

Part 3: 3D Animation in Autodesk MAYA

Intro to Animation

for Science Communication

Jessica Kendall-Bar



LAST WEEK'S AFTER EFFECTS WORKSHOP REVIEW

- Defining Animation v. Motion Graphics
- Adobe workflows: choosing software to fit your needs
- After Effects Animation Examples
- Tutorial Linking CSV data to After Effects Animations
- Take home practice: syncing timeseries data to videos

Key words and concepts:

Design:

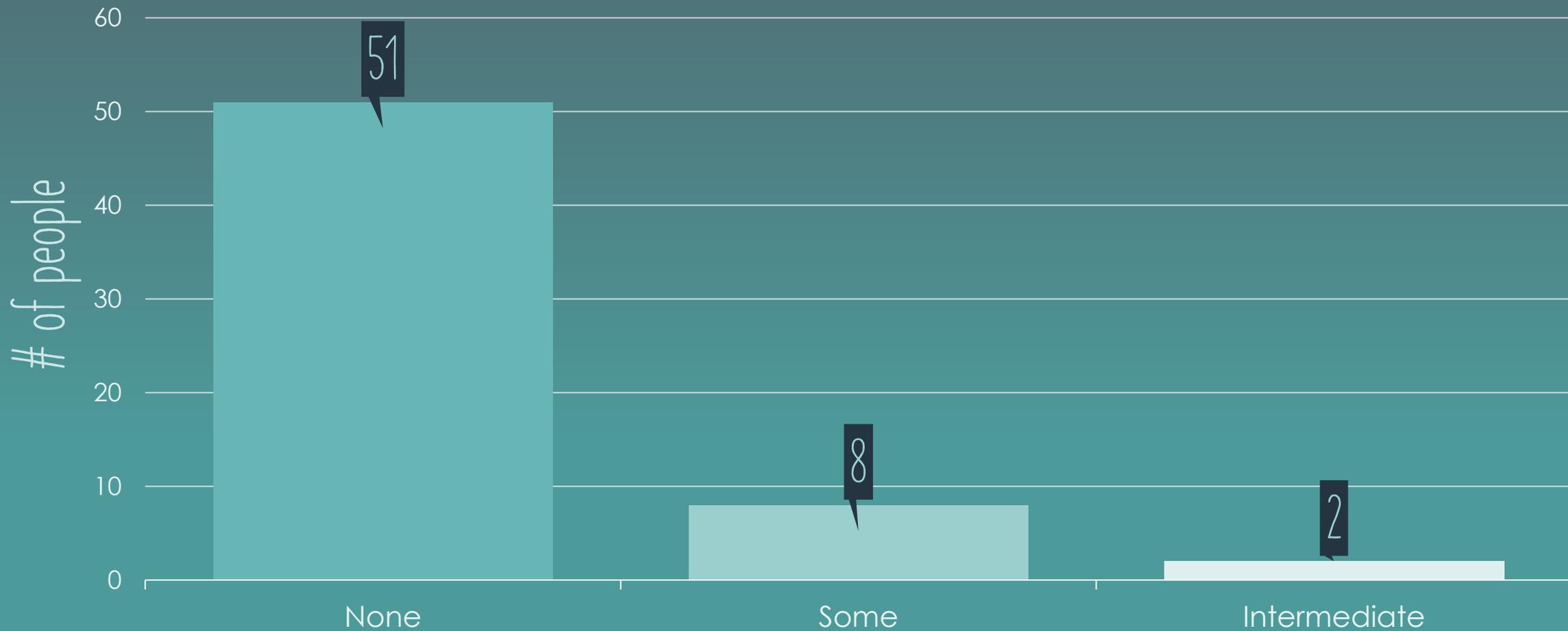
- Animation
- Motion Graphics

Shortcuts and Tools:

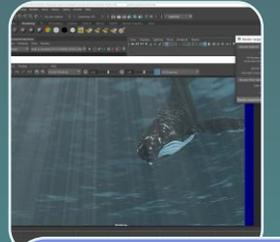
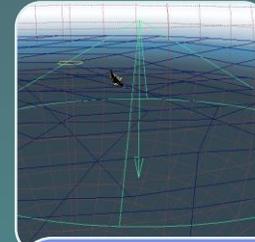
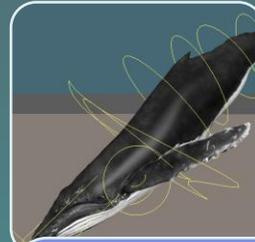
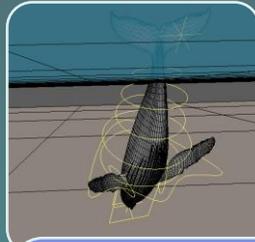
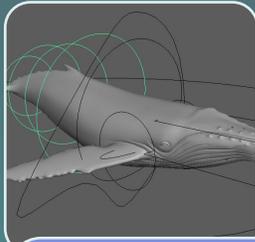
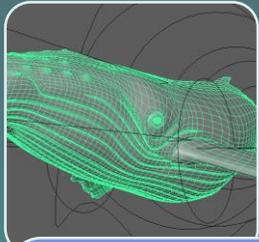
- Duplicate
- Align
- Add Keyframes
- Add Slider Controls
- Using expressions
- Using the Pick Whip

WHERE YOU'RE AT :

Your self-described experience level in Autodesk MAYA



3D ANIMATION WORKFLOW



MODEL

Create 3 dimensional models using polygon primitives

RIG

Rig a skeleton to constrain and direct motion of your model during animation.

ANIMATE

Animate the position and rotation of your model or its skeleton over time.

TEXTURE

Wrap models in UV textures to add color and detail.

LIGHTS, CAMERA, ACTION!

Add lighting, add and animate cameras.

RENDER

Once your 3D scene is ready, render high resolution 2D images for each frame.

Disclaimer: experts specialize in each of these fields as **professions**, don't be discouraged if these steps are hard, because they are! This broad overview is just to give you a sense of what's possible in the 3D realm!

3D Modeling

Creating a 3D character for your 3D animation using 3D shapes and surfaces.

OPTION 1) PURCHASE A 3D MODEL

Websites: Turbosquid, Sketchfab, CGTrader, etc!

A 3D model I purchased from:

<https://www.turbosquid.com/3d-models/3d-humpback-whale-hump/597221>



ANIMATED

Humpback Whale by MotionCow

\$129 Add to Cart

3D Model > nature > animal > mammals > marine mammals > whale > humpback whale

3D Model License: Standard Upgrade License >

FORMATS

NATIVE Maya 2008 Default Scanline

3ds Max 8 Default Scanline Softimage 5.11 mental ray

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Humpback Whale by MotionCow \$129 [Add to Cart](#)

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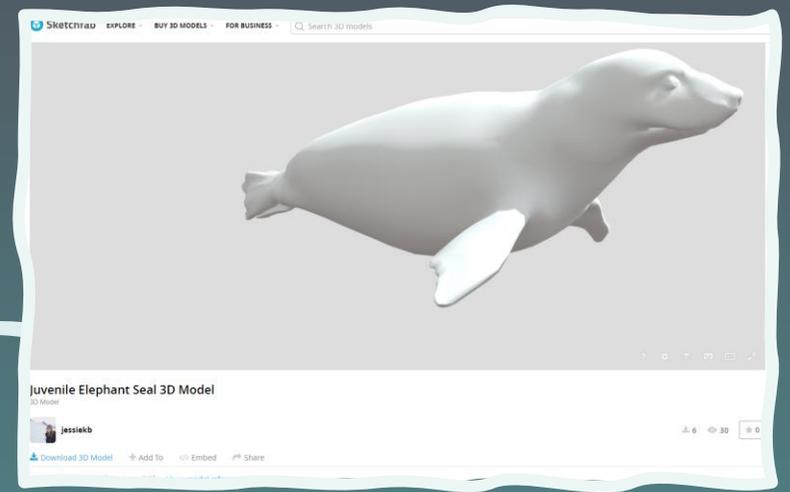
Photo Realistic Humpback Whale: Rigged & Animated.

Features:
.....

FORMATS
NATIVE | Maya 2008 | Default Scanline
3ds Max 8 | Default Scanline | Softimage 5.11 | mental ray

OPTION 2) DOWNLOAD A FREE 3D MODEL

Websites: Turbosquid, Sketchfab, CGTrader, etc!



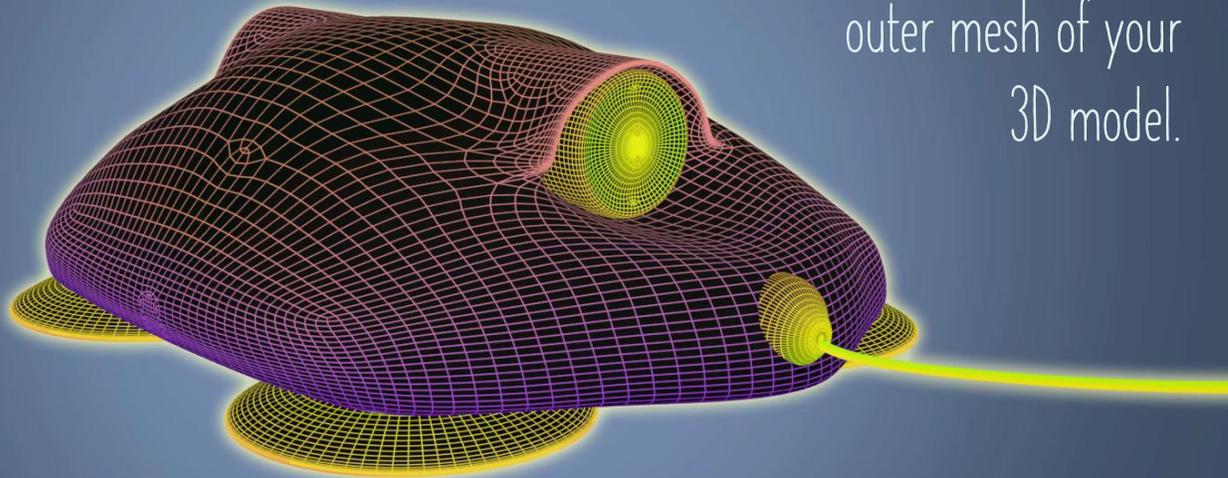
Free model I made:

<https://skfb.ly/6WSlz>

For this workshop, feel free to download and use a 3D model I modified from a free 3D model of a harp seal using photos and measurements of a juvenile elephant seal.

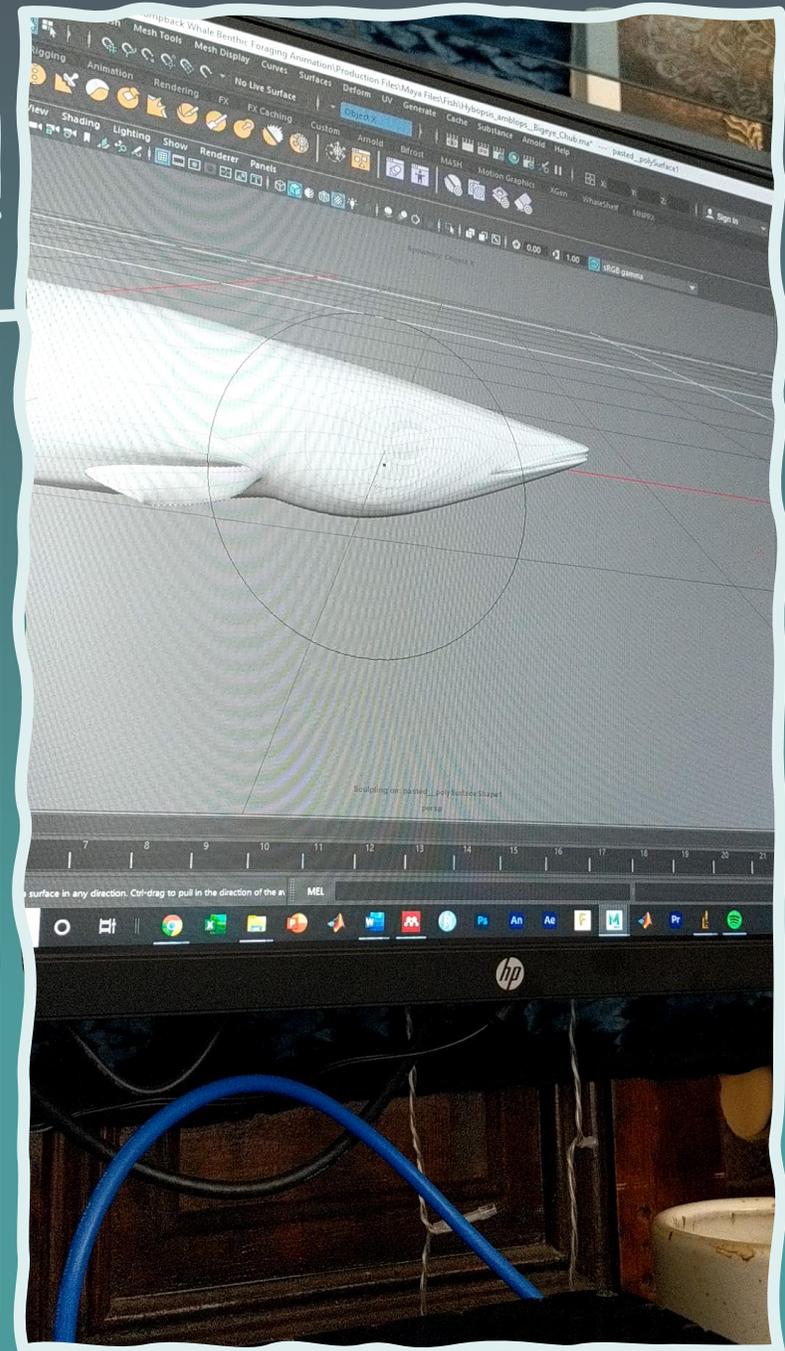
OPTION 3) MAKE YOUR OWN FROM SCRATCH!

the CATS tag
Customized Animal Tracking Solutions

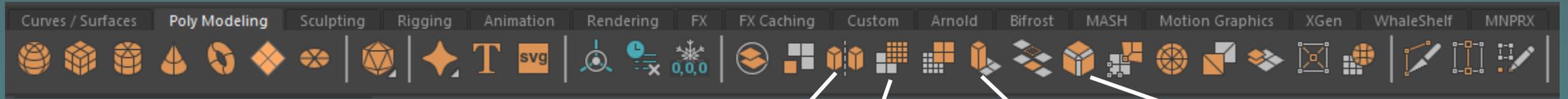


New tagging technology has allowed

Create and edit 3D shapes to create the outer mesh of your 3D model.



OPTION 3) MAKE YOUR OWN FROM SCRATCH!



Mirror

Smooth

Extrude

Bevel

Make spheres, cubes, cylinders, cones, donuts, planes or discs.

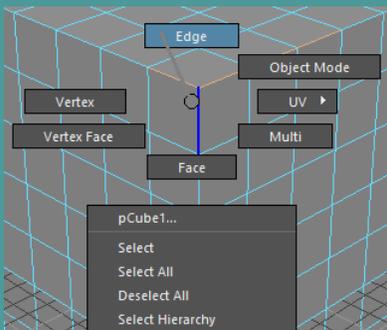
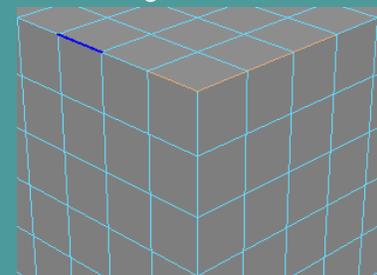
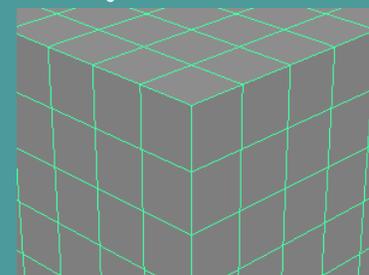
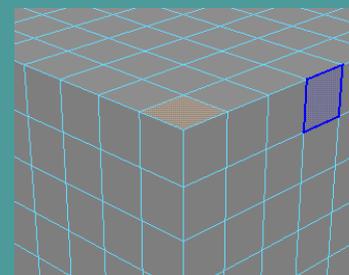
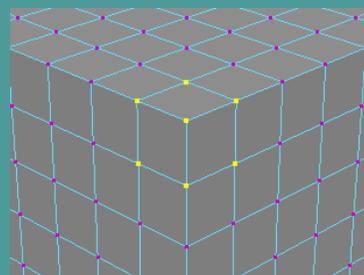
Change selection mode by right clicking, holding, and toggling selection modes:

Vertex mode

Face mode

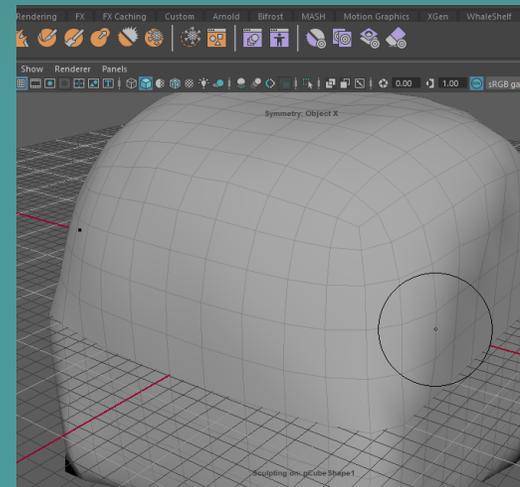
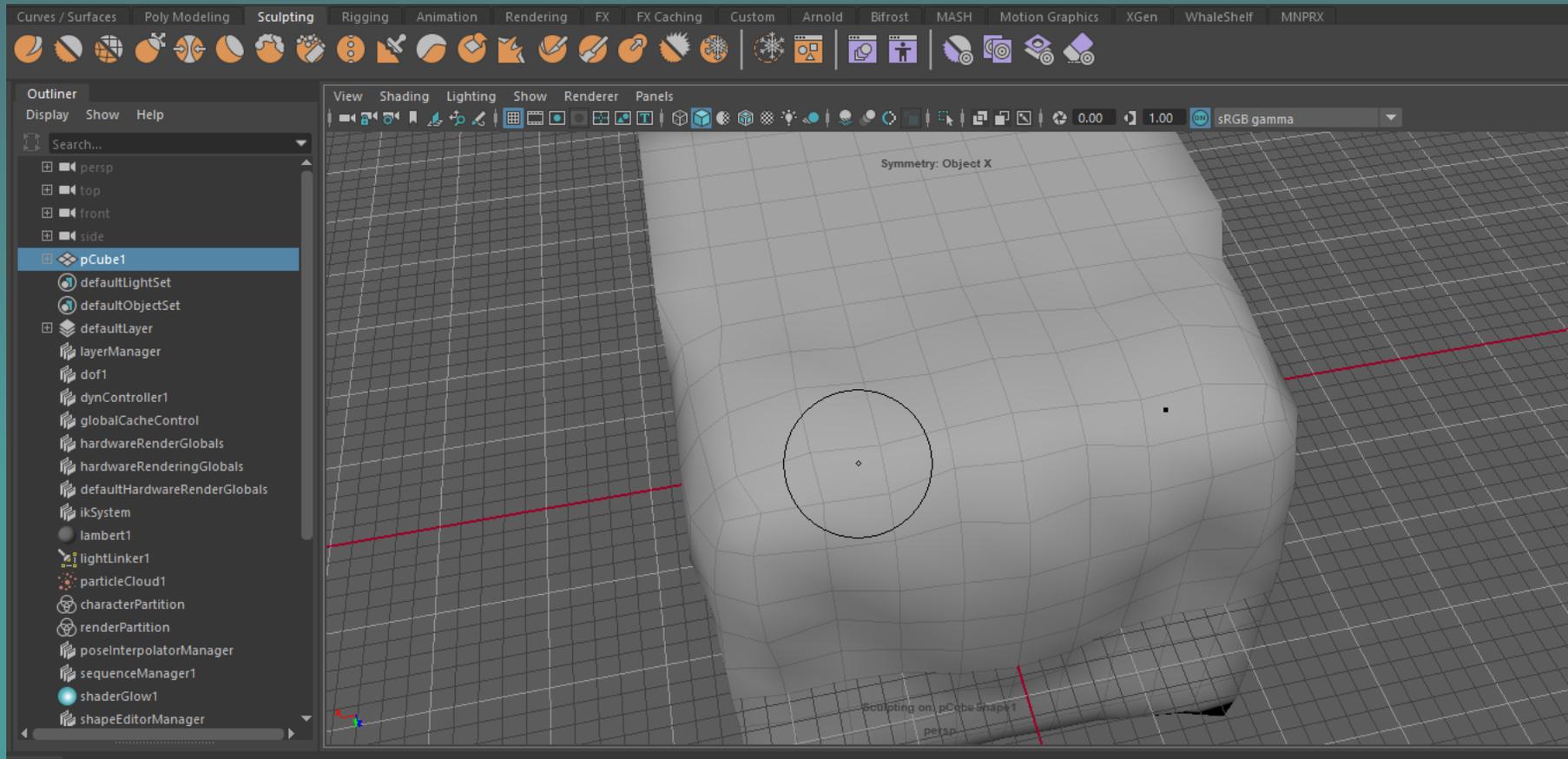
Object mode

Edge mode



OPTION 3) MAKE YOUR OWN FROM SCRATCH!

To achieve smooth organic shapes, you can use the sculpting tools.



SOME WILD STUFF

Entering virtual reality to use Oculus medium to sculpt characters!



