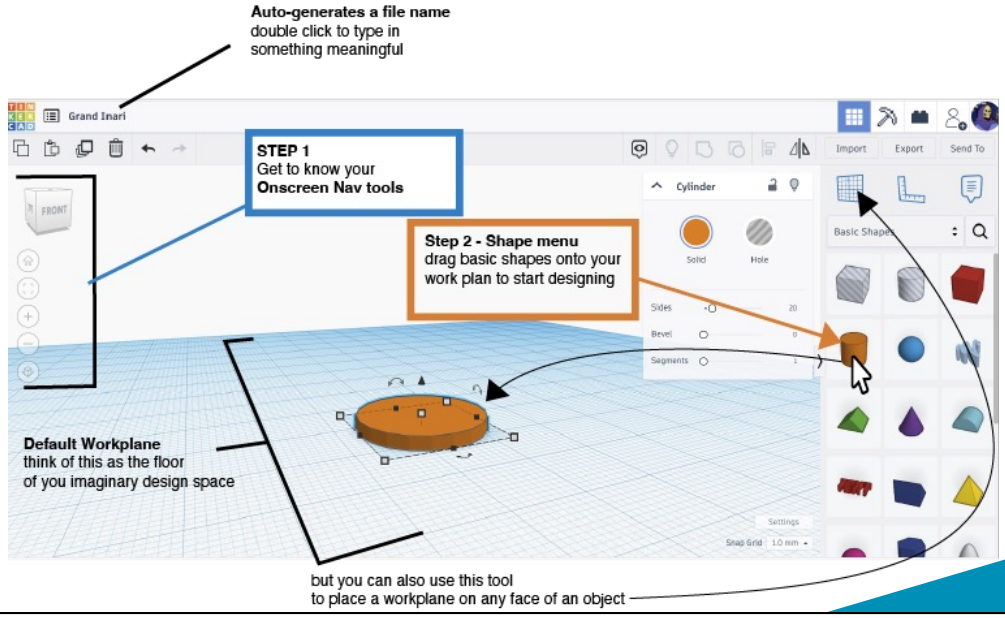
Go on the internet and navigate to

TinkerCAD.com

Sign up for a free account



The interface



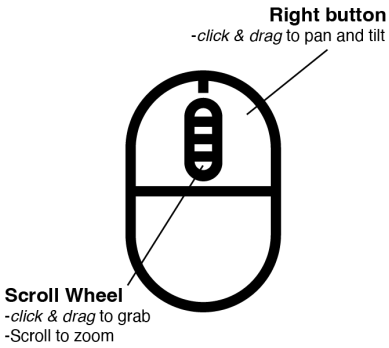
Navigating the 3-dimensional space

Moving around

- Zoom in and out using the scroll wheel

Pan & Tilt

- Right click and drag to change the aspect of your view or
- Click and drag the Cube device to rotate you view angle
- If you get lost click the **home icon** and it will take you back to the default view

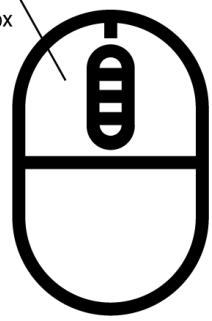


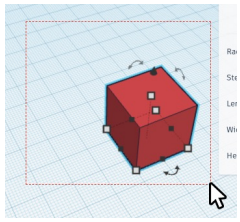
Moving and manipulating shapes

Select

- Using the left click (hold shift select multiple objects)
- Or left click and drag a selection box around multiple objects

Left button
-click to select
(hold SHIFT(to select multiple objects)
or
-*click & drag* a box select to select multiple multiple

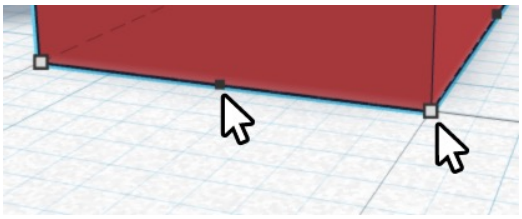


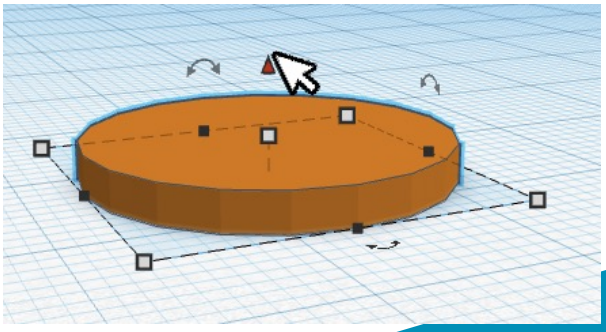


Moving and manipulating shapes

Resizing

- left click and drag the black or white handles to resize the your shapes.
- Hold the SHIFT key to constrain proportions.
- Left click and drag the black cone to change the elevation of your in relation to the work plane

