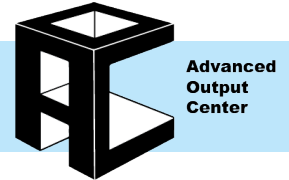


# Guide for 3D Printing



## General Information

Location:

Advanced Output Center, 1232 Sullivan

Access:

Technician-run; Online order form available on the website; Files can be shared over Google Drive; Open to the whole SAIC community (students, faculty, staff, alumni) All payments are through ArtiCard only.



	F370	Objet30 Prime	Formlabs
Max Build Size	14" x 10" x 14"	11.57" x 7.55" x 5.85"	5.7" x 5.7" x 6.9"
Resolution	0.127mm-0.330mm <small>*varies by material</small>	0.016mm	0.1mm-0.025mm <small>*varies by material</small>
Material	ABS, ASA, PC-ABS, TPU plastic in a solid color	Acrylic-like plastic in solid color	Acrylic-like plastic in solid color <small>*specialty materials available</small>
Material Options	White, Ivory, Gray, Black, Red, Orange, Yellow, Blue, or Green ABS. Black or White ASA. Black PC-ABS and TPU.	Clear acrylic	White, Gray, Black, Clear, and Monochromatic in Acrylic-like. Tough, Durable, Elastic, Clear, Gray-Pro*, Rigid*. <small>*add an extra week for ordering time</small>
Build Options	Infill choices: (listed strongest - weakest) Solid High Density Sparse Low Density Strong Low Density Sparse <small>*more infill = more \$</small>	Infill choices: Solid Shelled <small>*shelled may save \$ on larger parts</small>	N/A
Pricing	Model/support: \$5.00/in <sup>3</sup> Build base: \$0.50/2in <sup>2</sup>	Model: \$0.30/gram Support: \$0.18/gram	Model: \$0.50/milliliter
Turnaround	1 Week or less	1 Week or less	1 Week or less
File Types	STL	STL	STL
Applications and Benefits	- Strong, moving parts - Nested Geometry - Parts can be sanded to achieve smooth finish	- Fast printing - Presentation quality prints with highest resolution	-Fast printing -Can do high resolution -Very strong <small>*Tough only</small> -Mold making <small>*castable only</small>
Cost, Time, & Quality	Fast, low cost, but lower quality	Fast, high quality, but expensive	High quality, low cost, but potentially slow

## Model Preparation in Rhino

These instructions assume a basic working knowledge of modeling in Rhino. If you are unsure about your modeling skill, we recommend that you work with a faculty member who can guide you through the modeling process. You can also visit the AOC's website for links to helpful tutorials (see the URL at the bottom of this page). Remember, modeling is a skill; it can take months and even years of practice to become proficient!

### UNITS

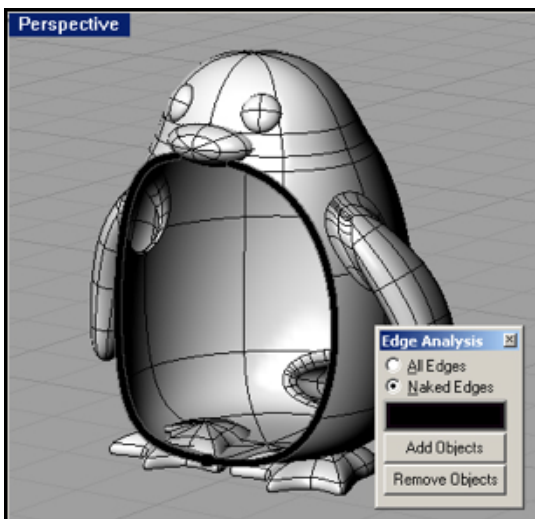
We recommend modeling in either inches or millimeters, especially if accuracy of size is important to your part. The units you use during modeling must correspond to the actual units used during output. To set the units, click on 'File -> Properties...' then click on 'Units.' Set the 'Model Units:' to either inches or millimeters.

