

## Digital Modeling Series

# 3D Color Printing

3D Color Printing is a new capability through the Design Shop 3D printing services. The quality of the 3D prints is impressive but requires special setup to make it succeed. Mistakes in the modeling, choice of colors and creation of textures/labels can be costly. 3D Color Prints cost 2 - 3 times as much as a normal 3D prints.

This guide has five sections: overview of the process, 3D color printing pro & cons, modeling consideration, KeyShot file setup, and GrabCAD print file setup. Unlike other 3D printing projects where you only send a STL file, 3D color printing works best setting up and sending the GrabCAD print file so you can control colors and transparencies.setup, and



# Overview

3D color printing involves exporting the file from KeyShot in the 3MF format (Figure 2). 3MF stands for 3D manufacturing format, which is an industry-standard format to fully define a model's color, texture, manufacturing, etc. Exporting from KeyShot is an easy step with few options. The challenge is properly modeling the form (so colors, textures, transparency, etc show correctly). Once the file is exported in the 3MF format, it is then imported into GrabCAD print program, which is setup to match the Design Shop's color printer. This helps to guarantee a successful print.

Figure 1 - Solid form in Fusion 360, Solid-Works or other CAD programs

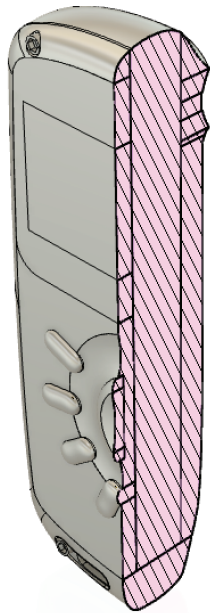


Figure 2 - KeyShot file is setup with materials, colors, textures, etc.

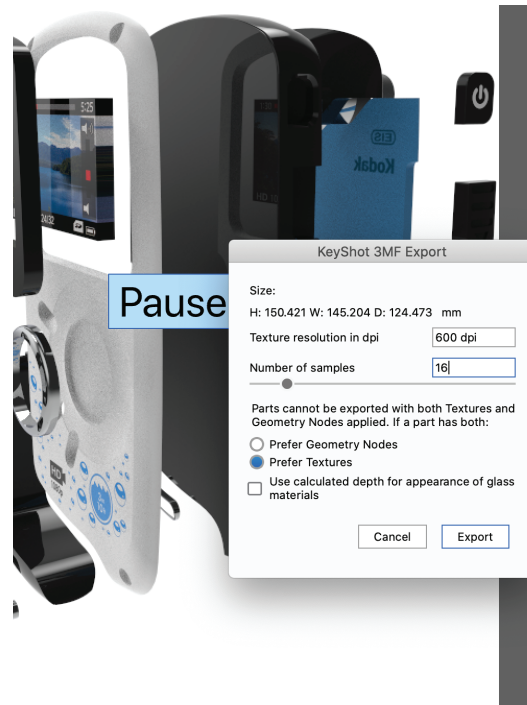


Figure 3 - GrabCAD print is used to setup the actual print



# Is Color Printing Worth it?

3D color printing can produce amazing results but has some issues. First is cost. In general, parts can cause 3-4 times as much as an FDM print. Below are examples of part cost: A - \$106.20, B - \$122.15, C - \$62.88, D - \$40.98, E - \$70.58 and F - \$40.64. One thing to note ... If a group of parts are printed together, the overall price is less. For example, instead of printing the silverware sets individually (\$152.20 total), printing them together only would cost \$123.09.

Figure 1 - Stud finder & mice models

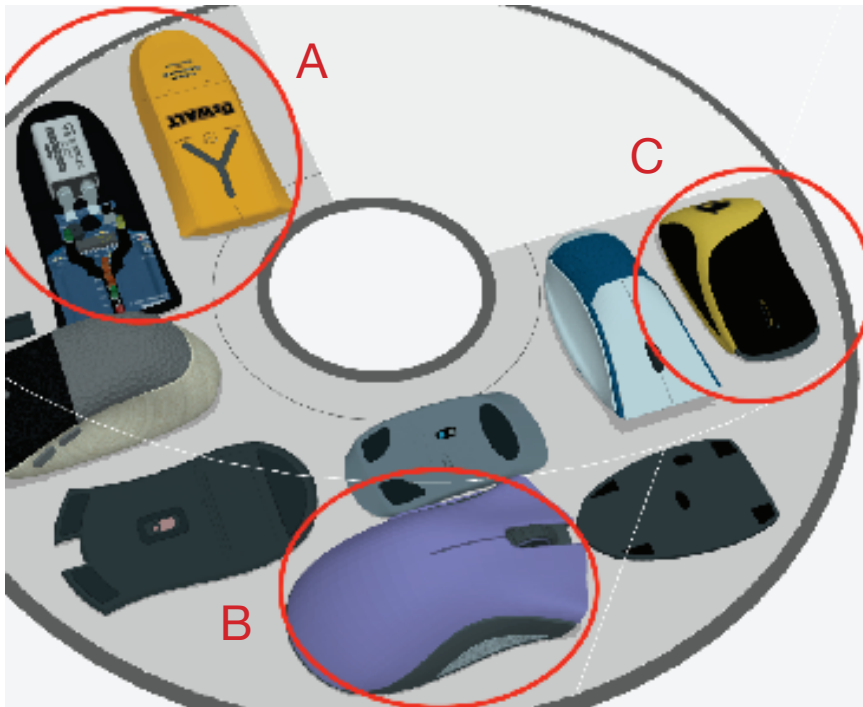
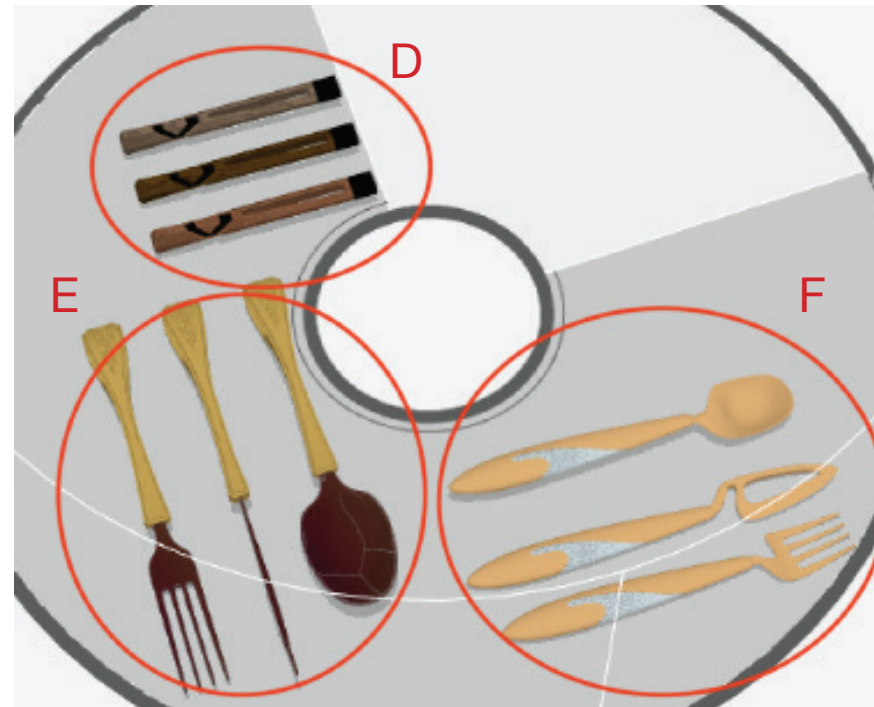


Figure 2 - Silverware Sets (D is handles only)



# Modeling Rework

As noted in the next section, Modeling Consideration, you may want to remodel the form so it actually prints (Figure 1), textures and labels are properly applied ((Figure 2), solid and transparent areas look correct (Figure 3), etc.