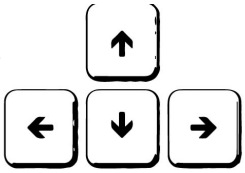




Moving and manipulating shapes

Moving

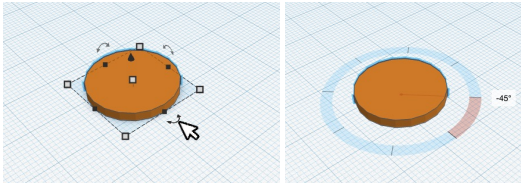
- You can nudge a selected object around the x & y axes with the arrow keys



Rotate

Left click and drag the curly one of the 3 arrows to rotate an object. Once the angle highlighted you an type in an angle too.*

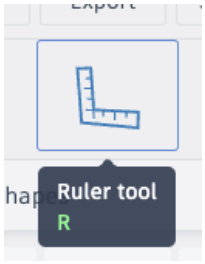
**it can be difficult to realign an object's angle once you've moved it so be deliberate with these changes*

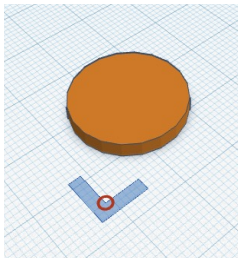


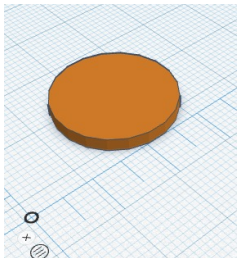
Moving and manipulating shapes

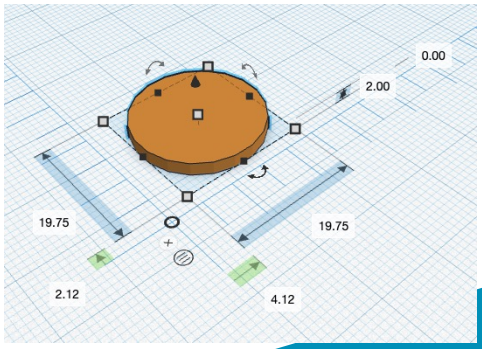
Ruler

- Drag the ruler out onto the workplane to resize or arrange shapes using typed in dimensions.









Make a complex shape

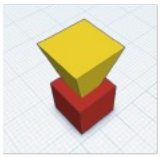
Grouping solids and holes

- You can make complex shapes by combining and subtracting the primitive (basic) shapes using the group tool.
- Select the objects you want to combine
- And then hit the group button

Make a complex shape

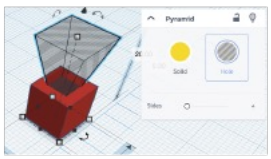
Make a complex 3D shape in 4 steps

1



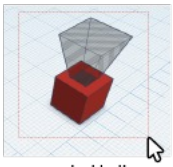
Start with 2 shapes

2



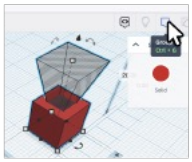
Select one shape and make it a hole

3

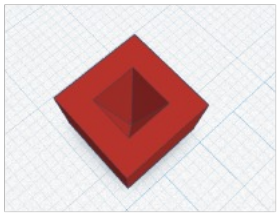


now select both
by dragging a box around them

4

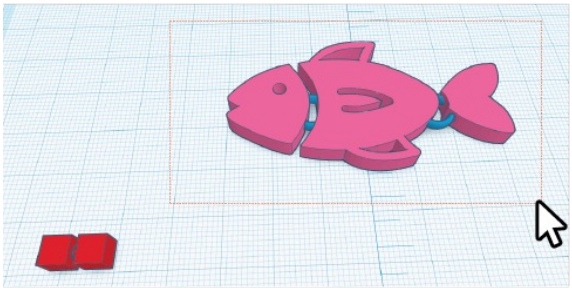


and hit the group button

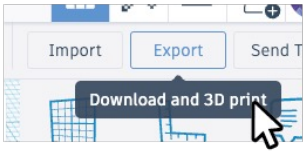


Da Na!