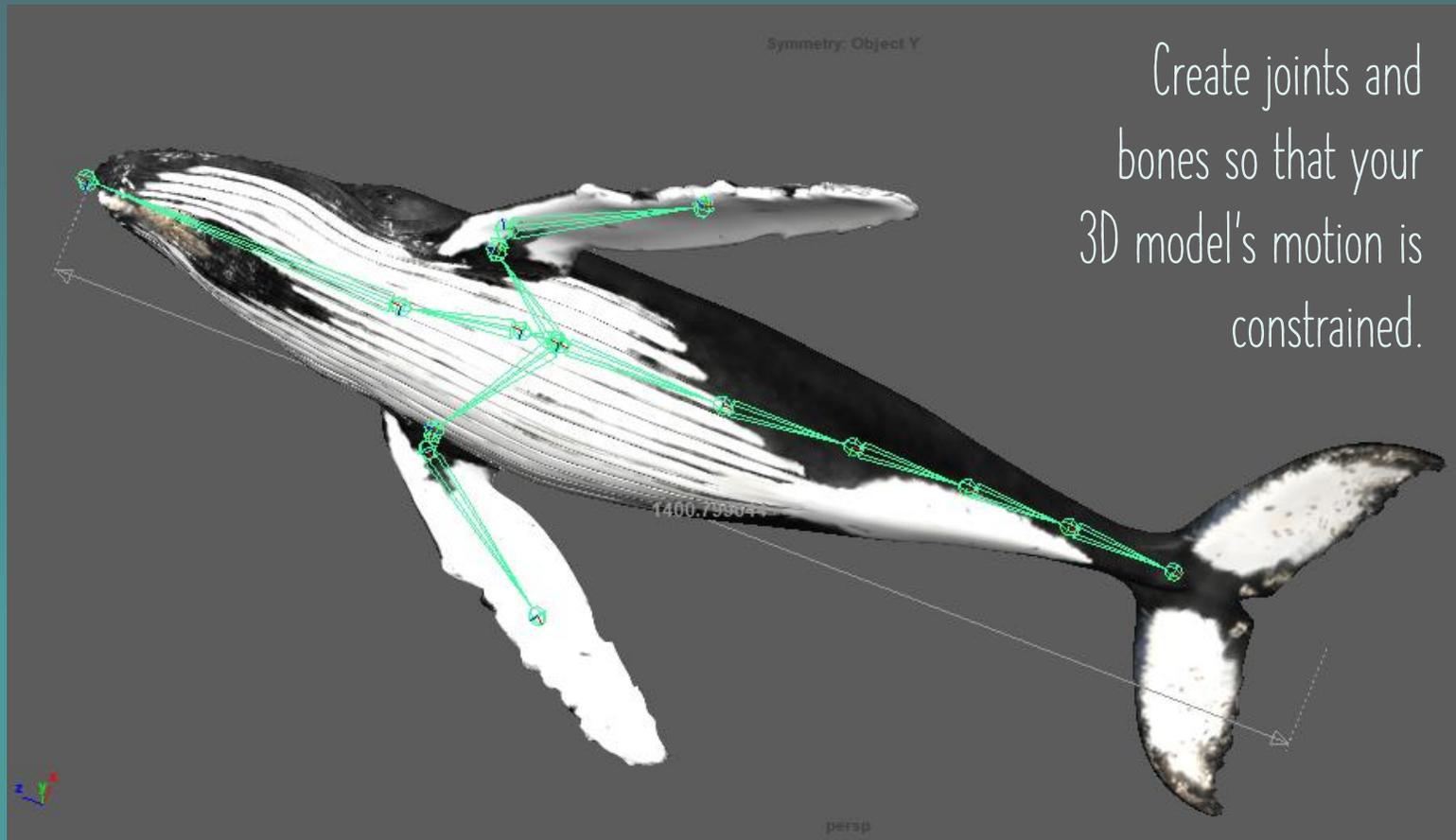
<https://youtu.be/qmuwXr3bNBV>



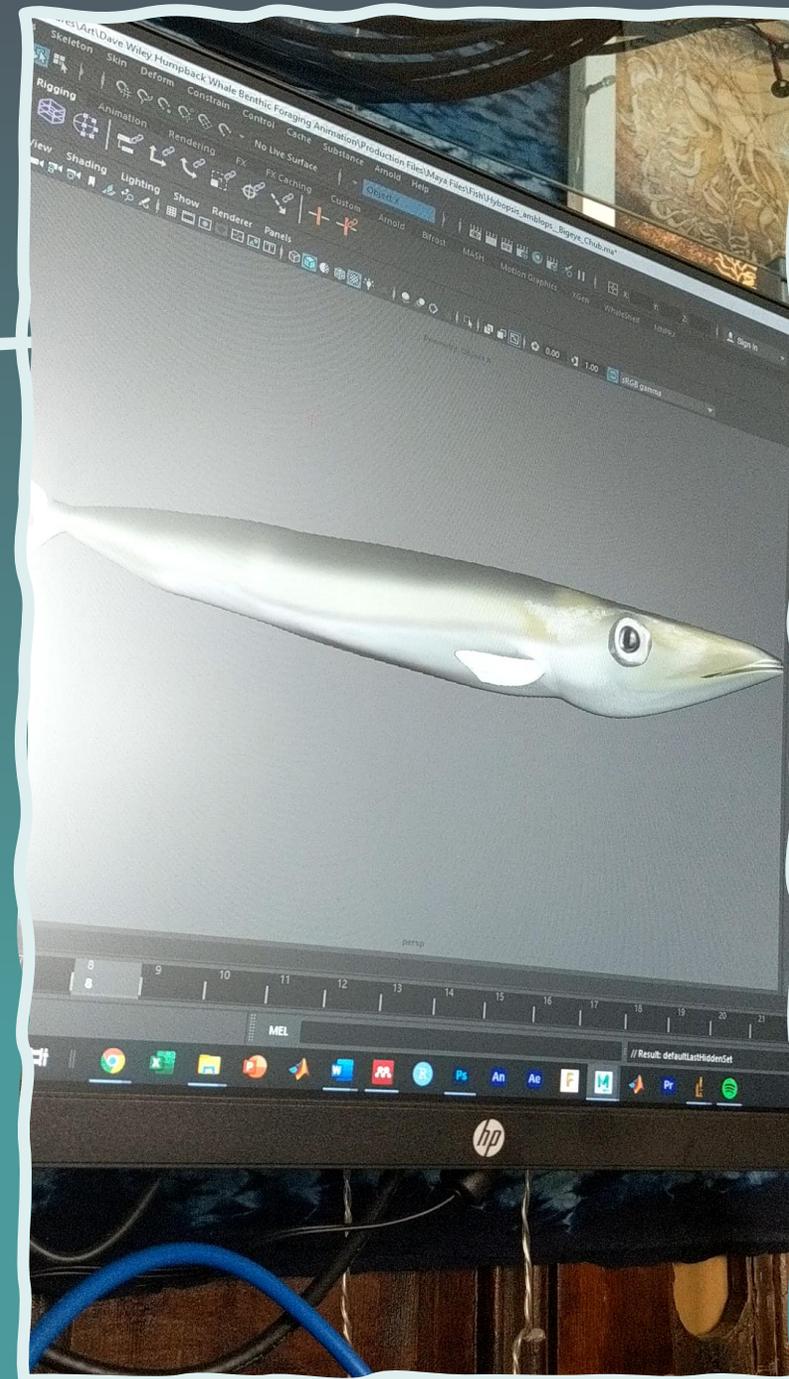
Rigging

Creating a skeleton to constrain the motion of your 3D model.

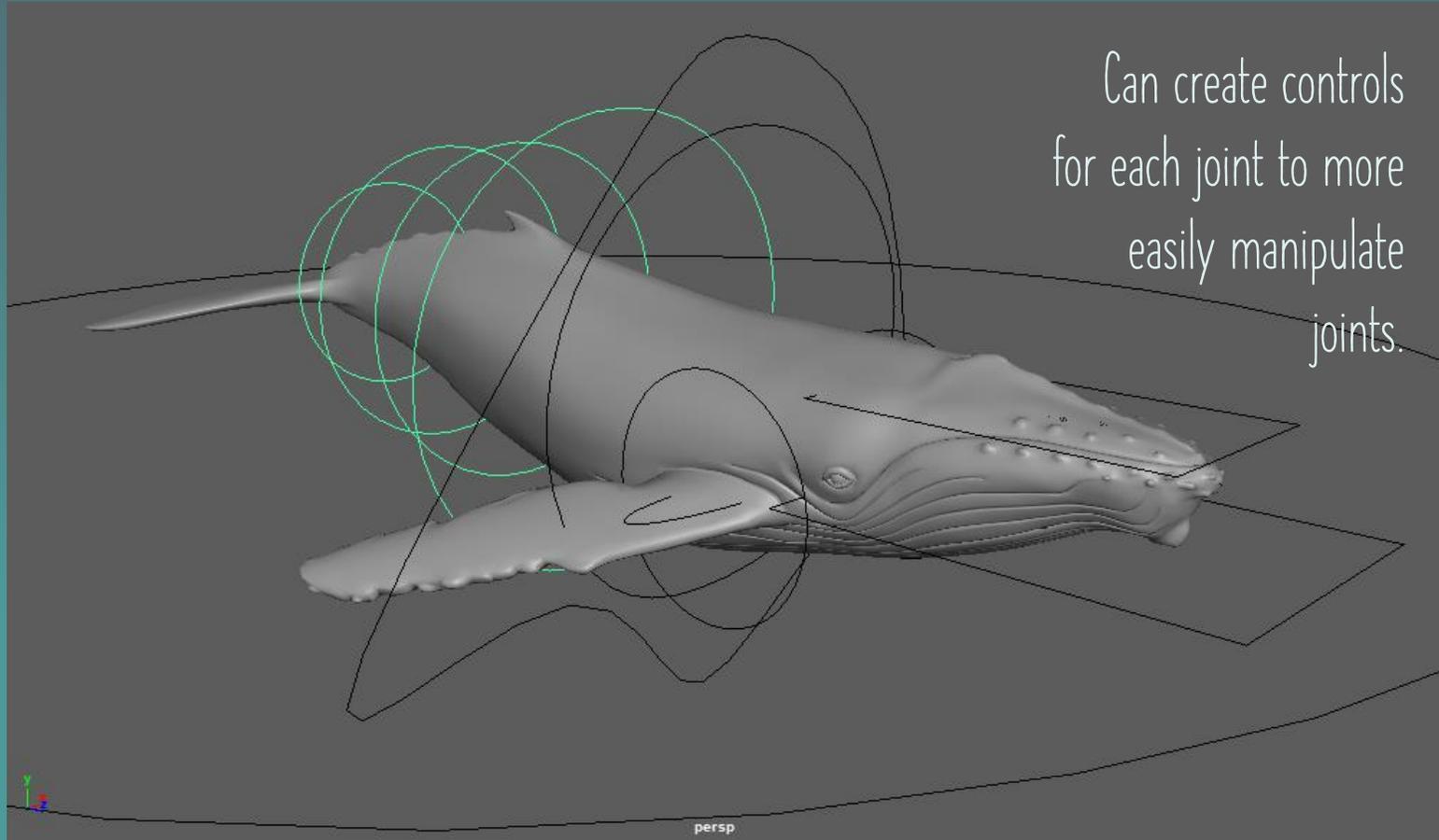
RIGGING



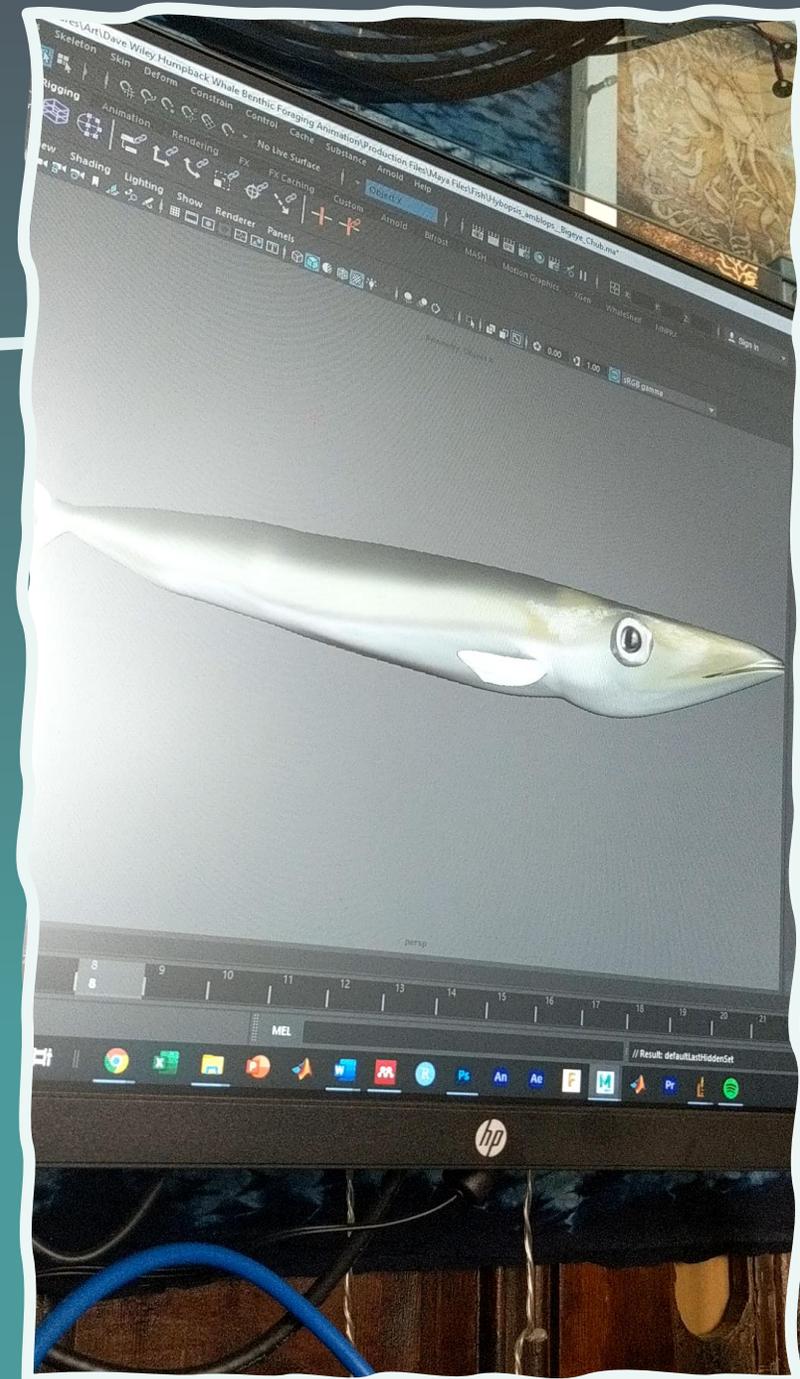
Create joints and bones so that your 3D model's motion is constrained.



RIGGING



Can create controls
for each joint to more
easily manipulate
joints.

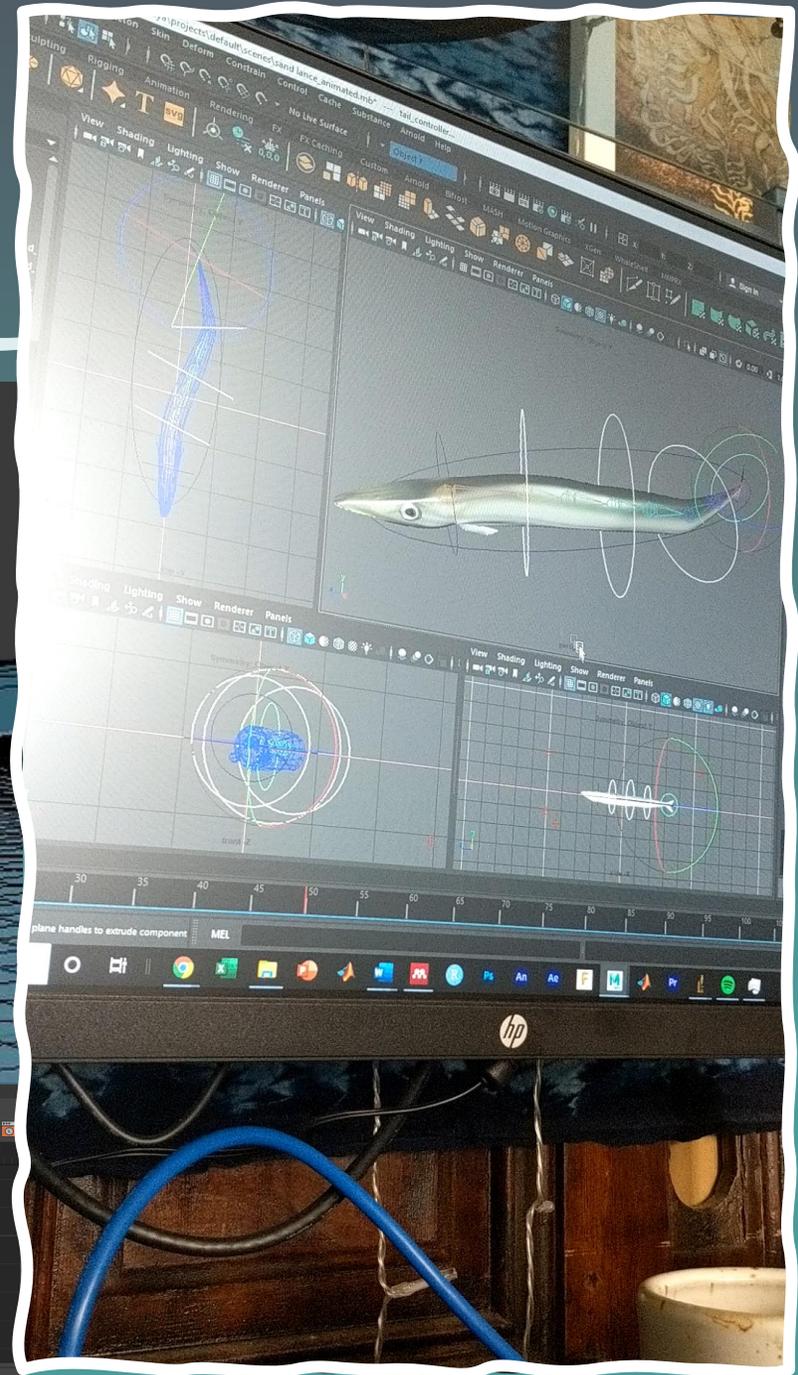
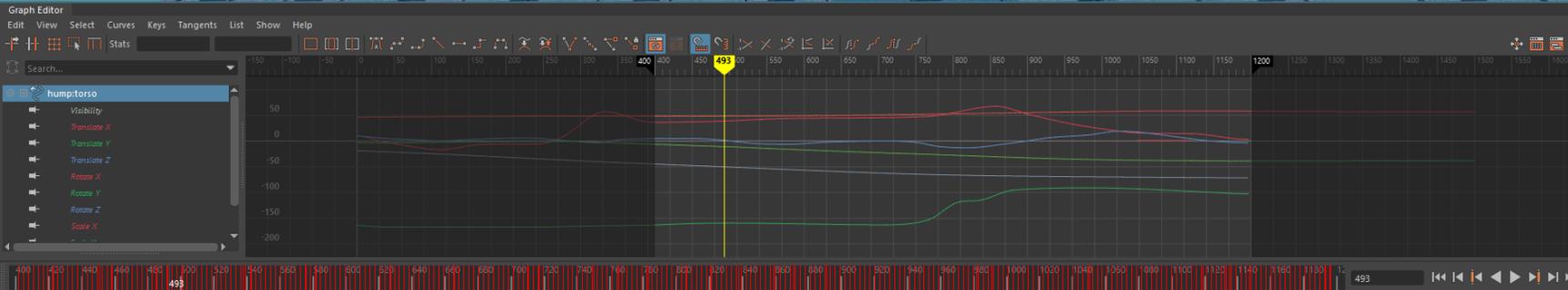
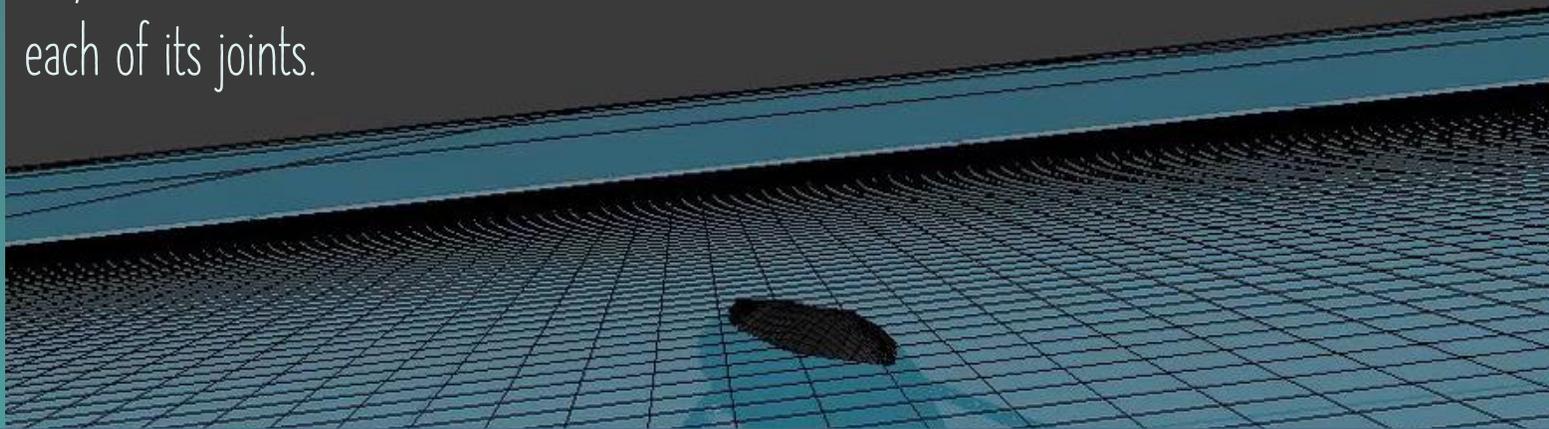


Animation

Creating keyframes to define the position and rotation of each object (including controls within a skeleton rig) over time

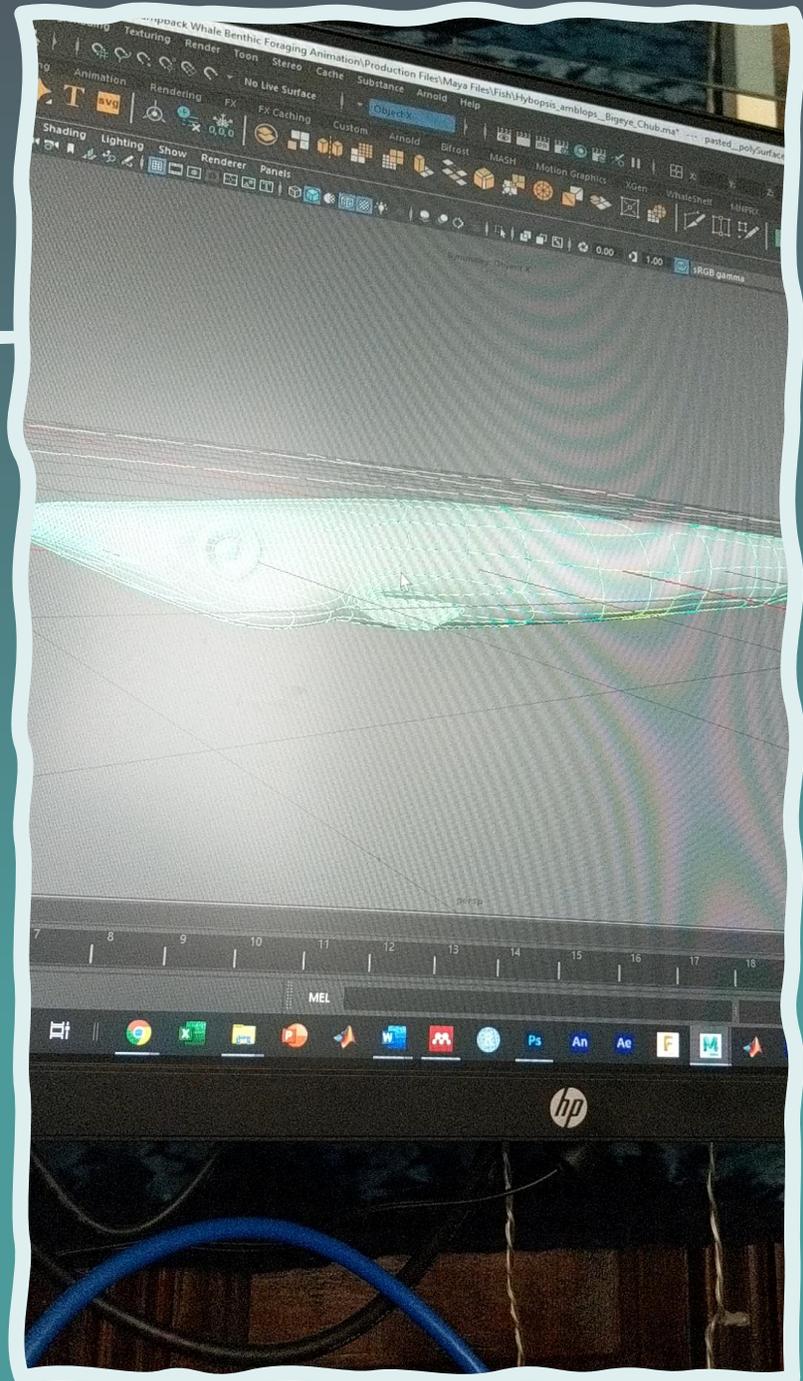
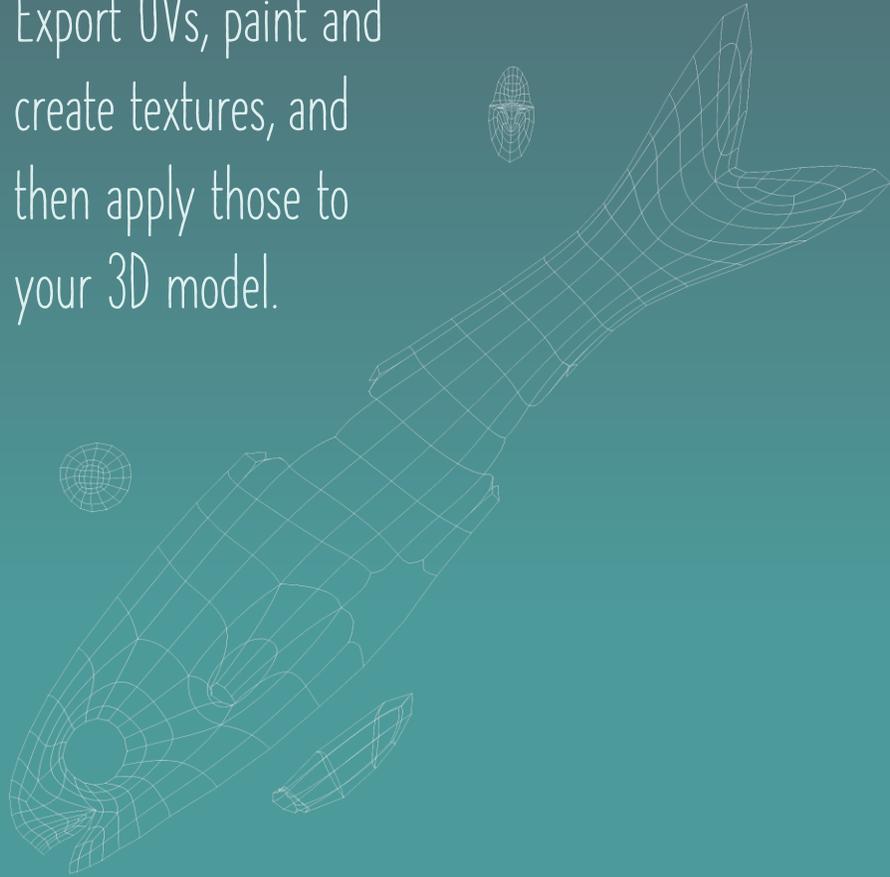
ANIMATION

Set keyframes to define the position and rotation of your character and each of its joints.