### CHECKING FOR NAKED EDGES

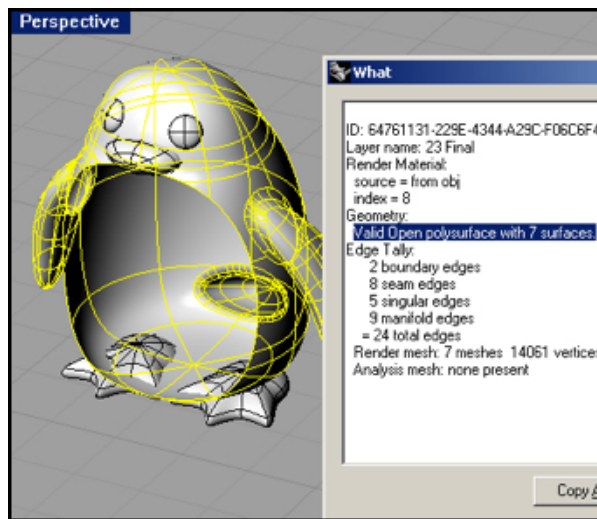
In order to output a correct .STL file for prototyping, NURBS objects in Rhino must be closed solids/polysurfaces (a.k.a "watertight" objects). This means your object can have no naked or unjoined edges.

This is one way to check for naked/unjoined edges during the modeling process (Fig. 1):

- Type the command ShowEdges into the command line, then hit Enter.
- You will be prompted to Select surfaces, polysurfaces or meshes for edge display. Select the object(s) you want to check, then hit Enter.
- This will bring up the Edge Analysis dialog. Select the radio button next to Naked Edges. All naked edges will be displayed highlighted in the color shown.



(Fig. 1) Edge Analysis



(Fig. 2) What Command

This is another way to check for naked/unjoined edges during the modeling process (Fig. 2):

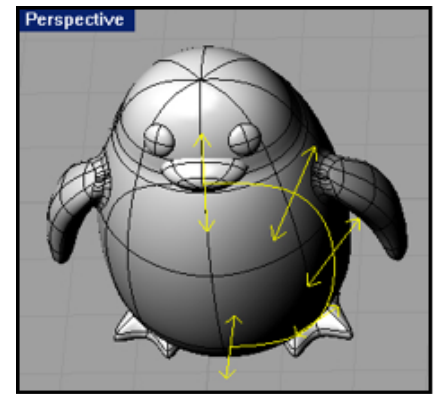
- Type the command What into the command line, then hit Enter.
- You will be prompted to Select objects. Select the object(s) you want to check, then hit Enter.
- This will bring up the What dialog. Look under the heading 'Geometry'; the object is described as open or closed (closed & valid = good; open &/or invalid = bad).

**NOTE:** We strongly recommend a periodic check of your model for naked edges as you work. Don't wait until you think your model is finished; check often and fix naked edges as you find them.

## Repairing naked Edges

To join two naked edges once they have been located:

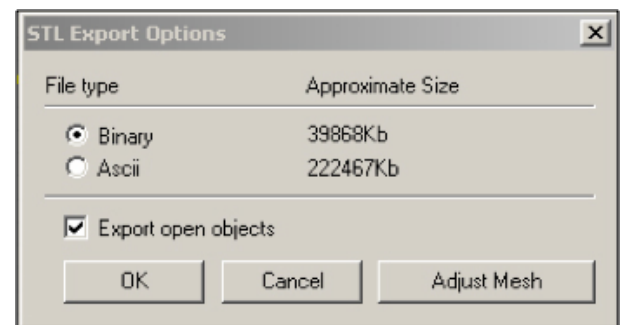
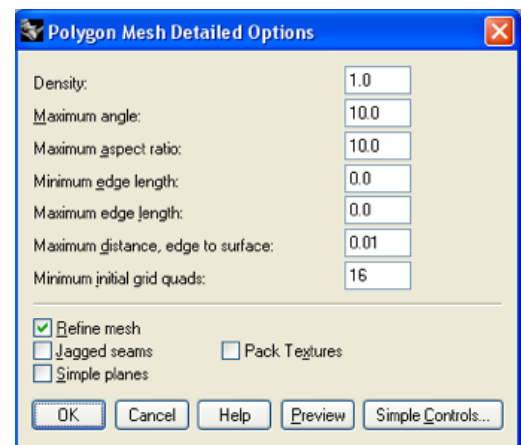
- Type the command JoinEdge into the command line, then hit Enter.
- You will be prompted to Select two unjoined edges. Select the edges you want to join, then hit Enter.