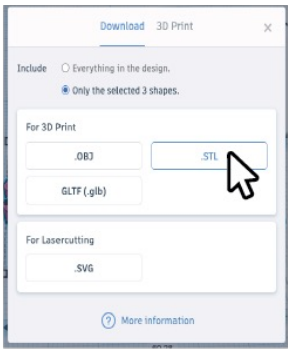
Export your job for printing



select the parts of your design you want to print



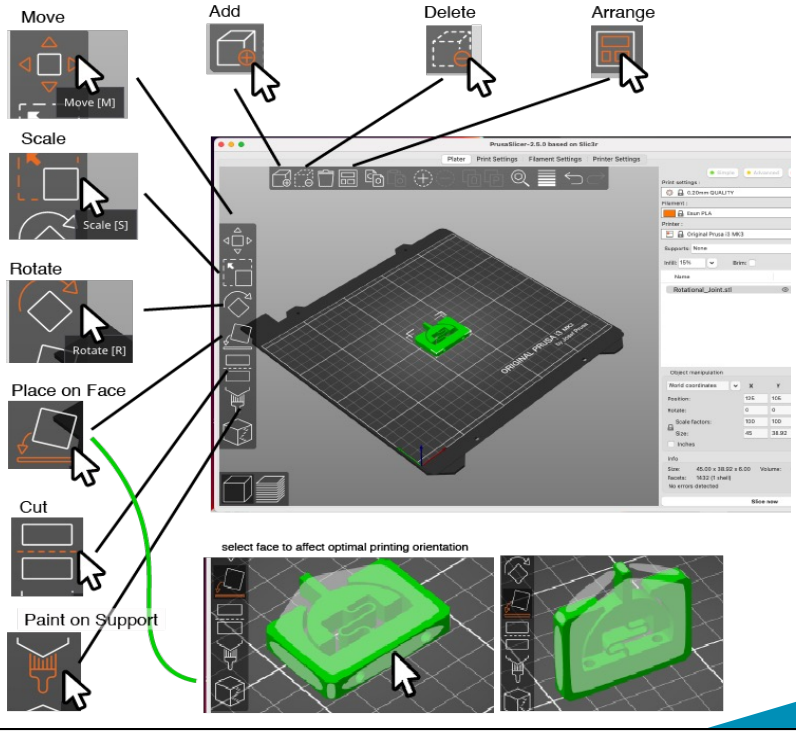
hit the export button



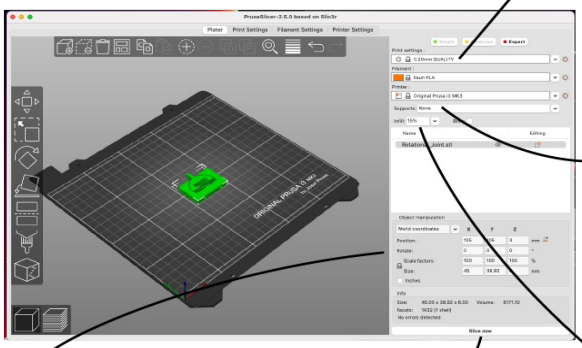
and select STL

Slicing with PrusaSlicer

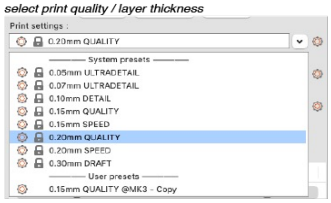
Slicing


Move
Move [M]
Add
Delete
Arrange
Scale
Scale [S]
Rotate
Rotate [R]
Place on Face
Cut
Paint on Support
select face to affect optimal printing orientation

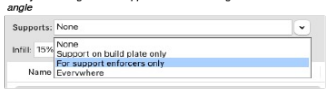
Slicing



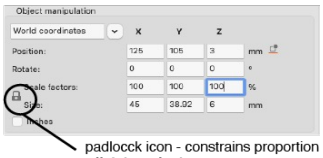
Print Resolution
select print quality / layer thickness