Figure 1 - Form failed



Figure 2 - Graphics Resolution (600 dpi)



Figure 3 - A solid shell with bottom open to allow supports to be removed



# Material Accuracy

As noted in the next section, Modeling Consideration, you may want to remodel the form so it actually prints, textures and labels are properly applied, solid and transparent areas look correct, etc.

Figure 1 - Stud finder & mice models



Figure 2 - Silverware Sets (D is handles only)



# Solid Form

To print properly, the model must be a solid form (Figure 1). Surface modeling and forms with thin outer shells (Figure 2) may print but will not be stable and can fall apart after printing. Avoid having interior voids so the form is solid throughout.

Figure 1 - Solid form

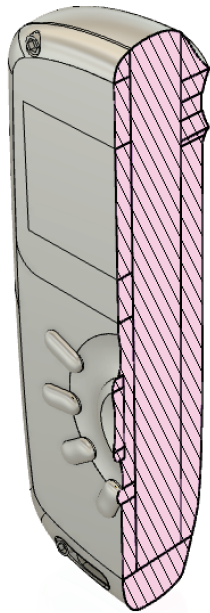


Figure 2 - Failed print, form was mostly a shell with internal support material



Figure 3 - A solid shell with bottom open to allow supports to be removed



# Thickness

Thin wall forms such as the hollow mouse (Figure 3) can print. The minimum wall thickness is 1 mm (thicker is better) and the support material used inside the form can easily be removed. Surface or face splits can be used as long as the area is thicker than 1 mm (Figure 2).

Thin forms in front of other forms can cause issues. Solid colors can appear to be translucent even if they are not. Additionally, a form that is thicker in one area and transitions to a thinner area can have different appearances through the form. Try to model so the form has an even thickness or separate into different forms.

Figure 1 - Solid form with enough thickness



Figure 2 - Areas too thin - blue shows through white areas.

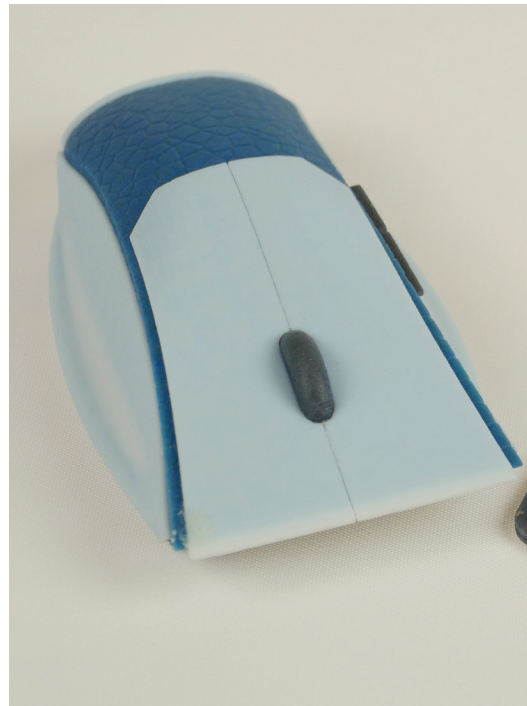


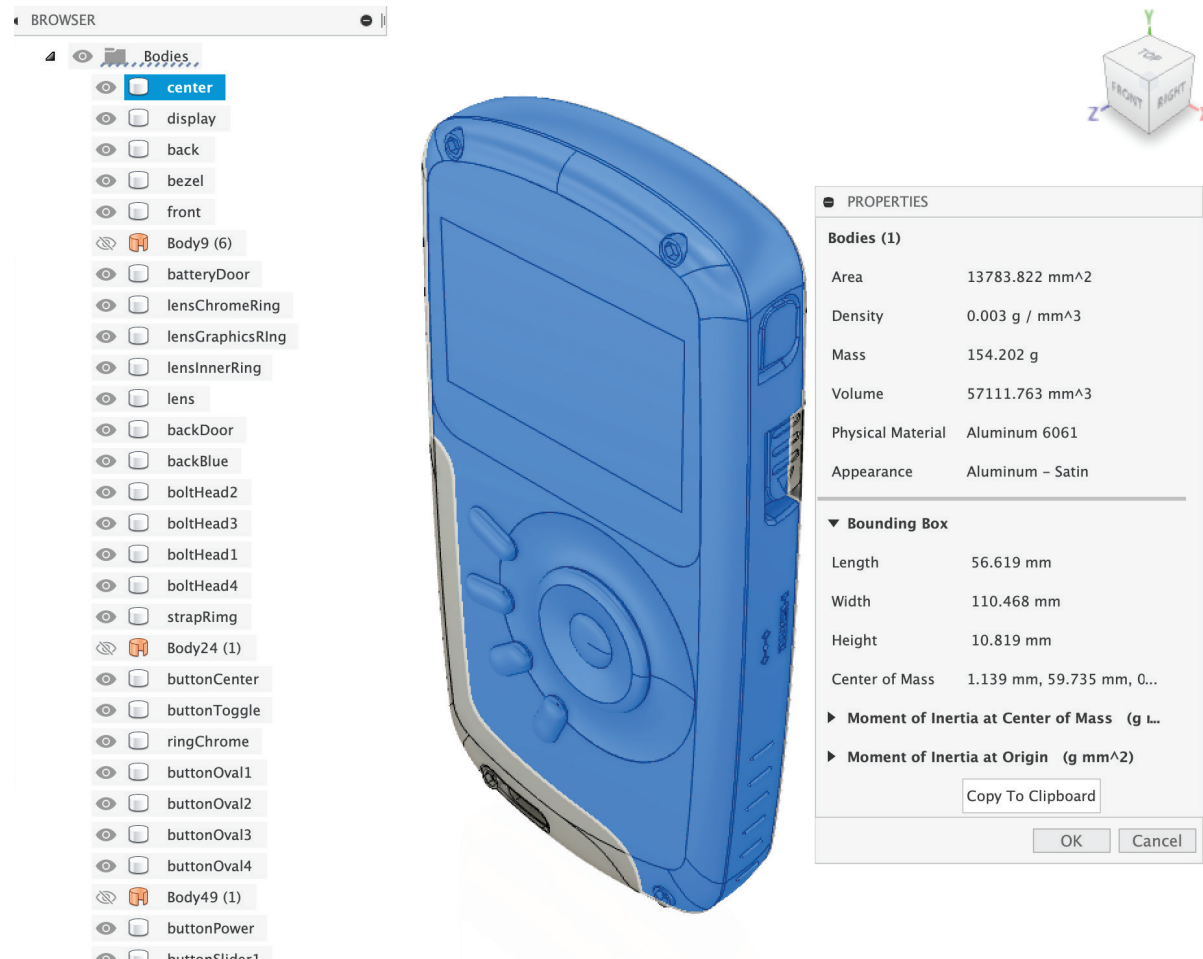
Figure 3 - A solid shell with bottom open to allow supports to be removed



# Scale and Units

Throughout the preparation process, make sure the model is the correct scale and units. If the scale or units need to be changed, it is best to go back to the CAD program (Fusion 360, SolidWorks, etc), correct it there and then import into KeyShot. Check the size in KeyShot and GrabCAD print to insure the scale or units do not change.

Figure 1 - In Fusion 360, right-mouse click on a body and choose Properties. Open the Bounding Box tab to see the physical size of the body.





# Solid Color Area

When 3D color printing, color areas should be at least 2 mm thick (Figure 1 & 2). This will ensure accurate and vibrant colors since the inside of the inner shell will be printed in white. Areas less than 1 mm will appear less accurate and less vibrant since there is no area for the white inner shell. For light or white colors, the edges will appear to have color bleed. In Figure 3, the white edges appear blue because you see through the material to the black areas around it.

Figure 1 - Each color area was modeled as a separate solid.