## .STL Export

Once your model has been made into a valid closed surface with no thin parts, you can export it to the .STL file format.

- Select the object you want to export. Models that will end up being physically separate pieces must be exported as individual STL files.
- Click on 'File -> Export Selected...'
- Name your file and set the 'Save as Type:' option to 'Stereolithography [\*.STL]', then click Save.
- In the 'Polygon Mesh Detailed Options' dialog, enter the settings for polygon conversion.
- You can preview the mesh settings, or export directly to an .STL in binary format.

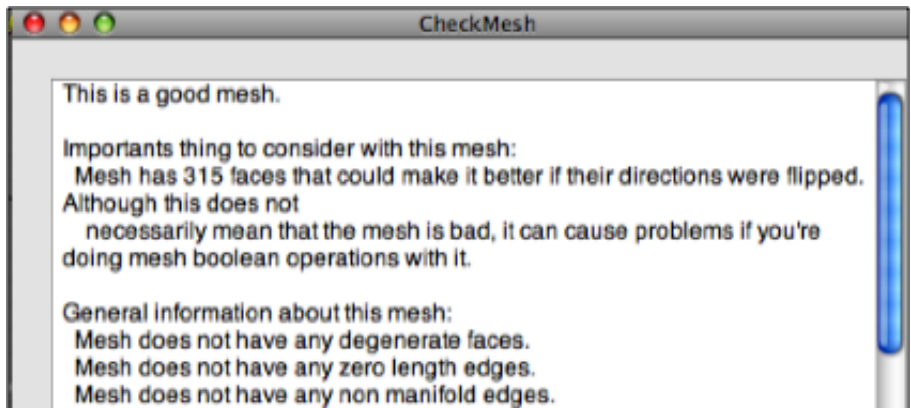
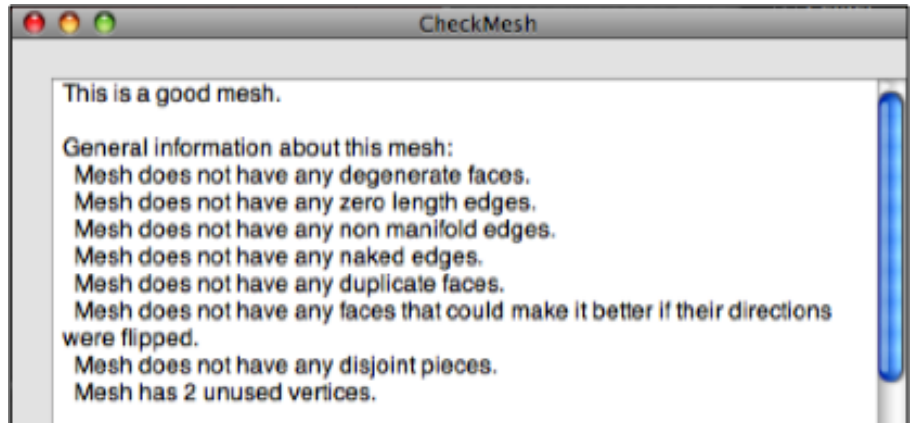


NOTE: These settings are recommendations only, and may not be ideal for all parts. These settings may produce extremely large .STL files. Files over 50MB will not be accepted.

## Checking Meshes

Sometimes errors in mesh export occur, even if the original model is a valid, closed polysurface. Bad meshes can lead to output problems including missing parts and the inability of the printer to process the file. Here's how to check for common problems in your exported mesh:

- Start a new file in Rhino. Make sure to use the same units as your original file.
- Click on 'File -> Import...' and select the .STL you just saved out. The mesh will import.
- Highlight the mesh by clicking on it, then type 'Check' into the command line. A message box will appear listing any problems with the mesh.
- Open the Rhino help file, and search for 'Check.' Refer to the help file page for specific commands to correct any problems in your mesh.
- Meshes are not always able to be fixed using Check. Sometimes it is best to go back to the original NURBS model to fix meshing problems.
- Once your mesh is fixed, save as an .STL and proceed to the Pre-Processing instructions.