Support - *select support mode*
None - *no support*
Support from build plate only - *only generate support for overhangs directly over build plate.*
For support enforcers only - *generate support structures cooresponding with paint on support*
Everywhere - *generate support where overhang exceeds threshold angle*



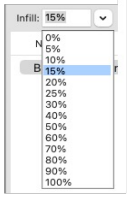
Manipulation
Position and rotate model using X, Y, & Z coordinates.
Scale or resize using percentages or dimensions



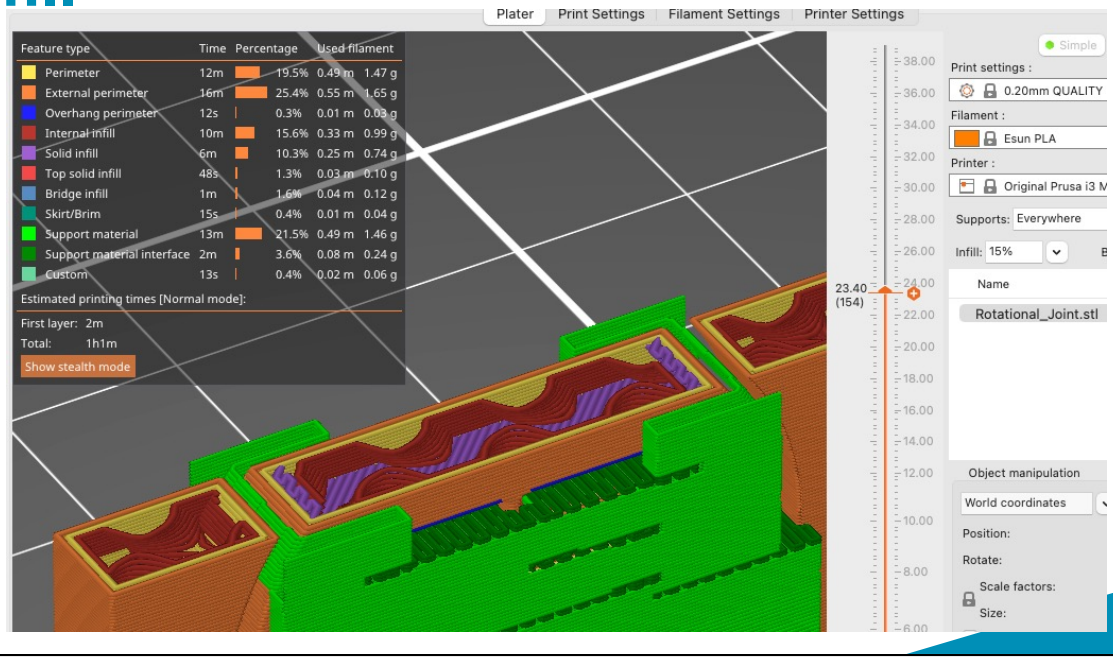
padlocck icon - constrains proportion
click to unlock

Slice Now
Hit slice to preview how your settings will pan out

Infill
select the volume of internal fill matrix added to the intenal spaces of your model.