Figure 2 - Creating solid, color areas was cared throughout the model

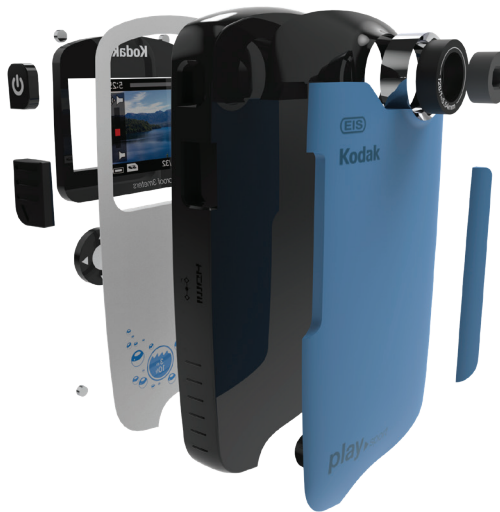


Figure 3 - The white area around the edges looks like it has color bleed.



# Material Choices

There are many material types in KeyShot that can be color printed. The more advance materials should be avoided .

## Prefer

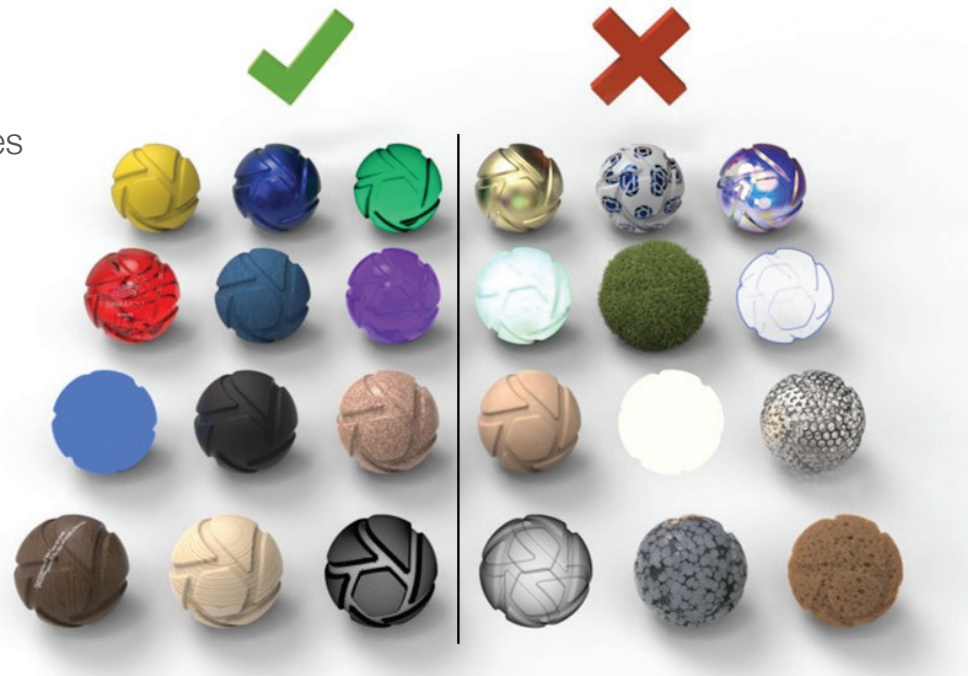
- Paint
- Plastics
- Textures - procedural and mapped
- Metal color
- Most transparencies
- Labels
- Gradients
- Displacement
- Bump
- Wood, stone, fabric

## Avoid

- Fuzz
- Sub-surface
- Reflective
- Light
- Real metal
- Soft
- X-Ray
- Cutaway
- Other render-only appearances

Material finish (matte/glossy) and transparency should be set in the print program. These values do not transfer directly into the 3D color print.

The chrome material does not work for printing. It will render in white. Choose a grey value to represent the chrome when printing.



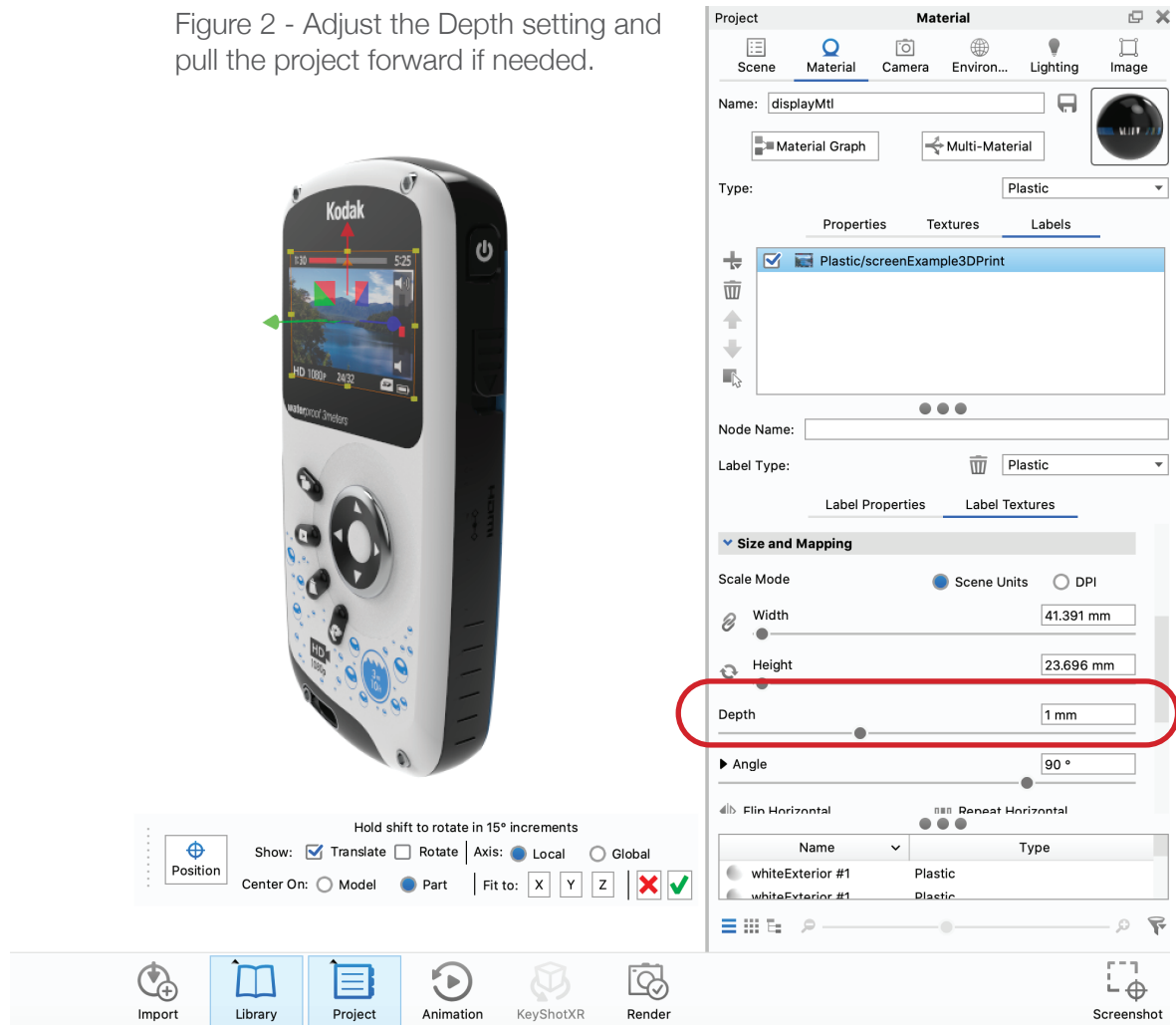
# Solid Texture/Label Areas

Materials with textures such as wood or marble and labels applied to a product print really well. These definitely can add to the realism and finish of a model. If using a image, make sure the resolution is a minimum of 300 dpi. Apply the texture or label as normal. The main consideration is that textures/labels appear throughout the area unless the depth is set (Figure 1). Use the Depth setting to limit the depth into the area (Figure 2) if both sides will be seen.

