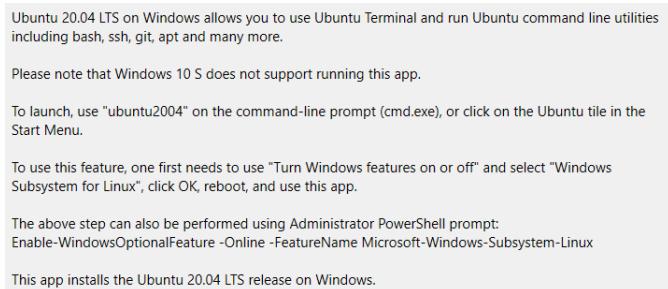


FREESURFER DOWNLOAD + INSTALLATION

How to Download Freesurfer to Windows:

1. Download the Ubuntu App from the Windows App store. Create your username and password.



2. Obtain your Freesurfer license key: <https://surfer.nmr.mgh.harvard.edu/registration.html>
3. Download the Freesurfer file that is compatible with the Linux OS:
https://surfer.nmr.mgh.harvard.edu/pub/dist/freesurfer/6.0.0/freesurfer-Linux-centos6_x86_64-table-pub-v6.0.0.tar.gz
4. Follow the instructions in the link below to install Freesurfer on the Ubuntu
https://surfer.nmr.mgh.harvard.edu/fswiki/FS7_wsl_ubuntu
5. developer@DESKTOP-LD48TB7:~\$ wget https://surfer.nmr.mgh.harvard.edu/pub/dist/freesurfer/dev/freesurfer_7-dev_amd64.deb

In the Ubuntu's command line, type 'wget' followed by the link as seen above

6. The following message should appear if Freesurfer was downloaded.

```
Resolving surfer.nmr.mgh.harvard.edu (surfer.nmr.mgh.harvard.edu)... 132.183.240.105
Connecting to surfer.nmr.mgh.harvard.edu (surfer.nmr.mgh.harvard.edu)|132.183.240.105|:443... connected.
HTTP request sent, awaiting response... 200 OK
Length: 3528163516 (3.3G) [application/vnd.debian.binary-package]
Saving to: 'freesurfer_7-dev_amd64.deb'

freesurfer_7-dev_amd64.deb 100%[=====] 3.29G 31.3MB/s in 1m 50s
2021-05-20 04:58:02 (30.7 MB/s) - 'freesurfer_7-dev_amd64.deb' saved [3528163516/3528163516]
```

7. Then type: sudo apt-get update

```
developer@DESKTOP-LD48TB7:~$ sudo apt-get update  
[sudo] password for developer:
```

8. This command show produce this output:

```
Get:1 http://security.ubuntu.com/ubuntu bionic-security InRelease [88.7 kB]  
Hit:2 http://archive.ubuntu.com/ubuntu bionic InRelease  
Get:3 http://archive.ubuntu.com/ubuntu bionic-updates InRelease [88.7 kB]  
Get:4 http://security.ubuntu.com/ubuntu bionic-security/main amd64 Packages [1726 kB]  
Get:5 http://archive.ubuntu.com/ubuntu bionic-backports InRelease [74.6 kB]  
Get:6 http://security.ubuntu.com/ubuntu bionic-security/main Translation-en [322 kB]  
Get:7 http://security.ubuntu.com/ubuntu bionic-security/restricted amd64 Packages [323 kB]  
Get:8 http://security.ubuntu.com/ubuntu bionic-security/restricted Translation-en [43.2 kB]  
Get:9 http://security.ubuntu.com/ubuntu bionic-security/universe amd64 Packages [1126 kB]  
Get:10 http://security.ubuntu.com/ubuntu bionic-security/universe Translation-en [254 kB]  
Get:11 http://security.ubuntu.com/ubuntu bionic-security/multiverse amd64 Packages [19.2 kB]  
Get:12 http://security.ubuntu.com/ubuntu bionic-security/multiverse Translation-en [4412 B]  
Get:13 http://archive.ubuntu.com/ubuntu bionic/universe amd64 Packages [8570 kB]  
Get:14 http://archive.ubuntu.com/ubuntu bionic/universe Translation-en [4941 kB]  
Get:15 http://archive.ubuntu.com/ubuntu bionic/multiverse amd64 Packages [151 kB]  
Get:16 http://archive.ubuntu.com/ubuntu bionic/multiverse Translation-en [108 kB]  
Get:17 http://archive.ubuntu.com/ubuntu bionic-updates/main amd64 Packages [2070 kB]  
Get:18 http://archive.ubuntu.com/ubuntu bionic-updates/main Translation-en [413 kB]  
Get:19 http://archive.ubuntu.com/ubuntu bionic-updates/restricted amd64 Packages [344 kB]  
Get:20 http://archive.ubuntu.com/ubuntu bionic-updates/restricted Translation-en [46.8 kB]  
Get:21 http://archive.ubuntu.com/ubuntu bionic-updates/universe amd64 Packages [1735 kB]  
Get:22 http://archive.ubuntu.com/ubuntu bionic-updates/universe Translation-en [369 kB]  
Get:23 http://archive.ubuntu.com/ubuntu bionic-updates/multiverse amd64 Packages [25.0 kB]  
Get:24 http://archive.ubuntu.com/ubuntu bionic-updates/multiverse Translation-en [6464 B]  
Get:25 http://archive.ubuntu.com/ubuntu bionic-backports/main amd64 Packages [10.0 kB]  
Get:26 http://archive.ubuntu.com/ubuntu bionic-backports/main Translation-en [4764 B]  
Get:27 http://archive.ubuntu.com/ubuntu bionic-backports/universe amd64 Packages [10.3 kB]  
Get:28 http://archive.ubuntu.com/ubuntu bionic-backports/universe Translation-en [4588 B]  
Fetched 22.9 MB in 27s (857 kB/s)  
Reading package lists... Done
```

9. Answer "Y" so any package dependences can be installed

10. Then type the command below: sudo apt-get install ./freesurfer_7-dev_amd64.deb

```
developer@DESKTOP-LD48TB7:~$ sudo apt-get install ./freesurfer_7-dev_amd64.deb  
Reading package lists... Done  
Building dependency tree  
Reading state information... Done  
Note, selecting 'freesurfer' instead of './freesurfer_7-dev_amd64.deb'  
The following additional packages will be installed:  
csh libglu1-mesa libgomp1 libjpeg62 libxss1 make tcsh  
Suggested packages:  
make-doc  
The following NEW packages will be installed:  
csh freesurfer libglu1-mesa libgomp1 libjpeg62 libxss1 make tcsh  
0 upgraded, 8 newly installed, 0 to remove and 148 not upgraded.  
Need to get 1156 kB/3529 MB of archives.  
After this operation, 3034 kB of additional disk space will be used.
```