**NOTE:** CheckMesh may report a good mesh with minor problems listed under Important things.... Some of these minor problems, such as reversed normals, can prevent the 3D printer from properly processing a file.

## Pre-Processing Your File for the Objet 30 Prime

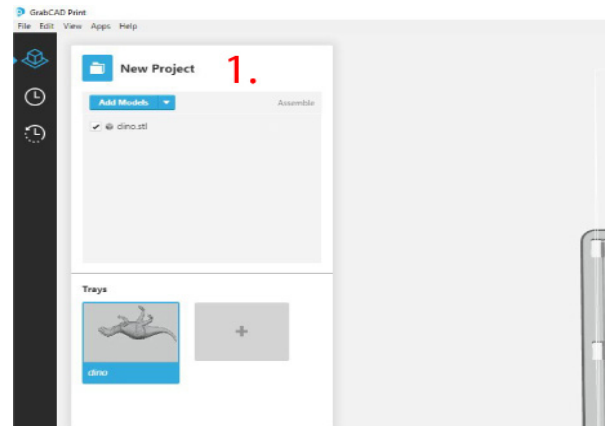
Unfortunately the Objet software is unable to be distributed. As long as you have a valid STL you can request a price quote on job submission.

## Pre-Processing Your File for the F370

Once your .STL is exported, you can use the GrabCAD software installed on all AOC computers to ensure that it will process correctly, as well as to estimate the material costs of your file.

Click on 'Start' and start typing 'GrabCAD'. Click 'GrabCAD Print' when it pops up on the right.

1. Click on 'Add Models' in the New Project tab on the upper left and navigate to your .stl file(s).
2. If your models have a red warning icon next to them in the top tab they will need to be repaired. This can be done in analysis mode.
3. Adjust printing options on the right with model selected:
  - Layer resolution: Set to desired resolution in mm.
  - Model interior: Set based on how strong and expensive you want the print to be.
    - Solid is most strong and expensive, followed by High Density, then Sparse Double Dense (We call this Low Density Strong on submission) and Low Density Sparse is the weakest and cheapest.
  - Support fill: Set to SMART.
  - STL units: Inches or Millimeters (match units used during modeling).
  - STL scale: Always leave on 1. Set scaling in Rhino instead.



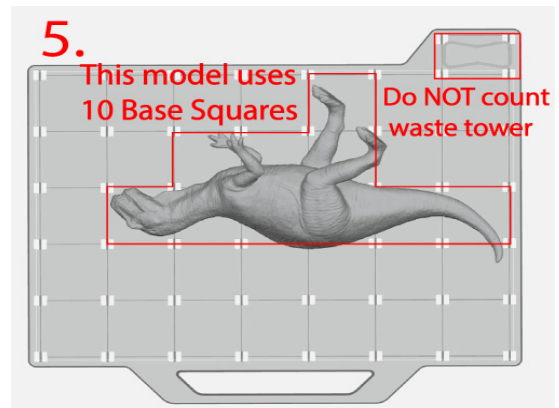
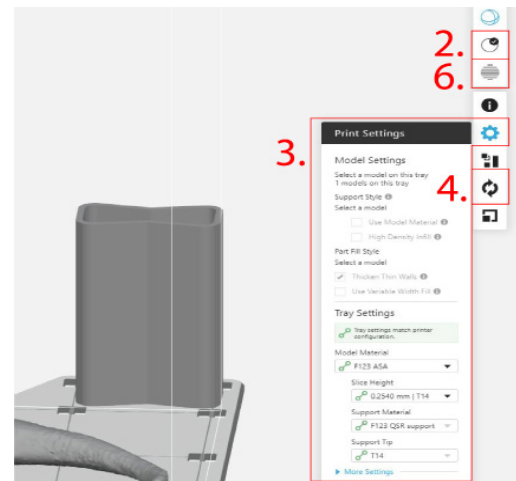
4. In the Orient menu, orient your model as desired or use Auto Orient to have the program find a good orientation.