Figure 1 - A mirror version of the model pieces is shown on the right.



Figure 2 - Adjust the Depth setting and pull the project forward if needed.



# Texture/Label Resolution

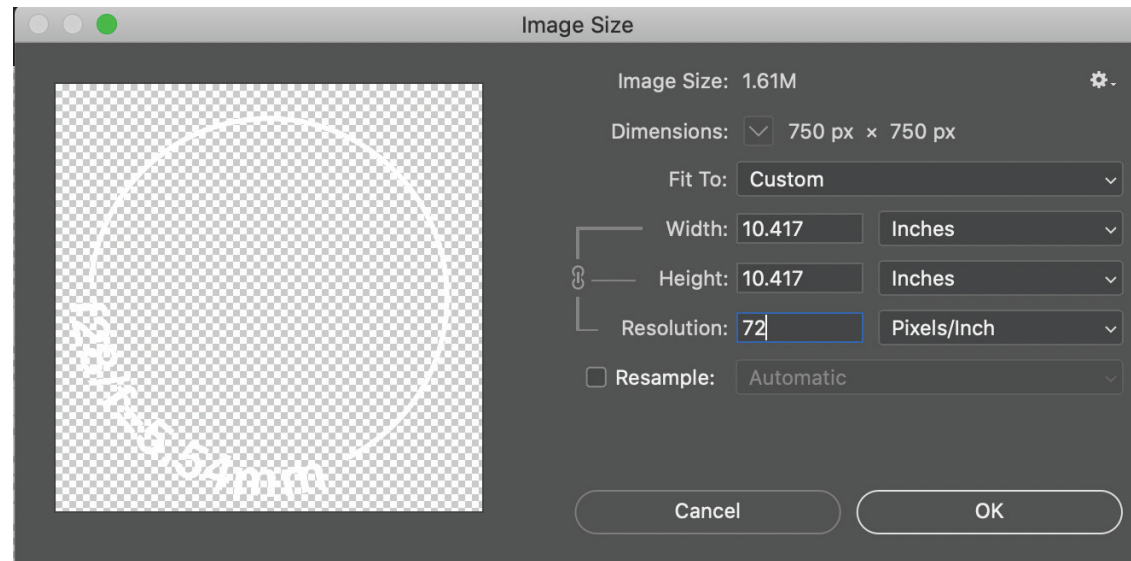
The minimum resolution for textures and labels should be between 300 - 600 dpi. This will insure that the textures and labels on the 3D print will look correct and sharp. The height and width of the image can vary depending on the area it is applied. Figure 2 shows how resolution depends on file size.

If there is a base material, the color needs to be set as close as possible to the finish color. Trying to adjust the color in the GrabCAD print program will cause the label to disappear. Using a PANTONE color that matches one of the PANTONE colors in the GrabCAD print program can help avoid colors that change on printing.

Figure 1 - Label as it appears in the rendering.

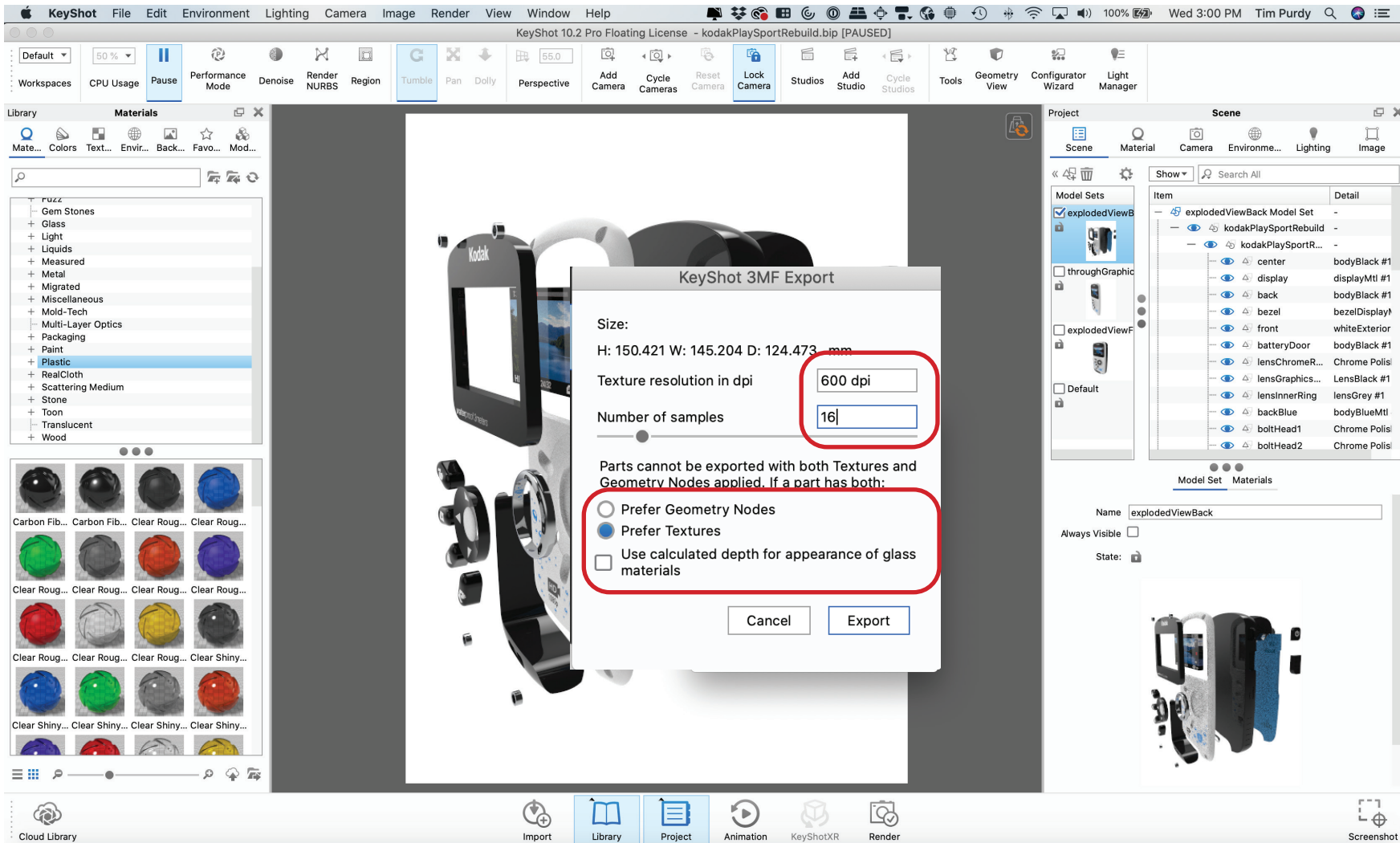


Figure 2 - Actual DPI is 72 pixel/Inch but the size is 10.41". The label will be 1" square in the model. When the size is set to 1", the resolution jumps to 750 dpi.



# Export Settings

Setup in KeyShot follows a normal rendering process but with special consideration regarding material type, material finish, use of transparency and label resolution. These are address in the following pages. Once the model is setup properly, it is exported out as a 3mf format (File > Export > Export to 3MF ...). The image shows the settings that should be used for the export.



# GrabCAD Print - Setup

Setup for GrabCAD print requires selecting the correct printer and then adjusting the materials in the Tray so they match the configuration in the Design Shop. Start the program and look for the pop menu in the bottom, right corner (Figure 1). Underneath the “Printer Templates (PolyJet)” popup, select the Statasys J55 Prime template. There maybe other J55 templates in the list, so verify it is the J55 Prime template. Next, click on the Tray Settings icon. Make sure the tray materials match the list in Figure 2. If not, then click select the Change button. Remove the extra material and add in any missing materials, usually the UltraClearS (Figure 3). Click on Save.