Do you want to continue? [Y/n] Y

11. Answer "Y"

12. The following output will be printing. (plus more)

```
Get:1 http://archive.ubuntu.com/ubuntu bionic/main amd64 libxss1 amd64 1:1.2.2-1
Get:2 http://archive.ubuntu.com/ubuntu bionic-updates/universe amd64 csh 1:1.2.2-1
Get:3 http://archive.ubuntu.com/ubuntu bionic/main amd64 make amd64 4.1-9.1
Get:4 http://archive.ubuntu.com/ubuntu bionic/universe amd64 tcsh amd64 6.15.0-1
Get:5 http://archive.ubuntu.com/ubuntu bionic/main amd64 libglu1-mesa amd64 9.0.0-0ubuntu1
Get:6 http://archive.ubuntu.com/ubuntu bionic-updates/main amd64 libgomp1 amd64 5.4.0-6ubuntu1
Get:7 http://archive.ubuntu.com/ubuntu bionic/universe amd64 libjpeg62 amd64 6.2-1
Get:8 /home/developer/freesurfer_7-dev_amd64.deb freesurfer amd64 7-dev [1156 kB]
Fetched 1156 kB in 40s (28.8 kB/s)
Selecting previously unselected package libxss1:amd64.
(Reading database ... 29293 files and directories currently installed.)
Preparing to unpack .../0-libxss1_1%3a1.2.2-1_amd64.deb ...
Unpacking libxss1:amd64 (1:1.2.2-1) ...
Selecting previously unselected package csh.
Preparing to unpack .../1-csh_20110502-3ubuntu0.18.04.1_amd64.deb ...
Unpacking csh (20110502-3ubuntu0.18.04.1) ...
Selecting previously unselected package make.
Preparing to unpack .../2-make_4.1-9.1ubuntu1_amd64.deb ...
Unpacking make (4.1-9.1ubuntu1) ...
Selecting previously unselected package tcsh.
```

13. Type the following command: ls/usr/local/freesurfer/7-dev/

```
developer@DESKTOP-LD48TB7:~$ ls /usr/local/freesurfer/7-dev/
```

14. The output below should displayed:

```
ASegStatsLUT.txt FreeSurferEnv.sh Simple_surface_labels2009.txt build-stamp.txt fsafd mni sources.csh tktools
DefectLUT.txt SegmentNoLUT.txt WMParcStatsLUT.txt diffusion fsfast models sources.sh trctrain
FreeSurferColorLUT.txt SetUpFreeSurfer.csh average docs lib python subjects
FreeSurferEnv.csh SetUpFreeSurfer.sh bin etc matlab sessions tkmeditParcColorsCMA
```

15. Then type the three commands below to set up the graphics for Freesurfer

```
developer@DESKTOP-LD48TB7:~$ echo "export XDG_RUNTIME_DIR=$HOME/.xdg" >> $HOME/.bashrc
developer@DESKTOP-LD48TB7:~$ echo "export DISPLAY=:0" >> $HOME/.bashrc
developer@DESKTOP-LD48TB7:~$ echo "export FREESURFER_HOME=/usr/local/freesurfer/7-dev" >> $HOME/.bashrc
```

16. Next enter your license information with the commands below

```
developer@DESKTOP-LD48TB7:~$ echo "export FS_LICENSE=$HOME/license.txt" >> $HOME/.bashrc
developer@DESKTOP-LD48TB7:~$ echo "source /usr/local/freesurfer/7-dev/SetUpFreeSurfer.sh" >> $HOME/.bashrc
```

17. Logout and log back into the Ubuntu. The message below should be seen. This lets you know that the freesurfer environment is set up.

```
-----freesurfer-linux-ubuntu18_x86_64-dev-20210518-60f02e6-----
Setting up environment for FreeSurfer/FS-FAST (and FSL)
FREESURFER_HOME /usr/local/freesurfer/7-dev/
FSFAST_HOME /usr/local/freesurfer/7-dev//fsfast
FSF_OUTPUT_FORMAT nii.gz
SUBJECTS_DIR /usr/local/freesurfer/7-dev//subjects
INFO: /home/developer/matlab/startup.m does not exist ... creating
MNI_DIR /usr/local/freesurfer/7-dev//mni
```

- 18.

```
nathan@LAPTOP-FF9FC75L:~$ cd /usr/local/freesurfer/7-dev/subjects
nathan@LAPTOP-FF9FC75L:/usr/local/freesurfer/7-dev/subjects$
```

This command calls the Subject Directory so that files can be uploaded to it.

UPLOADING FILES TO FREESURFER

19. Sample data-sets can be downloaded from the Nathan Kline Institute-Rockland Sample

https://fcon_1000.projects.nitrc.org/indi/pro/eNKI_RS_TRT/FrontPage.html

- Scroll to the bottom and download NIFTI

20. This command is used to upload NIFTI files to the Subject Directory so that they can be accessed in Freesurfer

```
----- freesurfer-linux-ubuntu18_x86_64-dev-20211020-b964143 -----
Setting up environment for FreeSurfer/FS-FAST (and FSL)
FREESURFER_HOME      /usr/local/freesurfer/7-dev
FSFAST_HOME          /usr/local/freesurfer/7-dev/fsfast
FSF_OUTPUT_FORMAT    nii.gz
SUBJECTS_DIR         /usr/local/freesurfer/7-dev/subjects
MNI_DIR              /usr/local/freesurfer/7-dev/mni
nathan@LAPTOP-FF9FC75L:~$ cd /usr/local/freesurfer/7-dev/subjects
nathan@LAPTOP-FF9FC75L:/usr/local/freesurfer/7-dev/subjects$ 
nathan@LAPTOP-FF9FC75L:/usr/local/freesurfer/7-dev/subjects$ sudo cp -r <Path to File> /usr/local/freesurfer/7-dev/subjects
```

EX: sudo cp -r /mnt/c/Users/cyntc/Downloads/sub26223.nii.gz

RECON-ALL (segmenting NIFTI file)

21. In order to perform the reconstruction of the NIFTI file use the recon-all command.

```
recon-all -s subj01 -i subj1_anat.nii -all|
```

Here subj01 is the name of the newly constructed file and subj1_anat.nii is the name of the NIFTI file being reconstructed.

If there are any permission errors, use the command:

```
sudo chmod -R a+w  
$SUBJECTS_DIR
```