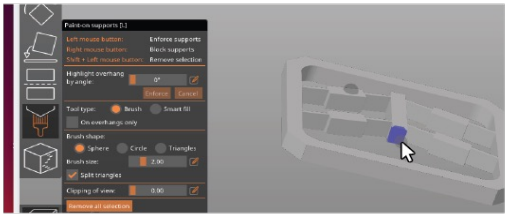


Infill

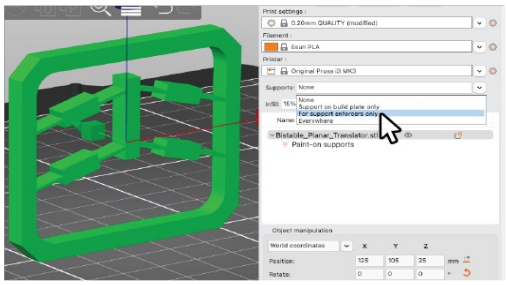

Plater
Print Settings
Filament Settings
Printer Settings
Feature type Time Percentage Used filament
Perimeter 12m 19.5% 0.49 m 1.47 g
External perimeter 16m 25.4% 0.55 m 1.65 g
Overhang perimeter 12s 0.3% 0.01 m 0.03 g
Internal infill 10m 15.6% 0.33 m 0.99 g
Solid infill 6m 10.3% 0.25 m 0.74 g
Top solid infill 48s 1.3% 0.03 m 0.10 g
Bridge infill 1m 1.6% 0.04 m 0.12 g
Skirt/Brim 15s 0.4% 0.01 m 0.04 g
Support material 13m 21.5% 0.49 m 1.46 g
Support material interface 2m 3.6% 0.08 m 0.24 g
Custom 13s 0.4% 0.02 m 0.06 g
Estimated printing times [Normal mode]:
First layer: 2m
Total: 1h1m
Show stealth mode
Simple
Print settings :
0.20mm QUALITY
Filament :
Esun PLA
Printer :
Original Prusa i3 M
Supports: Everywhere
Infill: 15%
Name
Rotational_Joint.stl
23.40
(154)
Object manipulation
World coordinates
Position:
Rotate:
Scale factors:
Size:

Custom Support in PrusaSlicer

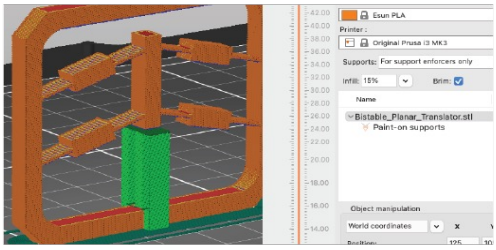
1 Use the **Paint on Support** tool



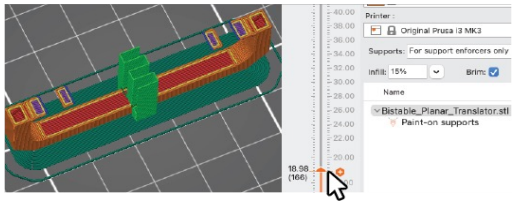
2 Select **for Support enforcers only**



3 Da Da!



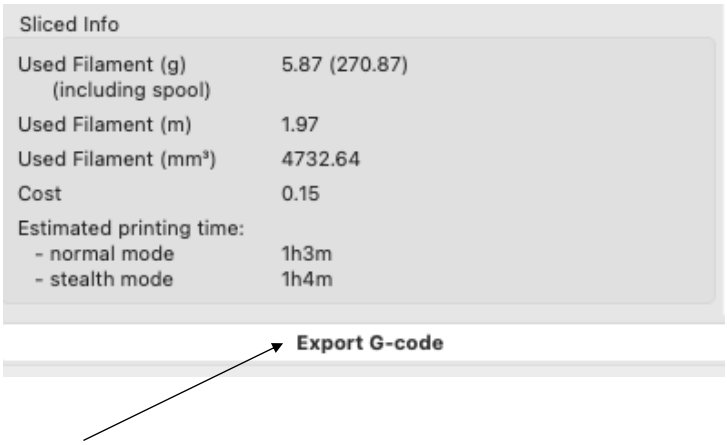
4 Inspect and other print features using the layer /time ruler



Export from PrusaSlicer

Whats it going to cost in terms of Filament and time?

If your happy with these costs when measured against the resolution, infill, support settings…?



Export your print job to an SD card

Finishing your model

Finishing FAQs

What's the best way to removing supports?

What's the best way to removing supports?

- Use a pair of plyers to work the support off. People also use (dental) picks and exacto blades.

- Be patient and try and get it off in one bit or bigger bits if you can't be patient… it will save you more time down the tract

Finishing FAQs

What's the best way to get my model smoother

What's the best way to get my model smoother?

- One good way to get it smoother is to sand it down with sand paper or some smooth files (cheap emery board from the $2 shop work well) Make sure your using the appropriate PPE (breathing protection) if you are going to make any particulates microscale particulates (in a range of materials) have been associated with lung cancer.

- Before you start sanding you may want to consider starting by filling the gaps with a body filler. This way when you sand your model your starting with atleast some of the low points filled in and the sdanding can take of the high points.

- Vapor Bath. We don't recommend this with PLA as the solvents associated with PLA are carcinogens. We can't allow isopropyl vapor baths on site cause trying to heat isopropyl is a good recipe for a bomb.

Finishing FAQs

Can I paint PLA?

Can I paint PLA?

1. If you are going to be painting a print consider whether you want the model to be fully assemble before painting. If so break the model down into parts (this will help with finishing and keep support to a minimum
2. Consider if you need to prime your model before applying paint. This will ensure your top coat especially detail adheres evenly.

3. Top coat / detail use brushes sponges, air brushes to apply acrylic paint

Yeh but don't take my word for it do some experiments

Design time!

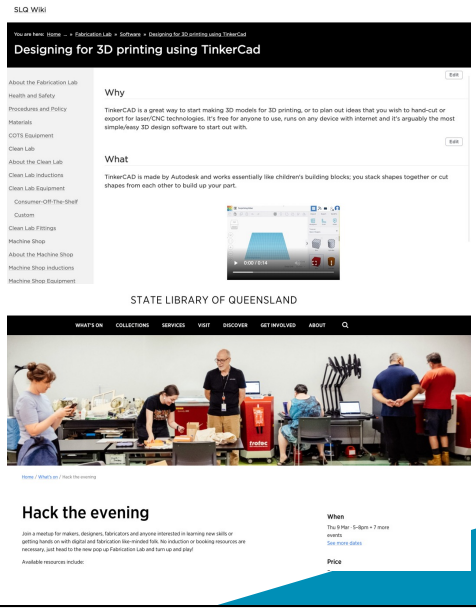
Where to go from here?

SLQwiki –

- There's a version of the tinkercad tutorial is on there.

Hack the Evening

- Come back and print your own designs,
- Get signed off on the induction.
- Talk to people about their projects.



Print-in-place

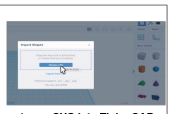
Print-in-Place articulated model in 7* easy steps

**some patience required*

1 **Find a vector artwork to extrude**
I use https://thenounproject.com for creative commons icons

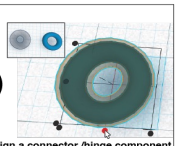
2 **Separate the componets in the vector file**
use you favourite Vector editing program to separate the components and then save as an svg.

Inkscape is free and there's a turorial on the SLQwiki.



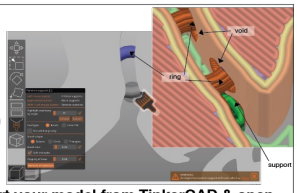
3 **Import your SVG into TinkerCAD**

4 **Separate each of the componets in TinkerCAD**
I make enough different coloured duplicates of my extruded artwork so that I have one for each component. And then go around and delete the other parts.



5 **Design a connector /hinge component**
You need a connector and a void (hole) for this to move in.

6 **Add connectors & then group each of the voids with coresponding components**
This way the connectors (rings in this case) are trapped but also free to move inside each of the link components

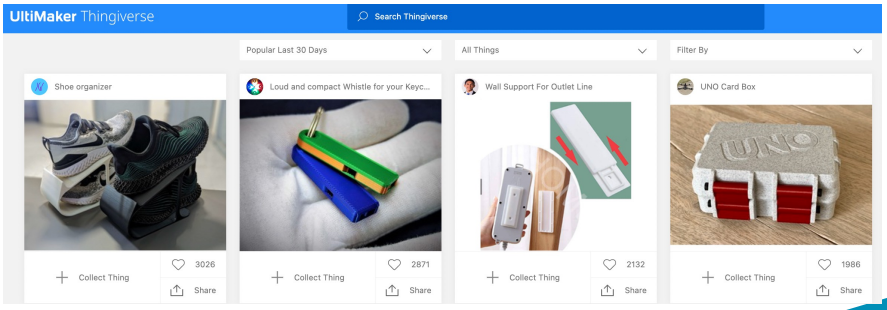


7 **Export your model from TinkerCAD & open it in PrusaSlicer adding support around your connectors**
Use the Paint-on-support tool to add support around the connectors. The support (shown in green) will hold the connector during printing

Where to go from here?

Thingiverse –

- Checkout things other people have designed for 3D printing.
- Save yourself a lot of time designing something someone else has successfully made.
- Remix / customise other peoples designs



Where to go from here?

Functional Print

- Check out the functional solutions people print up on Reddit https://www.reddit.com/r/functionalprint/