TEXTURE

Export UVs, paint and create textures, and then apply those to your 3D model.



TEXTURE

More complex example:



Tutorial

Linking CSV Motion Data to 3D Animation

Using sample dataset that can be found under Autodesk Maya Tutorial Resources at jessiekb.com/resources passcode ucsc

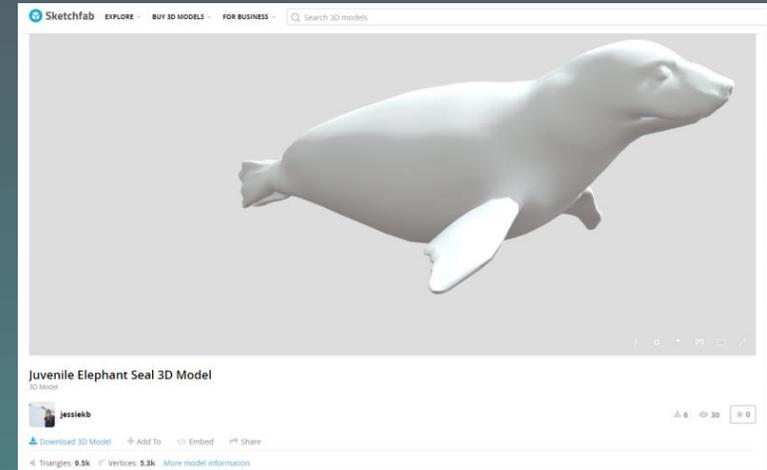
1. DOWNLOAD & STORE 3D MODEL

Find a free 3D model online with an .obj download option.

Can't decide on one?

Download my free 3D seal here:

<https://skfb.ly/6WSlz>



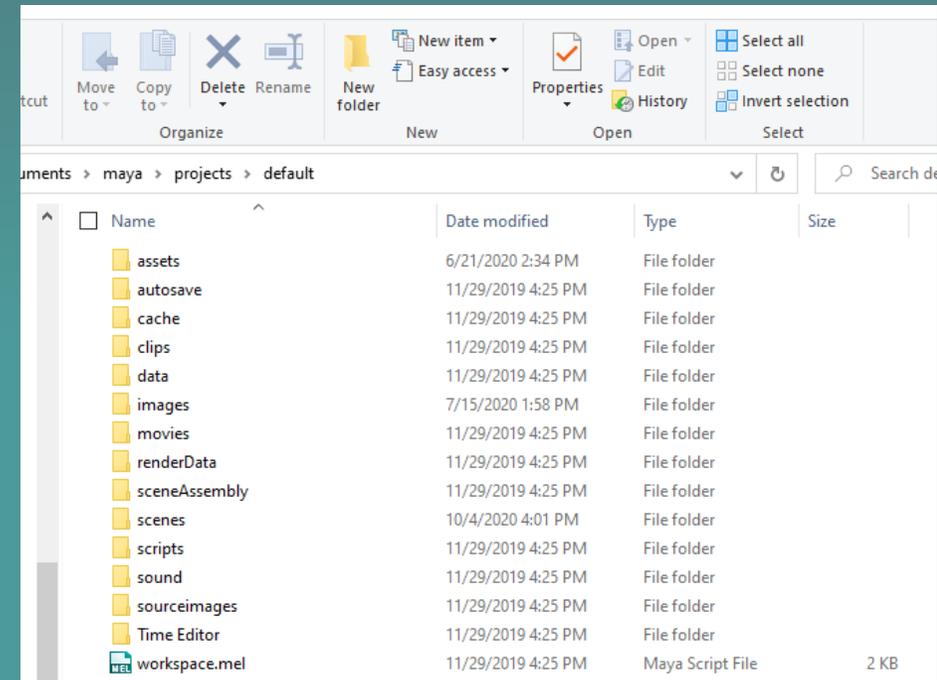
FILE ORGANIZATION IN MAYA

Put your seal .obj and .mtl files here

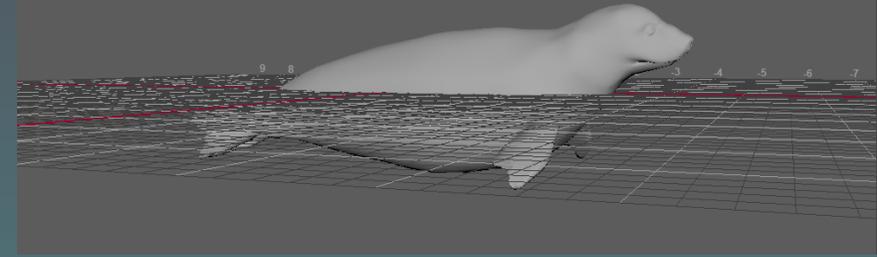
Documents > maya > projects > default > assets

Folder created by default
↑
Where you store different projects

↑
We will use default



2. IMPORT 3D MODEL



The screenshot shows the Autodesk Maya 2019 interface. The 'File' menu is open, and the 'Import...' option is highlighted. The 'Import' dialog box is open, showing the file selection process. The 'Look in' field is set to 'C:\Users\jmkb9\Documents\maya\projects\default\assets\Elephant Seal'. The file list shows 'elephant seal model.mtl' (104 bytes mtl File) and 'elephant seal model.obj' (1.1 MB obj File). The 'File name' field is set to 'elephant seal model.obj' and the 'Files of type' is set to 'All Files'. The 'Import' button is highlighted.

Autodesk Maya 2019 - Student Version: untitled*

File Edit Create Select Modify Display Win

New Scene Ctrl+N
Open Scene... Ctrl+O
Save Scene Ctrl+S
Save Scene As... Ctrl+Shift+S
Increment and Save Ctrl+Alt+S
Archive Scene
Save Preferences
Optimize Scene Size
Import/Export
Import...
Export Selection...
Game Exporter
Send To Unity
Send To Unreal
Adobe(R) After Effects(R) Live Link
Export to Offline File...
Assign Offline File...
ATOM
References
Create Reference... Ctrl+R
Reference Editor
View
View Image...
View Sequence...
Project
Project Window
Set Project...
Recent
Recent Files
Recent Increments
Recent Projects
Exit Ctrl+Q

Import

Look in: C:\Users\jmkb9\Documents\maya\projects\default\assets\Elephant Seal

Folder Bookmarks	Size	Type
My Computer		
Desktop		
Documents		
jmkb9		

File Name	Size	Type
elephant seal model.mtl	104 bytes	mtl File
elephant seal model.obj	1.1 MB	obj File

Options...

General Options

- Group
- Remove duplicate shading networks

Referencing Options

- Preserve references
- Load Settings: Load saved reference load state

Playback Options

- Always Override if Scene is Empty
- Framerate Import: Maintain Original
 Override to Match Source
- Animation Range: Maintain Original
 Override to Match Source
 Combine to Include Source

Namespace Options

- Use namespaces

Namespace Hierarchy:

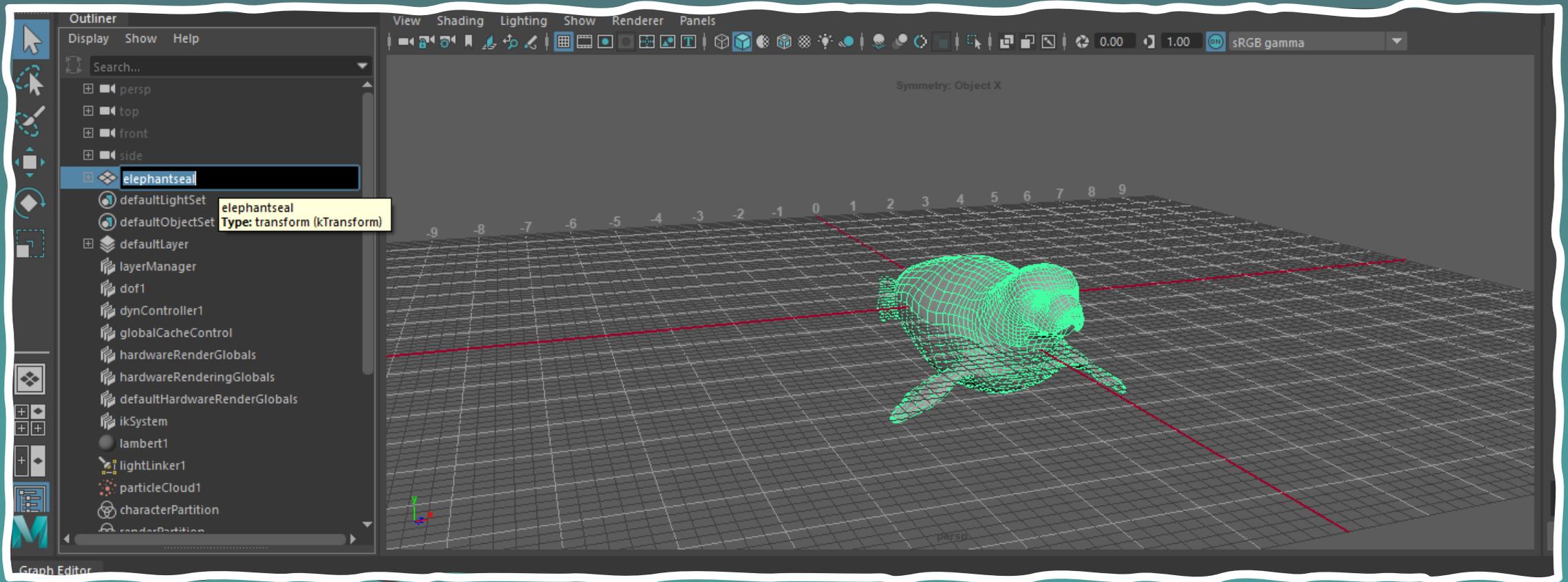
- :(root)
 - elephant_seal_model
 - elephant_seal_model1

File name: elephant seal model.obj
Files of type: All Files

Import Cancel

3. RENAME YOUR MODEL

Select your object in the outliner or by clicking on it (making sure you are in object mode).
In the Outliner, press Enter and type in the new name of your model.

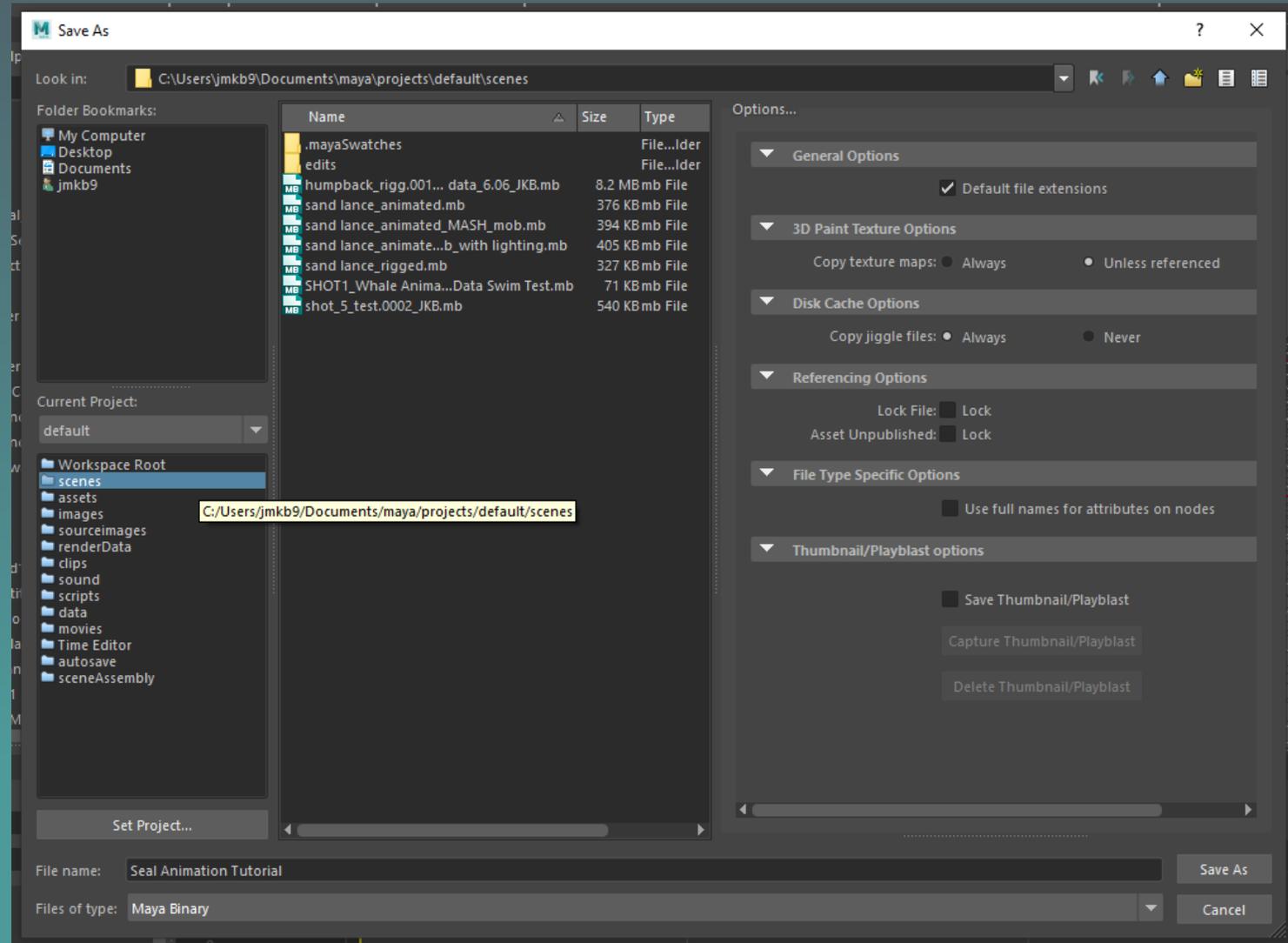


4. SAVE YOUR SCENE

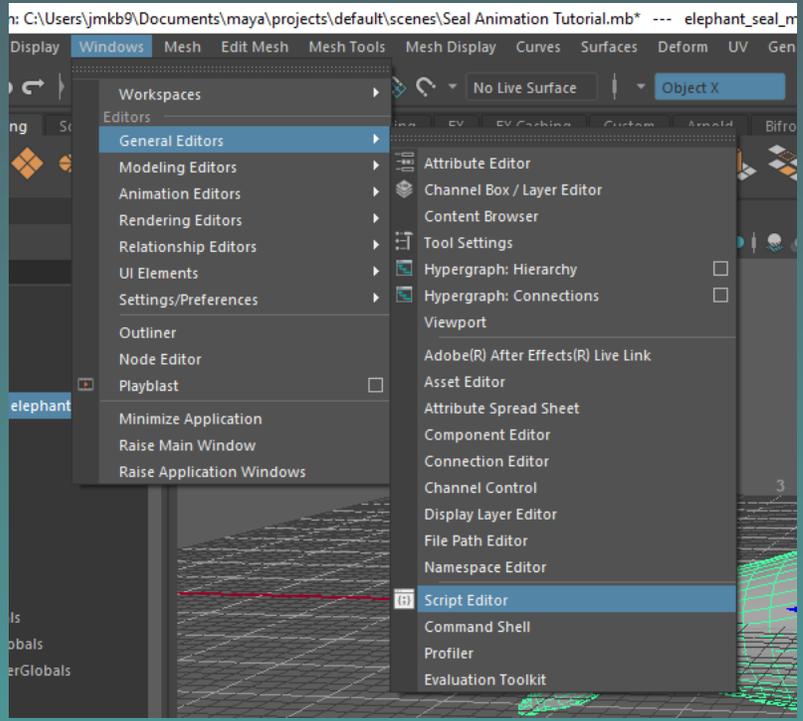
FILE ORGANIZATION IN MAYA

Put your scenes here:

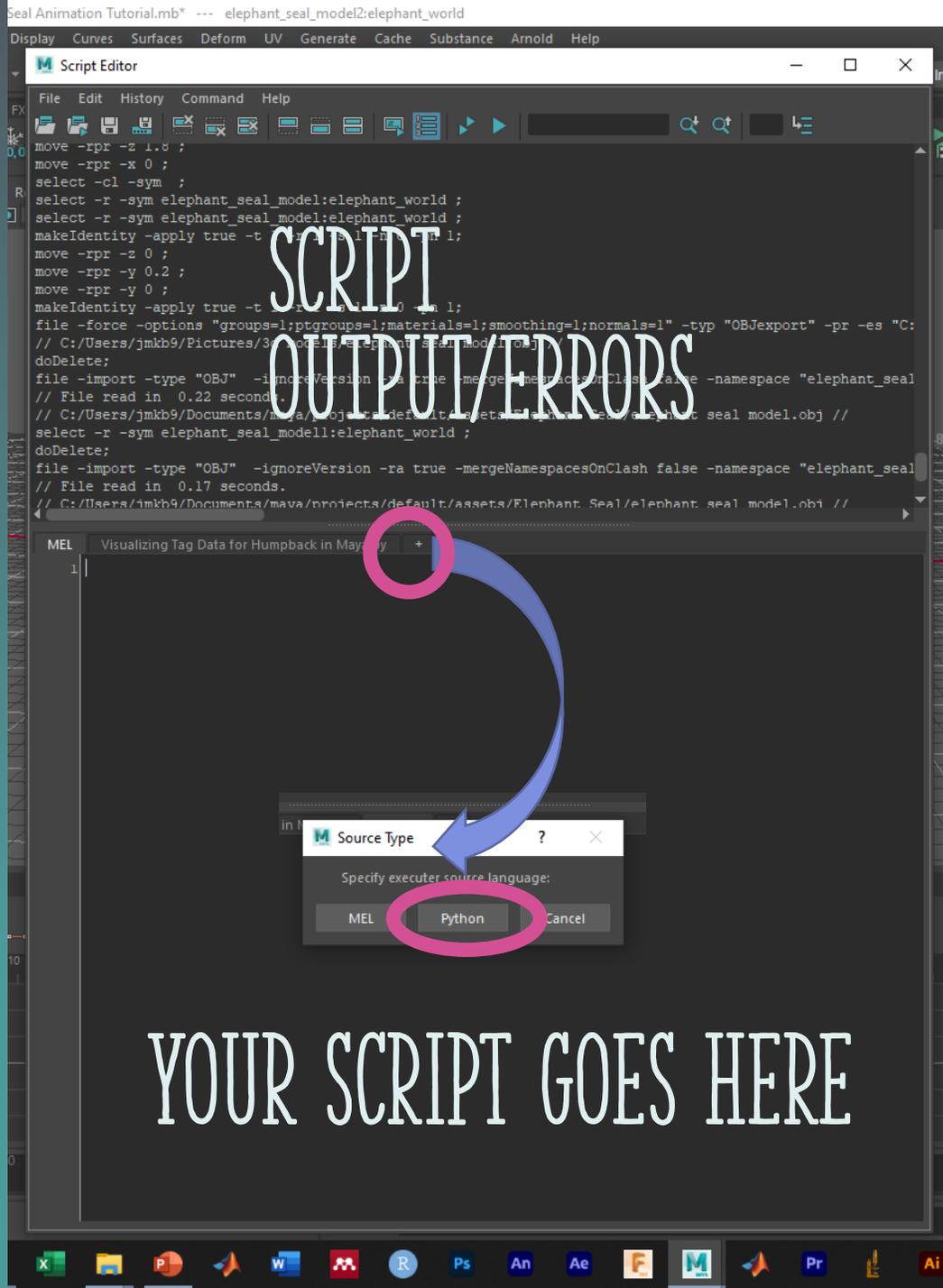
Documents > maya > projects > default > scenes



5. OPEN SCRIPT EDITOR



The script editor in Maya uses the coding language Python. Don't be afraid if you are not familiar- we will go over the code step by step.

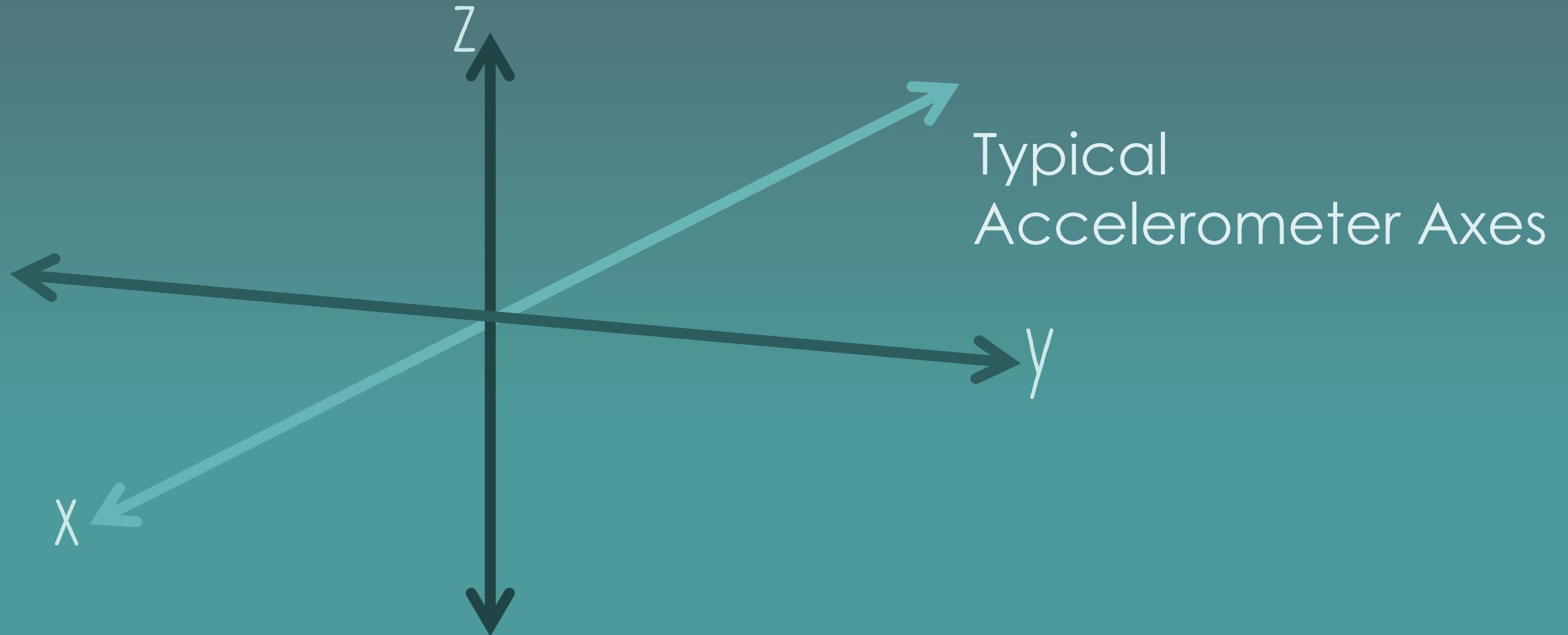


YOUR SCRIPT GOES HERE

Save your script!
File > Save Script...
Save in:
default > scripts

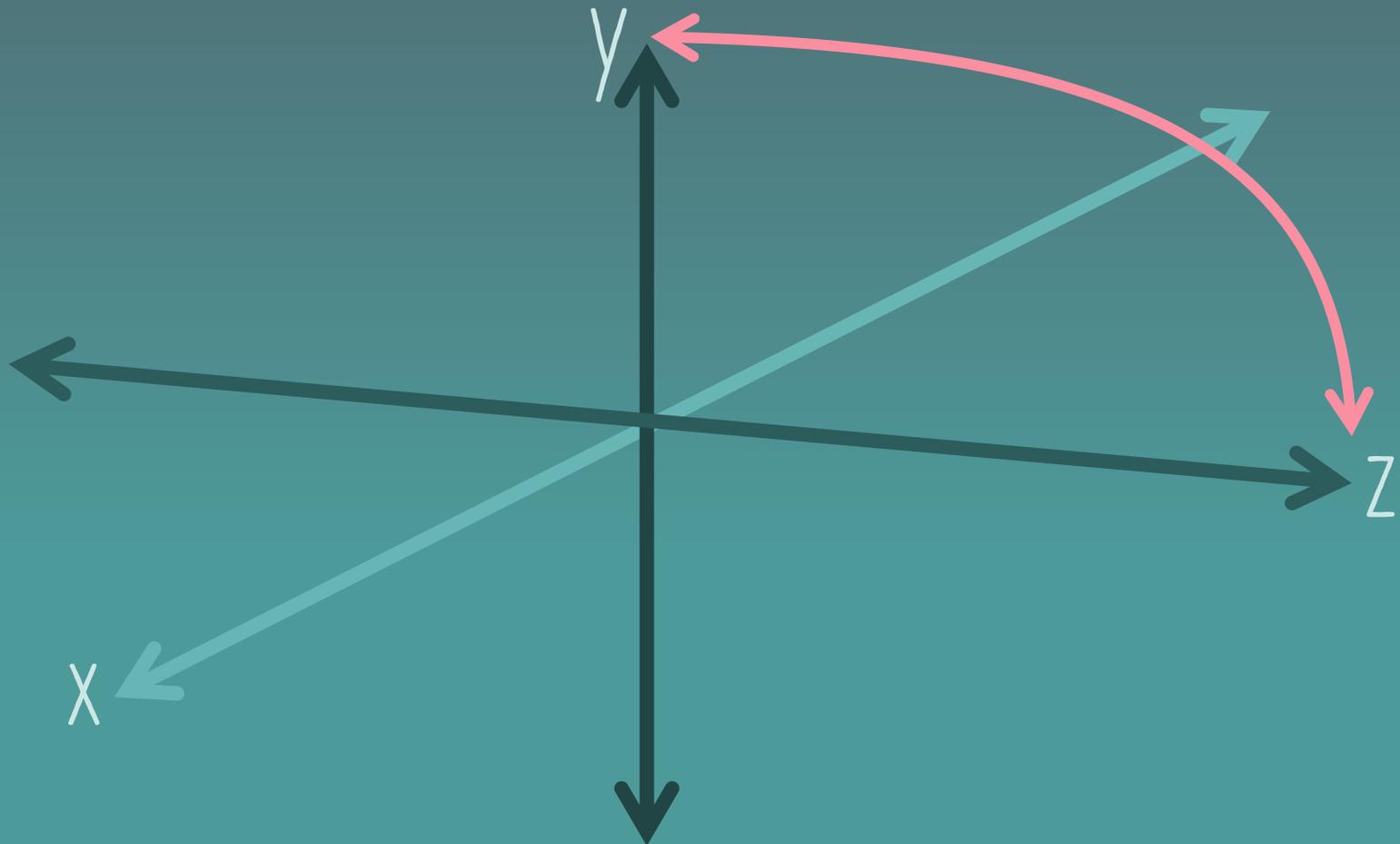
6. UNDERSTANDING 3D DATA

Seconds	pitch_deg	roll_deg	head_deg	x_position	z_position	Depth (y_pos)



6. UNDERSTANDING 3D DATA

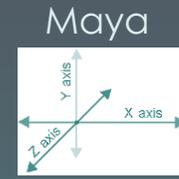
Seconds	pitch_deg	roll_deg	head_deg	x_position	z_position	Depth (y_pos)



Default
Maya Axes

(y and z switched so vertical direction is y)
Don't ask me y!

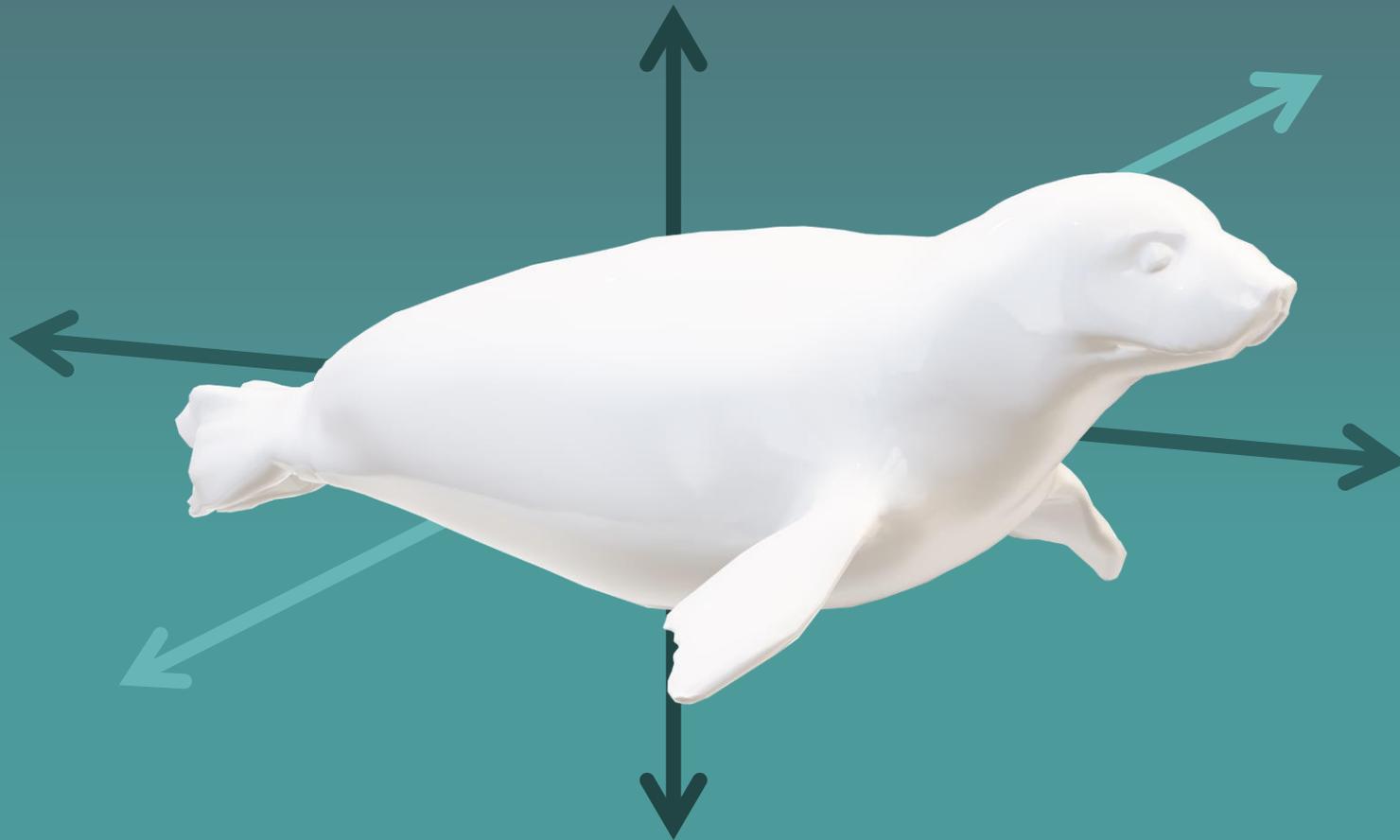
6. UNDERSTANDING 3D DATA



Maya
y_position on accelerometer, translates to z position in Maya

Depth (vertical position) is associated with y direction in Maya

Seconds	pitch_deg	roll_deg	head_deg	x_position	z_position	Depth (y_pos)

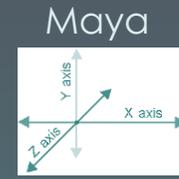


Pitch = 0°

Roll = 0°

Heading = 0°

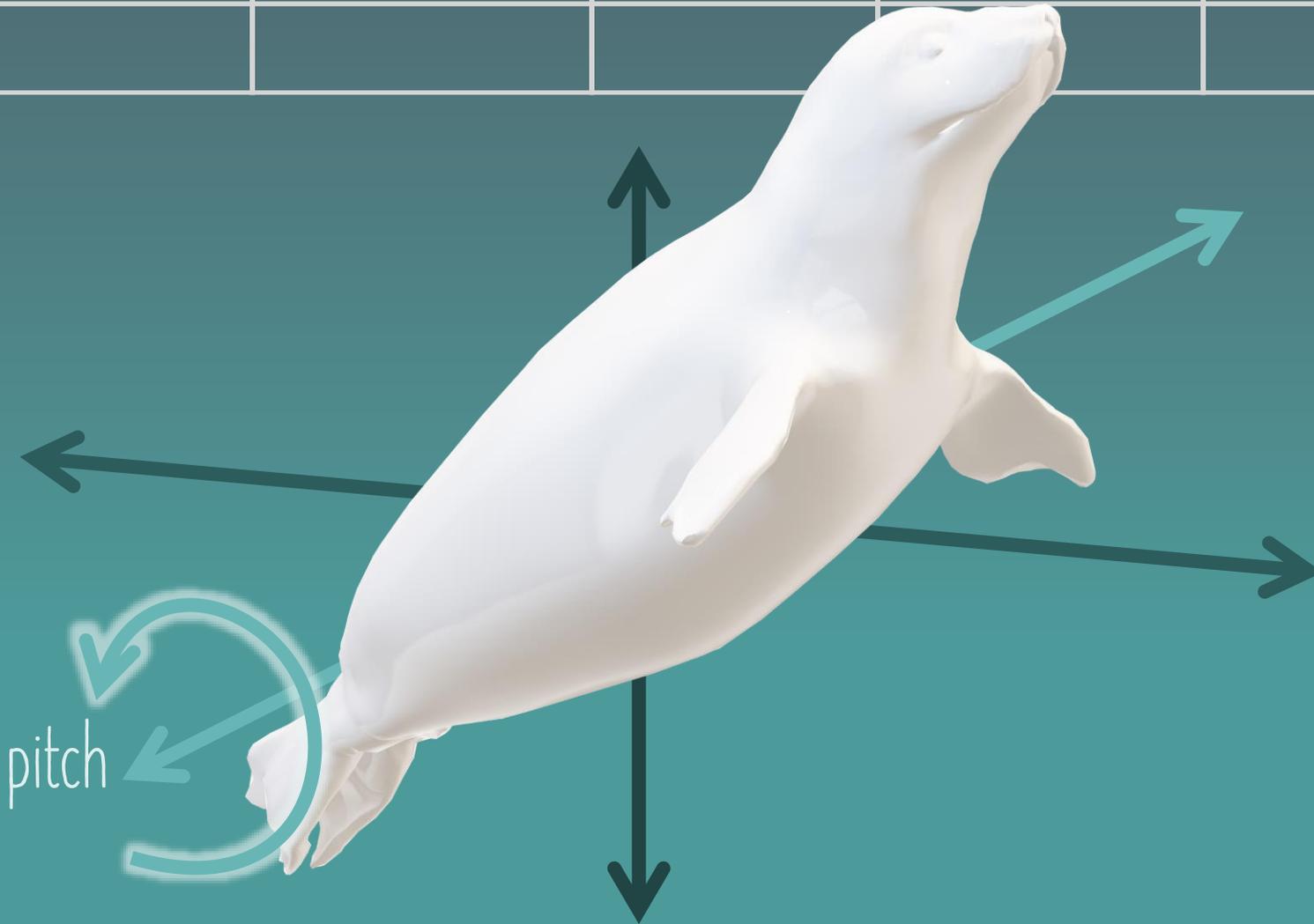
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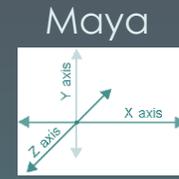


Pitch = **45°**

Roll = **0°**

Heading = **0°**

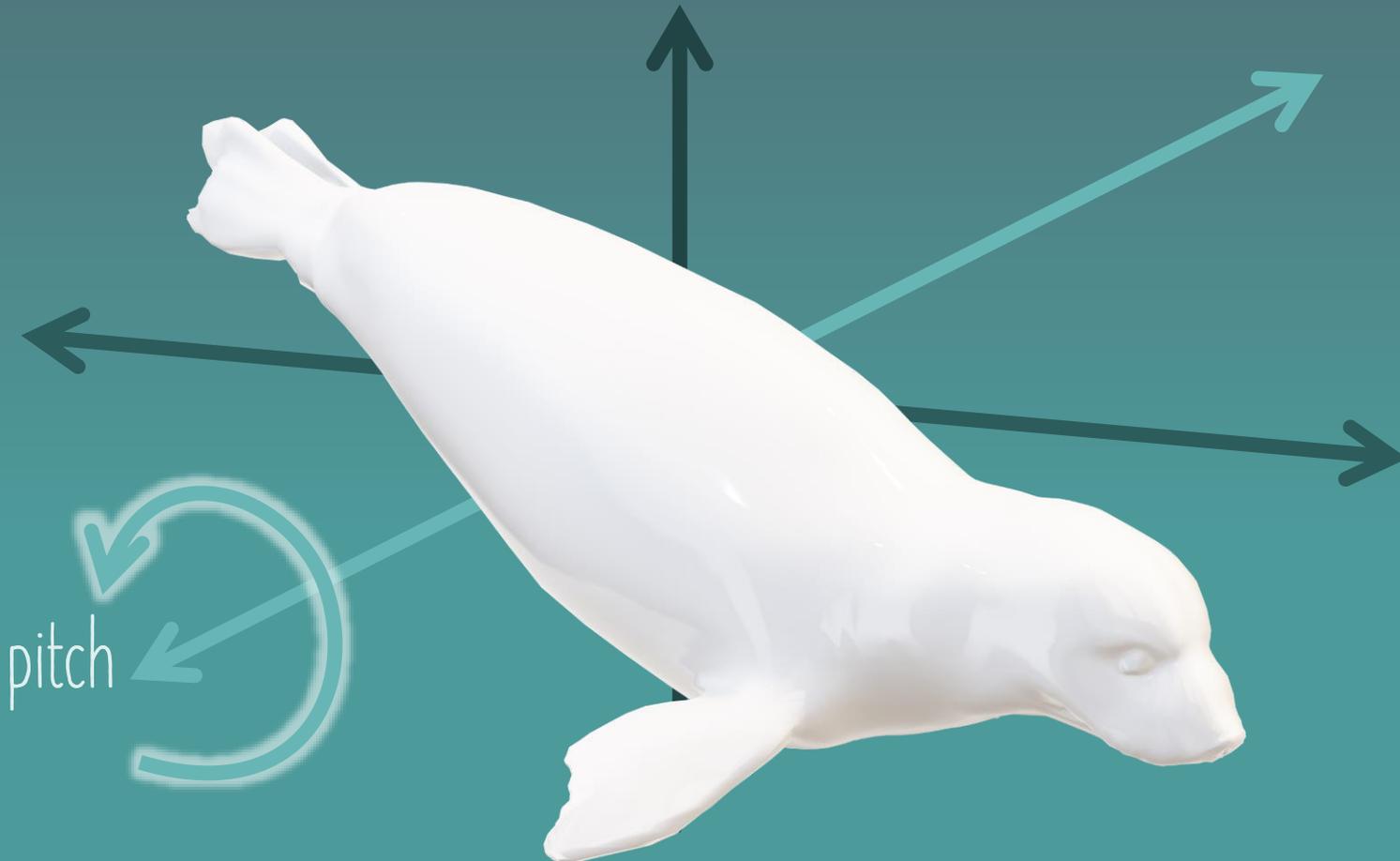
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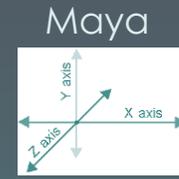
Depth (vertical position) is associated with y direction in Maya

Seconds	pitch_deg	roll_deg	head_deg	x_position	z_position	Depth (y_pos)



Pitch = **-45°**
 Roll = **0°**
 Heading = **0°**

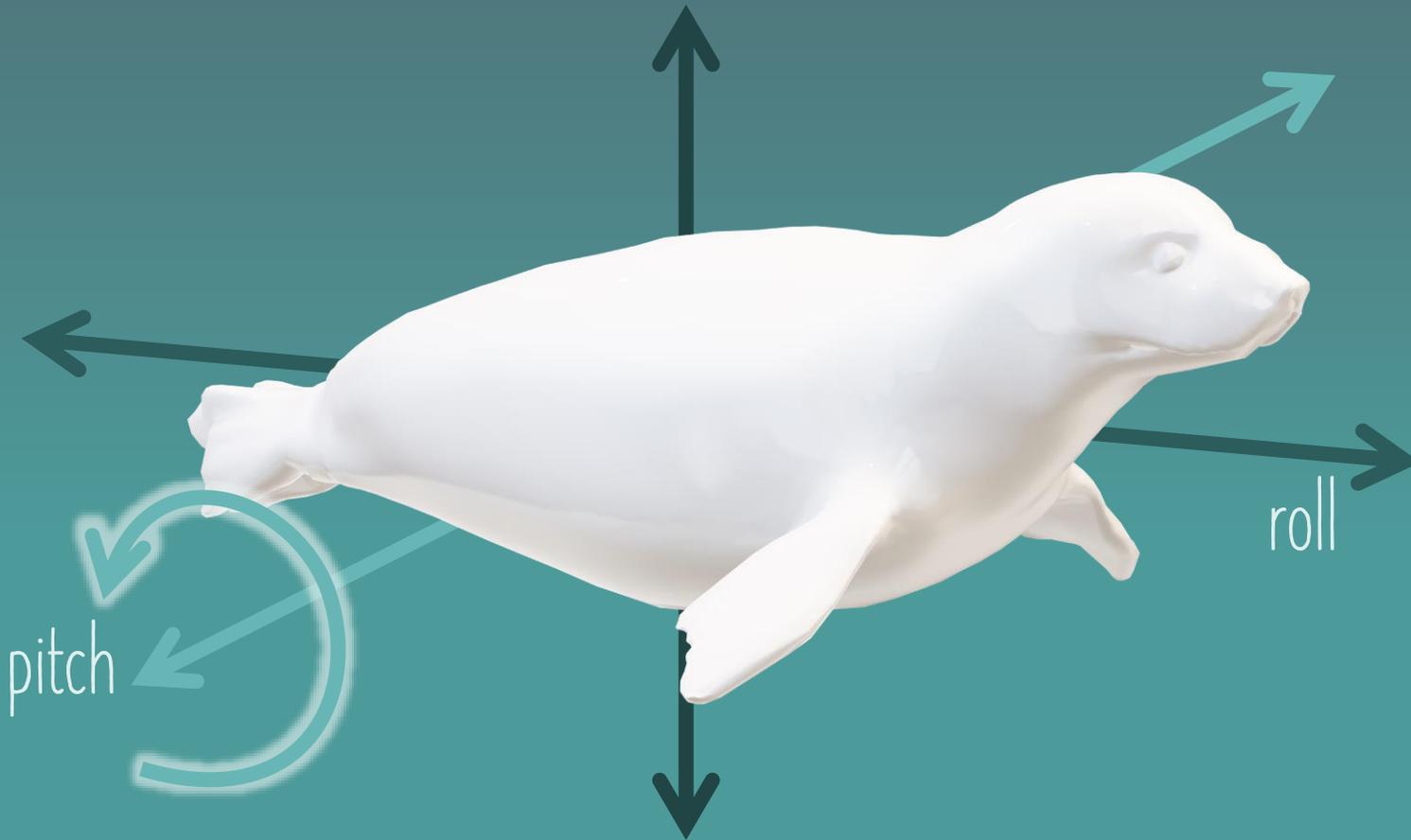
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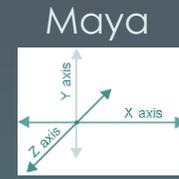