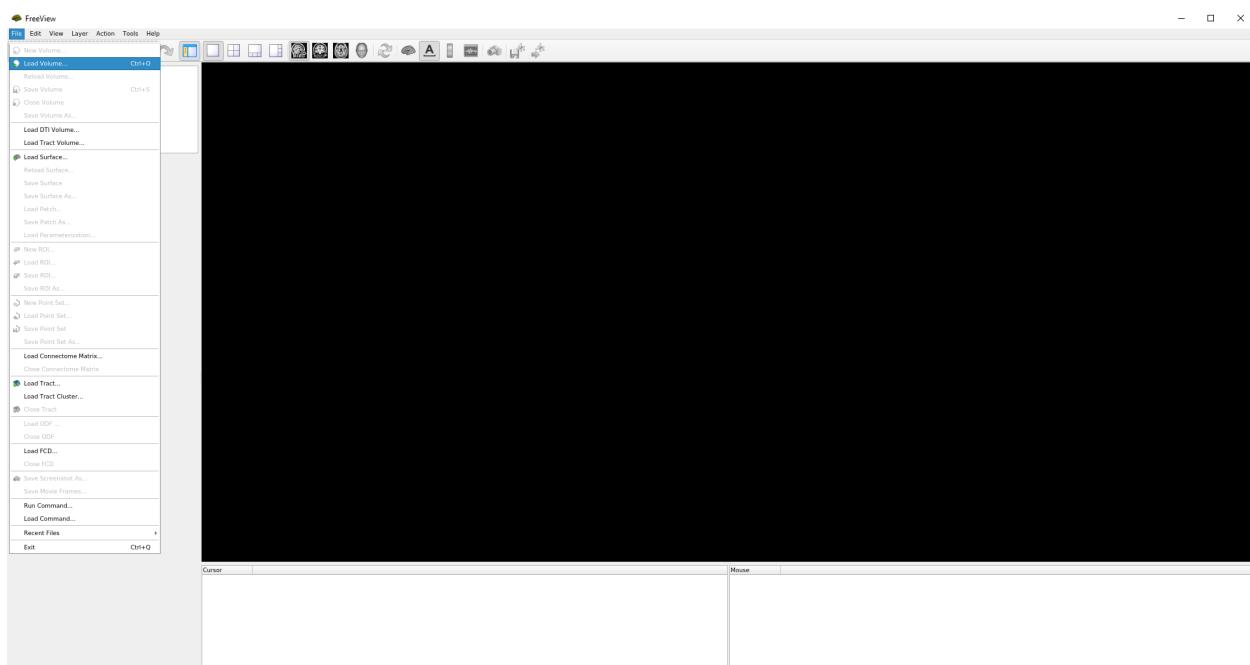
22. Once the recon-all process is complete, open freeview and load the following volumes and surfaces:

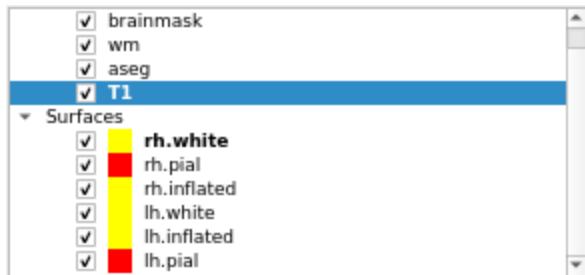
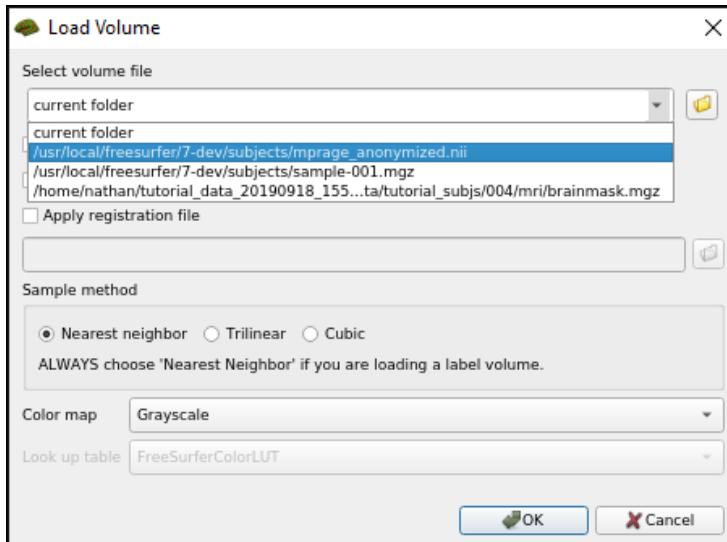
23. In order to open the Freesurfer GUI (graphical user interface) first Download the XLaunch file found at this link: <https://sourceforge.net/projects/xming/>

24. Once XLaunch has been successfully downloaded and configured, freeview can be opened by typing “freeview” into the command line

```
nathan@LAPTOP-FF9FC75L:/usr/local/freesurfer/7-dev/subjects$ freeview
```

25. The freeview GUI should open. Then click file -> Load Volume -> Then select the folder containing the NIFTI file

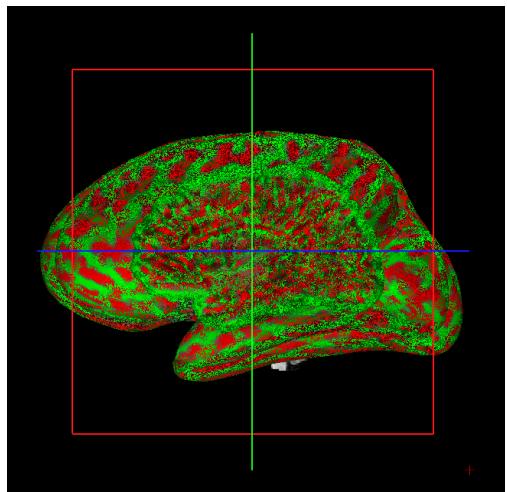




This process can be done from the freeview GUI or through the Ubuntu command line using the commands seen below:

```
[AndyHaskins:Cannabis/Completed/sub-101] Andrew% freeview -v \
mri/T1.mgz \
mri/wm.mgz \
mri/brainmask.mgz \
mri/aseg.mgz:colormap=lut:opacity=0.2 \
-f surf/lh.white:edgecolor=blue \
surf/lh.pial:edgecolor=red \
surf/rh.white:edgecolor=blue \
surf/rh.pial:edgecolor=red \
surf/lh.inflated \
surf/rh.inflated
```

26. If this process is done correctly the model view should show:



CONVERTING SEGMENTATION TO .STL

27. The next step is converting the pial surface of the brain to an stl file that can be printed by using the commands below:

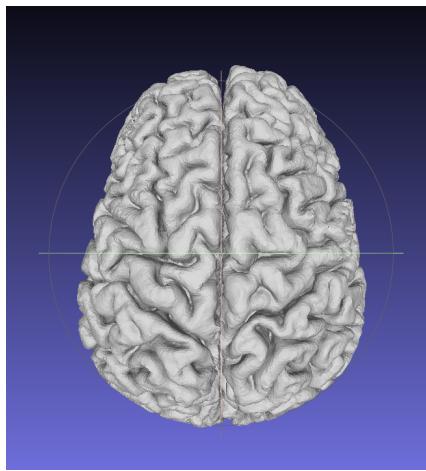
```
nathan@LAPTOP-FF9FC75L:~$ cd /usr/local/freesurfer/7-dev/subjects  
nathan@LAPTOP-FF9FC75L:/usr/local/freesurfer/7-dev/subjects$ mris_convert /usr/local/freesurfer/7-dev/subjects/NIFTI01/surf/rh.pial rh.stl  
Saving rh.stl as a surface  
nathan@LAPTOP-FF9FC75L:/usr/local/freesurfer/7-dev/subjects$ mris_convert /usr/local/freesurfer/7-dev/subjects/NIFTI01/surf/lh.pial lh.stl  
Saving lh.stl as a surface
```

28. To move the .stl files to your computer folder perform the following steps:

```
nathan@LAPTOP-FF9FC75L:~$ cd /mnt/c/Users/cyntc/
```

```
nathan@LAPTOP-FF9FC75L:/mnt/c/Users/cyntc$ sudo cp -r /usr/local/freesurfer/7-dev/subjects/NIFTI01/surf/rh.stl /mnt/c/Users/cyntc  
nathan@LAPTOP-FF9FC75L:/mnt/c/Users/cyntc$ sudo cp -r /usr/local/freesurfer/7-dev/subjects/NIFTI01/surf/lh.stl /mnt/c/Users/cyntc
```