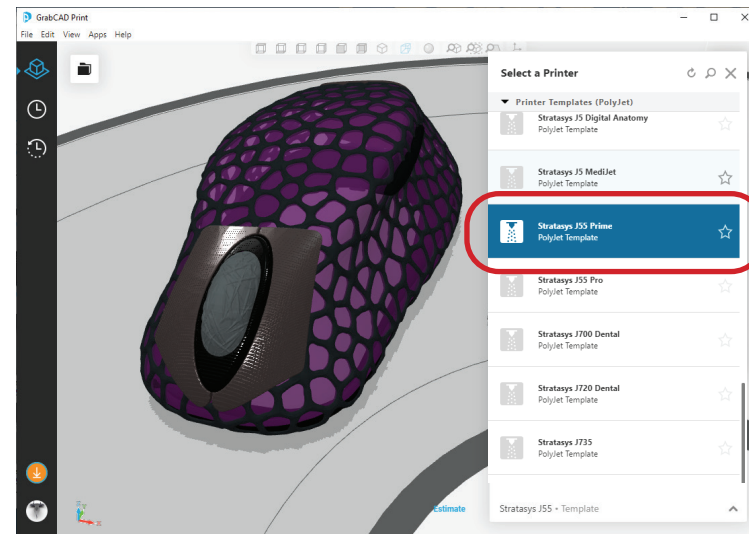


Figure 1 - Select Printer

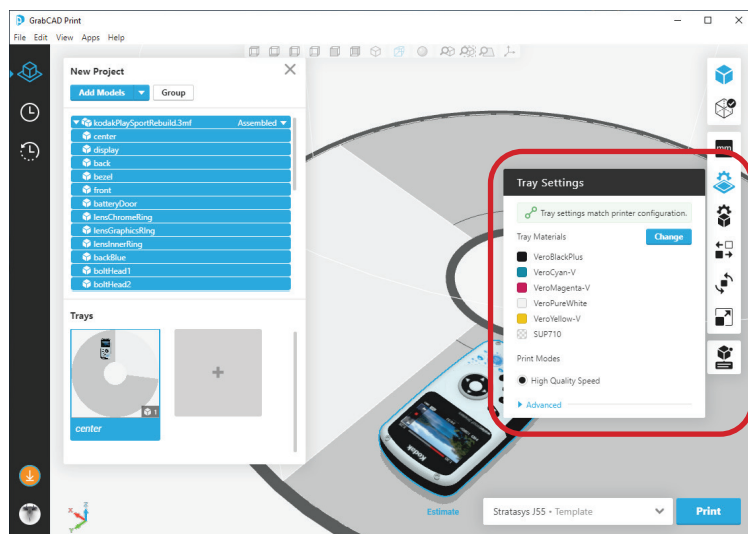


Figure 2 - Verify Tray Materials

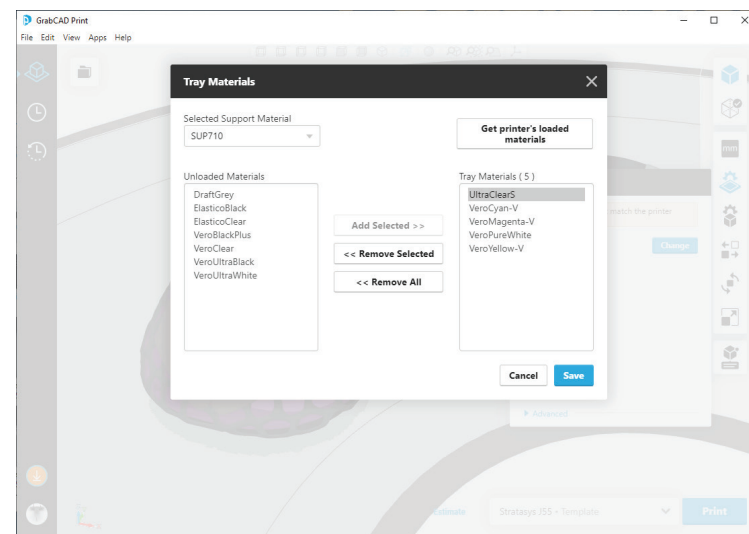


Figure 3 - Remove and Add Tray Materials

# GrabCAD Print - Resolve Errors

Models imported into GrabCAD Print usually have errors (Figure 1). Select the Analysis Model button (Figure 2) and then choose Repair All Models buttons. This will usually repair the model and remove all the errors. If not, there maybe other issues with the model that need to be addressed in the 3D modeling.

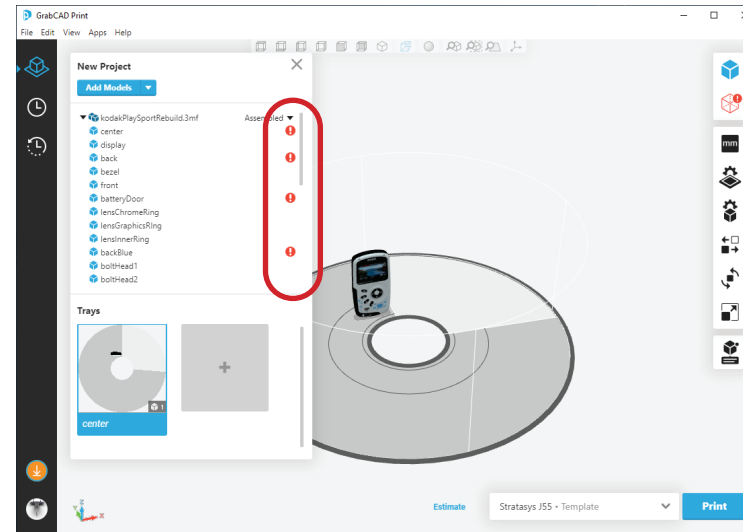


Figure 1 - Import models usually have errors

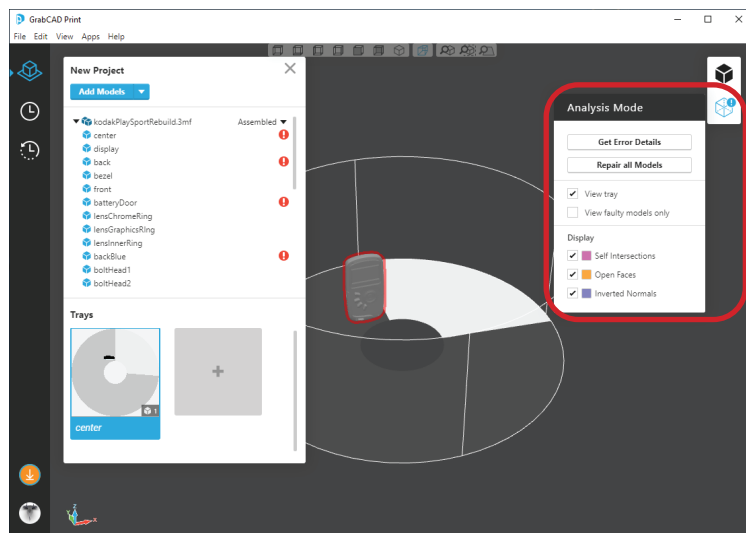


Figure 2 - Use the Repair all Models button

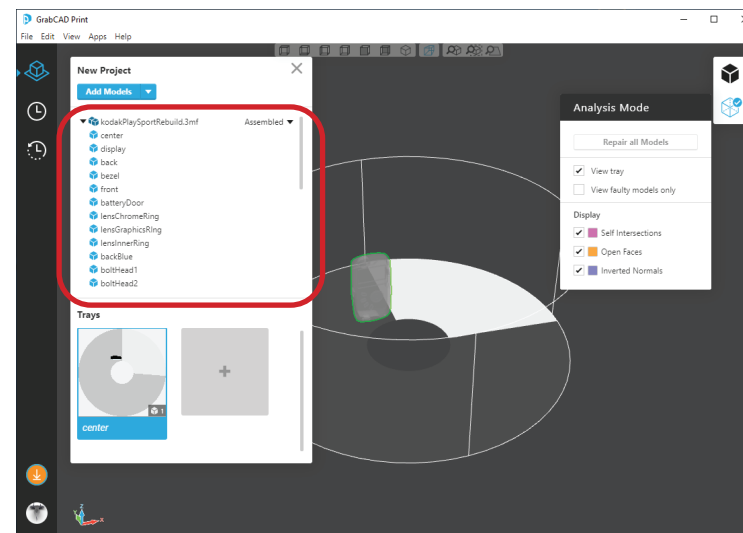


Figure 3 - List indicates no errors

# GrabCAD Print - Orientation and Placement

Models may need to be rotated using the Orient option (Figure 1). Marks from the support structures are usually not an issue. However, if materials with glossy finish, then the model needs to be oriented so the surface face up. Using the interactive plane, place it on the reference surface that will be facing down and choose Bottom (Figure 2). Make sure the models sits completely in the grey area of the print bed (Figure 3).