5. Place your models on the tray as best they can be arranged. Take note of how many base squares your models use, as that will be part of the cost. The waste tower does not count towards the cost of your print.

6. Click the Slice option now to generate the tool path. Once this is finished you will see your object in layer view.

7. You can now calculate your cost. Click the estimate button to get material usage totals, then take those numbers and the base squares from earlier to calculate the cost using the formula below.

$$\begin{aligned}
 &\text{model consumption} \times \text{model cost} \\
 &+ \\
 &\text{support consumption} \times \text{support cost} \\
 &+ \\
 &\# \text{ of base squares} \times \text{base square cost} \\
 &= \text{TOTAL COST}
 \end{aligned}$$



Tray Estimations		
dino	Print Time	1d 10h 5 6m
	Model Material (cm <sup>3</sup> )	364.466
	Support Material (cm <sup>3</sup> )	114.061

**NOTE:** Material and cost totals calculated during pre-processing are estimates only. The 'Time' reading under 'Build Estimates' is NOT the turnaround time for your file. Turnaround time depends on the size of your part as well as the number of 3D print jobs ahead of yours. The AOC cannot guarantee any turnaround time less than 1 week; ask a lab monitor for details about turnaround times.

## Pre-Processing Your File for the Formlabs

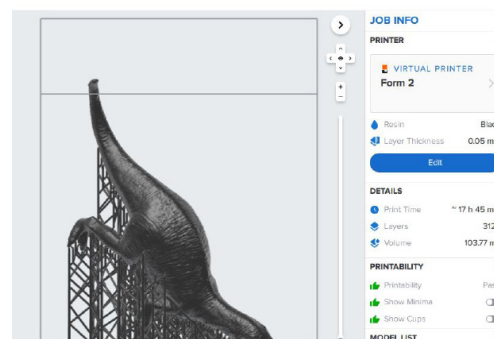
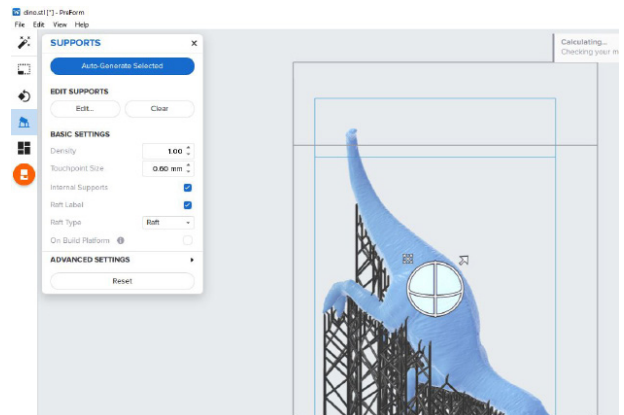
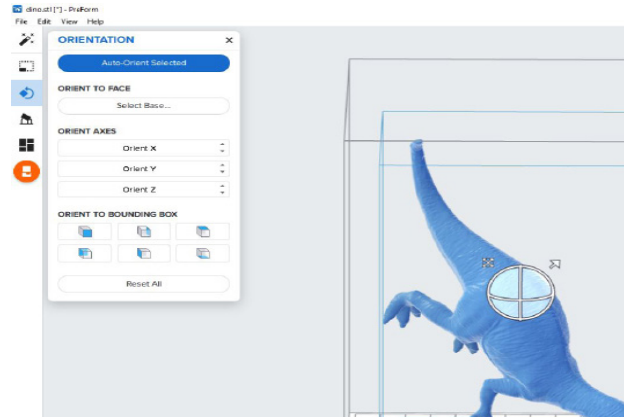
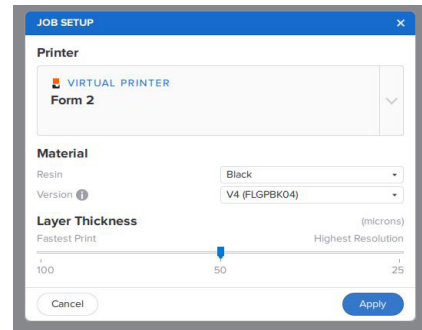
Once your .STL is exported, you can use the Preform software installed on all AOC computers to ensure that it will process correctly, as well as to estimate the material costs of your file. Preform is a free program and is available for Mac and PC so you can install it on your own computer by visiting Form Labs' website.