29. In order to save both hemispheres of the brain together to unify the model, use Boolean union by clicking rh or lh on the right toolbar



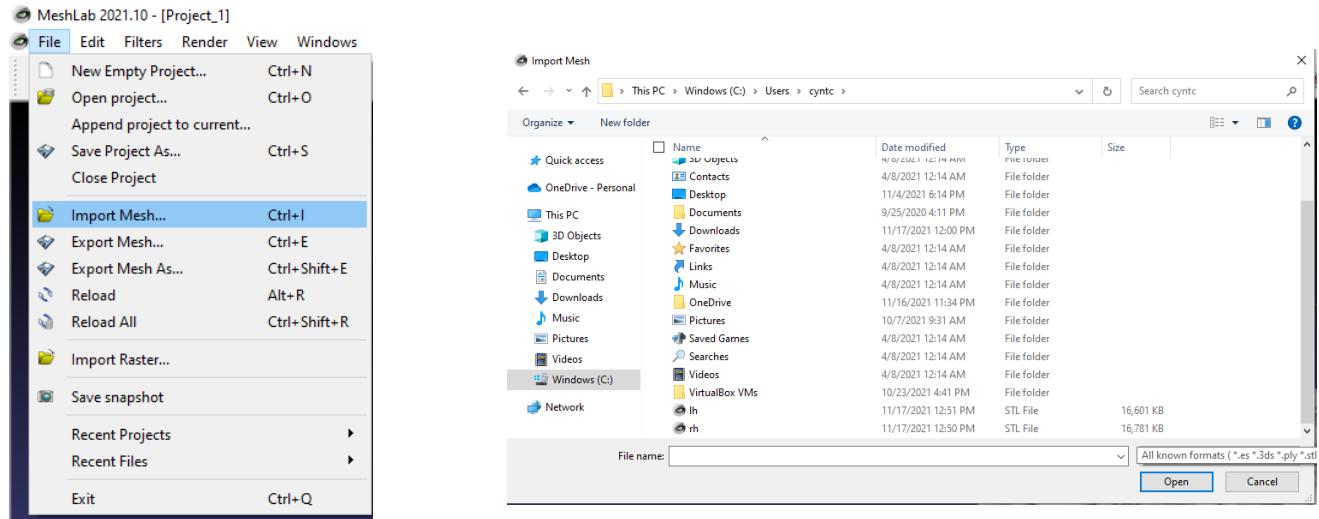
QUALITY CONTROL → PRINT

29. Download the appropriate version of MeshLab ---> <https://www.meshlab.net/>

For Instructions using MeshLab follow the link below:

<https://layerfmri.com/2018/07/25/3d-printing-nii-data/>

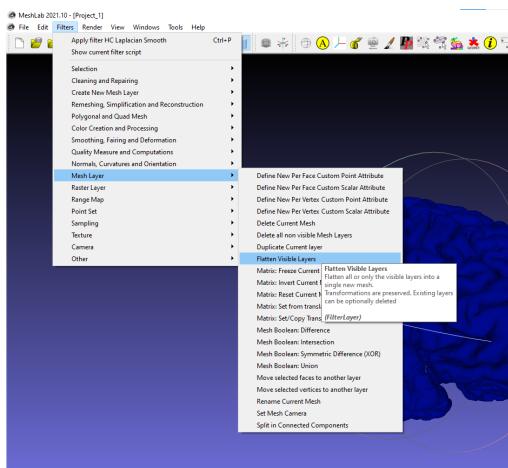
30. Open the application and go to File -> Import Mesh, then select the lh.stl and rh.stl files



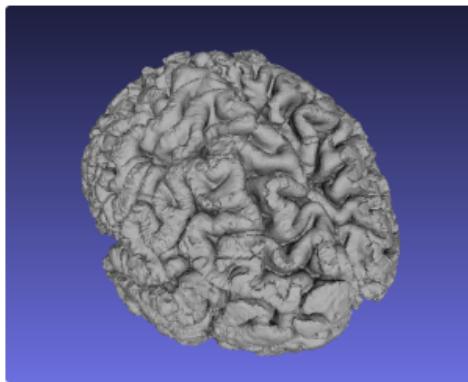
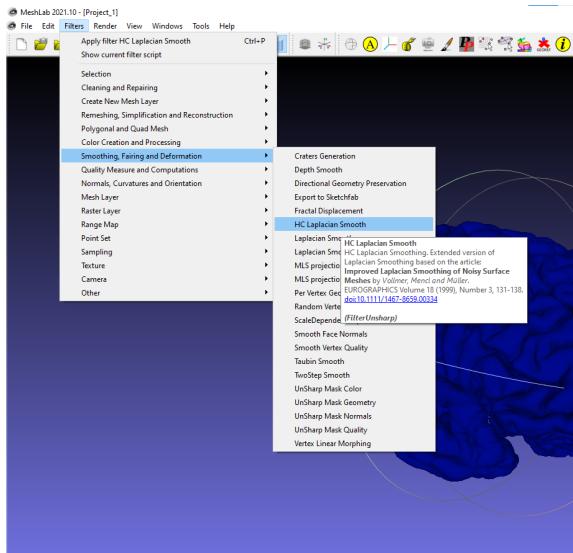
31. The quality of the model can be improved in Meshlab by performing the following operations:

4. Filters>Mesh Layer>Flatten Visible Layers

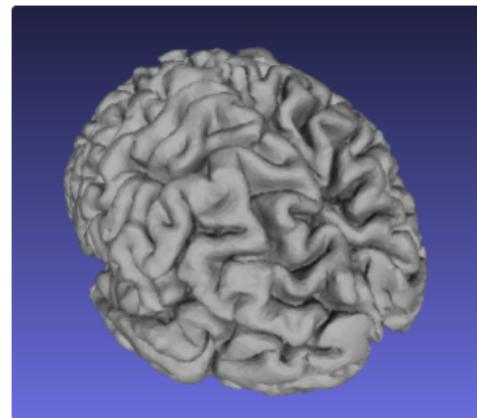
5. Click Apply



8. Optional: Filters>Smoothing, Fairing and Deformation>HC Laplacian Smooth (for esthetic reasons)



FreeSurfer output without corrections in Meshlab

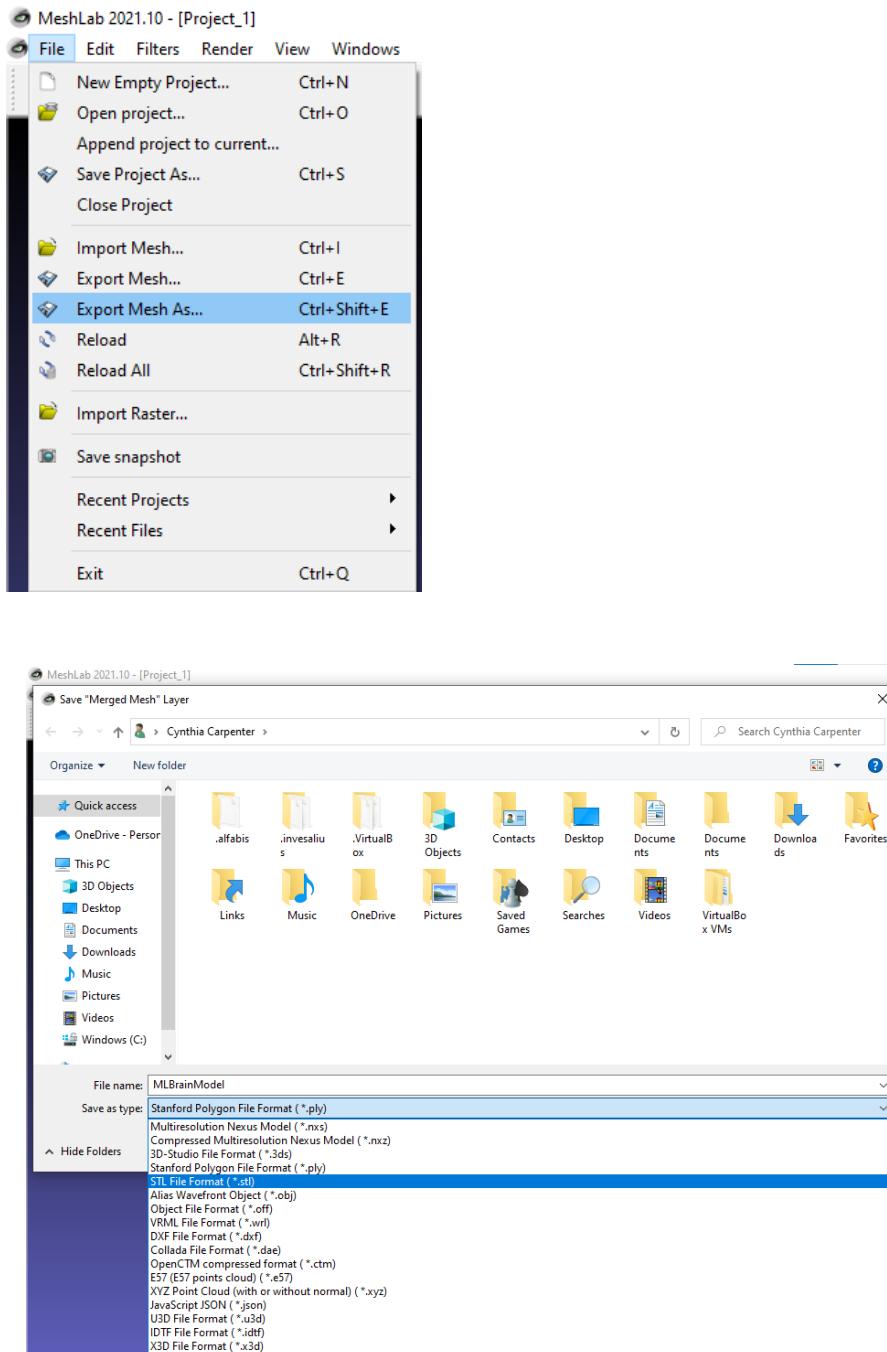


After corrections in Meshlab

In Meshmixer use the reduce without deviation tool to reduce the number of vertices.

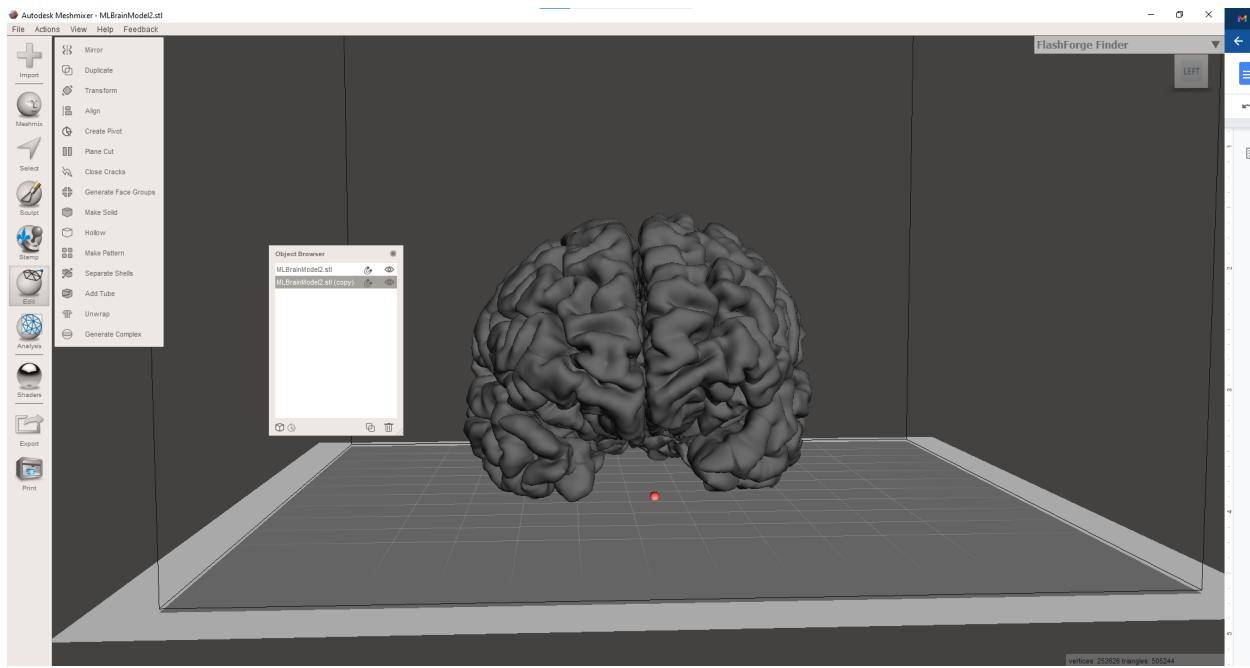
32. Once these modifications have been made, a 3D Brain Model should be visible