Pitch = 0°

Roll = 0°

Heading = 0°

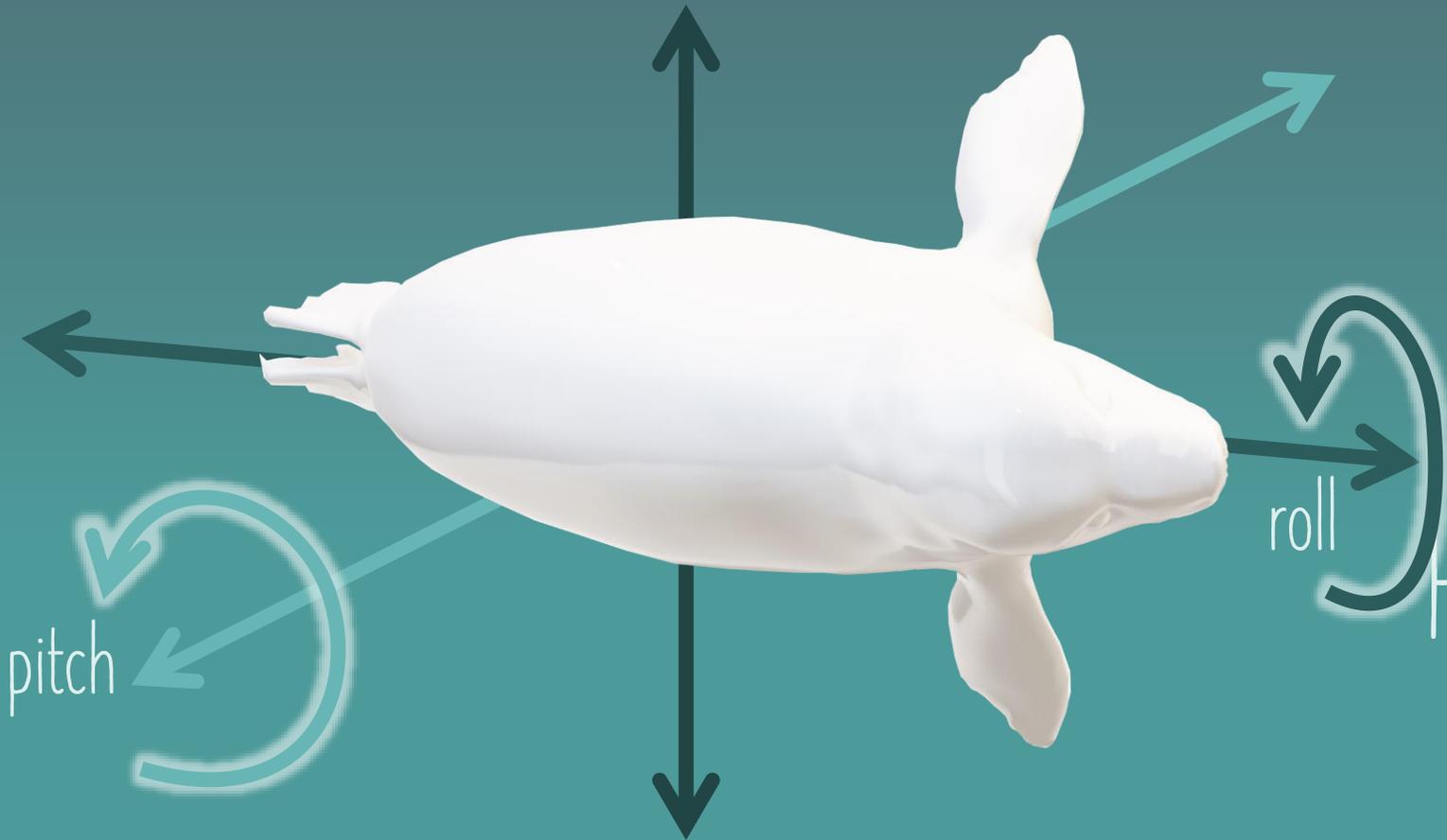
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Seconds	pitch_deg	roll_deg	head_deg	x_position	z_position	Depth (y_pos)

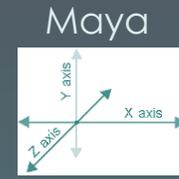


Pitch = 0°

Roll = 90°

Heading = 0°

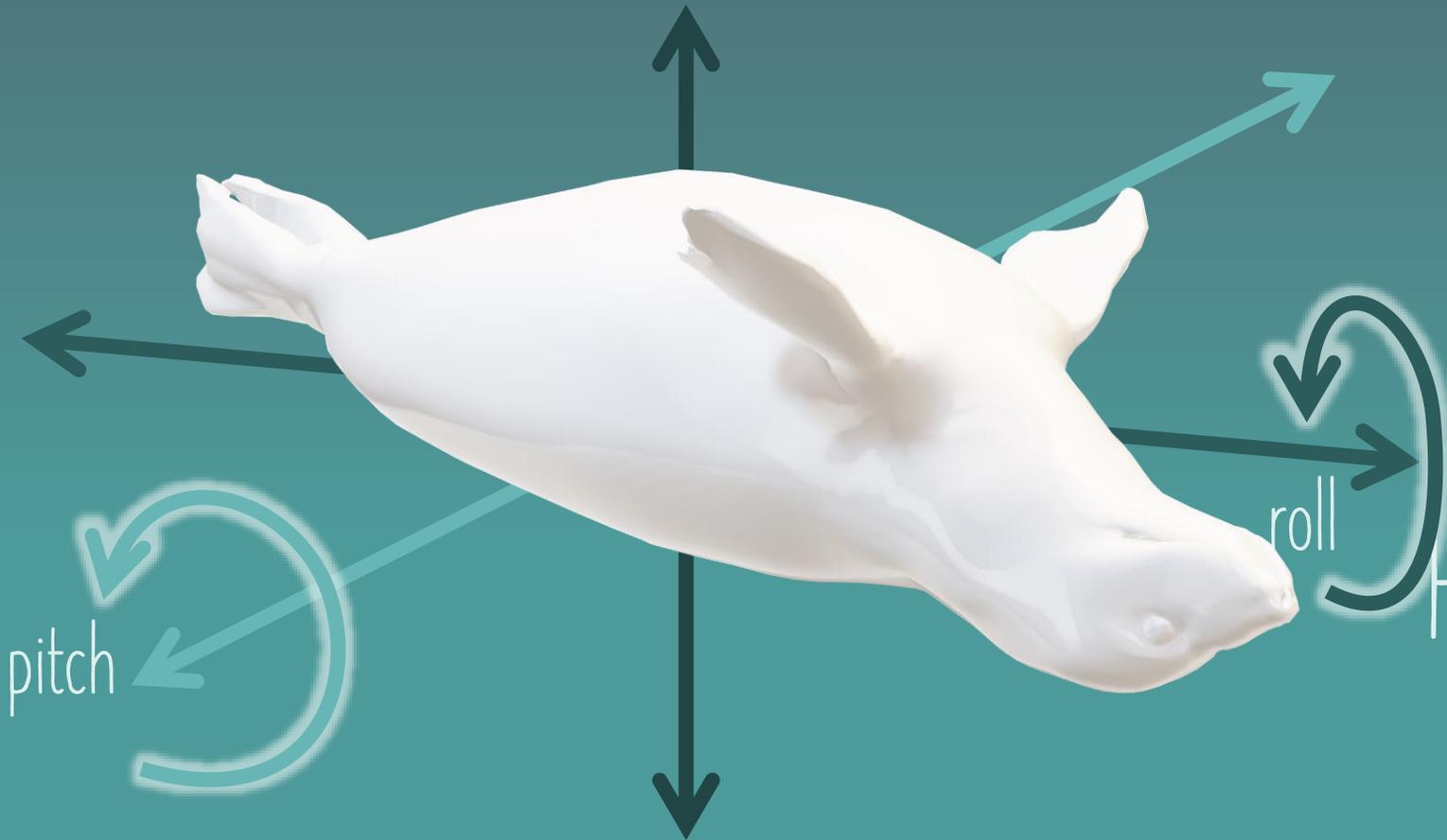
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Seconds	pitch_deg	roll_deg	head_deg	x_position	z_position	Depth (y_pos)

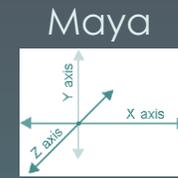


Pitch = 0°

Roll = 180°

Heading = 0°

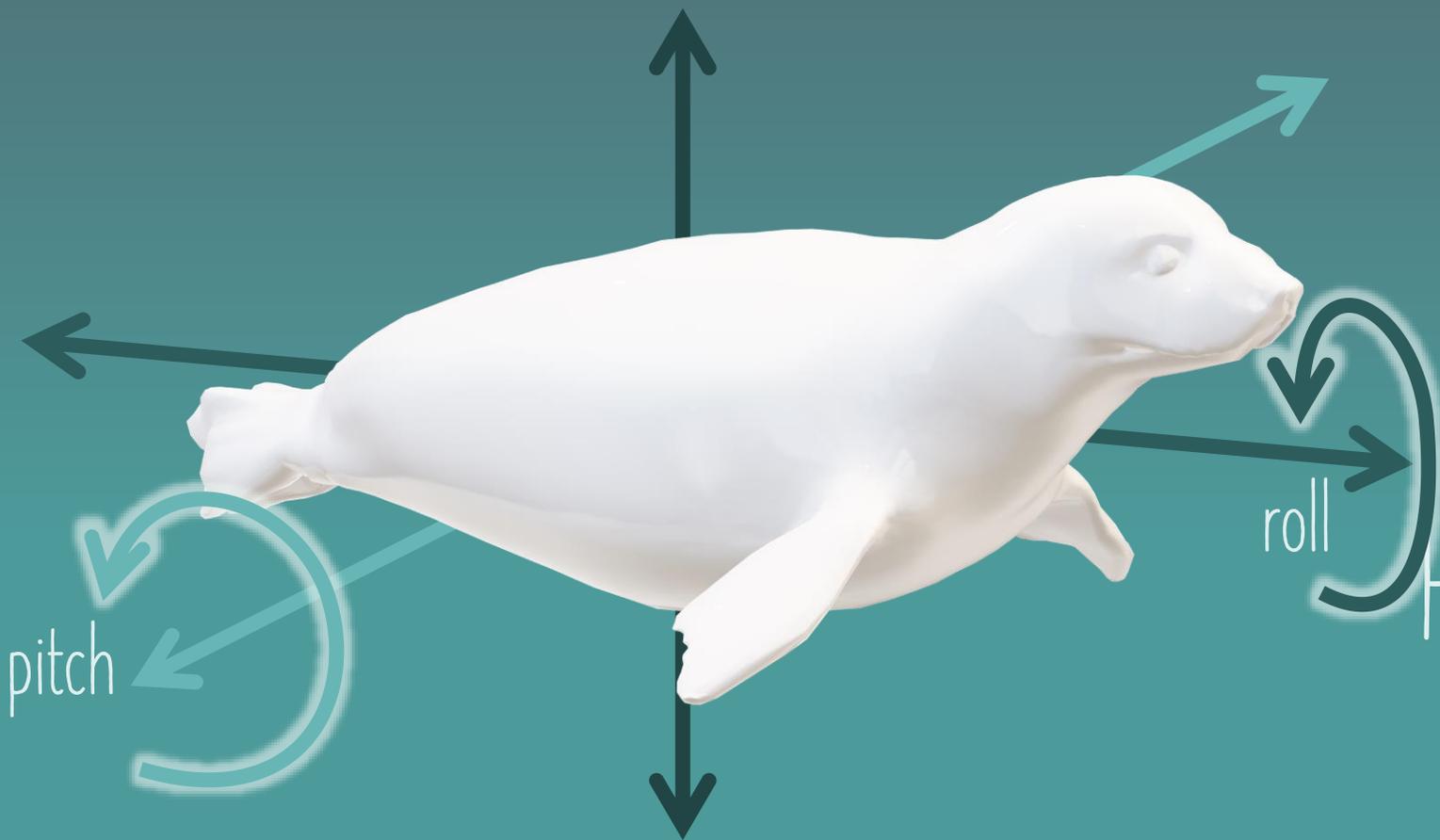
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Seconds	pitch_deg	roll_deg	head_deg	x_position	z_position	Depth (y_pos)

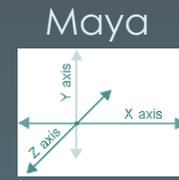


Pitch = 0°

Roll = 0°

Heading = 0°

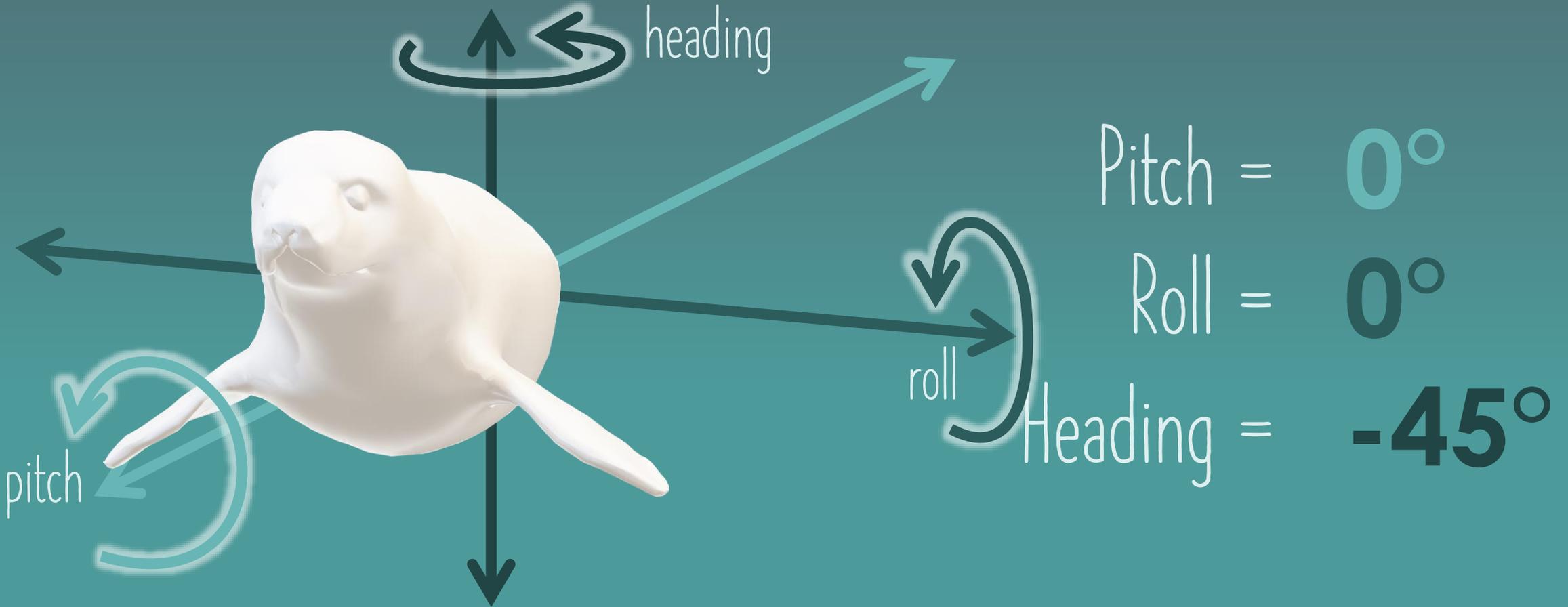
6. UNDERSTANDING 3D DATA



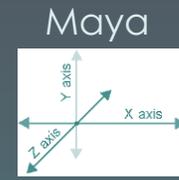
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y_position on accelerometer, translates to z position in Maya

Depth (vertical position) is associated with y direction in Maya

Seconds	pitch_deg	roll_deg	head_deg	x_position	z_position	Depth (y_pos)	
10 Hz sampling rate (10 samples per second)	0	-40	0	0	0	0	
0.1		-40	0	0	0	1	
0.2	-40°	-40	0	0 meters left/right	0	2	
0.3		0°	0				0°
0.4		-40	0	0	0	4	
0.5	Pitching body	-40	Rolling body	0	Pointing body	0	5
0.6	40 degrees below horizon	-40	0 degrees to either side (not rolled over)	0	0 degrees to the right or left (12 o'clock position)	0	6
0.1	↓	-40	0	0	0	0	1
0.2		-40	0	0	0	0	2
...	
4.4	↓	-6	0	0	0	44	
4.5		-4	0	0	0	45	
4.6		-2	0	0	0	46	
4.7		0	on belly (prone)	0	0	46	
4.8		0	0°	0	0	46	
4.9		0		0	0	46	
5		0	0	0	0	46	
5.1		0	2	0	0	46	
5.2	0	4	0	0	46		
5.3	0	6	0	0	46		
...	
13.7	↓	0	174	0	0	46	
13.8		0	176	0	0	46	
13.9		0	180°	178	0	0	46
14		0		180	0	0	46
14.1		0	upside down (supine)	180	0	0	46

0

0

0

-40°

0°

0°

46

-40

0°

180°



7. ADD YOUR CODE

This code is in Python. You can find this script ("Seal Sample Data Input Code.py") in the Google Drive resources at jessiekb.com/resources passcode ucsc

It reads in your Sample 3D data from a CSV (Sample Seal Data.csv) and sets position and rotation keyframes for each datapoint. Replace the directory for the CSV file to reflect where it is stored on your computer and you should be to go! Press CTRL + ENTER to run your code.

```
import csv
import pymel.core as pm

#Defining variables which will be used as column indices (can check these in 'Sample Seal Data Headers.csv')
SECONDS      = 0
PITCH_DEG   = 1
ROLL_DEG     = 2
HEAD_DEG     = 3
X_POS        = 4
Z_POS        = 5
DEPTH        = 6

#Defining two variables which will be used as indices where animation starts and ends
START = 0 #start time in sec
END   = 12 #end time in sec

fs = 10 #Sample frequency (in Hz or "samples per second")

#Reading in .csv file (update to reflect your own path)
with open('C:/Users/jmkb9/Pictures/Art/Workshops/Sample Seal Data.csv') as csv_file:
    data = csv.reader(csv_file, delimiter=',')

#For loop runs through all rows in data .csv file
for i, row in enumerate(data):
    if i % 10000 == 0:
        print 'Processing row %s' % (i)
#If the row number is between the start and end indices of where we want to animate, run this.
    if i >= START*fs and i < END*fs:

#We will use the function float() to return floating point numbers (with decimals) for data values
        time = float(i) / fs - START #Translate .csv data time into animation time
        time = time * 24 #Get from frames to seconds

        translateX_value = float(row[X_POS])
        translateZ_value = float(row[Z_POS]) #fixed in newest version of model so don't need -
        depth_value      = float(row[DEPTH])

        pitch_value = float(row[PITCH_DEG]) #add negative to fix orientation
        head_value  = float(row[HEAD_DEG])
        roll_value  = float(row[ROLL_DEG])

#Define which object will be transformed according to data (use name as described in "Outliner")
        object = pm.ls('elephantseal')[0]

#..setKey function sets a keyframe of the given value at the given time.
        object.translateX.setKey(value=translateX_value, time=time)
        object.translateZ.setKey(value=translateZ_value, time=time)
        object.translateY.setKey(value=depth_value, time=time)

        object.rotateX.setKey(value=pitch_value, time=time)
        object.rotateY.setKey(value=head_value, time=time)
        object.rotateZ.setKey(value=roll_value, time=time)

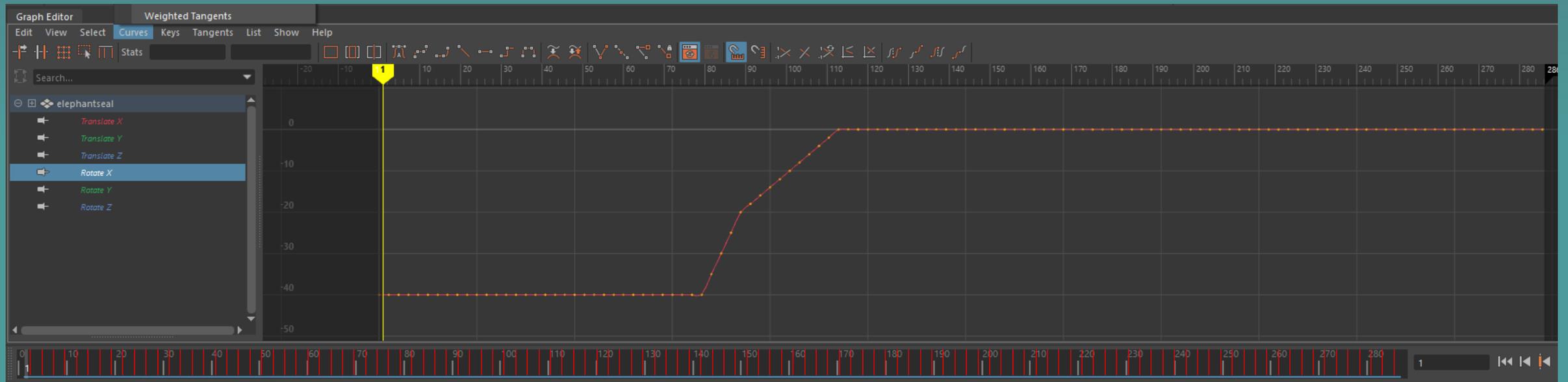
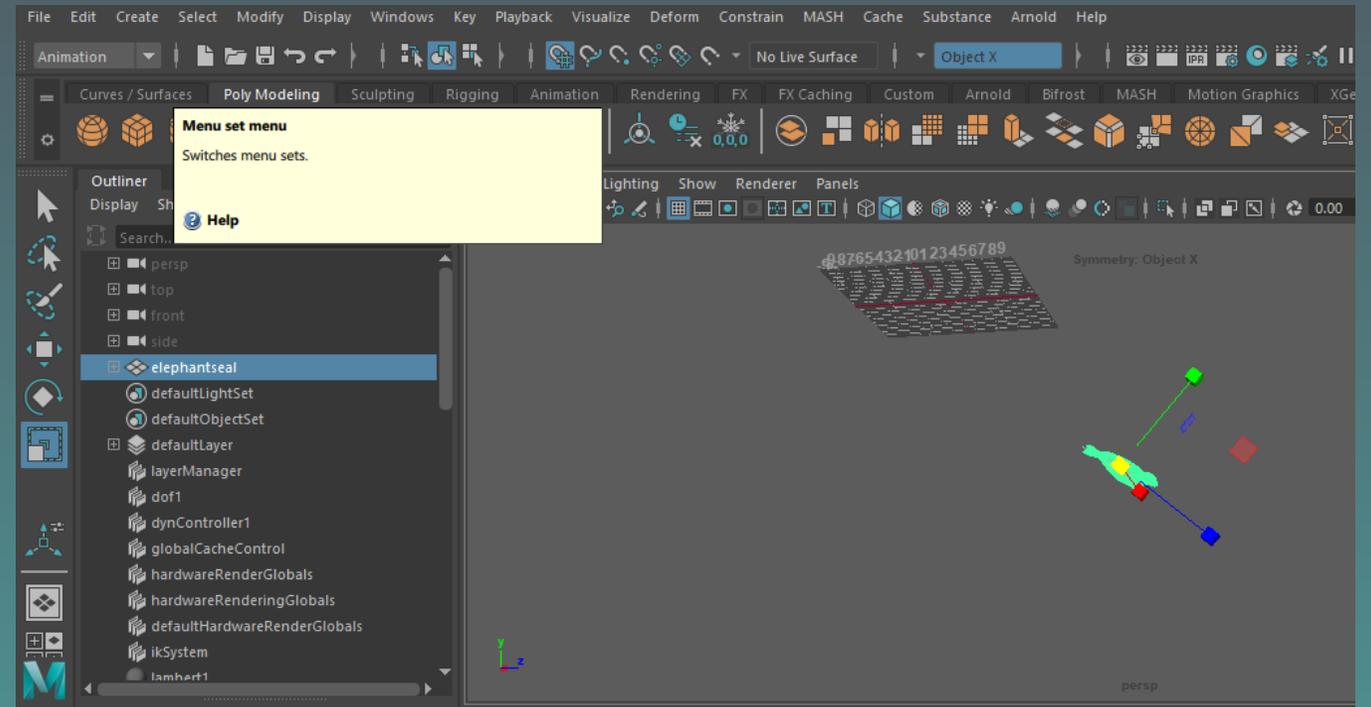
        print 'setting y= %s msw, x= %s, z= %s, rotX= %s, rotY= %s, rotZ = %s for time= %s frames' %
(depth_value , translateX_value , translateZ_value , pitch_value , head_value , roll_value , time)
```

8. PREVIEW ANIMATION

Scrub forward and backward using the yellow playhead in the Graph Editor (Windows>Animation Editors>Graph Editor)

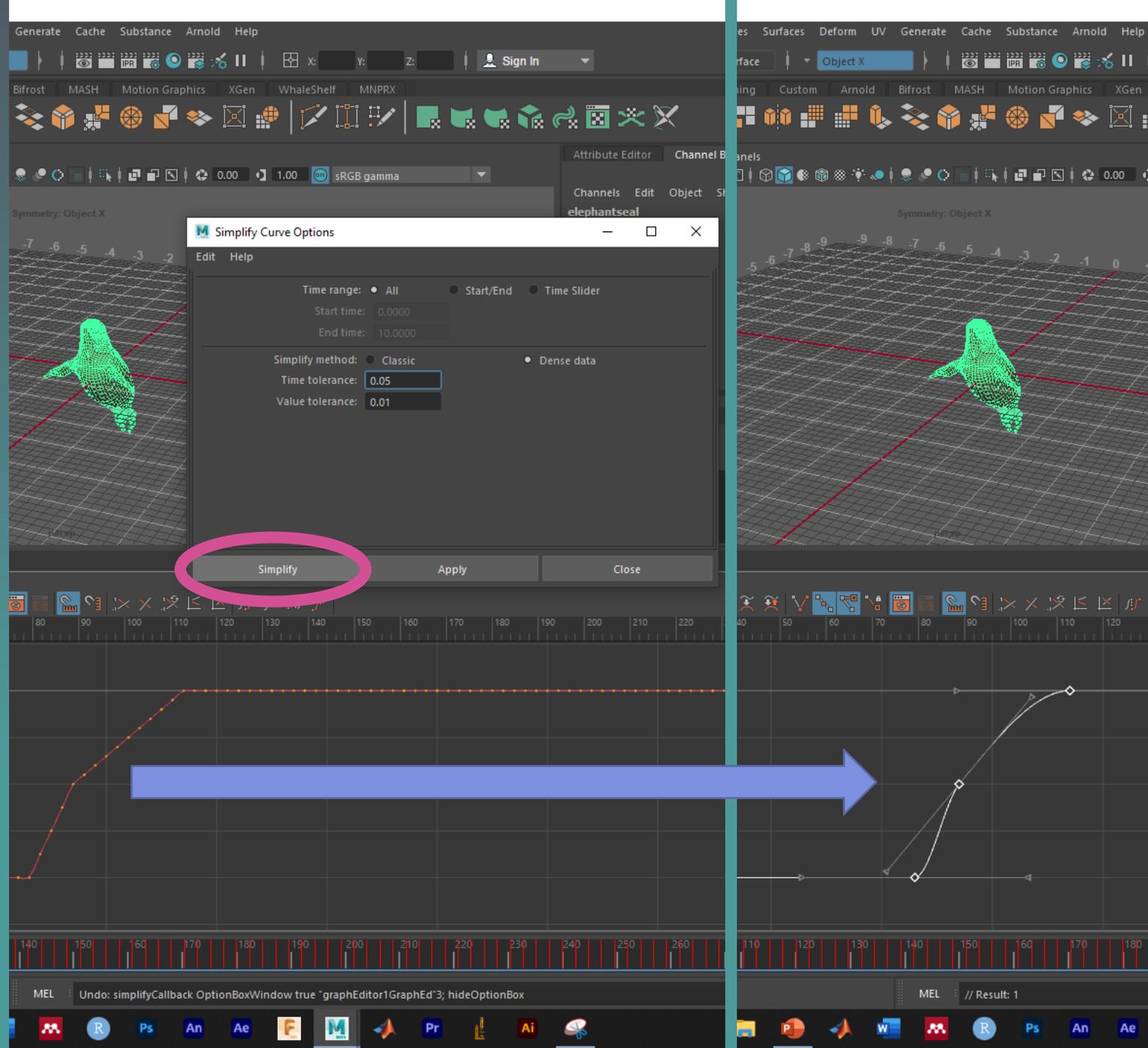
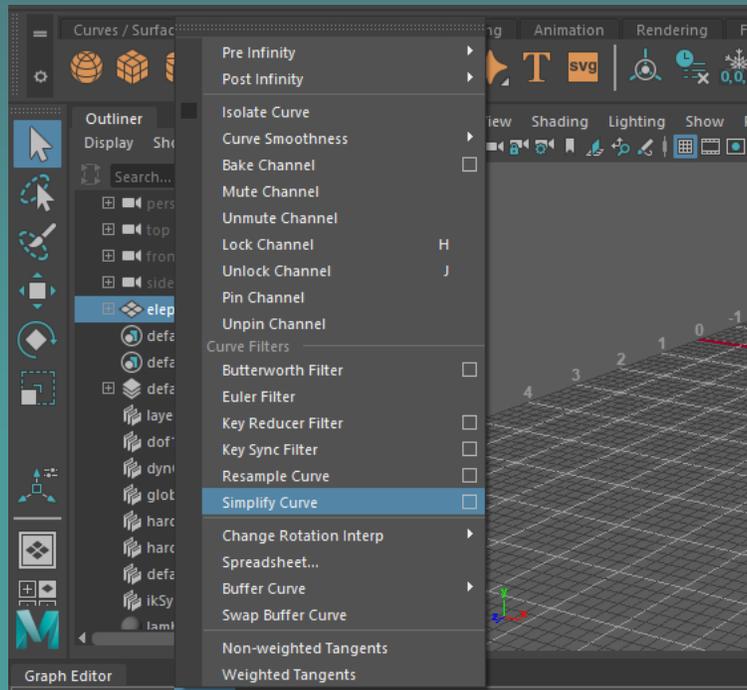
The code will have added many (120 in our case) red keyframes into the timeline, evenly spaced over 12 seconds (286 frames).

Change to "Animation" workspace and then use ALT + V to toggle play/pause.



9. SMOOTH ANIMATION

If the motion from your data is too choppy, you can reduce the number of keyframes by opening "Simplify Curve" options by clicking on the small box to the right of the option in the Curves menu.



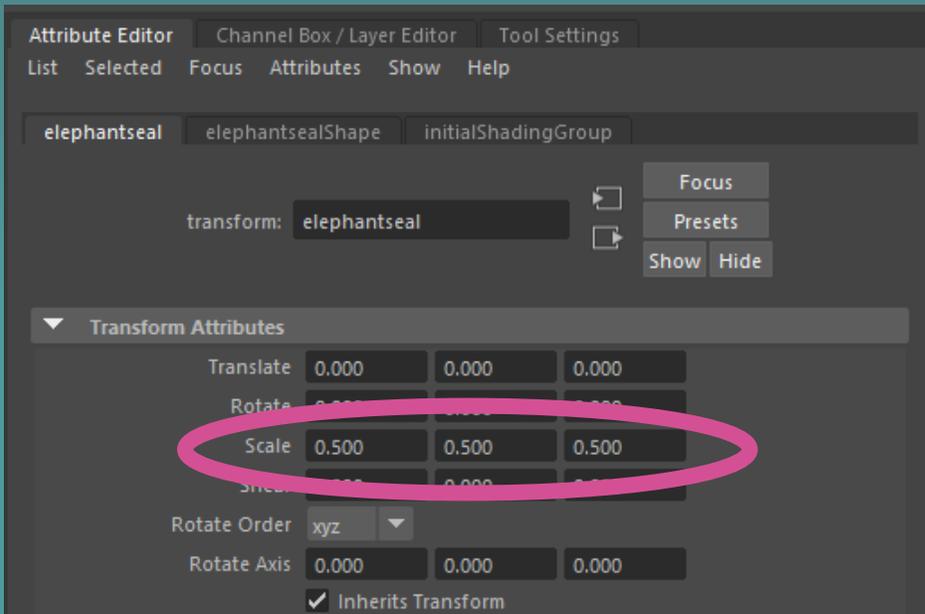
10. PLAYBLAST

You can export a quick, low resolution preview of your animation by going to `Windows>Playblast`



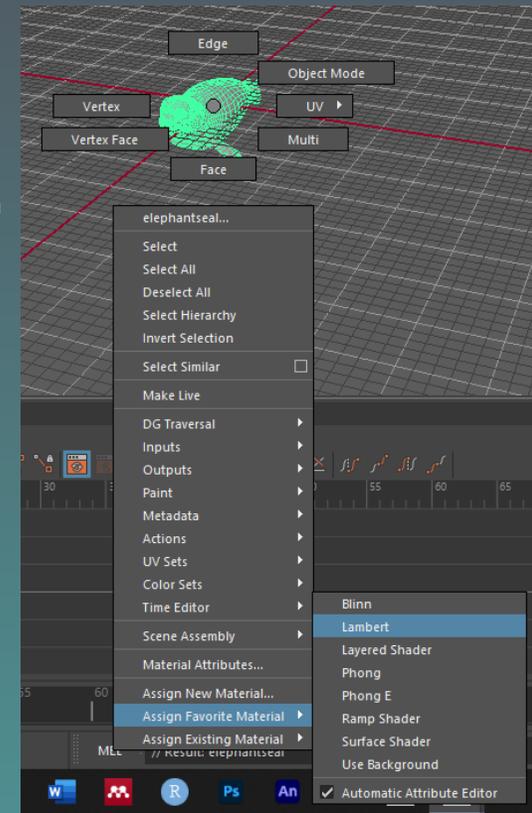
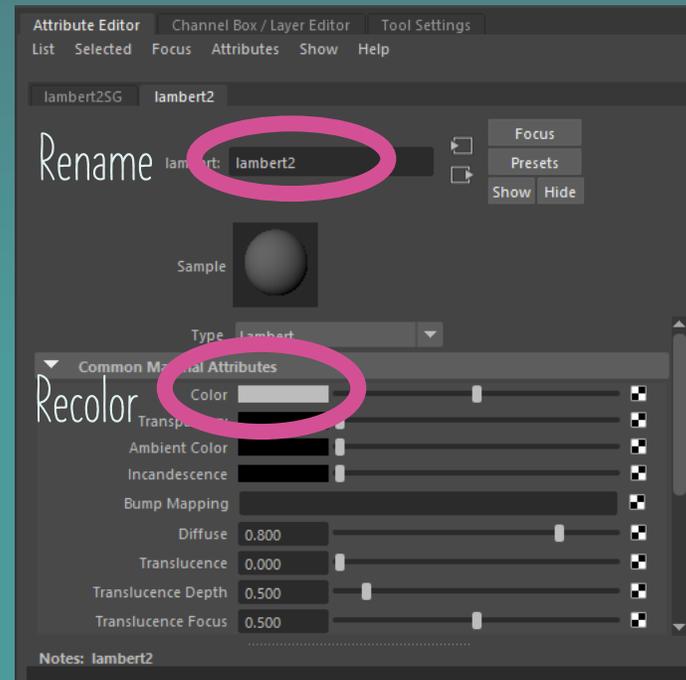
11. SCALE YOUR SCENE

Make sure that the size of your character makes sense in relation to the size of the scene. In my case, I found that downscaling my elephant seal by 50% (Scale to 0.5 in 3 dimensions) makes it the right size compared to a max depth of 40 meters.



12. TEXTURE YOUR SEAL

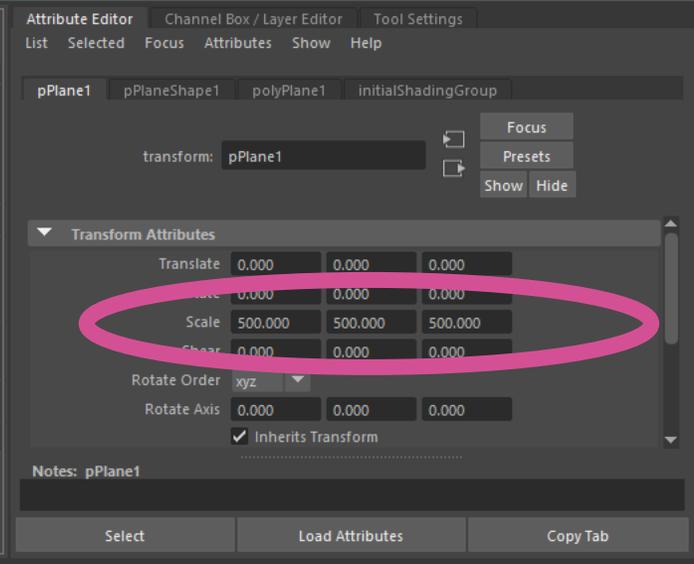
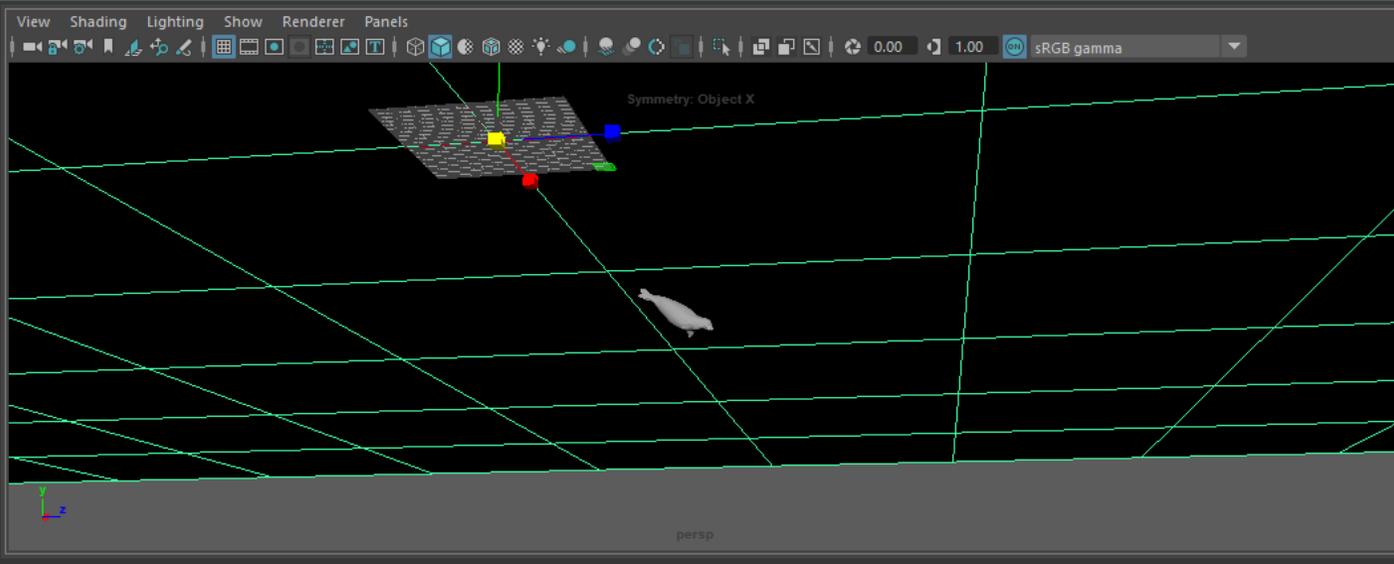
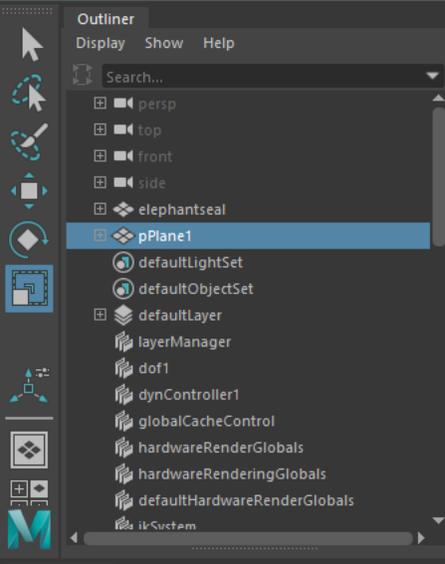
We don't have a detailed texture to add here so we'll just add a solid color. Right click and hold on the elephant seal object, scroll down to "Assign Favorite Material", and select the "Lambert" material.



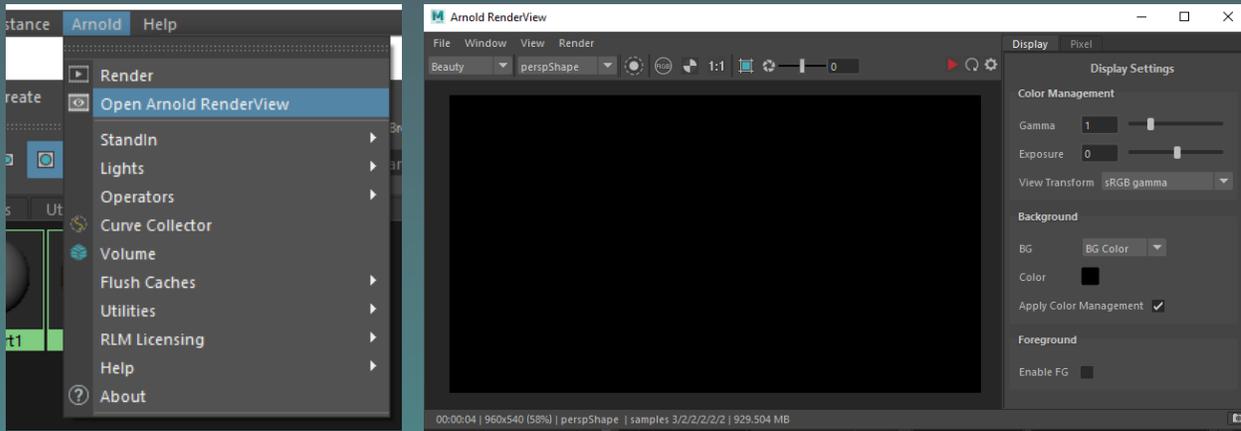
13. ADD SOME WATER

Create a plane and scale it up to 500 x 500 x 500

(don't ask me why there is a y [vertical] dimension to a plane!)

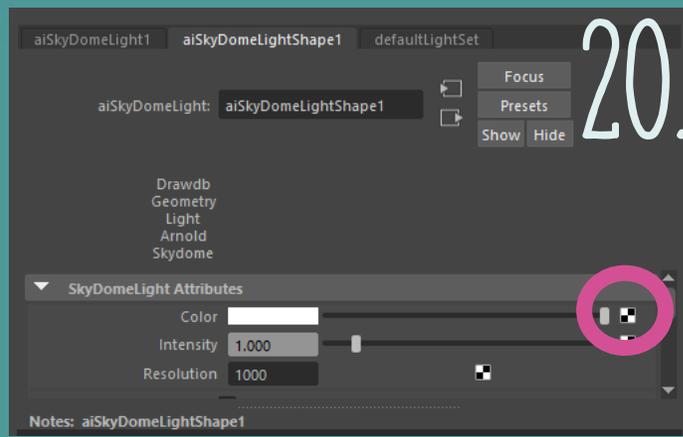
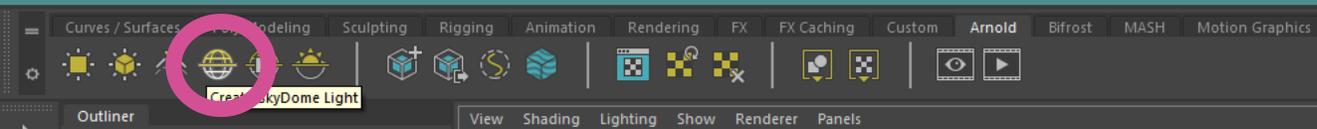


17. OPEN UP A RENDER PREVIEW



If you press the red play button to preview the scene, you'll see that you get an error message, saying there is no light in the scene. So let's add one!

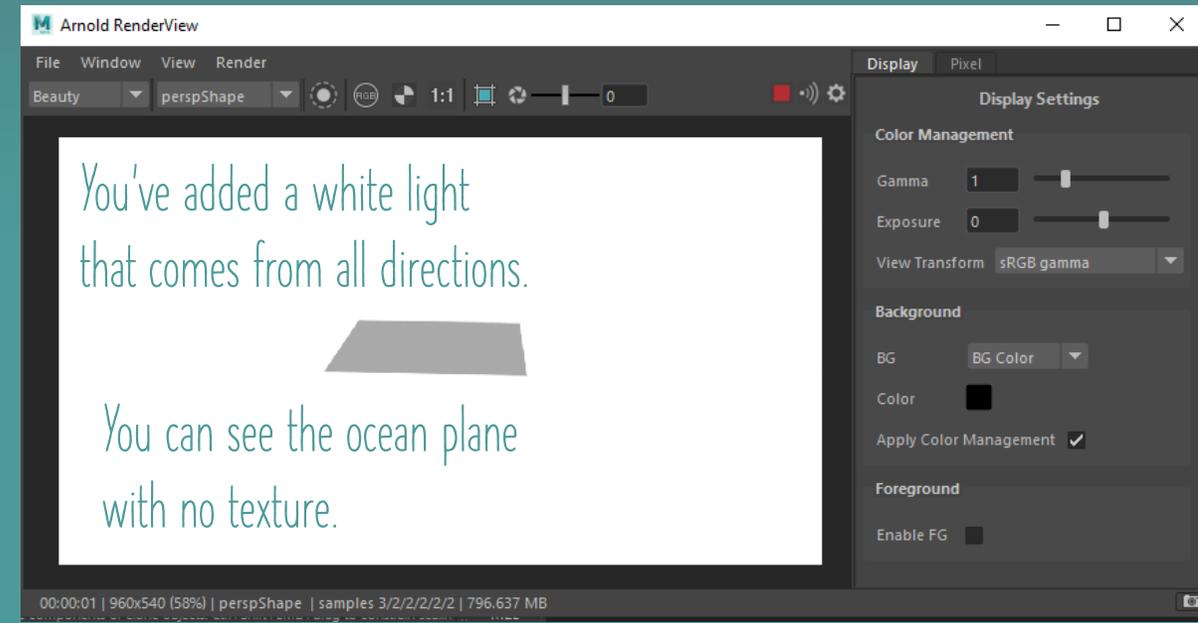
18. CREATE A LIGHT



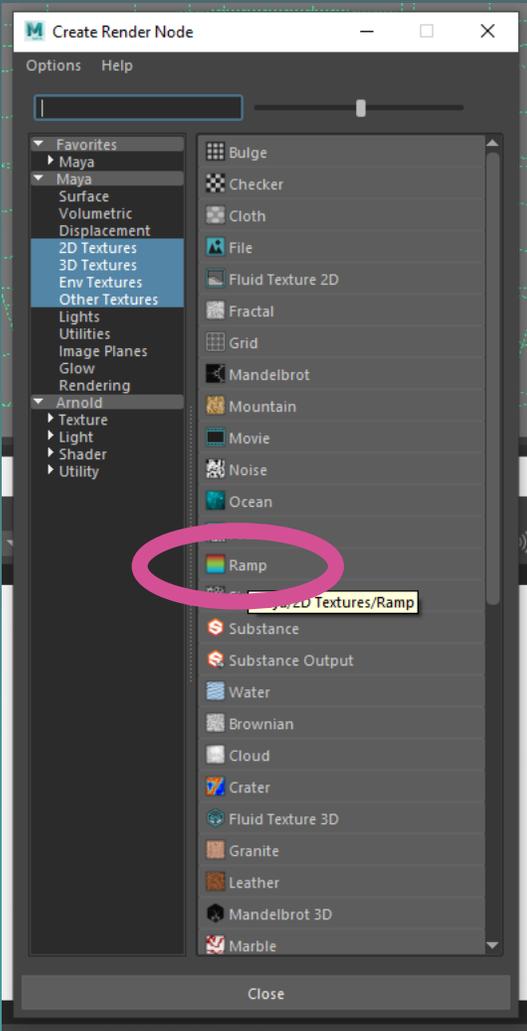
20. CREATE NODE

This opens a link from the color of the SkyDome Light to....

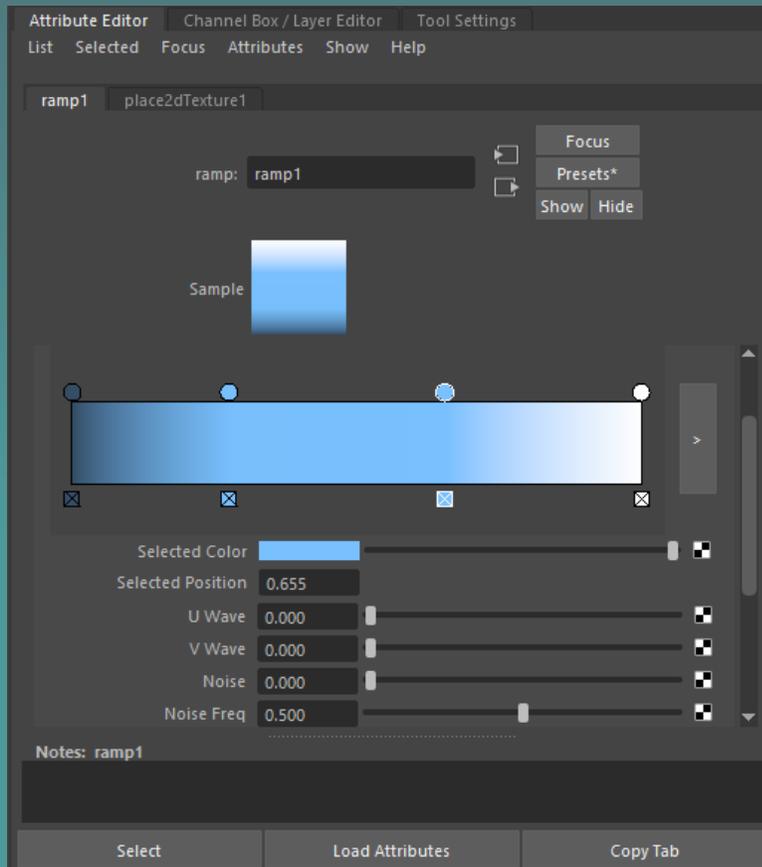
19. PRESS PLAY NOW



21. LINK RENDER NODE TO COLOR RAMP

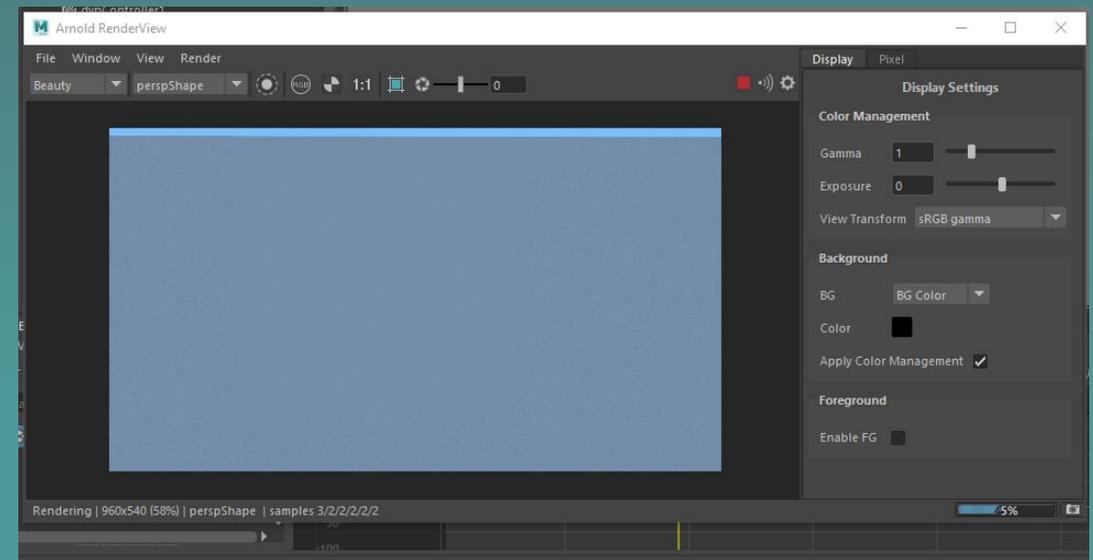


This step links the color of the SkyDome Light to this color gradient or "ramp".



22. PRESS PLAY AGAIN

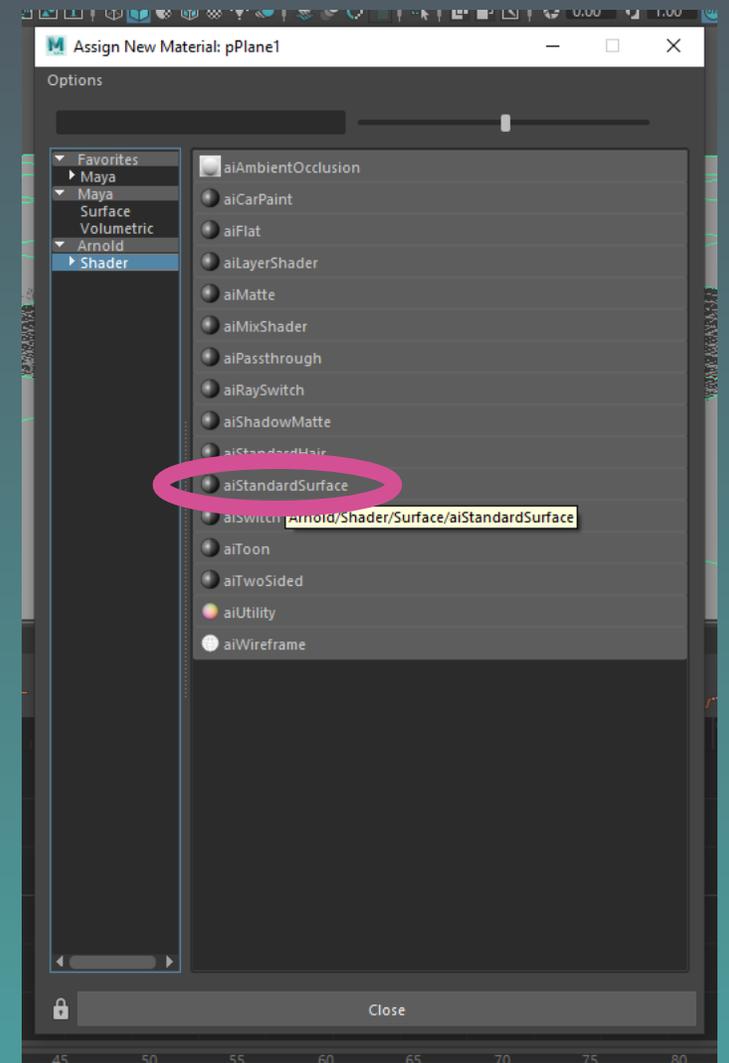
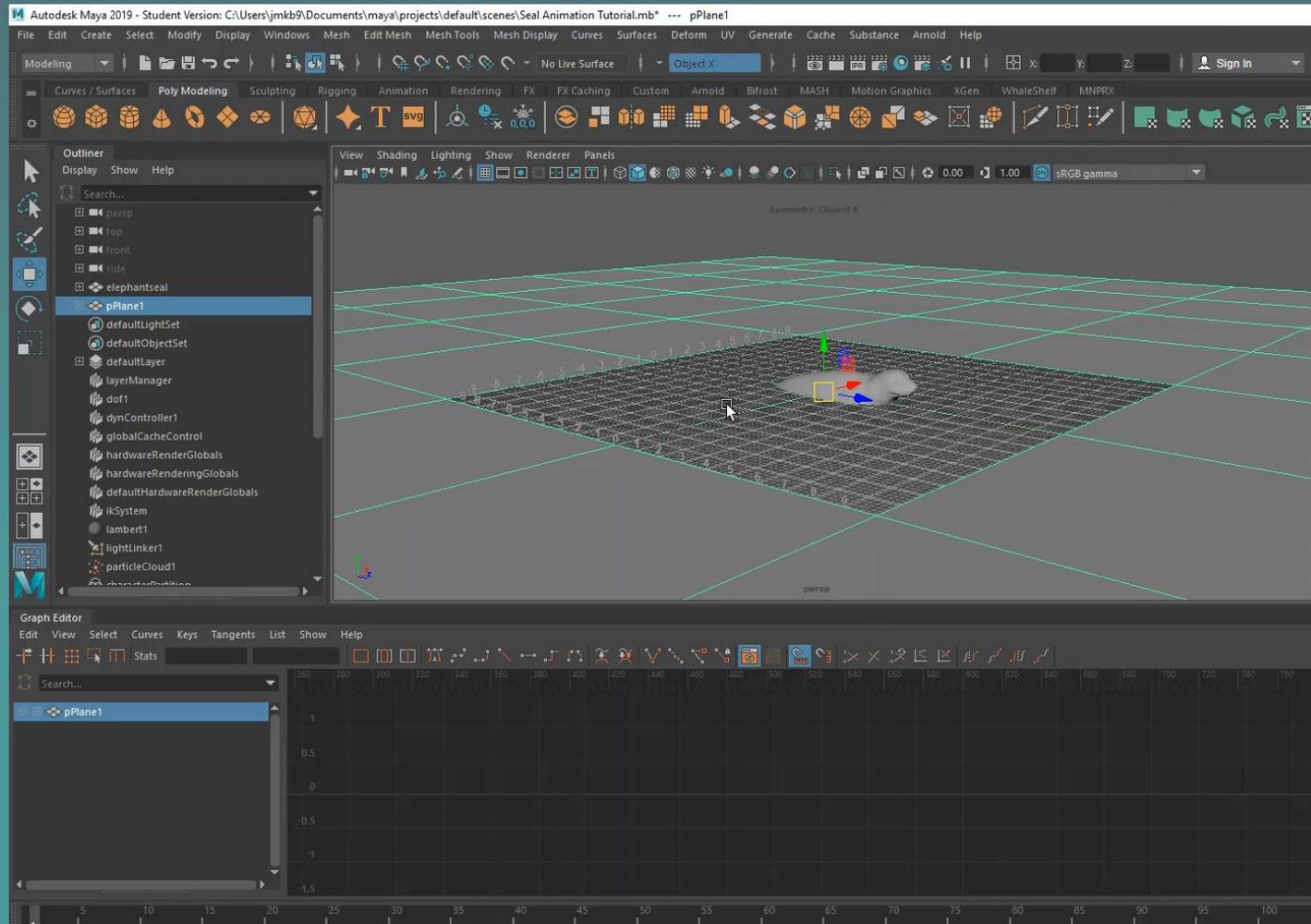
Now you have a blue sky around your scene. Next, we need to make the ocean look good!



Any issues? Make sure your Renderer under Arnold>Render is set to "Arnold Renderer", refresh if needed.

23. ASSIGN OCEAN TEXTURE

Assign a new material to the plane by right clicking and holding, scrolling down to "Assign New Material..." and then select aiStandardSurface from the Arnold > Shader menu (see right)

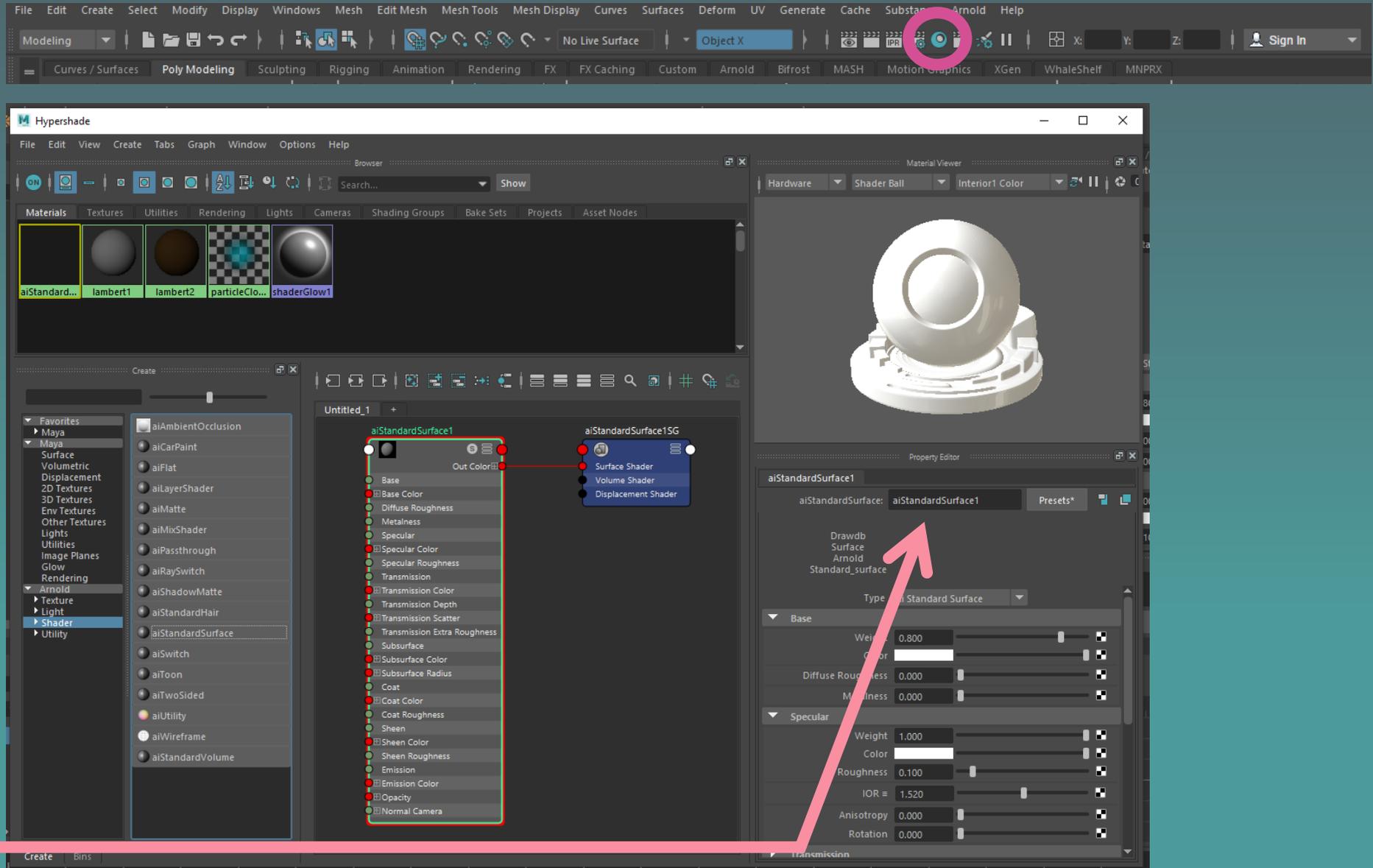


24. ANOTHER METHOD

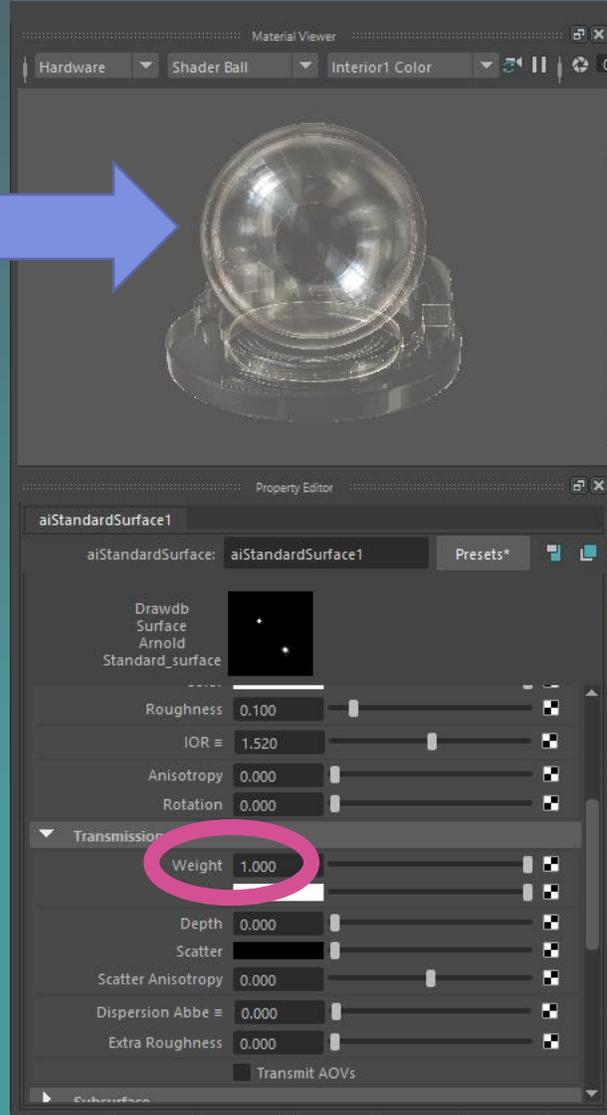
Open the "Hypershade Editor"

In the "Create" menu in the bottom left, navigate to Arnold>Shader> and click on "aiStandardSurface" to create a new texture. It will be added to the "Node Editor" to the right, where you can visualize each linked node of your texture.

Rename this texture to "Ocean Surface"



25. CUSTOMIZE OCEAN SURFACE TEXTURE

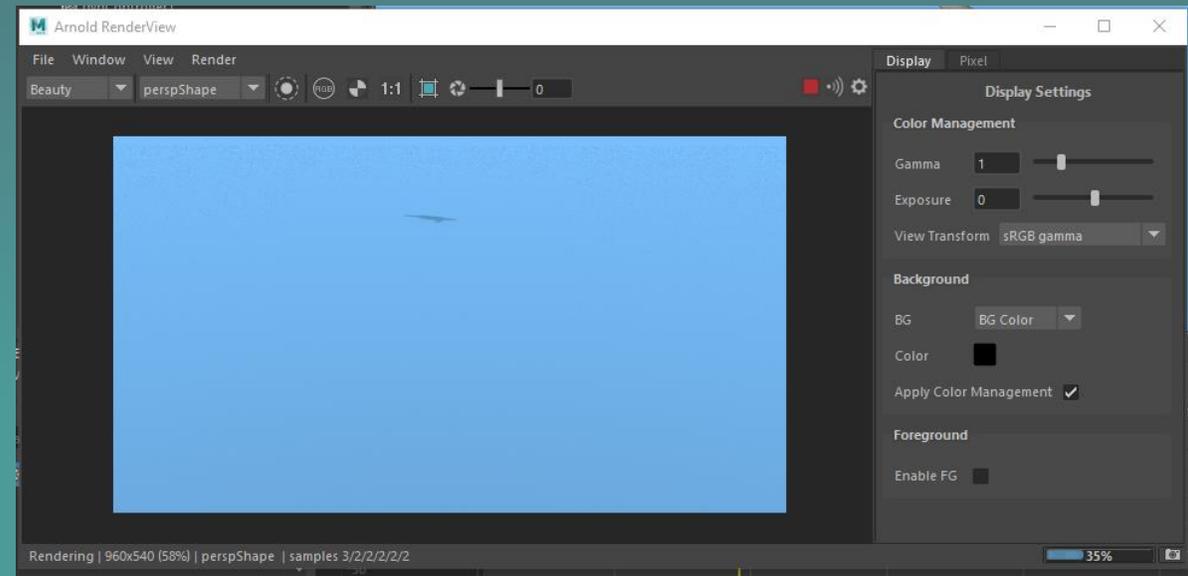


Make the ocean transparent, but reflective, by increasing Transmission Weight to 1 and keeping Specular Weight as is.

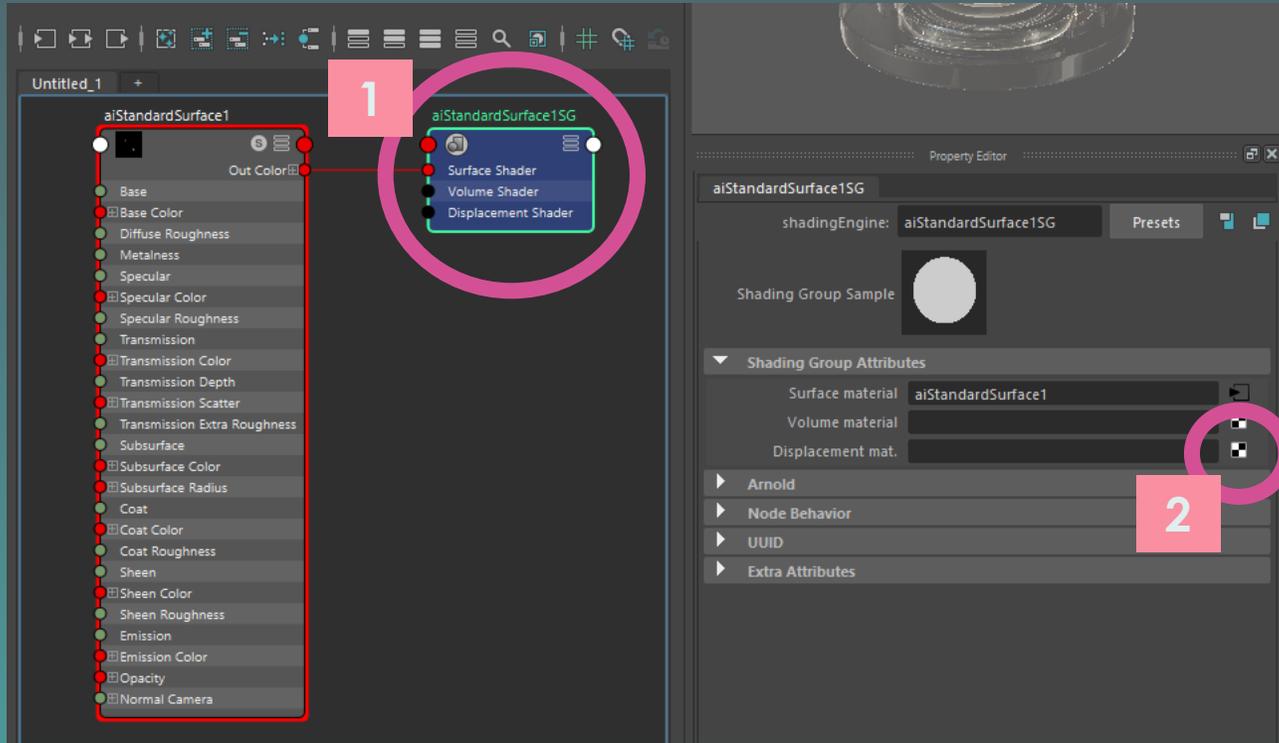
26. PRESS PLAY AGAIN

Now your ocean is transparent!

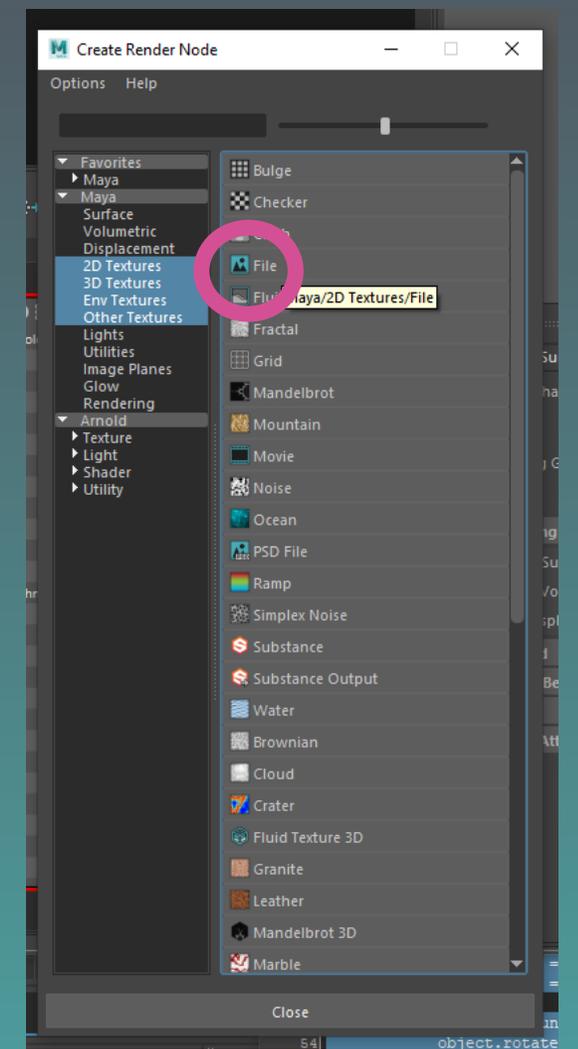
Pan around your scene in persp view to see the scene.



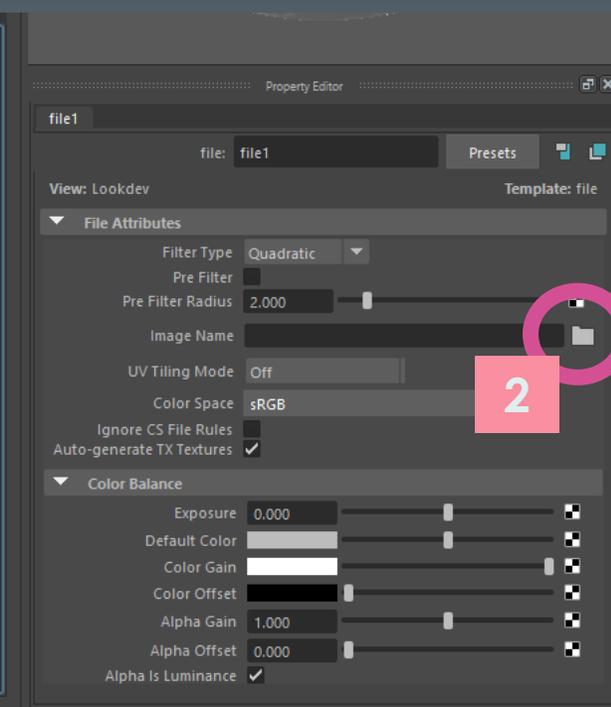
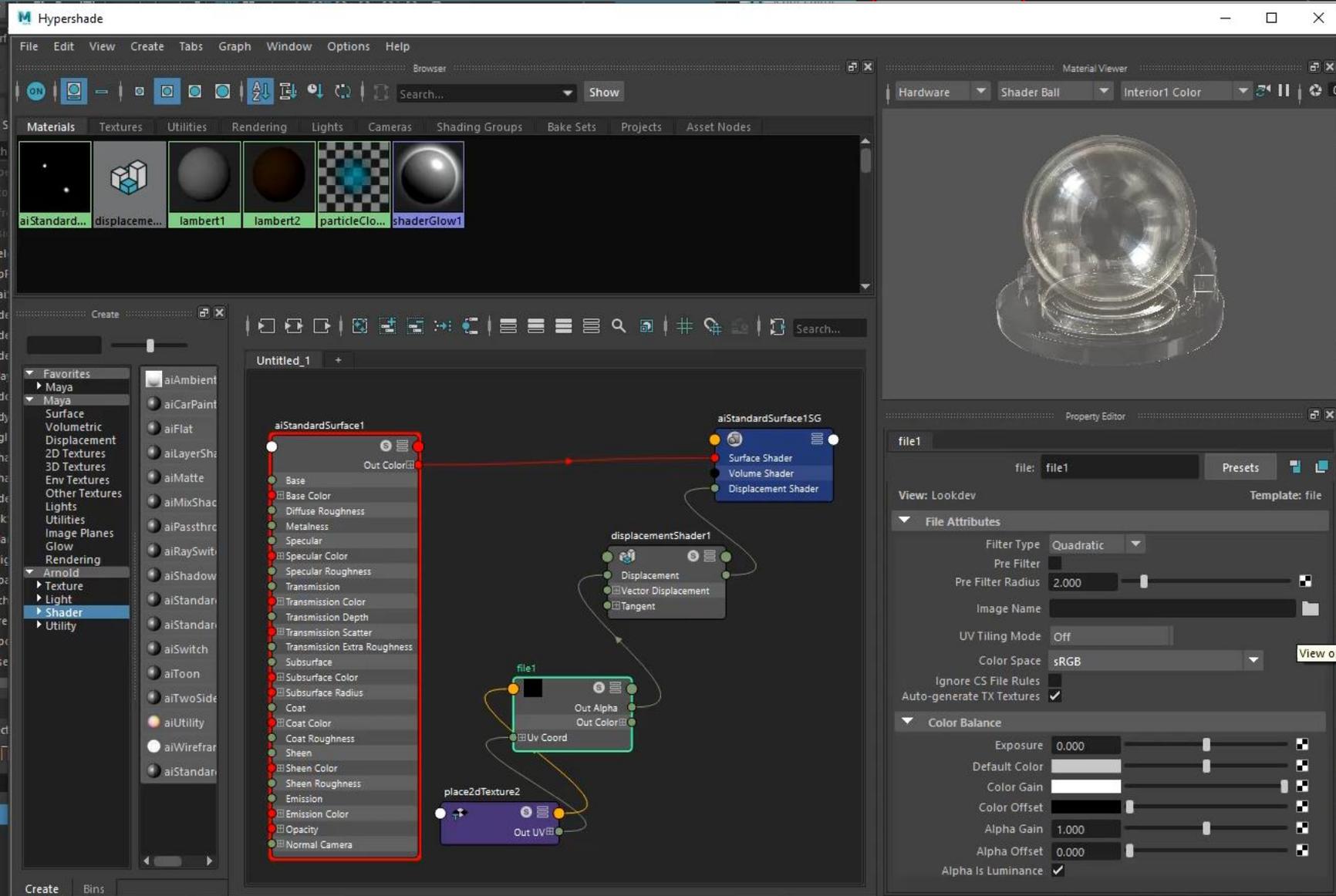
27. CUSTOMIZE OCEAN SURFACE TEXTURE



This opens a link from the displacement of this texture shader to...
a file:

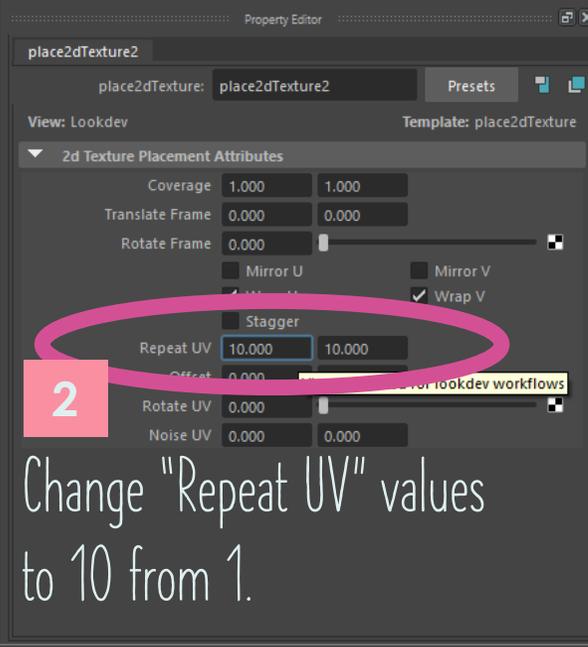
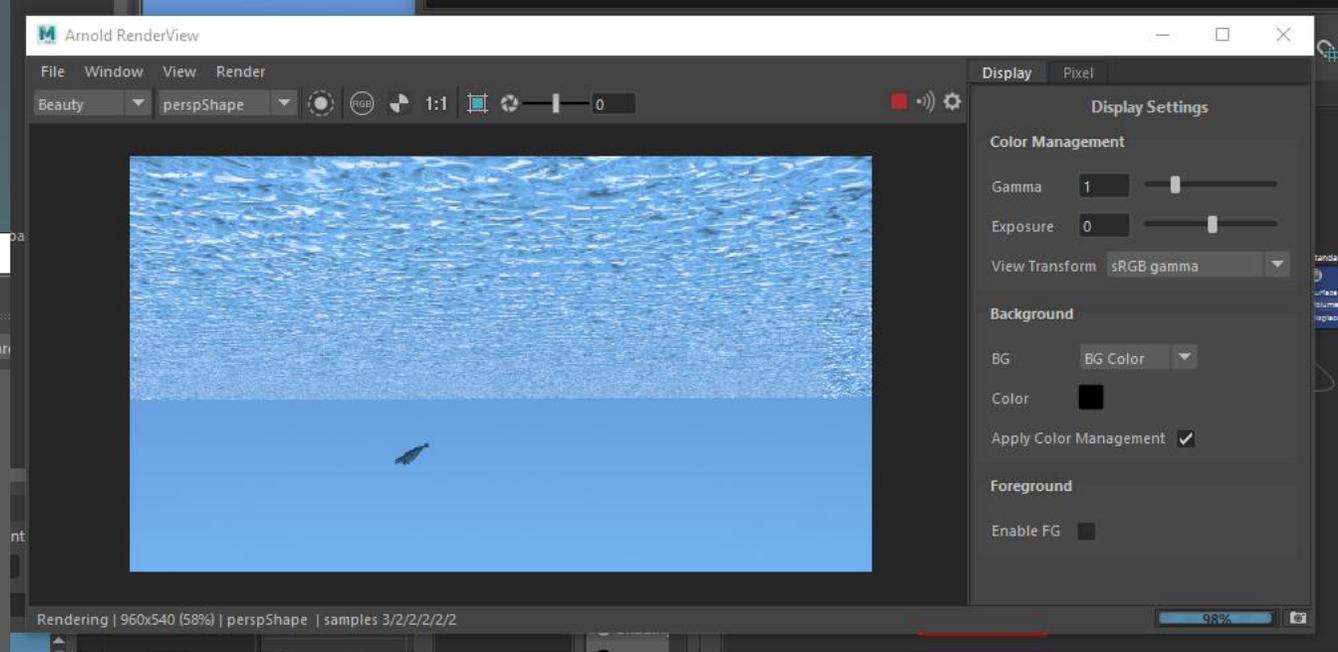
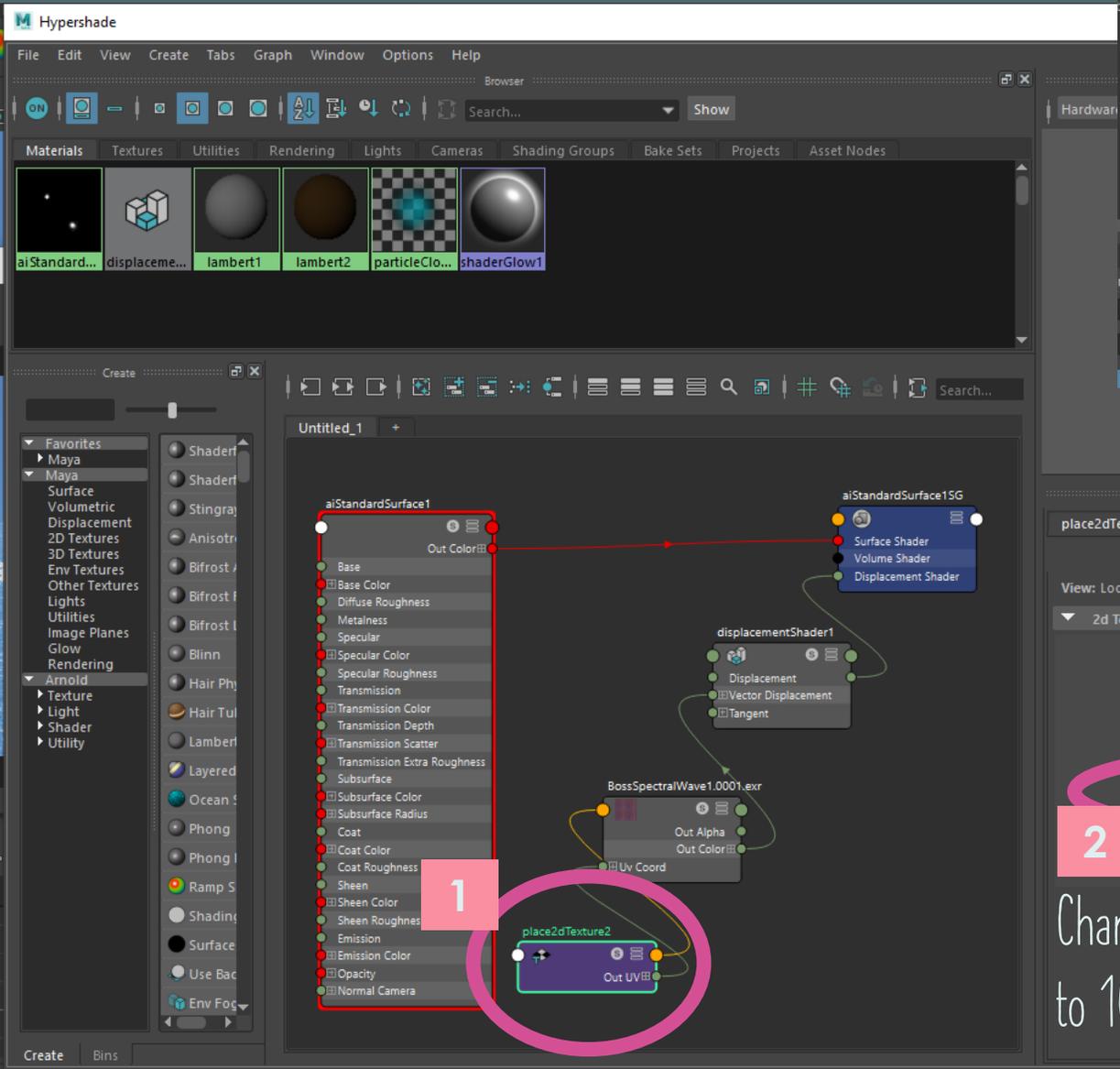


28. OPEN THE FILE NODE



Then open the first .exr image of the Ocean Texture Images folder
Remove link from Displacement to Out Alpha and Create one from Vector Displacement to Out Color.

29. ADJUST TEXTURE SCALE



Change "Repeat UV" values to 10 from 1.

30. LOOP DISPLACEMENT MAP TEXTURES

Autodesk Maya 2019 - Student Version: untitled* --- file1

File Edit Create Select Modify Display Windows Key Playback Visualize Deform Constrain MASH Cache Substance Arnold Help

Animation | Curves / Surfaces | Poly | No Live Surface | Object X | Sign In

Workspace: Modeling

Hypershade

Materials Textures Utilities Rendering Lights Cameras Shading Groups Bake Sets Projects Asset Nodes

Materials: a:Standard..., displacem..., lambert1, lambert2, partideClo..., shaderGlow1

Property Editor

file1

View: Lookdev

Template: file

File Attributes

Filter Type: Quadratic

Pre Filter

Pre Filter Radius: 2.000

Image Name: in Texture Images\BossSpectralWave1.0001.exr

UV Tiling Mode: Off

Color Space: Raw

Color Balance

Exposure: 0.000

Default Color

Color Gain

Color Offset

Alpha Gain: 1.000

Alpha Offset: 0.000

Alpha Is Luminance

Attribute Editor Channel Box / Layer Editor Tool Settings

List Selected Focus Attributes Show Help

file1 place2dTexture2 expression1

file: file1

Focus Presets Show Hide

Sample

File Attributes

Filter Type: Quadratic

Pre Filter

Pre Filter Radius: 2.000

Image Name: maya\Ocean Texture Images\BossSpectralWave1.<f>.exr

Reload Edit View

UV Tiling Mode: Off

Image Number: 46

4 (right click)

Edit Expression... Delete Expression Lock Attribute

Notes: file1

Select Load Attributes Copy Tab

6 Enter this expression:

```
File2.frameExtensions=((frame%120)+1);
```

31. RENDER YOUR SCENE

Navigate to Rendering Menu Set and open Render Sequence settings.

1

2

3

4

5

Important! Otherwise will only render 1 frame.

Save somewhere!

Arrange your perspective view so that the seal is in view the whole time. You can also use an animated camera but for our purposes this will be fine.

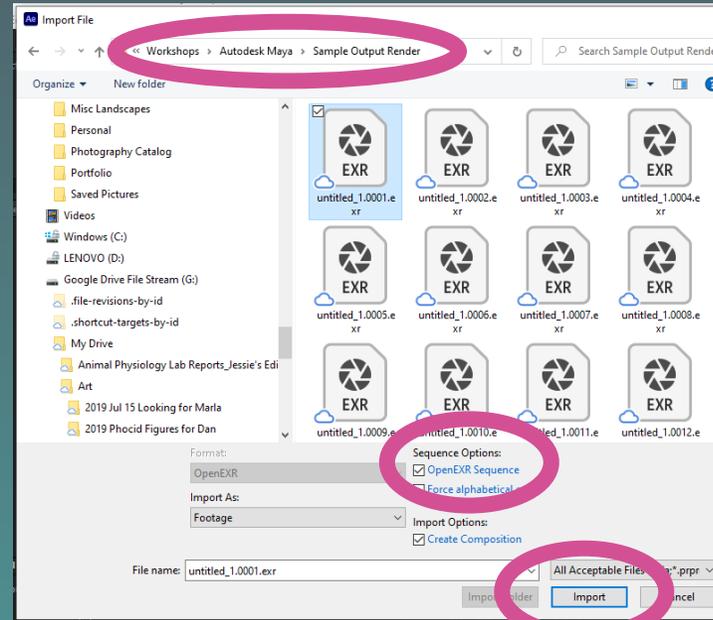
32. MAKE A VIDEO WITH YOUR SEQUENCE

1 Open Adobe After Effects (now free for UCSC students)

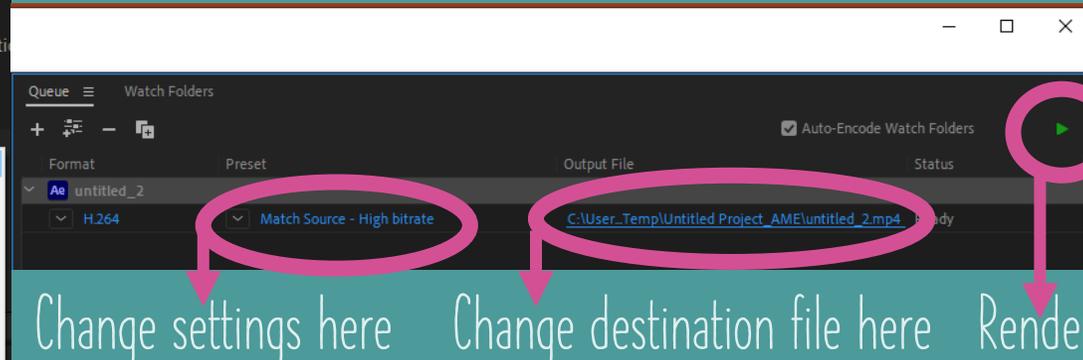
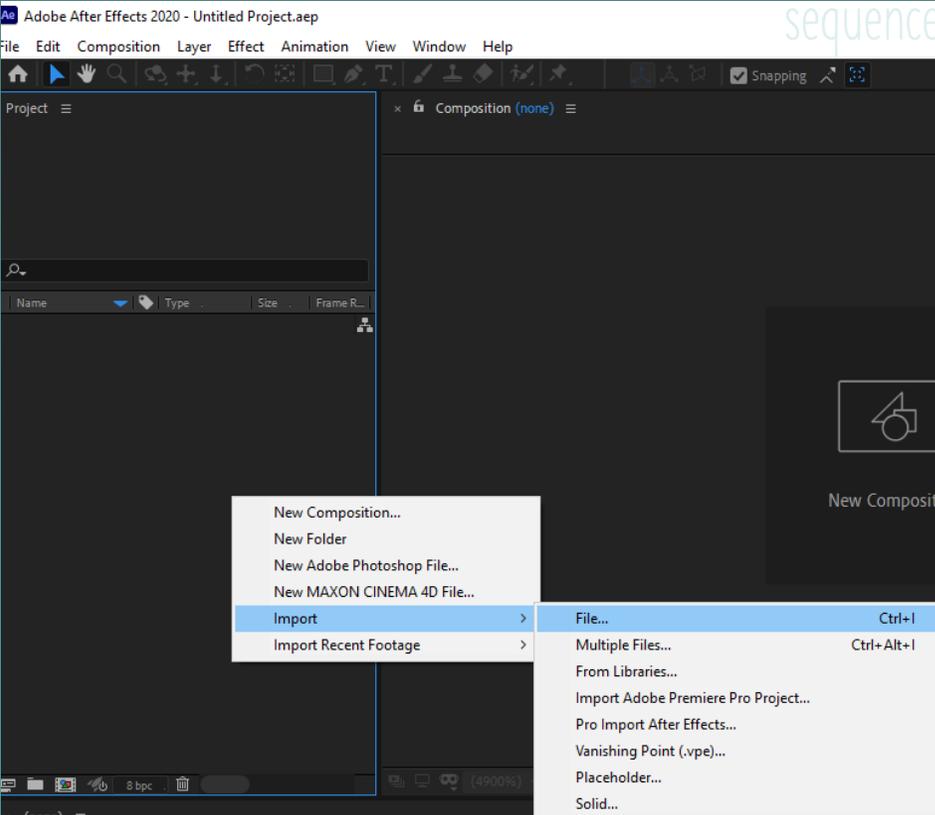
2 Right click in the project panel to Import a file.

3 Navigate to where you've saved your exported exr image sequence and import that image

4 Drag and drop footage into timeline.



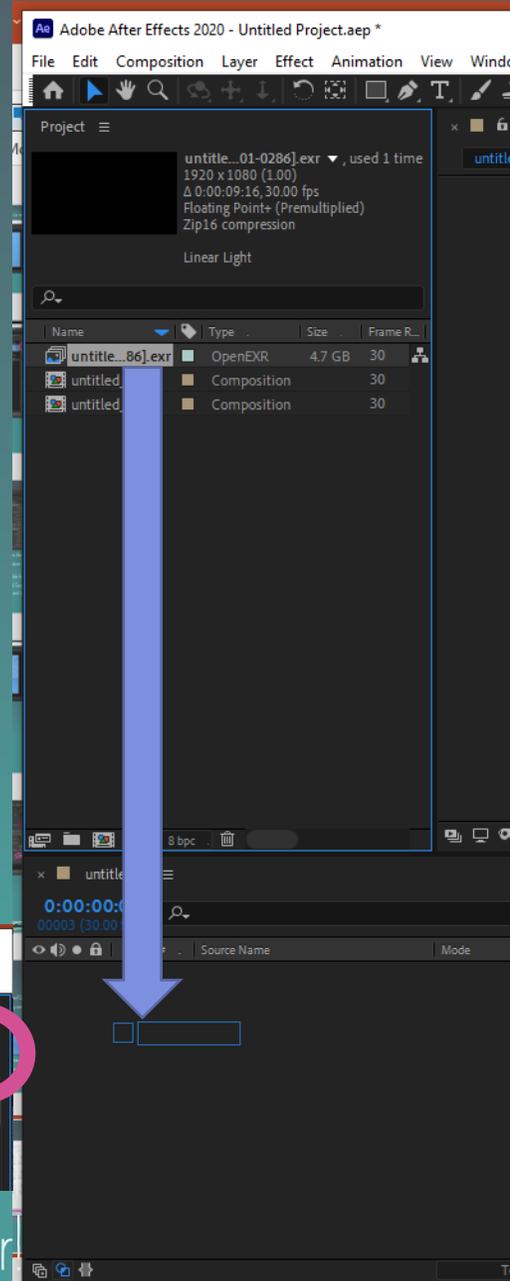
5 Export your video in File > Export > Add to Adobe Media Encoder Queue..



Change settings here

Change destination file here

Render





33. ADMIRE YOUR OUTPUT