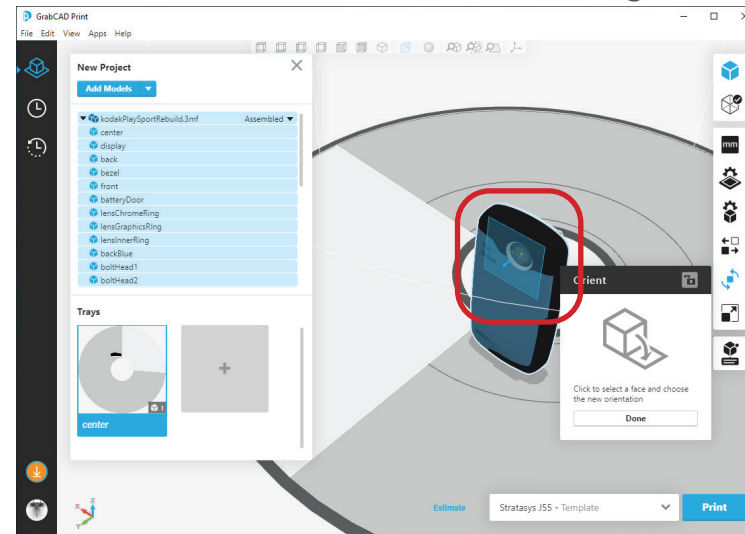


Figure 1 - Orient Tool

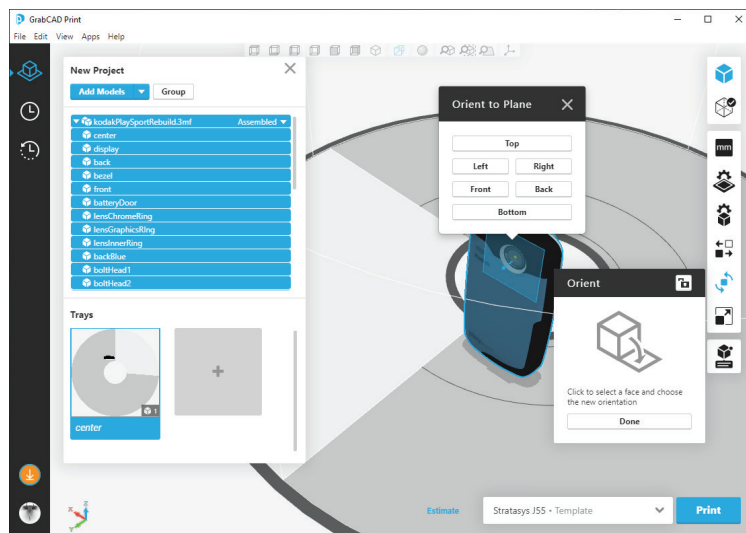


Figure 2 - Select Surface & Bottom

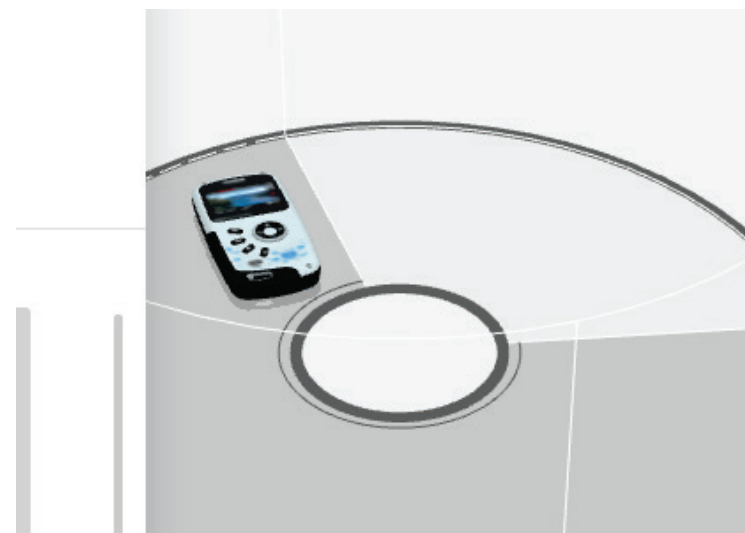


Figure 3 - Model must sit within the grey area



# GrabCAD Print - Colors

There are four different methods to define colors: PANTONE, Color Picker, CMYK, Tray. Switching between the different methods is allowed.

The Tray method limits you to only picking the different colors that are available in the printer's tray.

If matching a print piece, then the CMYK method might be a good choice.

If Color Picker is chosen, the Selected vs Actual swatches will be display. This is a good way to make sure the color will not shift when printing.

Use Patone as a way to easily match colors between KeyShot & GrabCAD Print. How to do this is covered on the next page.