33. Once model is ready to print do the following steps to save it as an .stl file

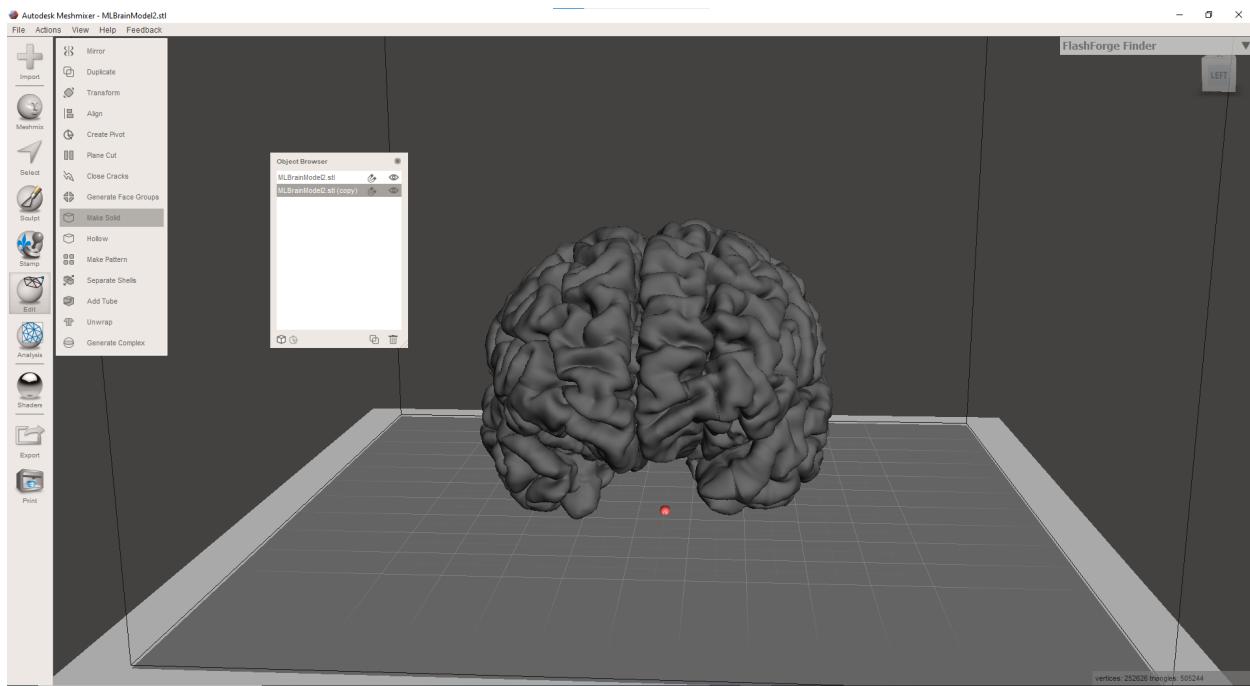


Meshmixer Lattice Structure

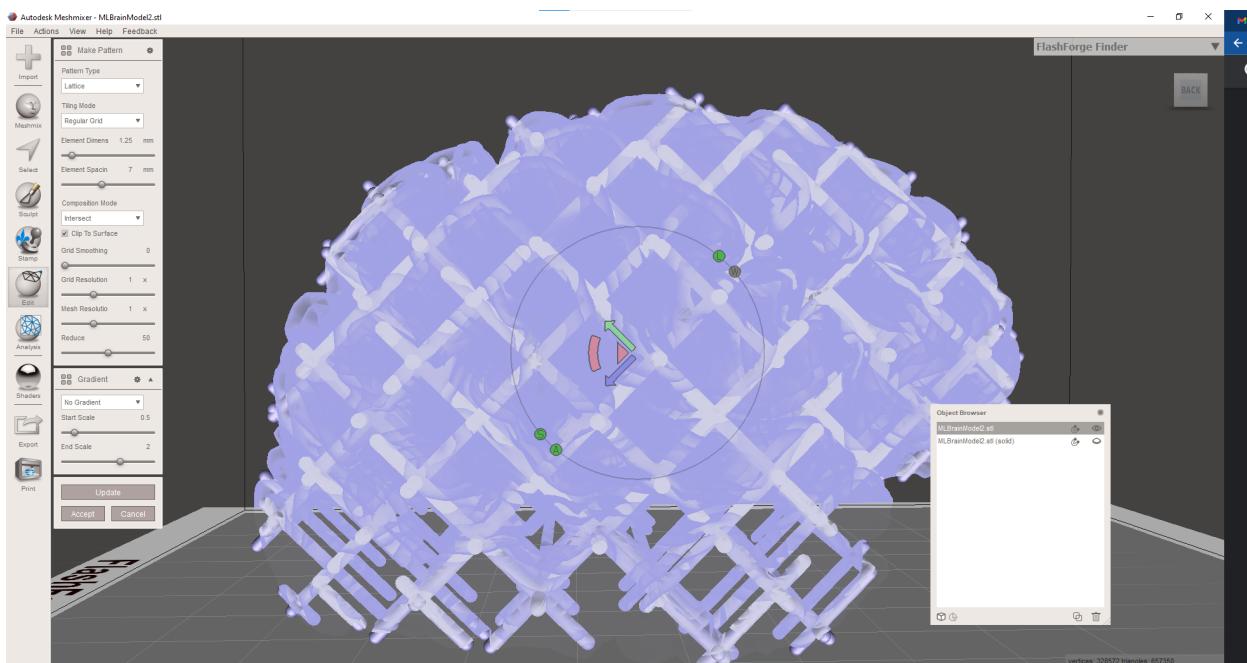
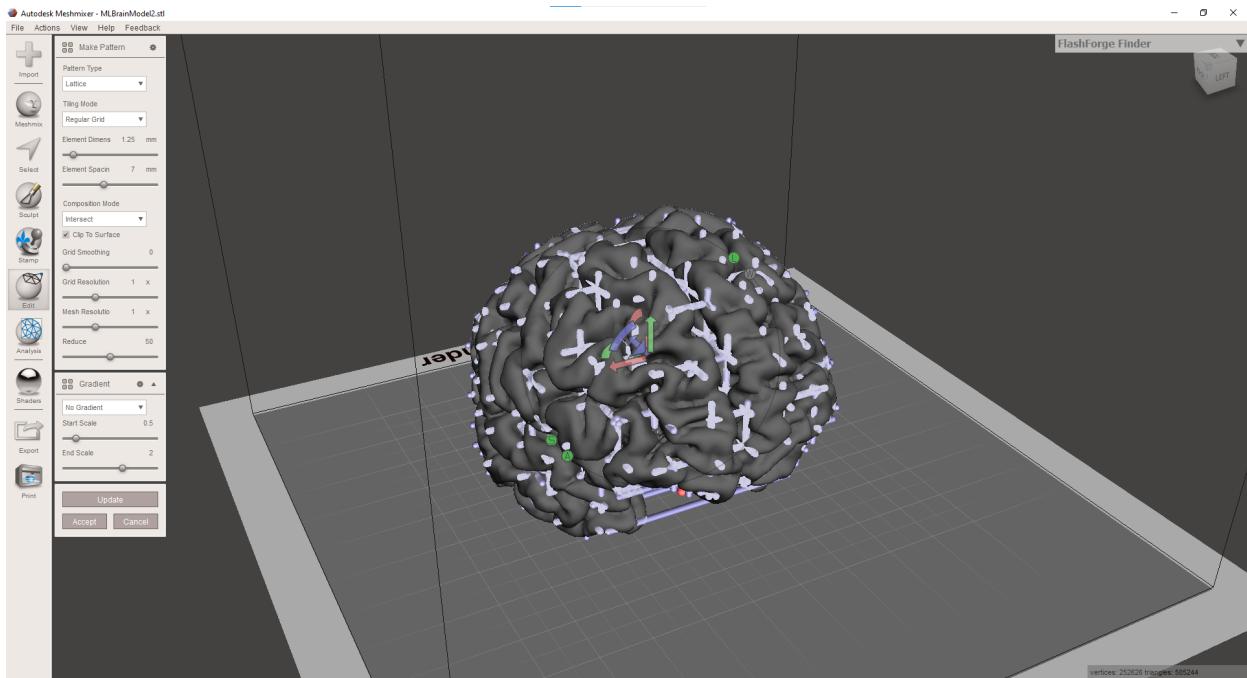
34. Copy the model so that one can be made into the exterior and one can be made the infill.

