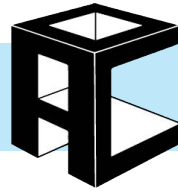


Guide for Geomagic Design X

3D Scan Data Cleanup and Editing



Advanced
Output
Center

General Information



- **Geomagic Design X** (formerly Rapidform XOR) is an extremely powerful reverse engineering and 3D modeling software that combines 3D scan data processing with history-based CAD. Geomagic is not part of SAIC's software template and is very expensive; however, it is installed on all of the AOC's lab computers in the front room and can be used at any time.
- **Geomagic workflow beyond scan data/STL cleanup and editing must be explored through online tutorials on your own or with your professor. The AOC also has checkout material on Geomagic that you can borrow.**

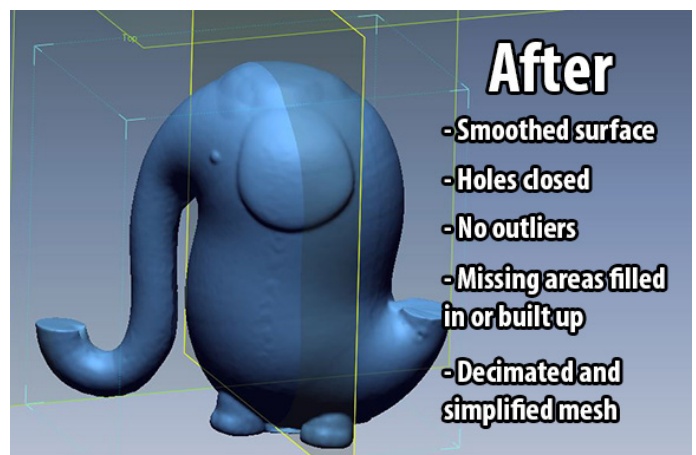
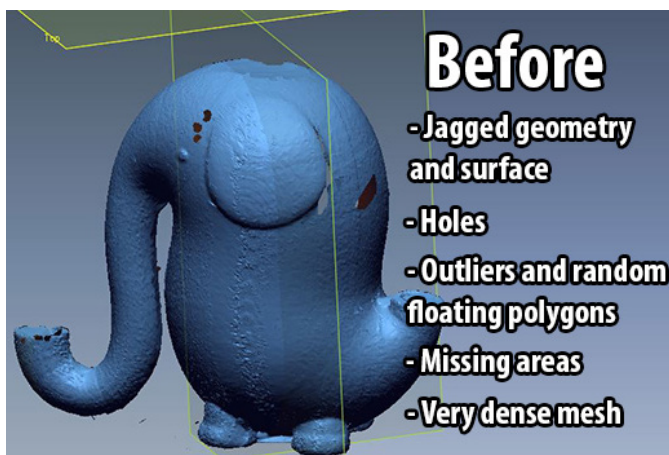
Overview

This guide will cover:

- Importing files
- Alignment of scans through Mesh Buildup Wizard
- Outlier deletion
- Hole filling and healing defects
- Building up Geometry
- Surface treatments
- Mesh splitting
- Mesh decimation
- Global remeshing and rewrapping
- Exporting

***Note:** Before you begin this workflow, make sure you have enough time to dedicate to the software - lots of time is required of you as each operation can take a long time to process. It is a good idea to close out as many other programs as you can before opening Geomagic.

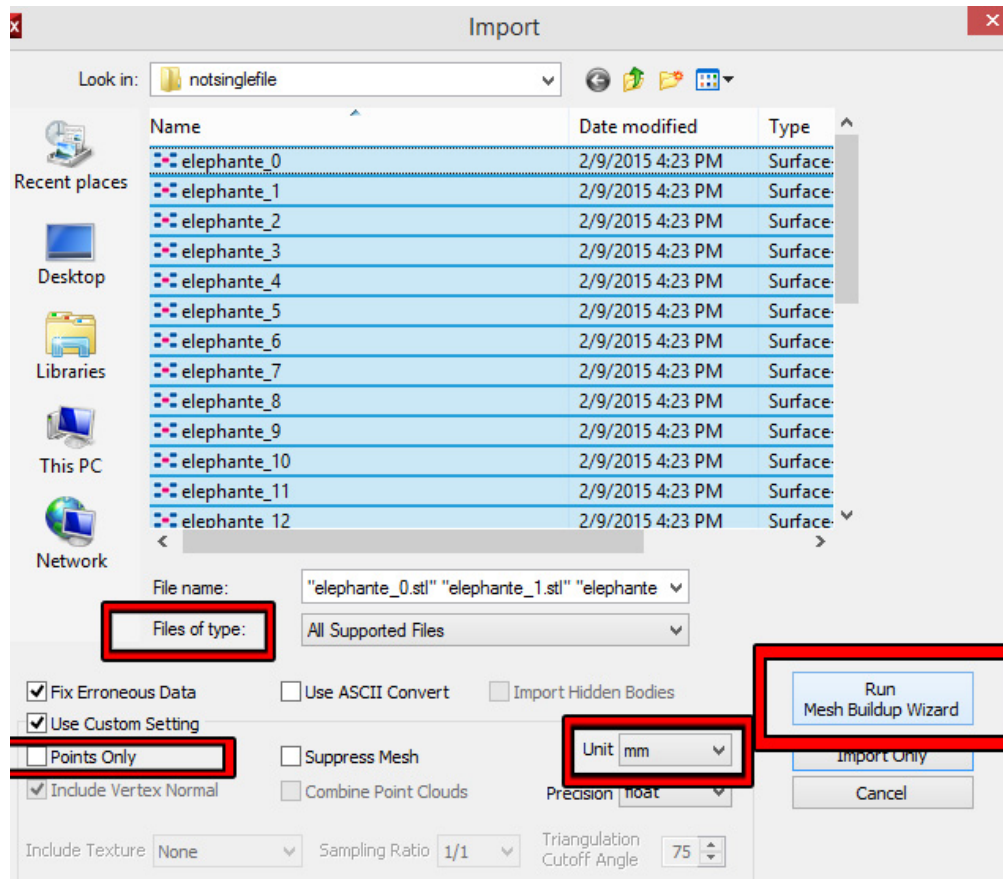
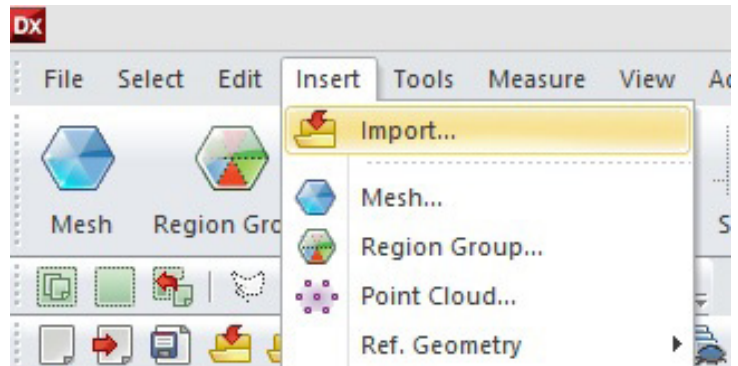
Through Geomagic, we can prepare incomplete and messy scan data to be output for 3D printing and other applications such as still image renders and animation.