On the lab computers:

Click on 'Start' and start typing 'Preform'. Click 'Preform' when it pops up on the right.

1. A window will pop up asking you to choose your printer, material and resolution. Choose Virtual Printer Form 2 for the printer and enter the model material you wish to use. Resolution does not matter for price estimate, though it will change the estimated time.
2. Click on 'File' → 'Open...' and navigate to the folder where your .STL file is saved.
3. Once you've brought your model into the software, you will see a preview of it on the gridded platform. Click the model to select it and it will turn blue. The 6 buttons on the left side of the software outline processing categories. Do not scale your model in this software as it should already be scaled. Click on the 3rd button down and orient your model by clicking the 'Orient Selected' button.
4. Next, click the next button down and hit "Generate Selected" to generate the support system. Leave the support options at their defaults.
5. At this point, you can estimate your cost. On the right of the software, you will see a panel of information under Job Info. The important value here is the 'Volume' which will be displayed in milliliters. Use this value along with the equation below to calculate your estimated cost.

$$\text{model consumption} \times \text{model cost} = \text{TOTAL COST}$$



**NOTE:** Material and cost totals calculated during pre-processing are estimates only. The 'Time' reading under 'Build Estimates' is NOT the turnaround time for your file. Turnaround time depends on the size of your part as well as the number of 3D print jobs ahead of yours. The AOC cannot guarantee any turnaround time less than 1 week; ask a lab monitor for details about turnaround times.

## File Submission

When you're ready to submit your job, fill out the online order form located on the AOC site under "3D Printing". Each printer has its own form, so make sure you select the right one. The form contains options like color, finish, model fill, and quantity. If you have multiple print configurations (different quantities, color, etc.), please submit one form for each configuration.

You can send us your files using Google Drive by supplying a link on the order form. When submitting multiple files using the same configuration, compress them to a .ZIP archive before uploading to Google Drive.

### 3D Printing File Checklist

- No parts thinner than 0.04"/1mm
- Solid .STL, with no open edges
- When possible, export one .STL file per physically separate part
- .STL file size less than 50MB each
- .STL file preprocessed in Catalyst, Objet Studio, or Netfabb Studio to check for errors

***Remember, you are responsible for the files you submit.***

***Calculate your price, we do not provide quotes and will start printing as soon as we receive your file  
Check for errors and check your wall thickness.***

***If you submit an invalid file, we can't guarantee that it will print successfully.***

***If you submit fragile geometry, we can't guarantee that it will stay in one piece.***

## Payment and Pickup

The AOC will send an email notification as soon as your 3D print job is finished. Payment is due via ArtiCard when your prints are picked up.

### Properties of a 3D Print: What to Expect

3D printed parts will have a slightly ridged surface due to the way the printer outputs material. Depending on the shape of your parts, this will be more or less apparent. On the F370 Parts will have a 'seam', or a slightly raised line where the extruded plastic sometimes layers up on itself.

This surface, including the 'seam', can be left as is or sanded down and/or covered with primer to achieve a smooth finish. ABS machines and sands very easily; solid ABS is durable enough to be used for mechanical parts. We recommend parts that will be sanded or machined be printed with a solid material fill.

This "seam" does not occur on Objet 30 prints or Formlabs.

Feel free to ask a lab monitor for sample parts to get an idea of standard resolution and surface quality.

# Pricing

<b>Objet30 Pro</b>	
Model Material	\$0.30 / gram
Support Material	\$0.18 / gram

<b>F370</b>	
ABS Model Material	\$5.00 / in <sup>3</sup>
Soluble Support Material	\$5.00 / in <sup>3</sup>
Printing Base Area	\$0.50/ 2in <sup>2</sup>

<b>Formlabs</b>	
Model Material	\$0.50 / ml