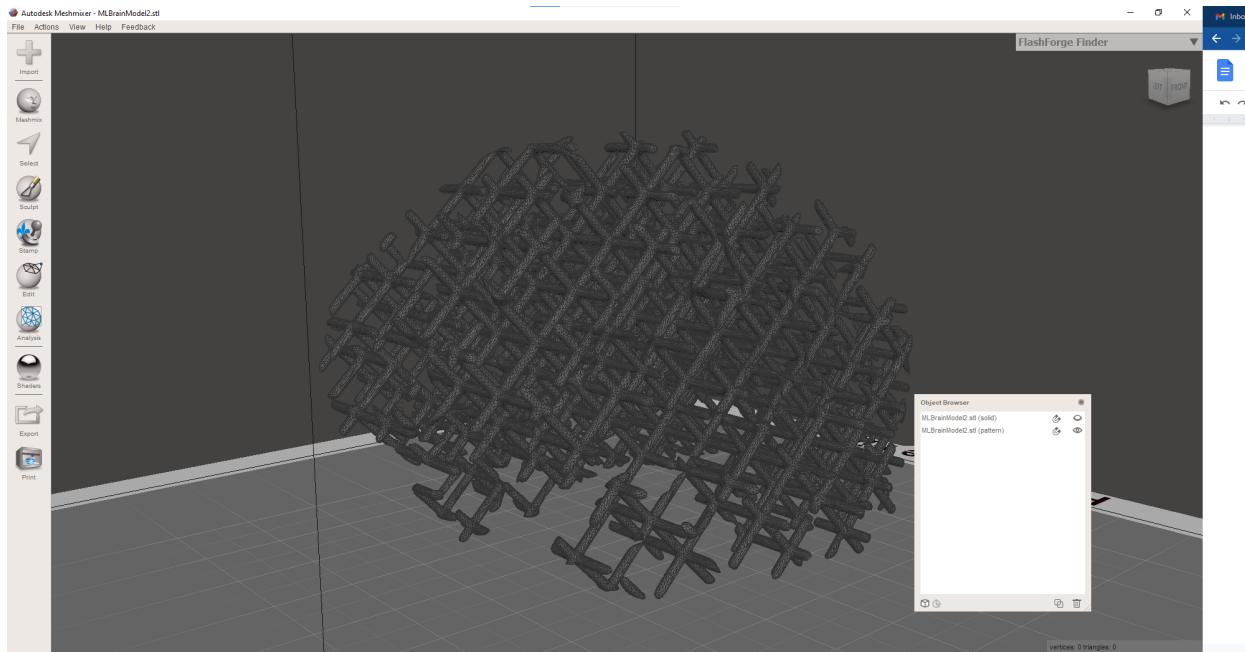


35. Use the MAKE SOLID tool to make the interior or the model HOLLOW

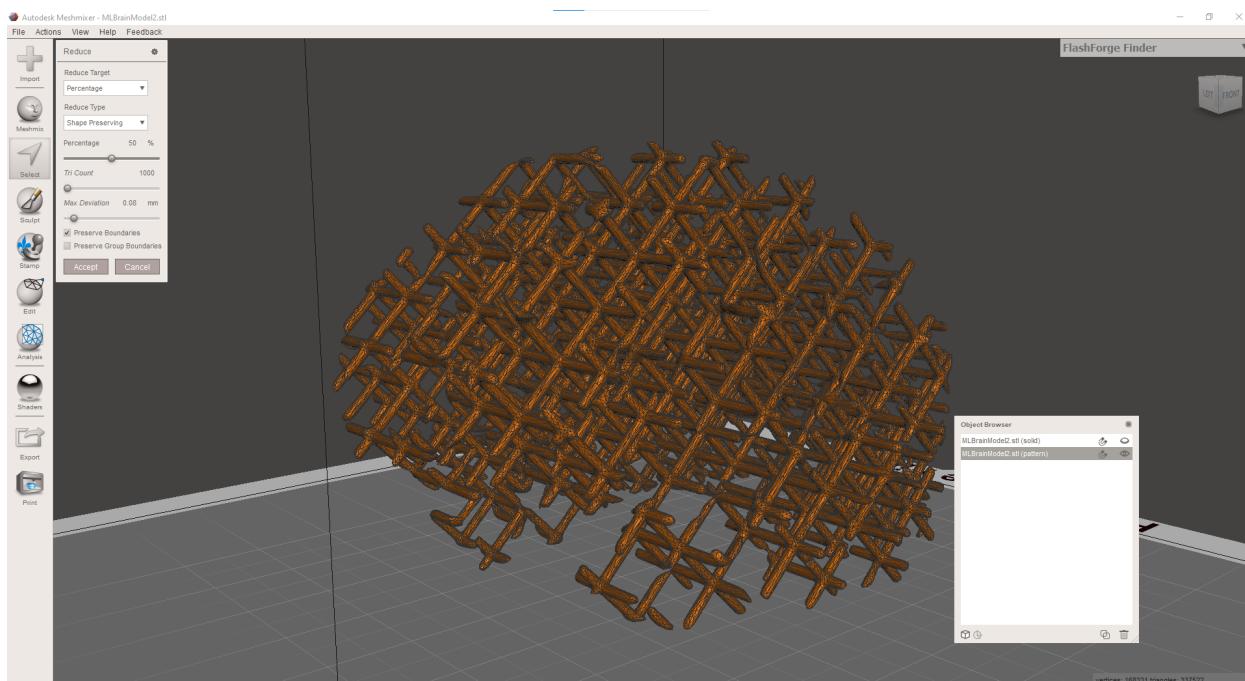


36. Make the lattice structure with the copy of the model with the parameters seen below. Tilt the lattice to a 45 degree angle to support the print.