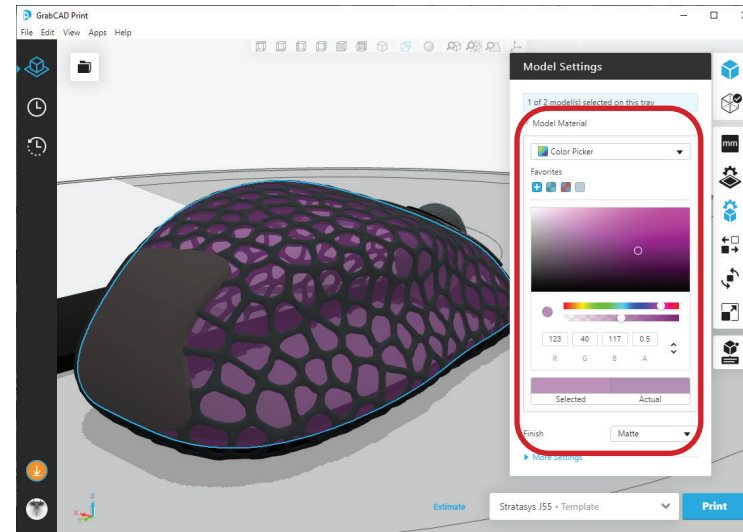


Figure 1 - Color Picker Method

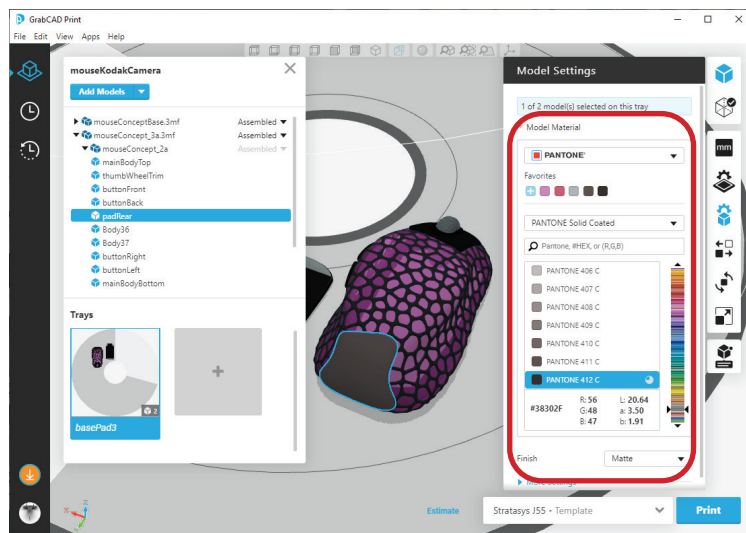


Figure 2 - PANTONE

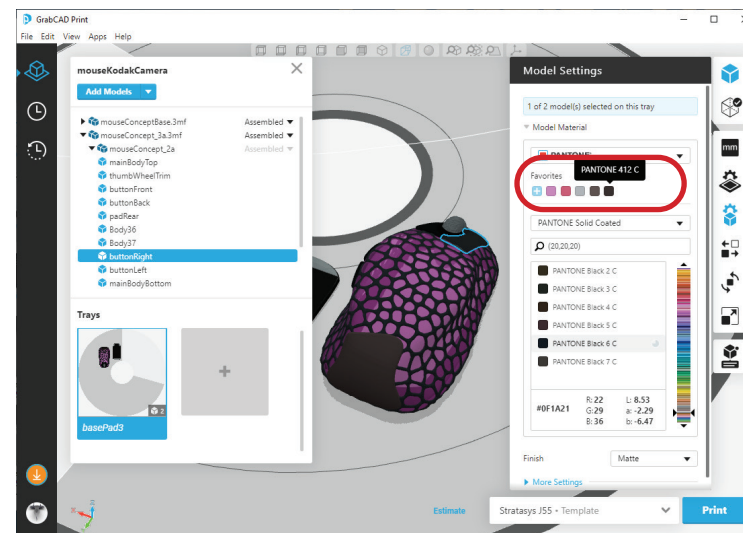


Figure 3 - Favorites

# GrabCAD Print - Matching Colors

Using the PANTONE color system can help with matching colors between KeyShot & the actual color printed. GrabCAD Print has the ability to match colors using the PANTONE Solid Coated library. In KeyShot, use the Library > Color > PANTONE + Solid Coated to find a color. Drag and drop the color swatch unto the model (Figure 1). The color is only applied to the Diffuse value so materials without the Diffuse value will not change. Make note of the PANTONE swatch used (279C) and the RGB values. When applying PANTONE colors in KeyShot, the actual PANTONE swatch reference is not kept. After importing the model into GrabCAD print, select the body and reselect the same PANTONE swatch. In this example, there is a slight difference between the Selected and Actual color printed (Figure 2). Switch the color mode to Color Picker to see the difference (Figure 3).

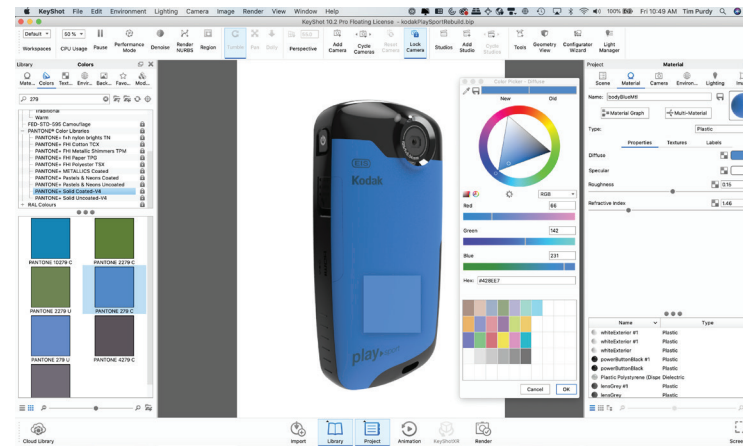


Figure 1 - Setting PANTONE color in KeyShot

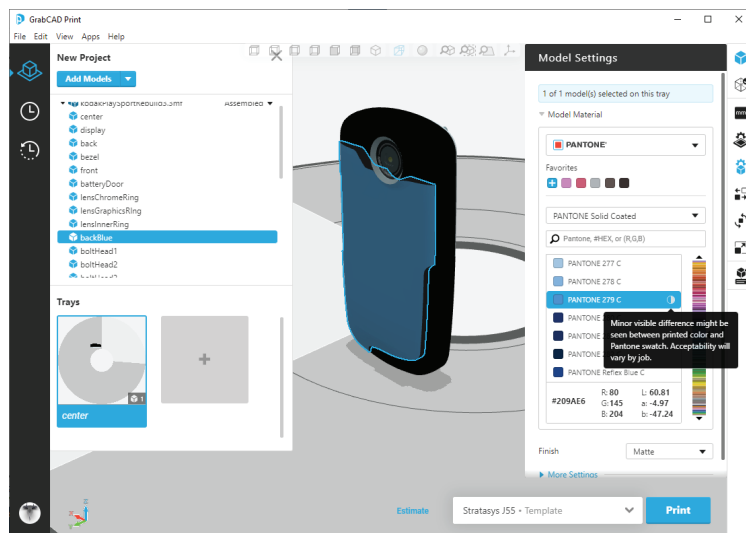


Figure 2 - Setting the PANTONE color in GrabCAD print

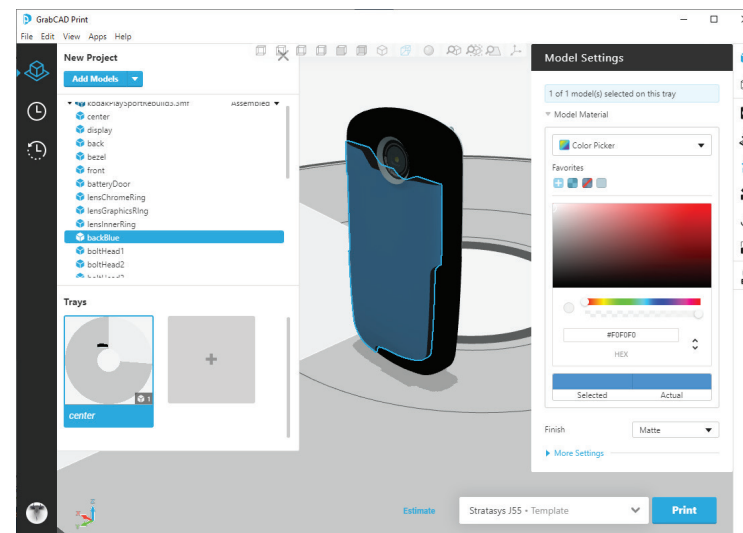


Figure 3 - A very slight difference is indicated

# GrabCAD Print - Transparency

Transparency can be achieved on a model but it is best set in the GrabCAD print program. Make sure the UltraClearS tray material has been selected. If not, transparency will not be available. The Color Picker method for setting color is the only method that allows for an opacity setting (transparency). Select a body and then open the Model Settings palette (Figure 1). Use either the slider or type in a new value for the alpha (Figure 2). Previews of the model represent the amount of transparency. Other colors such as PANTONE do not have the ability to set the alpha/transparent value (Figure 3).

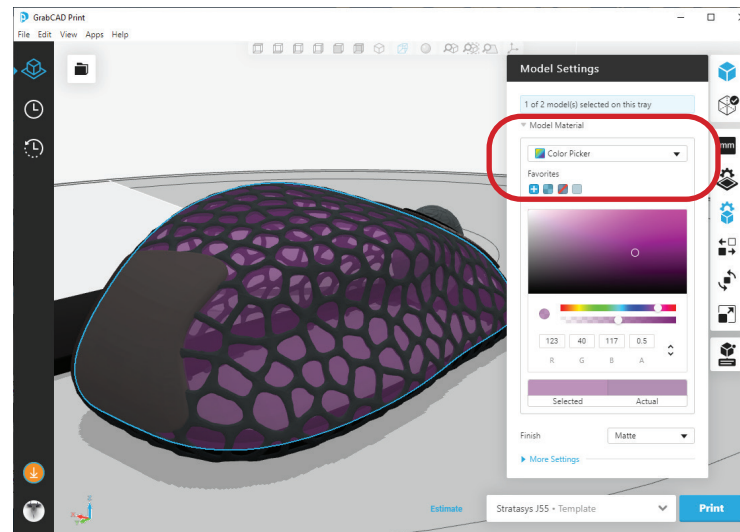


Figure 1 - Choose Color Picker

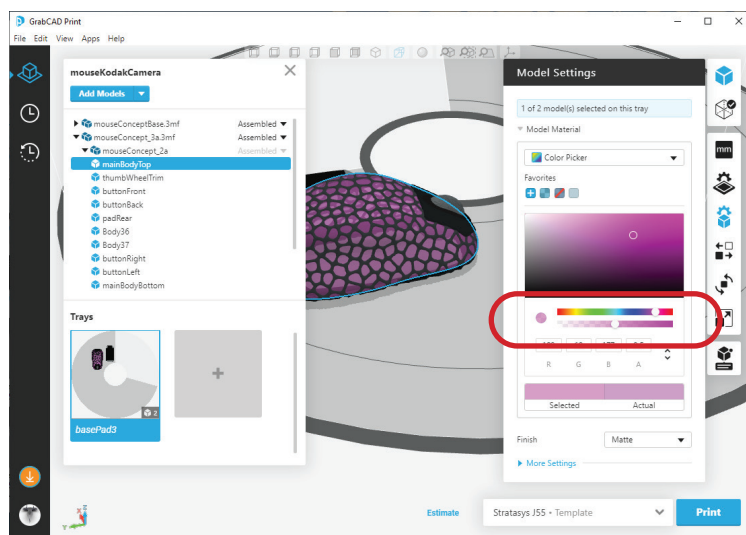


Figure 2 - Adjust the Opacity value

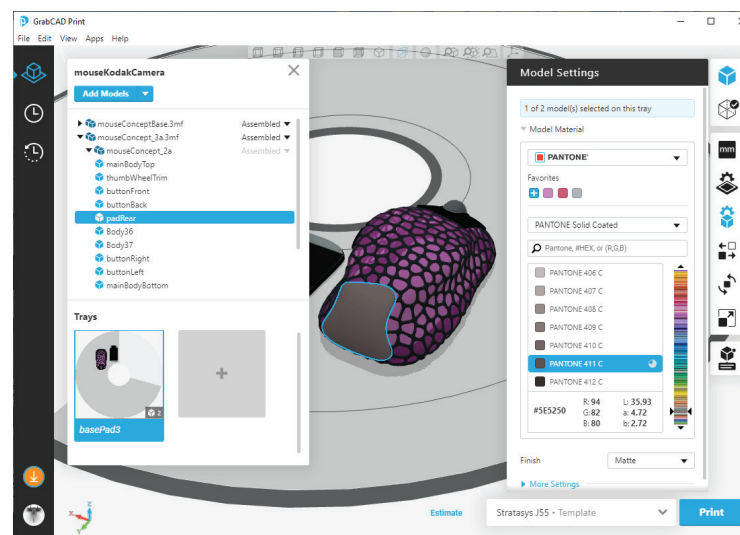


Figure 3 - PANTONE does not have an opacity setting

# GrabCAD Print - Matte/Glossy Finish

When 3D color printing, materials default to Matte finish. There is an option for Glossy finish but it comes with several caveats. The Glossy finish works best on up facing geometry. If the material is also applied to geometry on the side of the form, it will not appear be glossy. On some geometry, the glossy finish will appear on the sides randomly.

Select the object that you want to change the finish. A drop down menu for Finish is available in the bottom second of the Model Settings (Figure 1). Switch between Matte and Glossy. Keep in mind the caveats noted on the previous page (Figures 2 & 3).

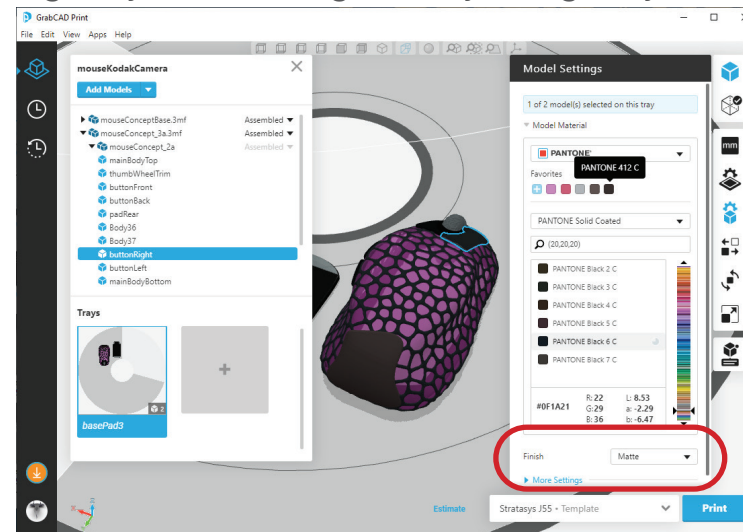


Figure 1 - Finish menu

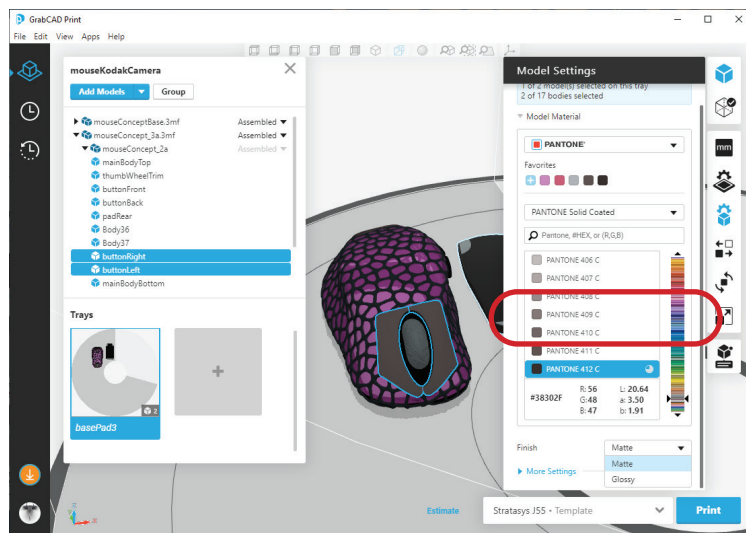


Figure 2 - Switching from Matte to Glossy

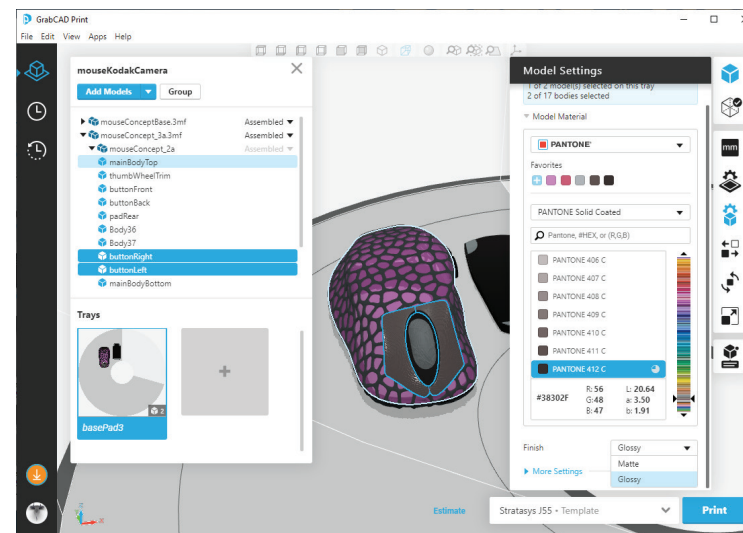


Figure 3 - Switching back to Matte