Importing files:

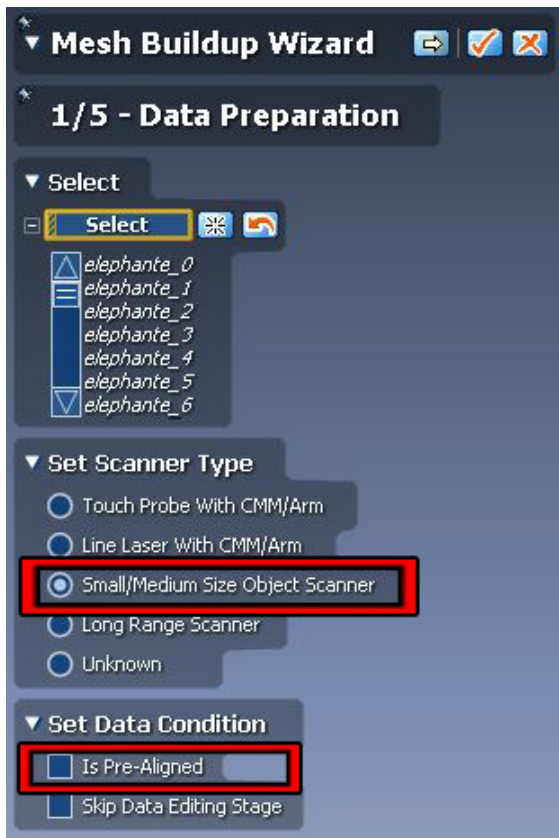
- Geomagic will accept mesh data, point data, any kind of model file (STL, OBJ, etc.), and individual scan meshes to be aligned. The following workflow will take you through importing multiple scan files, aligning, fusing, and editing. The first step is to get our multiple scans into Geomagic.
- The scans that were used for this tutorial were done on the AOC's **NextEngine HD 3D** scanner and were exported as individual STLs.

- Once in Geomagic, go up to the top left of the screen and click “**Insert**” and then “**Import**”.



- When the import screen pops up, select all your scan files by holding down the Shift key. If your files are not showing up in your folder, make sure you choose “**All Supported Files**” in the “Files of Type” box. Next, for our purposes, uncheck the box for “**Points only**”. You can also set your **units** in the unit box.
- If you are just importing a single STL that won't need alignment, you can choose “**Import Only**” and skip the Mesh Buildup Wizard. For our purposes, and for aligning multiple scans from NextEngine or Artec Studio, choose “**Run Mesh Buildup Wizard**”.

Mesh Buildup Wizard:



- Once your files have loaded in, the Mesh Buildup Wizard menu will show up in the top left of the screen and your individual scans will be shown in a row at the bottom. You will also see a rainbow preview of your scans fused together.
- If you do not see the settings pictured to the left, make sure to click the white triangle to drop down the menu. Press the push pin icon above this triangle to keep the menu visible.
- Mesh Buildup Wizard is broken into 5 separate operations, the first being **"Data Preparation"**. For these settings, choose **"small/medium size object scanner"** if you are working with scans from any of the AOC's 3D scanners.
- Under **"Data Condition"**, you can choose to check the box next to **"Is Pre-Aligned"** if your scans are aligned and only need to be fused. If they are coming from the Artec Eva scanner, they will most likely require alignment. Even if your scans appear aligned, it is a good idea to run alignment for better accuracy.
- When ready, you may move onto the next stage of the Mesh Buildup Wizard by pressing the arrow button.



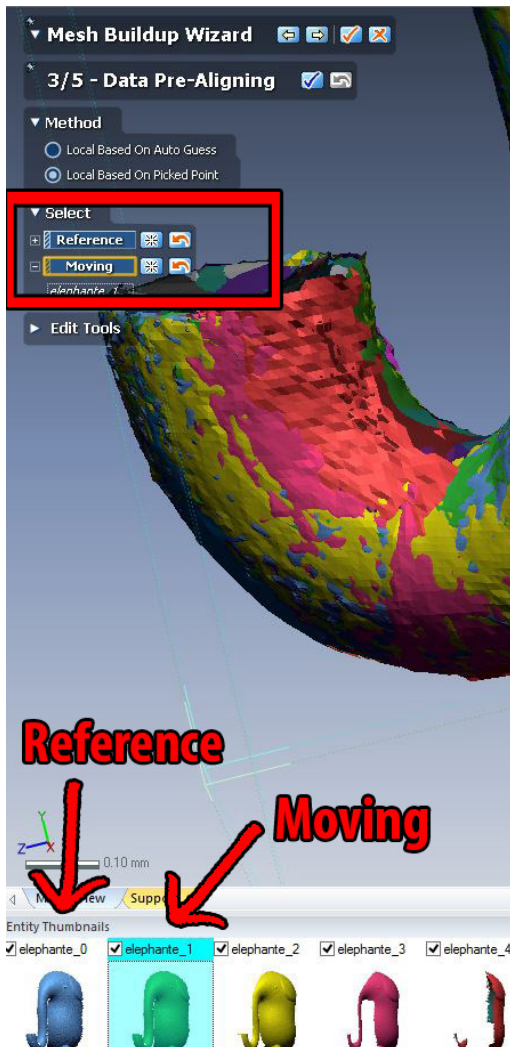
- The next step involves deleting unwanted data - for example: the platform or table the object was scanned on. You can simply use a selection tool (found at the bottom left of the software) to select these areas. When you let go of the mouse while selecting, the selection will turn blue and be locked in. You can then hit the delete key on your keyboard to rid the data of the unwanted area.



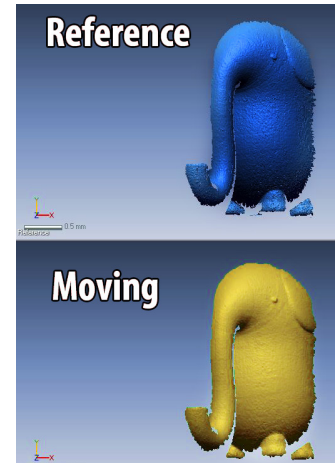
- You can also use one of the buttons under the Data Editing menu shown to the right such as **"Find Floor"** (helpful for quickly selecting the table you scanned on) or **"Find Noisy Cluster"** (will find abnormal outliers automatically)

- When you are ready removing unwanted areas, you can move onto step 3 by pressing the arrow button.
- Remember, you can always delete unwanted data later on in the editing process through selection and deletion.

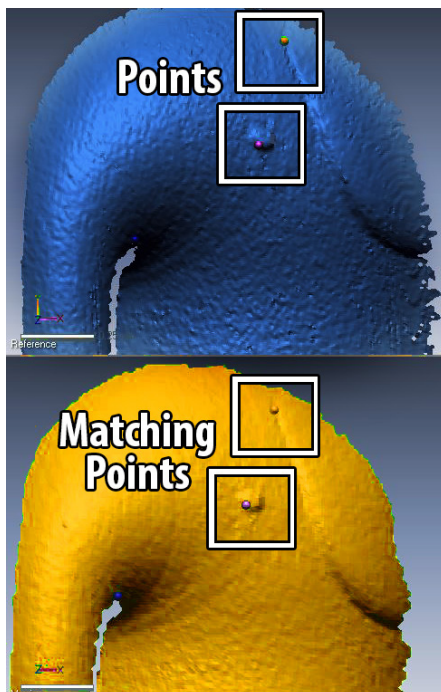
Mesh Buildup Wizard:



- The next step in the mesh buildup wizard is “**Data Pre-Aligning**” and is broken down into 3 main processes: selecting a reference and a moving mesh, assigning alignment points, and applying that alignment.
- Under “**Method**” it is ideal to choose “**local based on picked point**” instead of relying all the time on auto-alignment. The auto processes in Geomagic as a whole are impressive, but it is always good to be responsible for your own editing as it can come in handy in other programs and when auto-processes fail - which they often do.
- Under “**Select**” Click the “**Reference**” box and then choose a reference scan from your row at the bottom. When choosing a reference scan, it is best to choose one that has the most information rather than a scan with less geometry in it.
- Next, click the “**Moving**” box and select a single scan you will align with the reference scan to create a basis for global alignment. Again, choose a scan with lots of information in it and with information that overlaps the “**Reference**” scan.



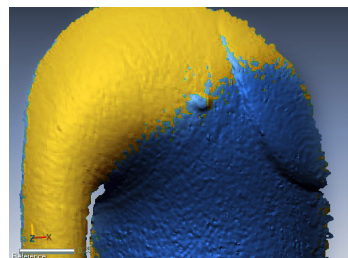
- Once these two scans are chosen, you will see them pop up in their own windows on the right-hand side.



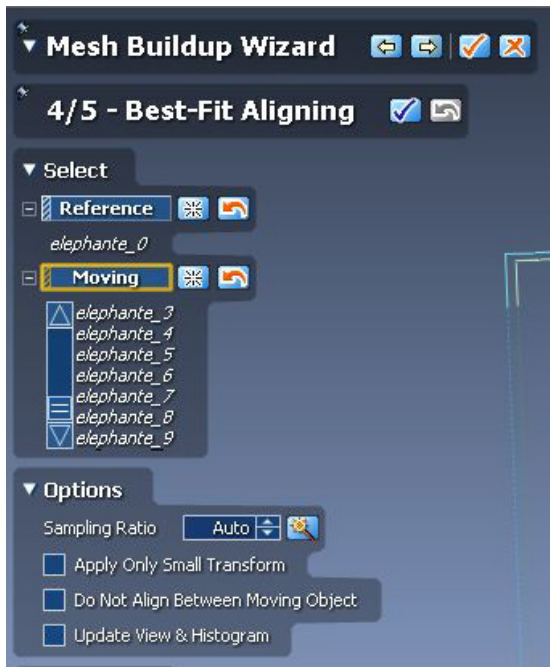
- Next, you must assign corresponding alignment points to these two scans by first putting a point on a recognizable feature on the reference scan. Next, place a point on the moving scan on the same feature. Place 4-5 points if possible.
- Once you have placed all your points, hit the “**Apply**” checkmark button at the top of the menu.



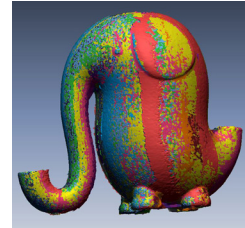
- The operation will merge the scans creating a basis for global alignment. Go to the next step using the arrow.



Mesh Buildup Wizard:

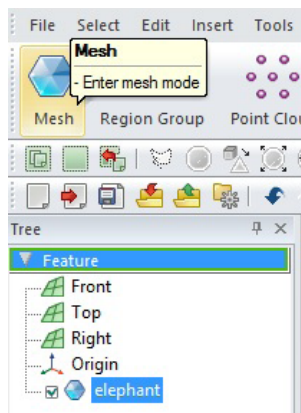


- Step 4 of the Mesh Buildup Wizard deals with the actual alignment of all the scans. Much like the last step, you must first click the **“Reference”** box and choose your reference scan - choose the reference scan from the last step.
- Next, click the **“Moving”** box and select all of the rest of the scans by holding down the shift key.
- To accept this selection and run the alignment operation, press the **“Apply”** checkmark button. When this has completed, press the next arrow to move on to the final step of the Mesh Buildup Wizard.



- The 5th and final step of the Mesh Buildup Wizard will take all of your aligned scans and combine them into a single fused mesh. There are a few options to think about before running this command. Consider if you will need a looser mesh or a more accurate tight/dense mesh.
- Also, **“Remesh and Fill All Holes To Create Watertight Mesh”** is a great option if your output will eventually be 3D printing. This will create a mesh with less holes and missing geometry and will make the editing and 3D printing preparation steps a lot faster. This option may not be appropriate if the scans are missing large chunks of data.
- With your options chosen, hit the apply checkmark next to the **“Data Merging”** title to run the process. This can take a very long time to complete so be patient.

- Once this completes, you may finish the Mesh Buildup Wizard by hitting the apply checkmark next to the main **“Mesh Buildup Wizard”** header. This will apply all your processes. Finally, to get the model ready for the next editing steps, make sure to press the large blue checkmark at the bottom right of the software to lock in all the changes.



- ***Note:** Saving your progress in Geomagic can be a little bit confusing. To save your work as you go, make sure you accept the changes in the menu for the operation you are working in and apply the changes in the lower right corner with the large blue checkmark. Once you have approved these operations, go to **“File”** and **“Save”**.
- Now, if you look on the lefthand side of the screen under the **“Tree”** menu, you should see a new mesh with a blue circle next to it. It will probably be named something similar to your STL names. Click on this mesh and then click on the large **“Mesh”** button at the top to hop into **Mesh Mode**, which we will do the rest of our editing in.

Important Mesh Mode Operations:

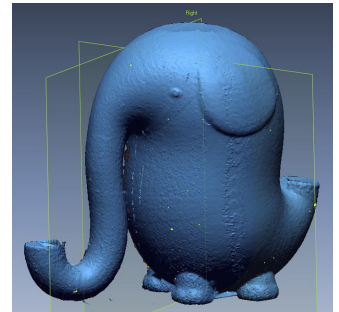


- The icons starred above indicate either the operations that will be outlined in the following steps or those that are very effective in clean-up but are very self-explanatory.

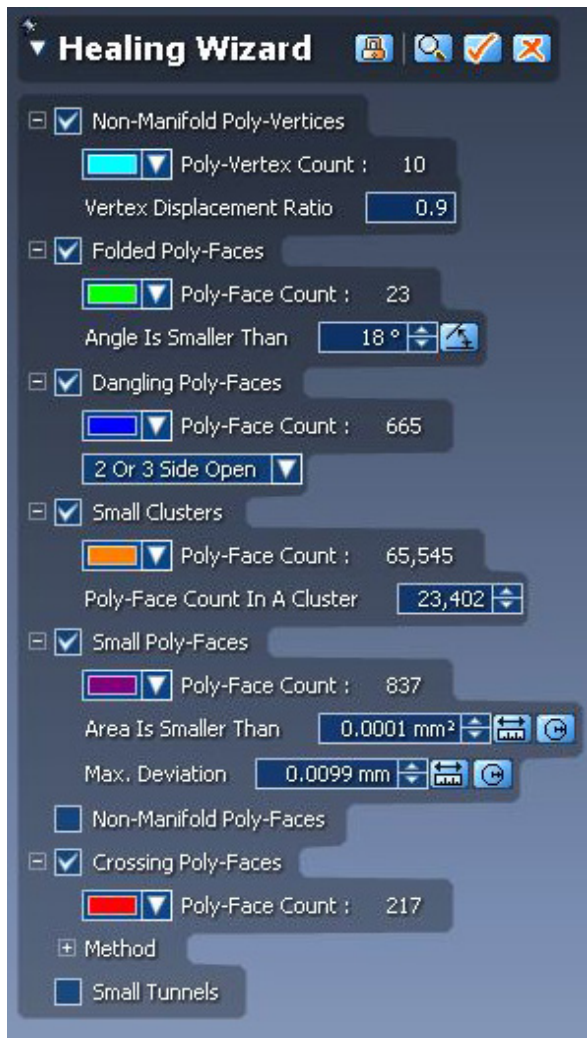
Mesh Mode: Find Defects



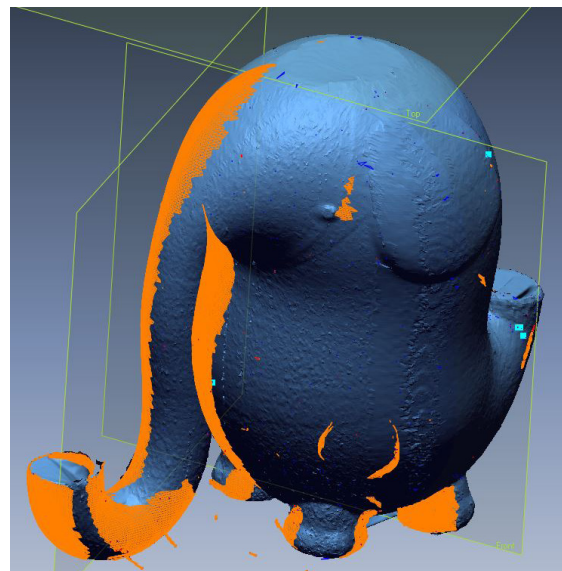
- Find Defect** is an operation that, once applied with the checkmark button, will show you messy areas of geometry that you may want to focus on as you begin editing. These areas include intersecting and jagged poly-faces. The process will highlight these areas in yellow.



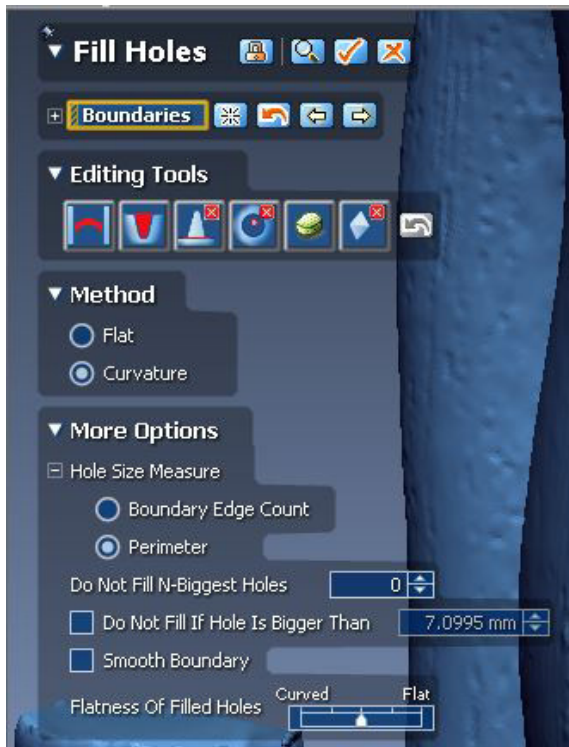
Mesh Mode: Healing Wizard



- Healing wizard** is similar to **Find Defects** in that it will highlight potentially problematic areas of your mesh in a color coded manner.
- Healing wizard** goes a step further and when applied, will actually attempt to fix these areas which will improve your overall surface texture and will push the mesh to closer to 3D printable validity.
- This operation can take a very long time to process depending on how dense your mesh is and how problematic it is.

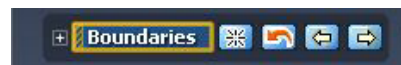


Mesh Mode: Filling Holes

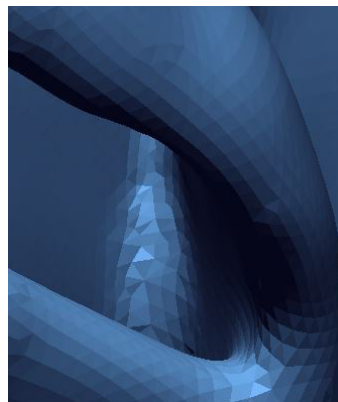
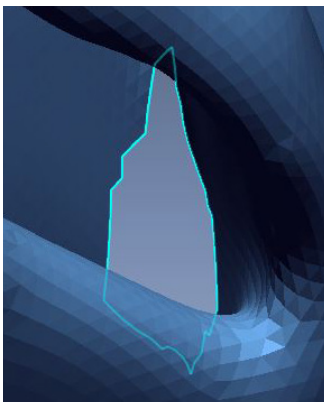


- **Filling Holes** in Geomagic, is a lengthy and complicated process. Sometimes, the “**Fill Holes**” operation is not enough and you must use other operations to first edit the holes before filling them.

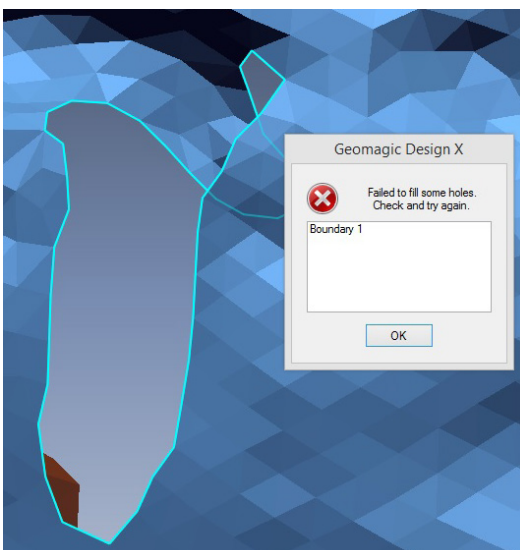
- A good first step to filling holes is to select your entire mesh by using a marquee selection tool and dragging it across the entire model. Next, do a global hole fill attempt by simply checking the checkmark button next to the “**Fill Holes**” title. This operation will look at all the holes and it will fill as many as possible.
- You will likely get an error message stating the software “**Failed to fill some holes**” and will list the holes unable to be filled. This is to be expected. Hit “OK”.
- Find the holes the software could not fill globally by pressing the forward arrow. This will zoom to individual holes at a time.



- Select a singular hole and think about how it sits on the model. If it is curved, change the “**Method**” to “**Curvature**”. Also take a look at the “**Editing Tools**” and choose the best filling method whether it be filling a gulf or adding a curved bridge. This can take some experimentation.



- In the example to the left, a curved method was used along with a bridge editing tool.



- Sometimes, even attacking each hole individually will not fill it. Oddly shaped holes or holes that curve into figure eight shapes will need to be physically edited before attempting to fill them. For that we must jump to **Edit Boundaries**.

Mesh Mode: Edit Boundaries

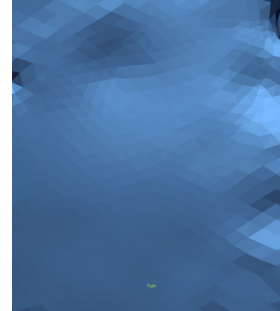


- **Edit Boundaries** allows you to morph and distort or shrink and smooth holes and cracks in your mesh. Each method has its own set of options to experiment with. The methods **Shrink** and **Fill** seem to work best for preparing oddly shaped holes to be filled in the **Fill Holes** operation.

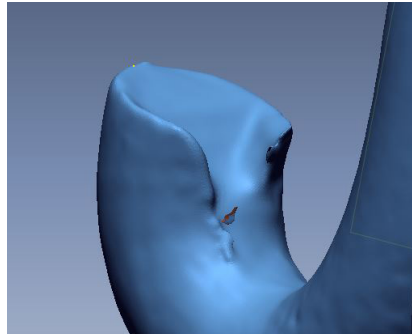
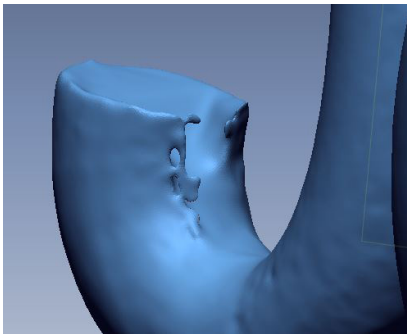
- For the hole shown on the bottom of page 7, the **Shrink** method was used to eliminate twisted boundaries. Though the hole has increased in size, it will be easier to fill now as Geomagic can handle large holes, but gets confused with smaller holes that intersect themselves.



After Shrinking in **Edit Boundaries**

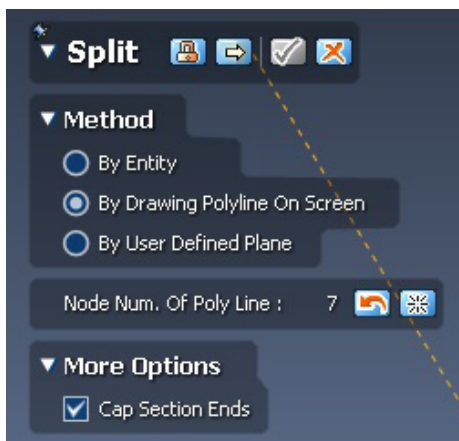


After **Fill Holes** operation



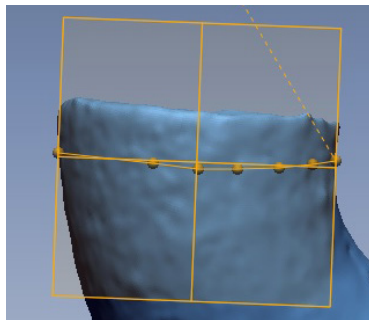
- The operation, **Sew Boundaries**, can also be helpful for stubborn oblong holes or cracks.
- Remember, you can also use hole filling in conjunction with deletion of data. If you are not satisfied with part of a mesh and want to delete it, go ahead and then fill the remaining hole so you can smooth it. Splitting the mesh can also help with this.

Mesh Mode: Splitting the mesh



- **Splitting** your mesh is a good way to get rid of unwanted data. It is also an effective way of capping off parts of your mesh.

- There are three ways of defining your splitting area - **entity** (defined part of a model), **polyline** (a drawn cut line), or a **plane** (a cutting plane similar to a cut-off plane in many other modeling softwares).

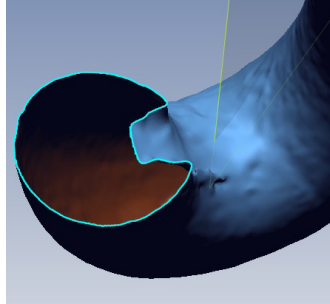


- Draw your polyline and make sure not to change the view by tumbling or panning your model. Hit the arrow button to split the mesh.

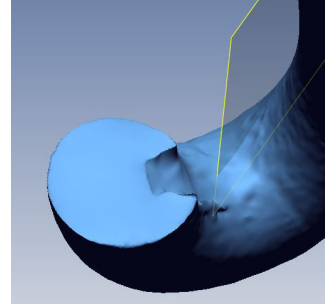
Mesh Mode: Splitting the mesh



- Once your mesh has been split, the operation will ask you to define the area you want to remain as the other area will be deleted. Once you have chosen the area of the mesh you want to keep, hit the checkmark button.
- A hole will be left where you split your mesh, but a hole filling operation with a flat method will most likely cap it without any issues.



After splitting the mesh



After filling the hole

Mesh Mode: Various Surface Treatments

- You may find yourself unsatisfied with the overall surface texture of your model. Geomagic Mesh Mode has many different operations to smooth, sharpen, and form your mesh both globally and through fine detail. A good first move to begin to smooth your mesh is the **Smooth** operation.

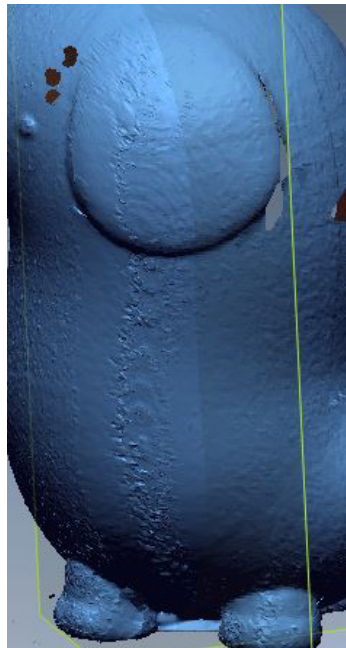
Mesh Mode: Smooth



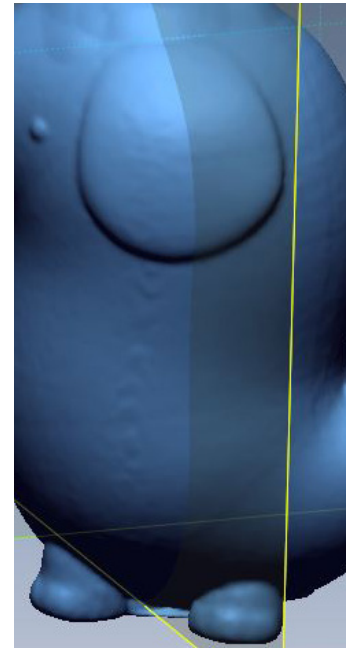
- The **Smooth** operation applies a global smoothing effect according to your selection. Select the entire mesh and run the command with "**Feature Preservation**" on to create a smooth base to then go into with fine detail brush-based operations.



- After the Smooth operation, the **Enhance Shape** operation can also be useful in applying a similar global texture change. In Enhance Shape, you can begin to experiment with sharpness as well.



Before Global **Smooth**

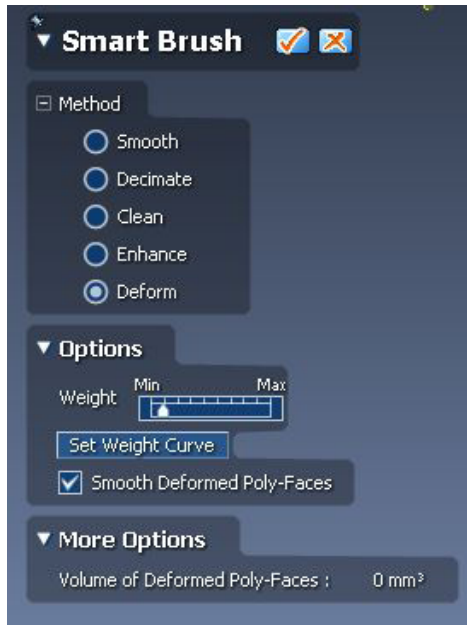


After Global **Smooth**

Mesh Mode: Smart Brush

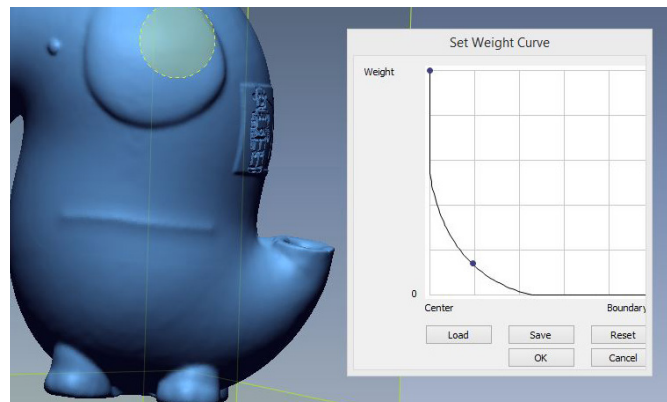
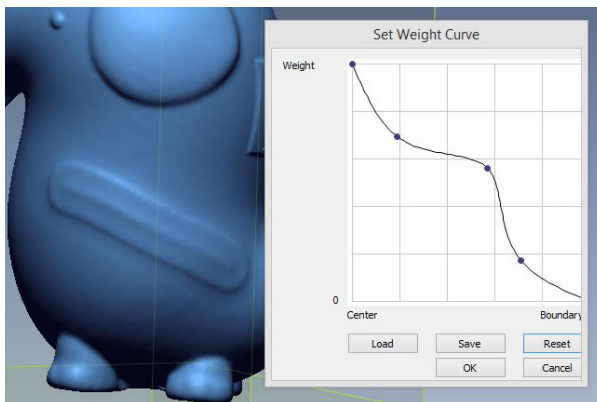
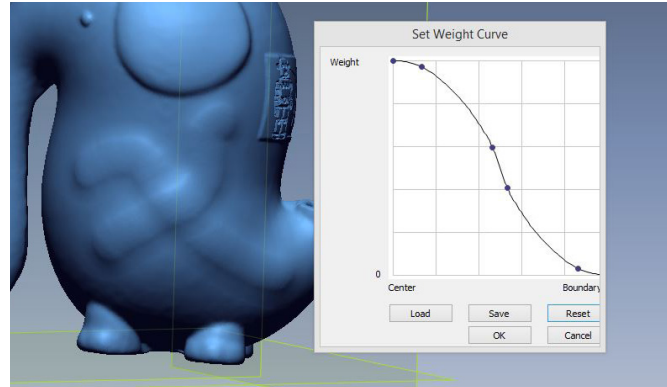
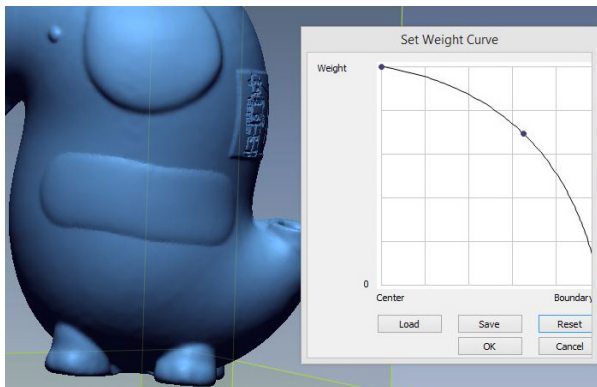


- **Smart Brush** is a tool that allows you to interactively fine-tune your mesh's surface.
- **Smart Brush** has 5 main functions:
 - **Smooth:** evens out mesh roughness.
 - **Decimate:** simplifies the mesh makeup and reduces denseness of mesh.
 - **Clean:** Reduces sharp angles of intersecting polyfaces and stabilizes the mesh.
 - **Enhance:** Sharpens and smooths the mesh and boosts detail.
 - **Deform:** You can build up parts of your mesh with this brush as it pushes and pulls geometry.



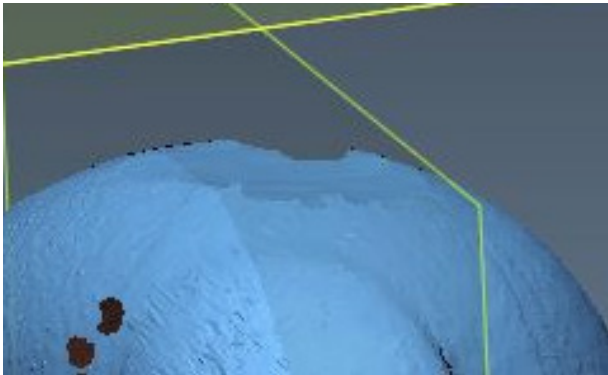
- All of these different functions have a different set of options you can experiment with. For the most part, they are self-explanatory. However, when it comes to the **Deform** brush, you may want to try editing your **Weight Curve**. Press "**Set Weight Curve**" to begin.
- The weight curve determines different characteristics about your brush stroke such as boundary and weight. Take a look at the examples below to see what kind of effects you can get out of the **Deform** brush.

Default Curve:

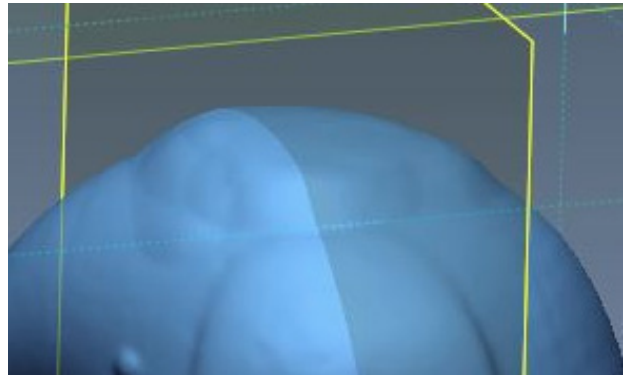


Mesh Mode: Smart Brush

- A good order of operations for the **Smart Brush** would most likely be to smooth, then deform. Then, smooth your deformed section to better integrate it into the rest of the mesh. You may also want to try decimating after smoothing and before deforming as this will allow the mesh to move a bit easier. After you are done smoothing your deformed area, you may want to use clean or enhance.

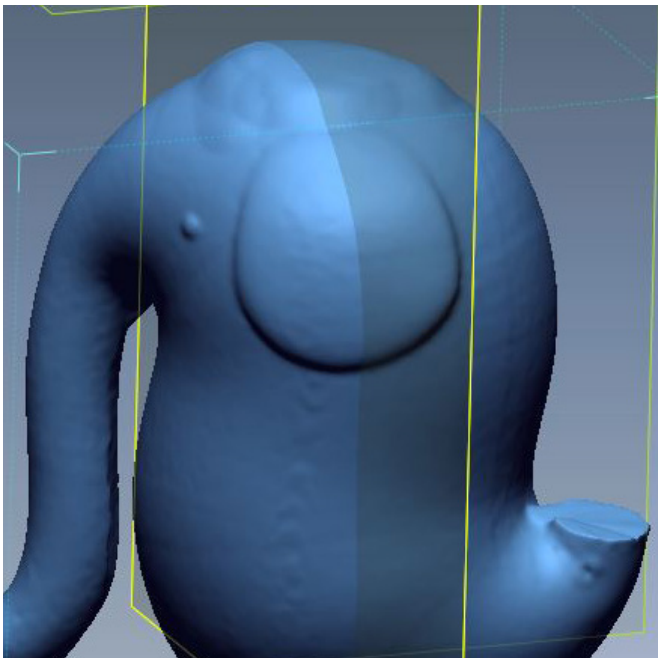


Before any **Smart Brush** editing

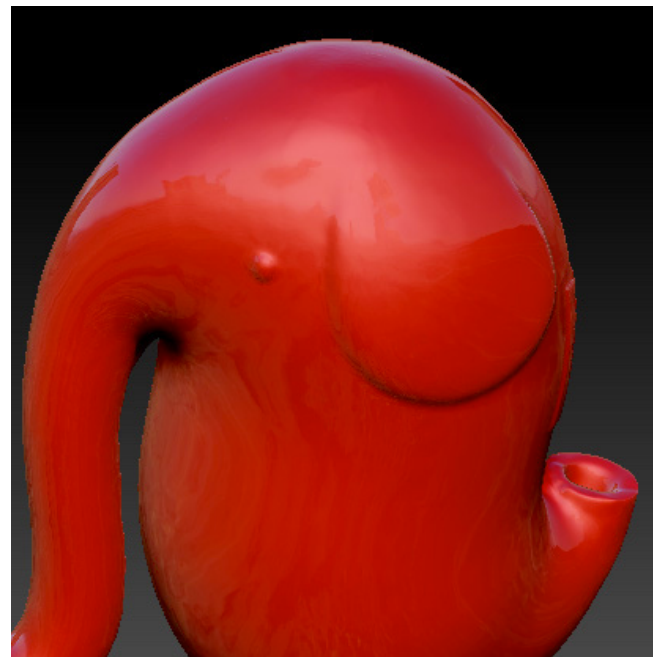


After deforming and smoothing with **Smart Brush**

- *Note:** Getting a newly built-up deformed area to completely smooth out and blend with the mesh is very difficult and time-consuming in Geomagic. If a particular area must be built up, you may want to get a single scan of the missing area and fuse them together. If this is not possible, follow the workflow above and later on you can bring the exported mesh into 3D sculpting programs such as **Mesh Mixer** and **Sculptris** to achieve a more well-blended mesh.



Smoothing in **Geomagic**



Smoothing in a **3D sculpting program**

- Notice how these sculpting programs can also be used to easily add-in small details such as the shallow hole in the tail.
- Both **Sculptris** and **Mesh Mixer** are free programs with a very user-friendly interface. Mesh Mixer has a very effective “**Shrink**” tool that can shrink down unwanted blobby geometry.

Mesh Mode: Preparation for Output

- Now that you are satisfied with the look of your model, you will want to prepare the mesh for output whether it be animation, still-image, or a physical output such as 3D printing.
- Physical output requires a much more specific type of mesh as opposed to still-image rendering or even animation. Animation may require **Decimation** if you plan on rigging, but for 3D printing your model must be as **water-tight** as possible.

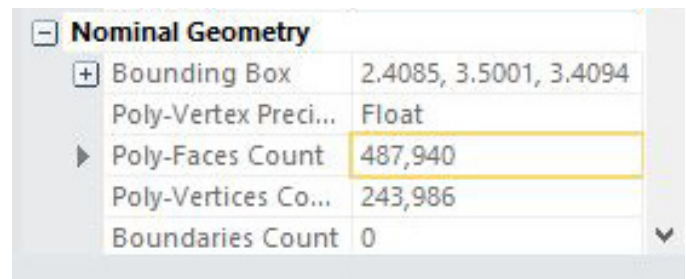
Mesh Mode: Decimation



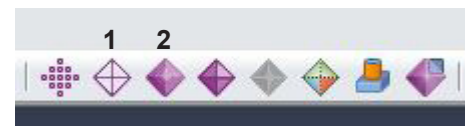
- Decimation** is an operation that reduces your polygon count and reduces the denseness of your mesh while retaining feature definition and quality.
- Having a model with a simplified mesh is important when moving your model to other 3D programs - a more sparse mesh will result in less lag within software.
- Decimation is also important for animation if you plan on rigging your model for movement.



- Within the **Decimation** menu, we want to decide on our target number of poly-faces. You can also decide on a reduction percentage to reduce the density by that amount.
- You can view your model's current number of poly-faces under the "**Properties**" menu in the lower right corner of the software.

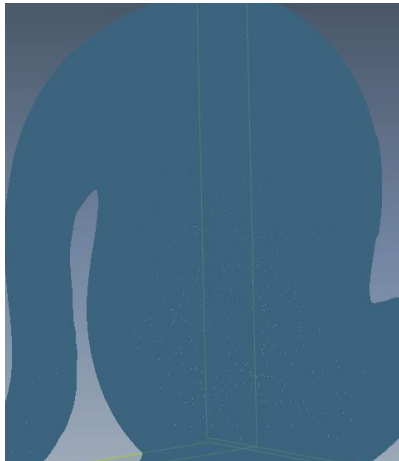


- To better view your mesh, use the view tools at the top to view your model in wireframe (1). You can switch back to shaded view (2) at any time.

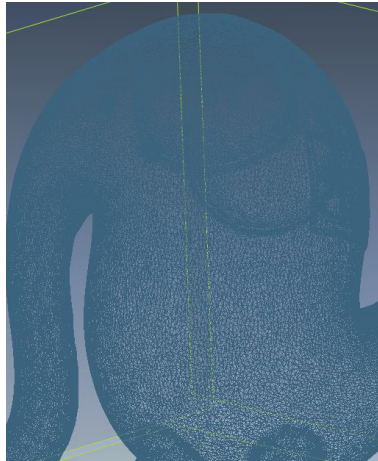


Mesh Mode: Decimation

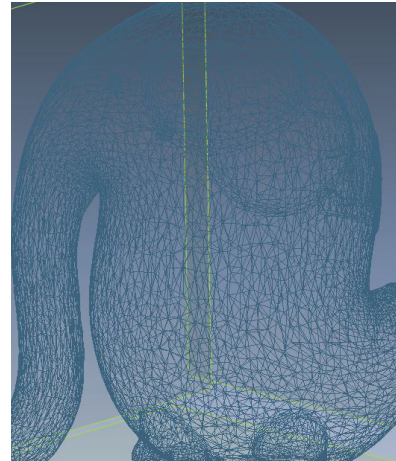
Different levels of Decimation:



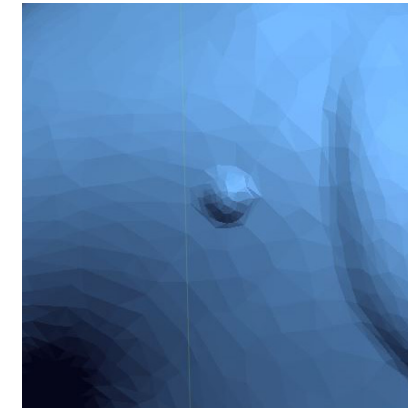
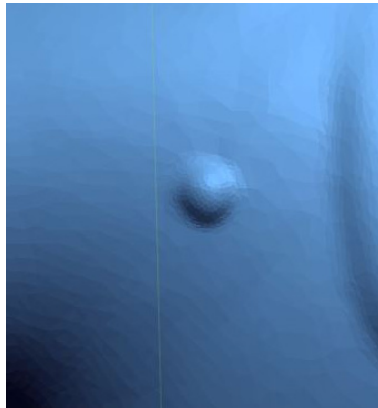
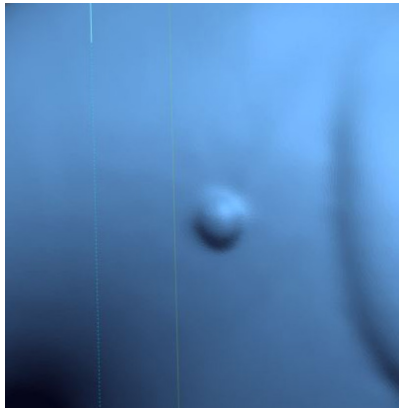
500,000 poly-faces



100,000 poly-faces



30,000 poly-faces



Mesh Mode: Rewrap Vs. Global Remesh

- Within **Mesh Mode**, there are two very effective modes of global preparation for output. Though I am mentioning these as the end of this guide, note that you can perform these operations at any point during your editing.
- **Rewrap** in particular can be used instead to fill holes globally if the hole filling is either taking too long or not giving you the results you want.

Global Remesh



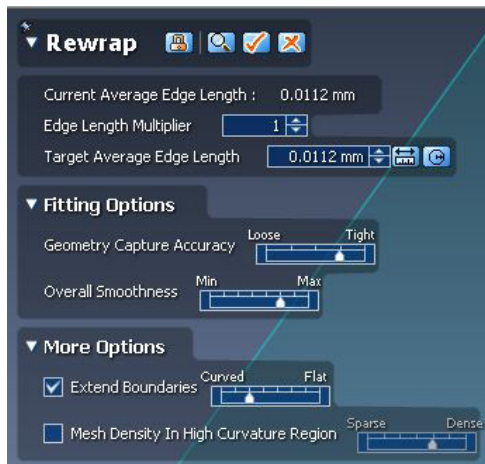
- Retriangulates entire mesh and creates a brand new mesh makeup.
- Improved mesh quality through global mesh cleanup.
- A cleaner uniform mesh will create less chance of error and lag in other 3D programs and in validation for 3D printing.
- May be useful for animation as a more uniform mesh is easier to rig.

Rewrap



- Shrinkwraps the entire mesh and can fill in large missing areas.
- Recreates the mesh based on underlying points.
- Fixes defects and rough areas.
- A great operation to prepare your mesh for 3D printing.

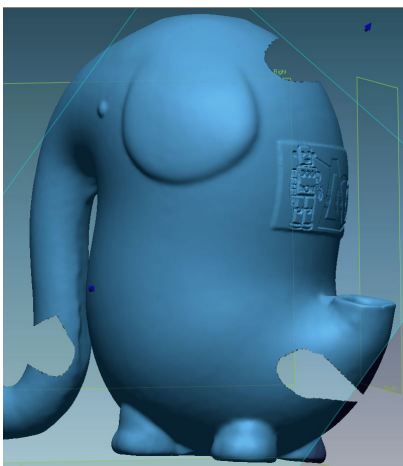
Mesh Mode: Rewrap Vs. Global Remesh



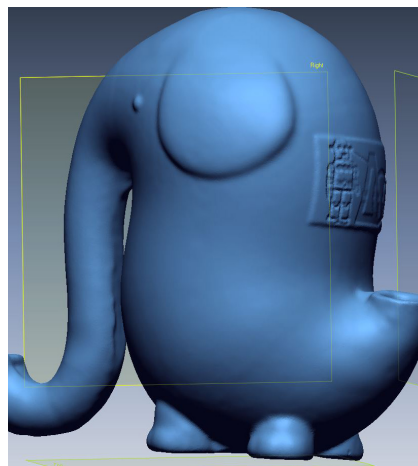
- Both **Rewrap** and **Global Remesh** can both fill missing areas, but as you can see from the images below, Rewrap does a much better job of taking the surrounding areas into account and then building up the missing data.



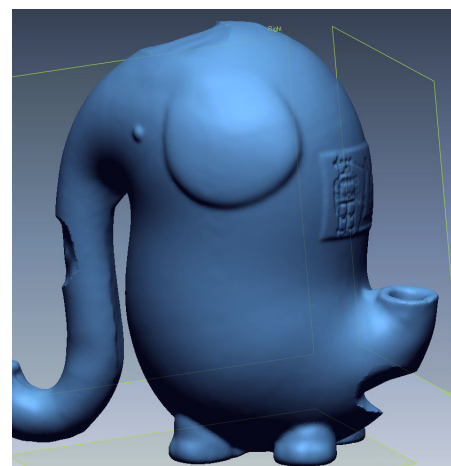
- Global Remesh** can sometimes obliterate sharp detail on a model, so experiment with different edge lengths to compromise detail for cleanliness of your mesh.



Large chunks missing from model



Rewrapped



Global remeshed

Exporting your model

- Once you are satisfied with your model, you must **Export** it out of Geomagic.
- Hop out of Mesh Mode by clicking the large blue mesh icon.
- Next, go to **"File"** and then **"Export"**. Click the checkmark in the Export menu to bring up the Export window.
- STL** files are needed for 3D printing at the AOC. **OBJ** files work well with **Maya** and other animation applications.