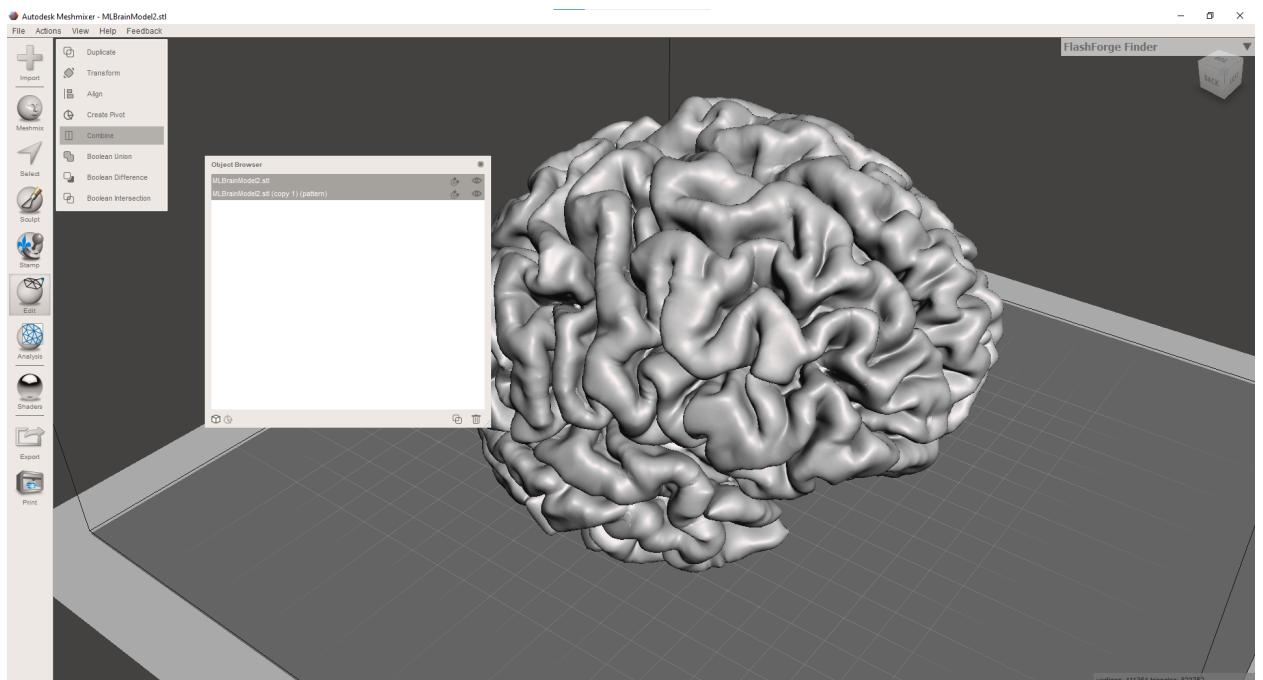
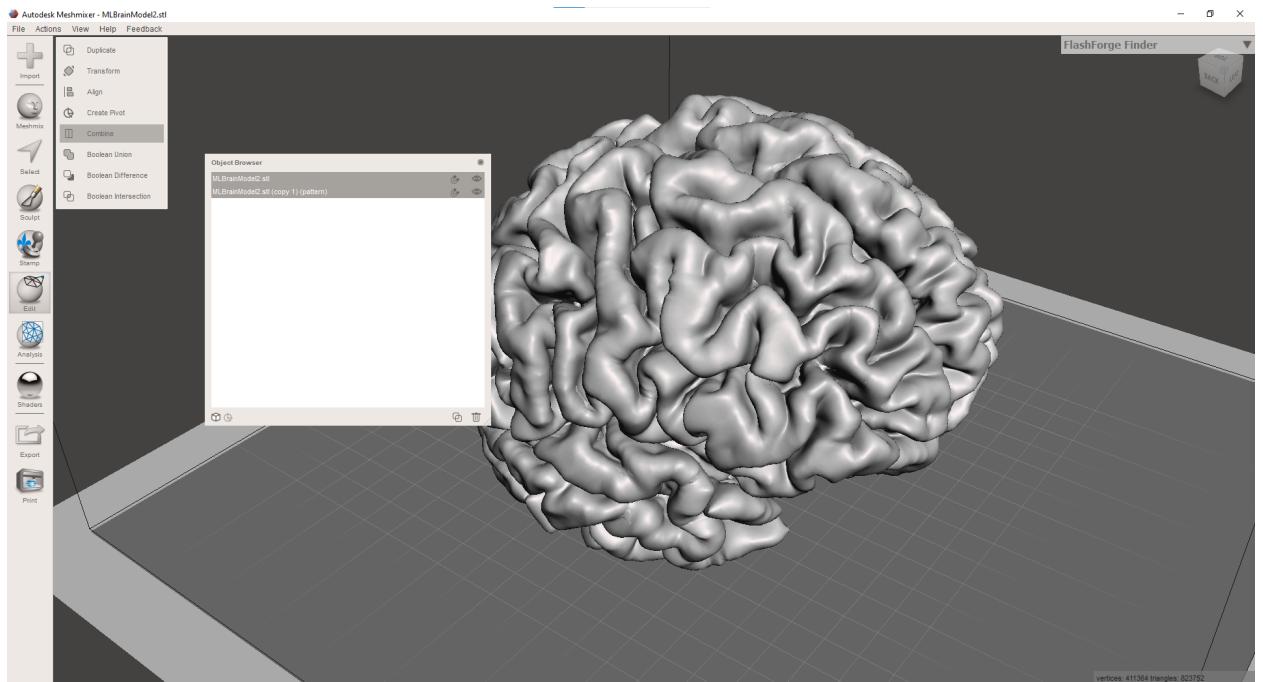




37. Reduce the lattice structure.

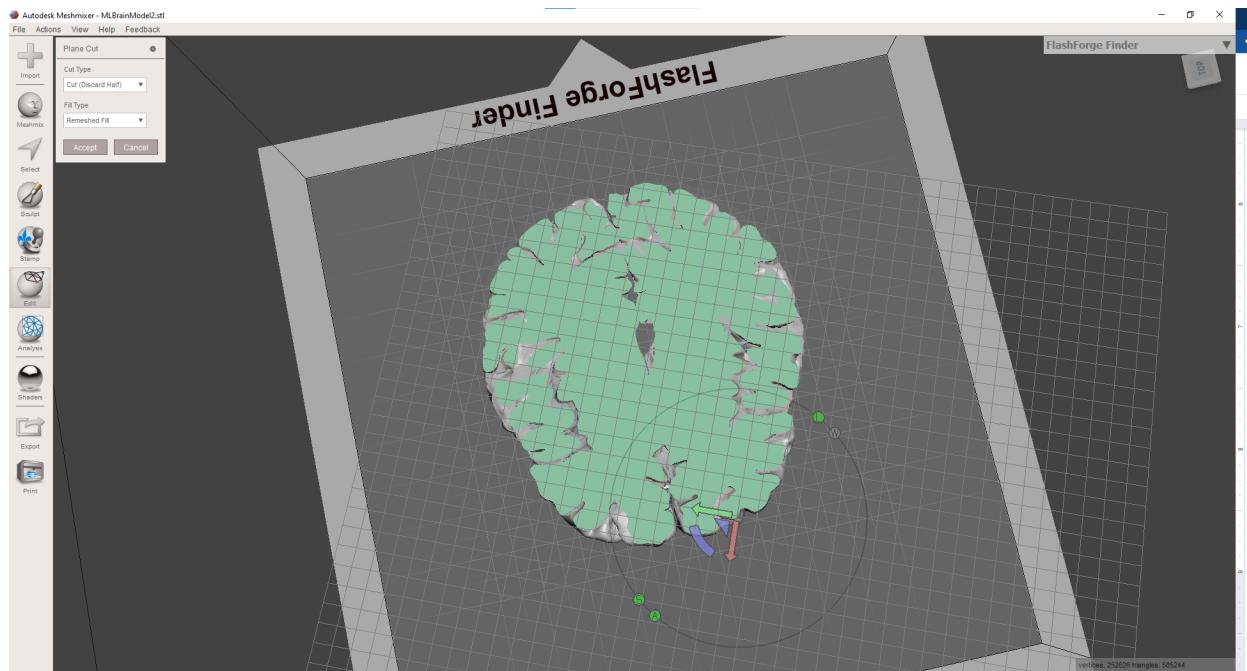


38. Combine the two structures.



39. Use the make solid tool to stitch the interior and exterior together.

Original Model Interior:



Lattice Model Interior:

