PBR ASSET PIPELINE

A 3D Pipline Overview for Physically Based Rendering in Unreal Engine 4

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Giving Credit where credit is due

- I used the following resources to put together this slide share. A lot of it is cut and pasted or I worded description similarly added clarification where I thought I needed to explain more.
- https://docs.unrealengine.com/latest/INT/Engine/Rendering/Materials/PhysicallyBased/
- http://www.marmoset.co/toolbag/learn/pbr-practice
- http://www.marmoset.co/toolbag/learn/pbr-theory
- http://wiki.polycount.com/wiki/PBR

Presentation Overview

- What is PBR and why does it change everything about texturing and modeling?
- Misconceptions and Myths
- What PBR Pipeline does Unreal Engine 4 use?
- The texture maps that are involved in an asset pipeline
- Overview of “High Resolution” to “Low Resolution” Workflow
- Modeling the “High Resolution” Model first
- Next, modeling the “Low Resolution” Model (Game Model)
- UV Mapping the “Low Resolution” model and why it is important for Substance Painter
- Texture baking your texture maps from High to Low resolution
- Using Substance Painter to paint your model with baked supporting textures
- Visualizing your model in supporting 3rd Party PBR Programs
- Moving your Final Asset into Unreal Engine 4

What is PBR and why does it change everything?

Physically based shading means we approximate what light actually does in the real world as opposed to approximating what we intuitively think it should do in past game engines.

The end result is a more accurate and typically more natural looking scene.

Image courtesy of www.marmoset.co

Image courtesy of www.marmoset.co

Myths and Misconceptions

- PBR in the most basic sense is a combination of sophisticated shaders that represent the physics of light and matter, along with art content that is calibrated using plausible values to represent real world materials. PBR is essentially a holistic system of content creation and rendering, which can and often does have variances (generally shader models or texture input types) in actual implementation, depending on what tools or engine you use.
- Additionally, loading any old content into a PBR shader does not guarantee physically accurate results. I see this misconception rearing its head equally as often as the “Why not PBR?” one mentioned above. Fancy shaders are only half of the equation, you also need logically calibrated art content.

Joe “EarthQuake” Wilson

Lead Artist at Marmoset

PBR and Lighting

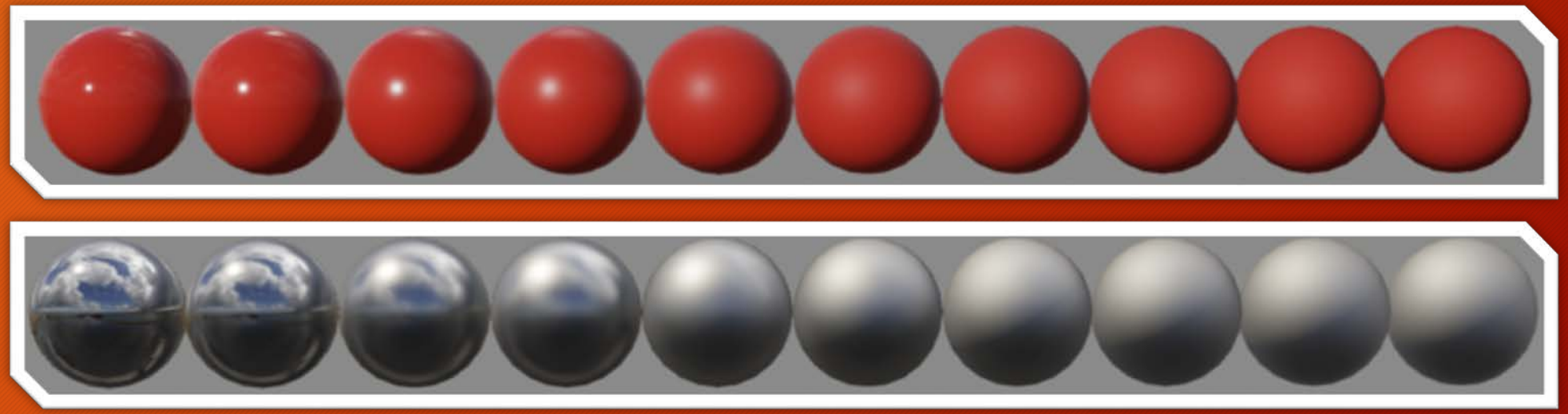
- Physically based Materials will work equally well in "**all lighting**" environments.
- In addition, the Material values can be less complex and interdependent, resulting in a more intuitive interface.
- Past game engine assets would not work well with scenes that are lit differently. Assets textured for a full daytime scene would still look lit in a dark or night time scene.

UE4 Material Base Parameters

- In terms of the "physically based" aspect of the Unreal 4 Materials system, there are really only 4 different properties with which you need to be familiar. These are:
  - Base Color (Albedo) replaces old Diffuse
  - Roughness
  - Metallic
  - Specular
  - Normal (Tangent Space, Object Space)
  - Ambient Occlusion (AO)

Roughness Rules Them all

- The Roughness input literally controls how rough the Material is. A rough Material will scatter reflected light in more directions than a smooth Material. This can be seen in how blurry or sharp the reflection is or in how broad or tight the specular highlight is. Roughness of 0 (smooth) is a mirror reflection and roughness of 1 (rough) is completely matte or diffuse.



Base Color / Albedo

- **Base Color** simply defines the overall color of the Material. It takes in a Vector3 (RGB) value and each channel is automatically clamped between 0 and 1.
- If taken from the real world, this is the color when photographed using a polarizing filter (polarization removes the specular of nonmetals when aligned).
- The Base color should not contain any light information such as baked in shadows or specular highlights. Do not edit your color map by painting in highlights or shadows if you are to use a PBR material.

Heavy Metal Rocks!

- The **Metallic** input literally controls how "metal-like" your surface will be. Nonmetals have Metallic values of 0, metals have Metallic values of 1. For pure surfaces, such as pure metal, pure stone, pure plastic, etc. this value will be 0 or 1, not anything in between. When creating hybrid surfaces like corroded, dusty, or rusty metals, you may find that you need some value *between* 0 and 1.

Specular, should I stay or should I go?

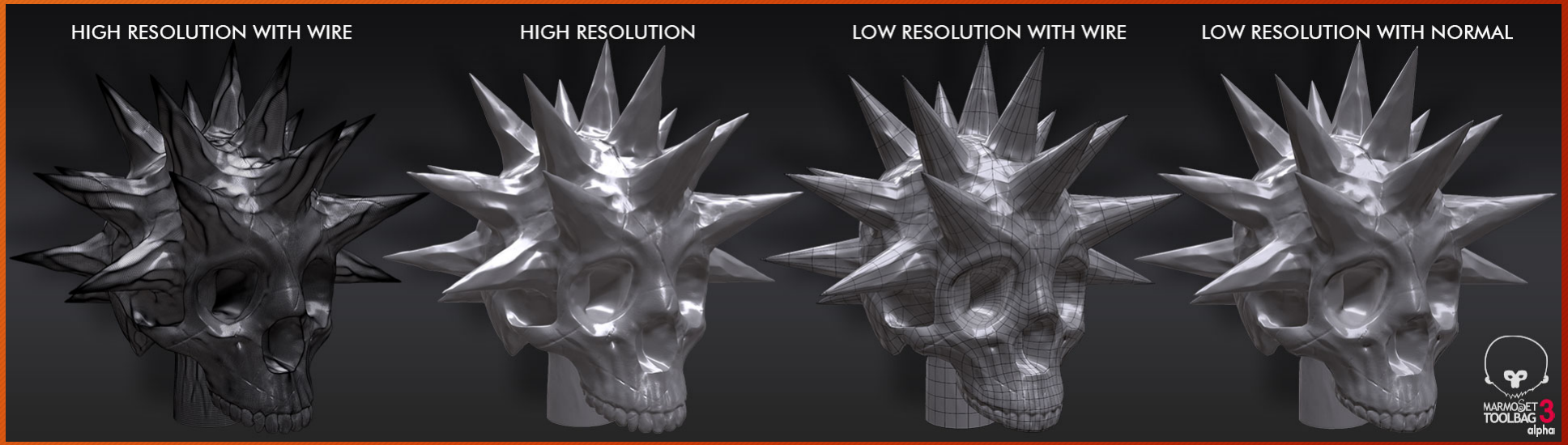
- The **Specular** input should not be connected and left as its default value of 0.5 for “most” cases.
- For very diffuse Materials, you may be inclined to set this to zero. **Resist!** All Materials have specular. What you really want to do for very diffuse Materials is make them rough.
- Commonly, if we modify Specular, we do so to add micro occlusion or small scale shadowing, say from cracks represented in the normal map. These are sometimes referred to as cavities. Small scale geometry, especially details only present in the high poly and baked into the normal map, will not be picked up by the renderer's real-time shadows.

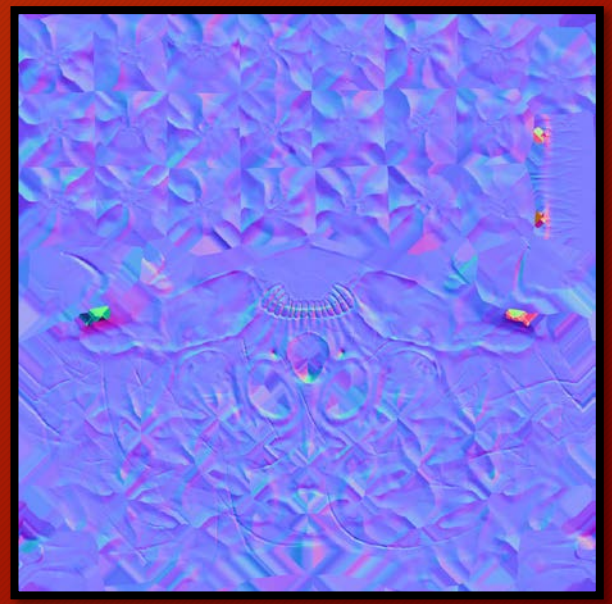
Ambient Occlusion Map, fake shadows

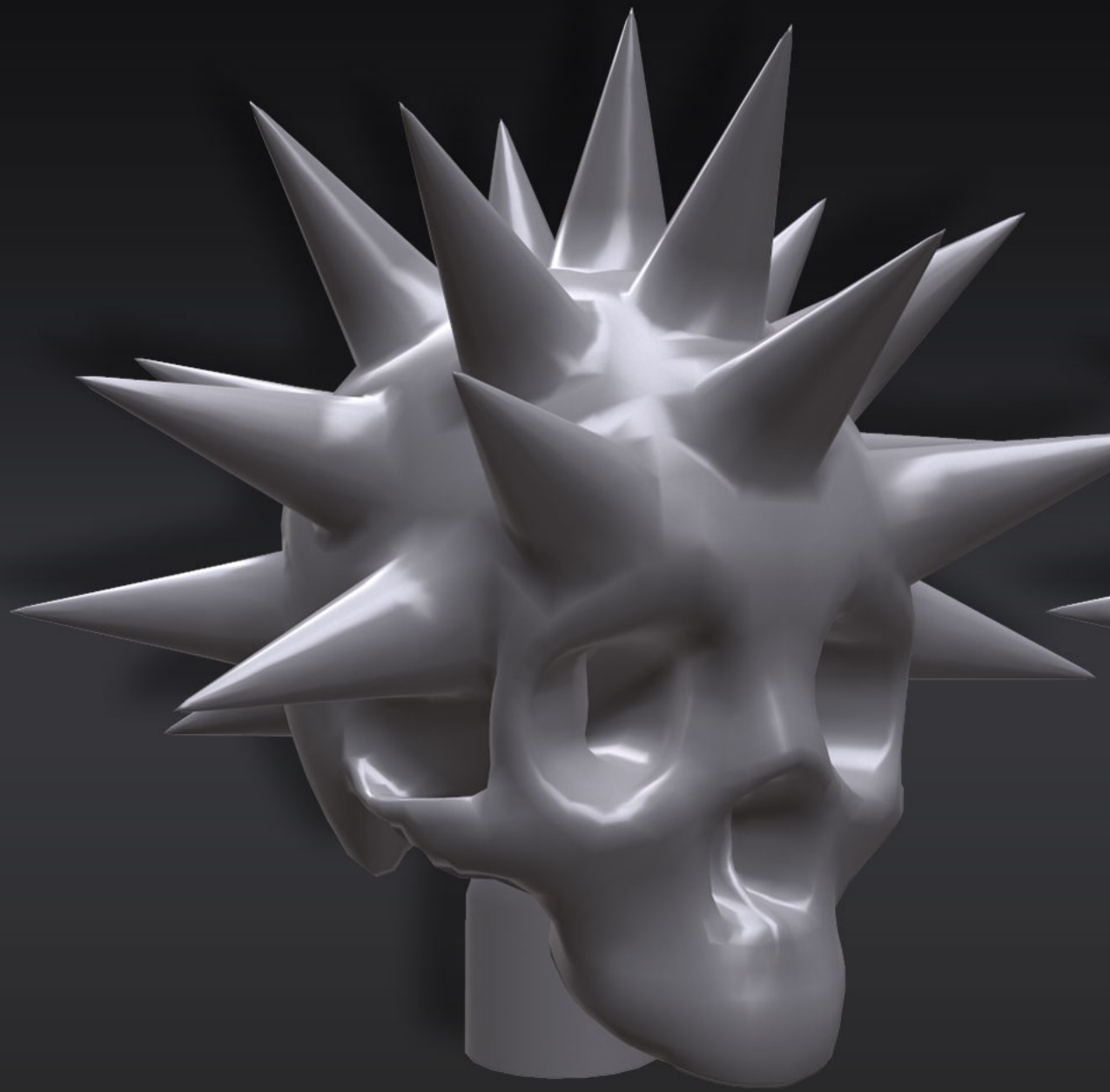
- An Ambient Occlusion (AO) map creates soft shadowing, as if the model was lit without a direct light source, like on a cloudy day.
- AO is usually baked from geometry because it is created using a non-realtime ray-casting lighting solution. It can either be stored in a texture, or it can be stored in the vertex colors of the model.
- There are a number of programs that can assist in baking out an ambient occlusion map.
- Substance Painter, Knald and Marmoset Toolbag 3(Still in Alpha) are all good for baking
- For speed, I prefer to use Knald for all of my AO Bakes

Normal Map

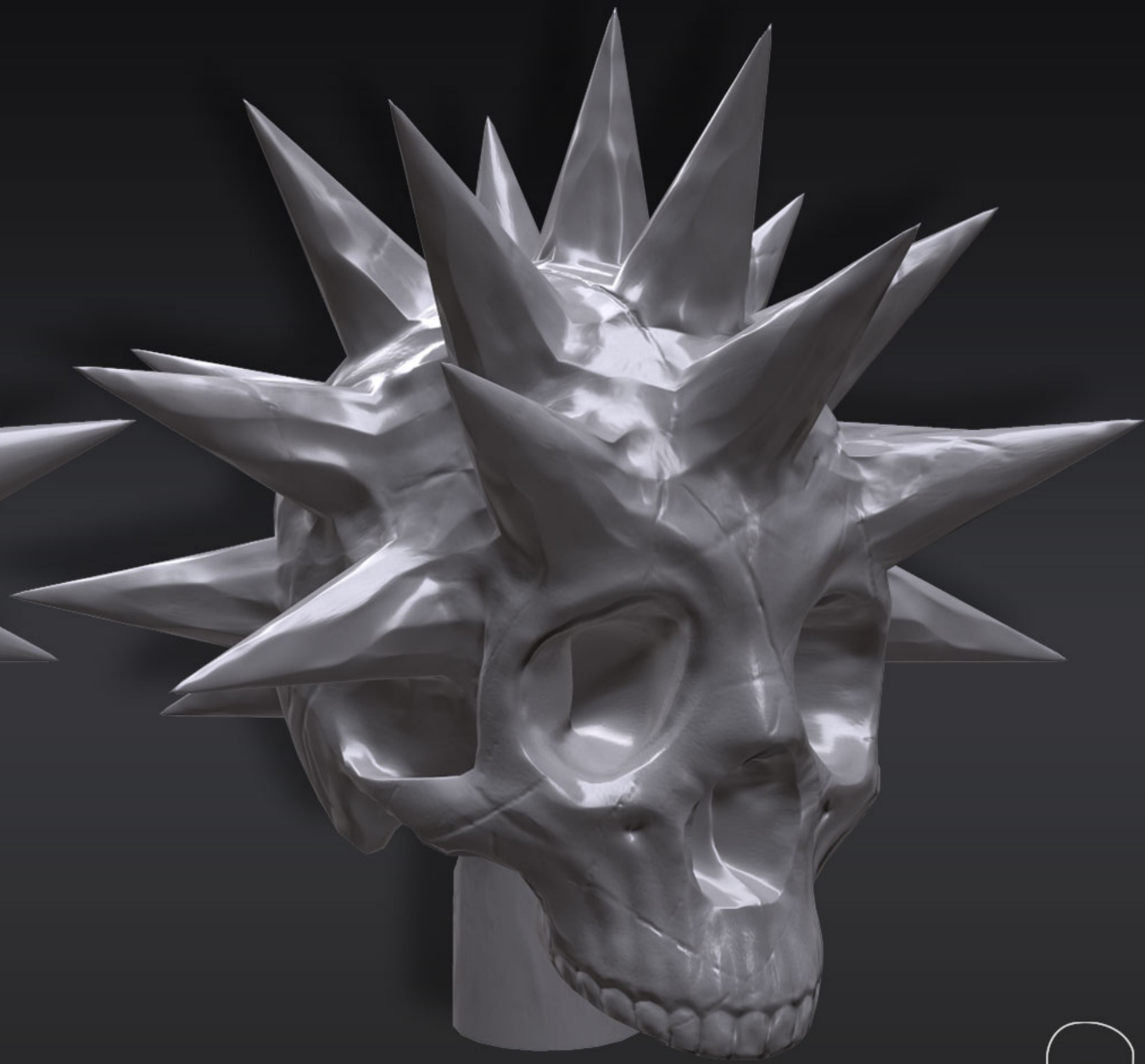
- A normal map is an image that stores a direction at each pixel. These directions are called normal. The red, green, and blue channels of the image are used to control the direction of each pixel's normal.
- A normal map is commonly used to fake high-resolution details on a low-resolution model. Each pixel of the map stores the surface slope of the original high-res mesh at that point. This creates the illusion of more surface detail or better curvature. However, the silhouette of the model doesn't change.







LOW RESOLUTION NO NORMAL MAP



LOW RESOLUTION WITH NORMAL MAP

MARMOSET TOOLBAG 3 alpha

High to Low Resolution Production Workflow

- Model Your High Resolution Model
- Retopologize your Low Resolution Model to match the shape of your High
- UV Map your Low Resolution model
- Triangulate Your Low Res Model before baking
- Mirror and duplicate any geometry that is the same
- Separate or explode your model into separate pieces and label match for baking
- Baking your textures in Knald or Substance Painter
- Import into Substance Painter
- Texture your model in Substance Painter
- Export your textures
- Final touch ups in Photoshop
- Import to UE4 Game Engine

High Resolution Model (HR)

- First rule to High Resolution Modeling club. There are no rules! You are not held to any specific software or technique to make your model.
- As long as your model looks physically as close to the the real world object as possible, then you are on the right track.
- Reduce fasciting as much as you can on your HR model. This means smooth transitions and curved surfaces as much as you can.
- Even hard surface models have rounded edges. These translate well into a curvature map for edge wear and damage.

Polygon Modeling Software for HR Models

- Maya, 3DS Max, Modo
  - Using the crease tools to get soft edges when subdividing your model
    - Maya 2015 on up and 3DS Max 2016 Ext 2 on up have a crease tool that allows you to define edge hardness in smooth mesh preview and OpenSubDiv modifier. This process has its advantages but can be confusing if not explained in detail.
    - Use crease sets to organize your edge crease assignment process easily
    - Subdide your object at least 4 to 5 times depending on the current mesh resolution when previewing
    - Never Crease your edges at the value of your current subdivision or they will just continue to be hard edges.
    - Avoid long rectangles in your model. Model as if your are going to subdivide for sculpting.
  - (Old Way) Using Supporting edges to get smooth rounded surfaces
    - In Maya 2014 you use the 3 Hot Key Smooth Mesh Preview
    - In old versions of 3DS Max you use the Turbo Smooth Modifier
    - This process can waste hours of time and cause lots of frustration when you need to go back and change something

CAD Solids Modeling Software for HR Models

UnrealPhx

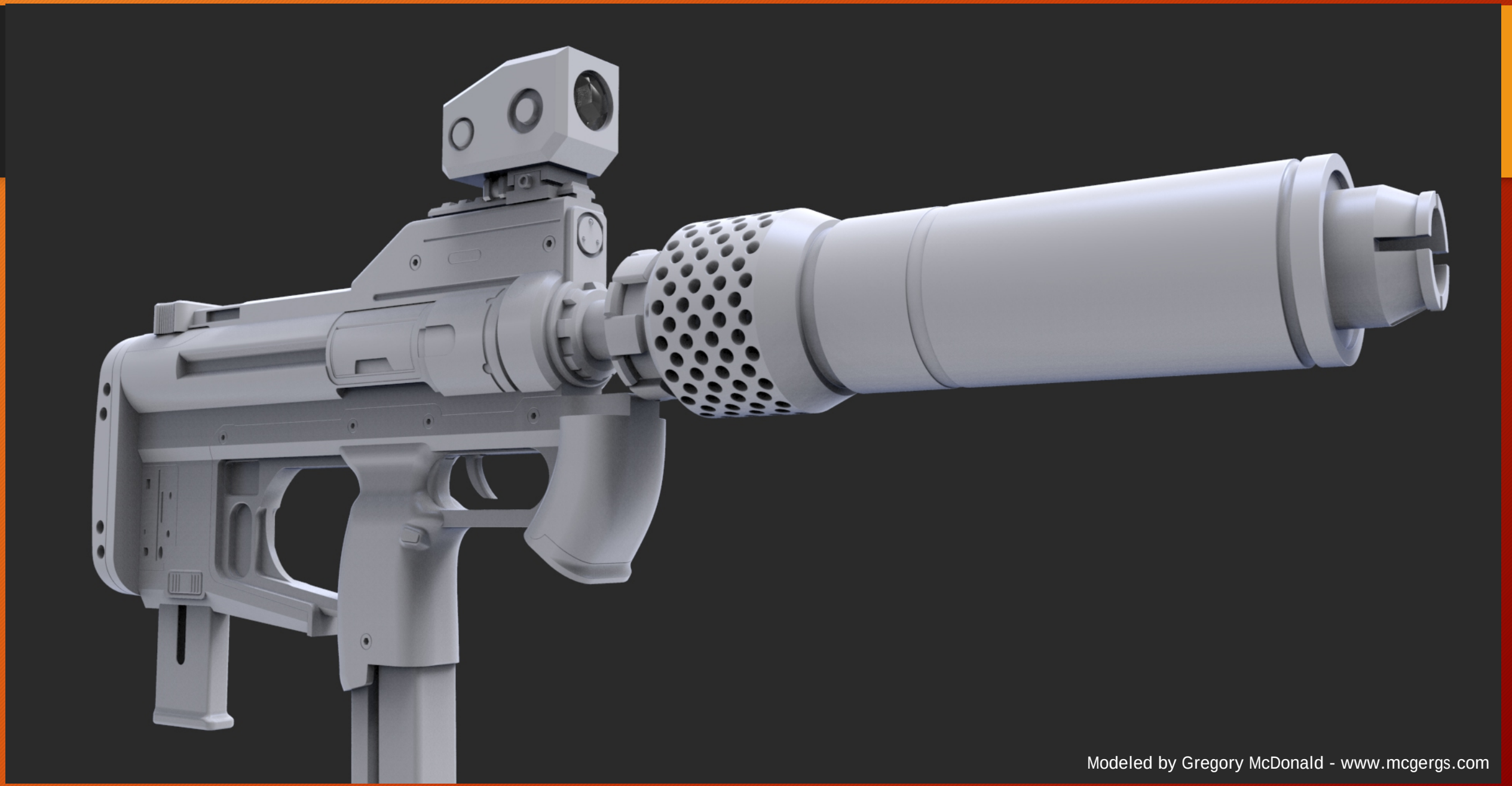
- Solidworks – Commonly used in product design and the manufacturing industry. Creates very accurate high res models quickly using Solids modeling techniques. The model I am showing later in the presentation was modeled in Solidworks. (Student Discount Price $99)(Veterans Get Free Student Version)
- OnShape.com – Web based Subscription Solids modeling software. Works versy similar to Solidworks. (Fully Unlocked for Students)
- Autodesk Inventor – Autodesks competitor to Solidworks (Free Student Version Available)
- Autodesk Fusion 360 – Cheaper Solids modeler just recently released by Autodesk for the exploding rapid prototyping industry. (Free Student Version Available)

Demo Software Stuff and Stuff

- From here I will demo a gun model that I did in collaboration with my friend Elliot Lilly (http://eliottlillyart.com), a Freelance Concept Designer.
- Elliot's latest concept design was the grenade launcher in Call of Duty Black Ops III. He has also worked on the DOOM Franchise, Rage and Fear
- When modeling have a good concept to go from when you start your modeling process. This will help you get moving quickly and will helpwith design block if you are working on your own design.

This is the concept Elliott gave me permission to model. It is important to always get permission before modeling other peoples designs.

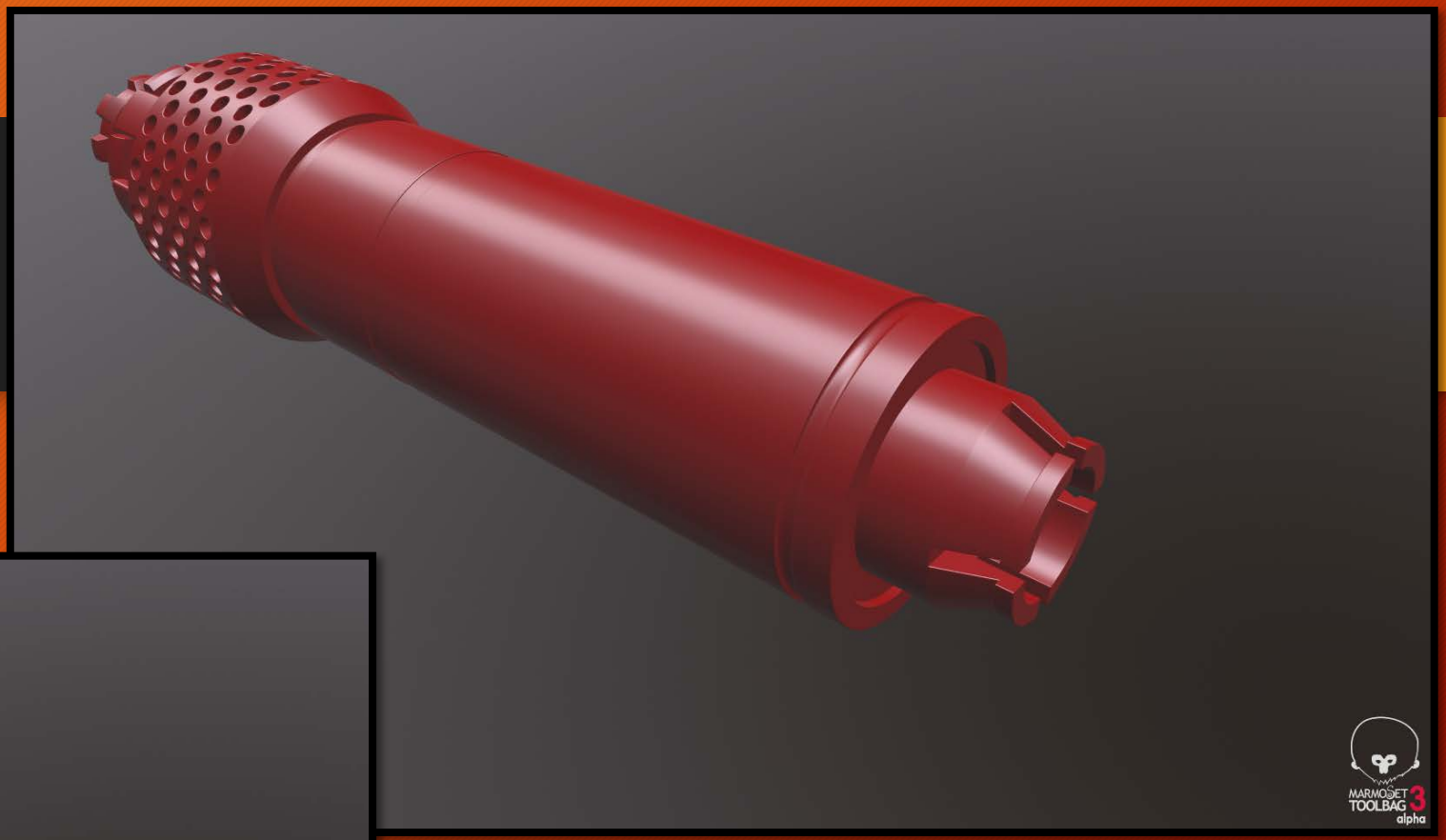
THE IMPORTANCE OF GETTING AN ACCURATE HIGH POLY MODEL



Modeled by Gregory McDonald - www.mcgergs.com

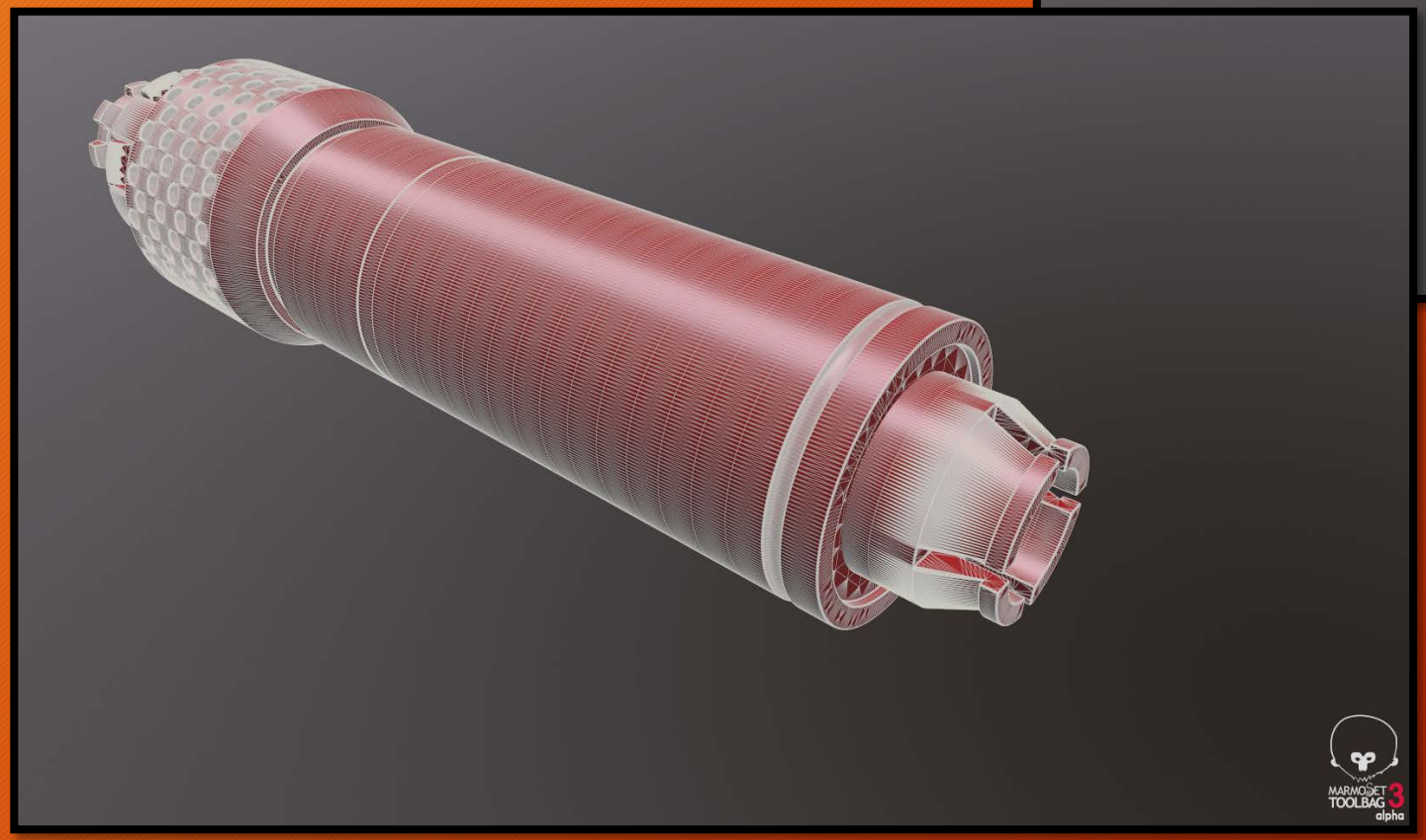
High Poly Silencer

We will focus on this piece for now

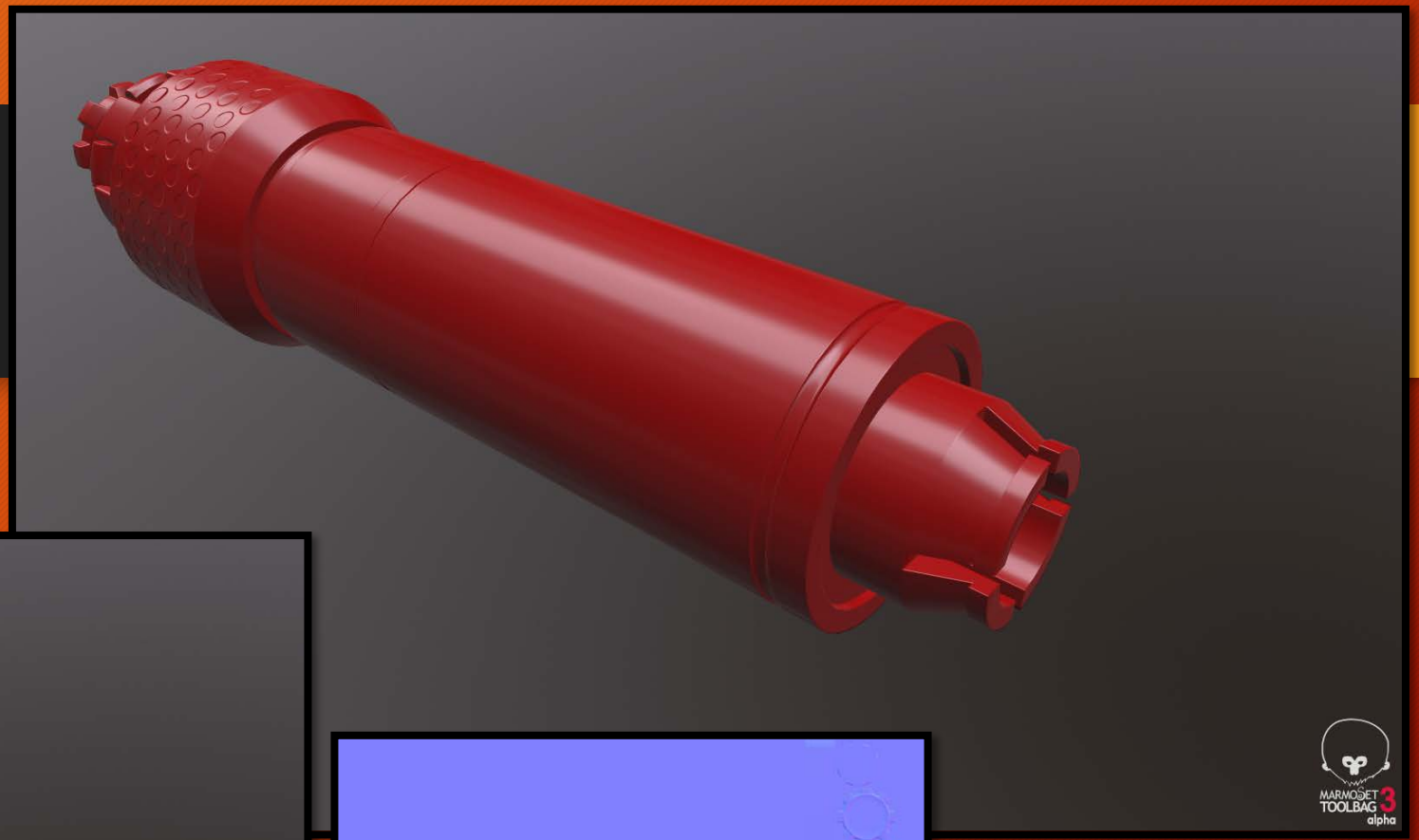


High Resolution Model from Solidworks

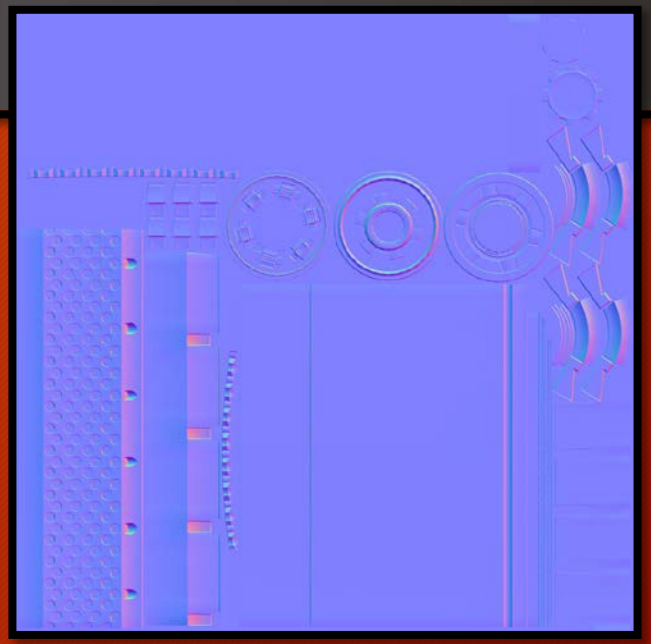
HR With Wireframe



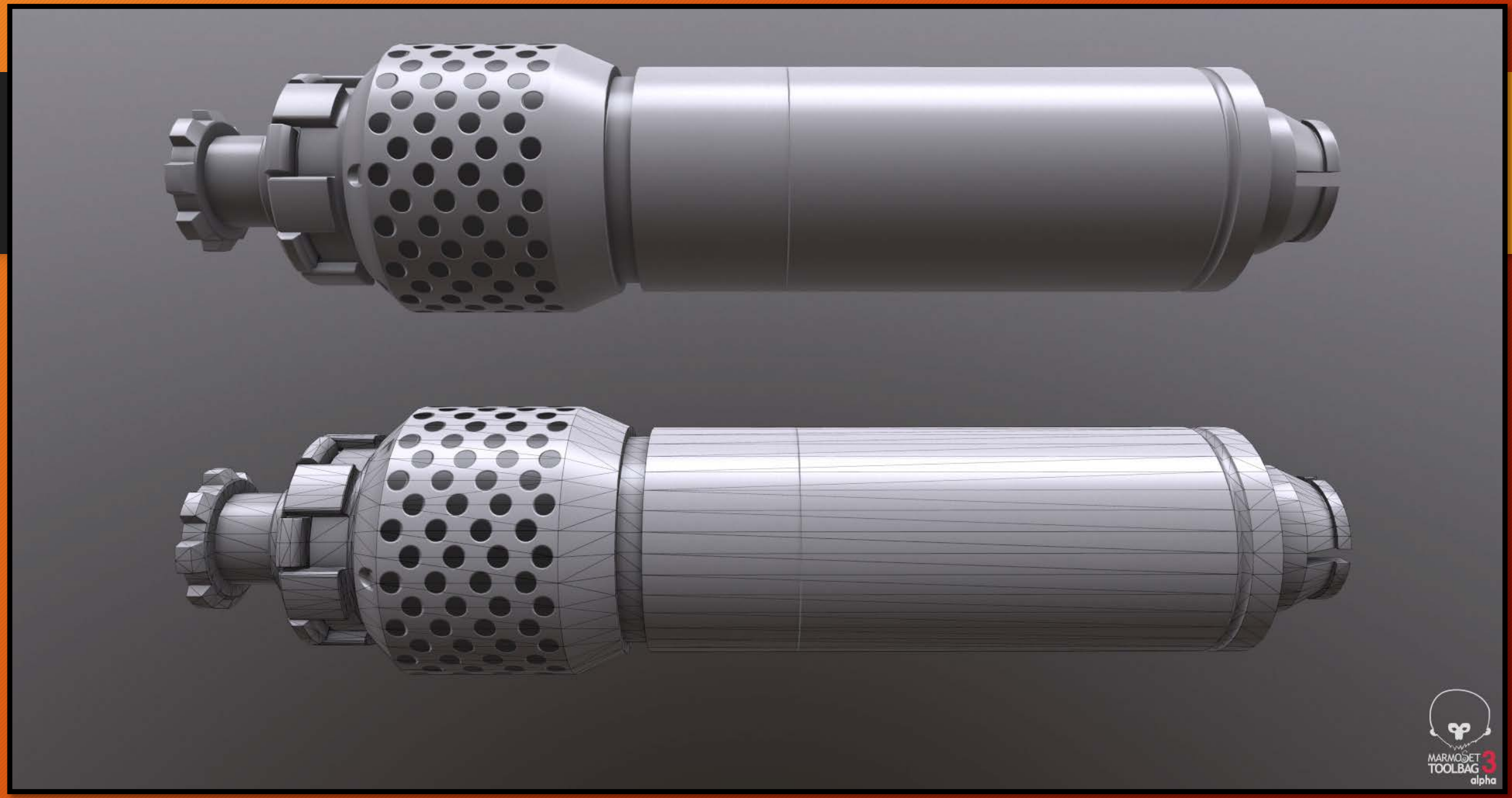
Low Poly with Tangent Normals



Low Resolution With Wireframe

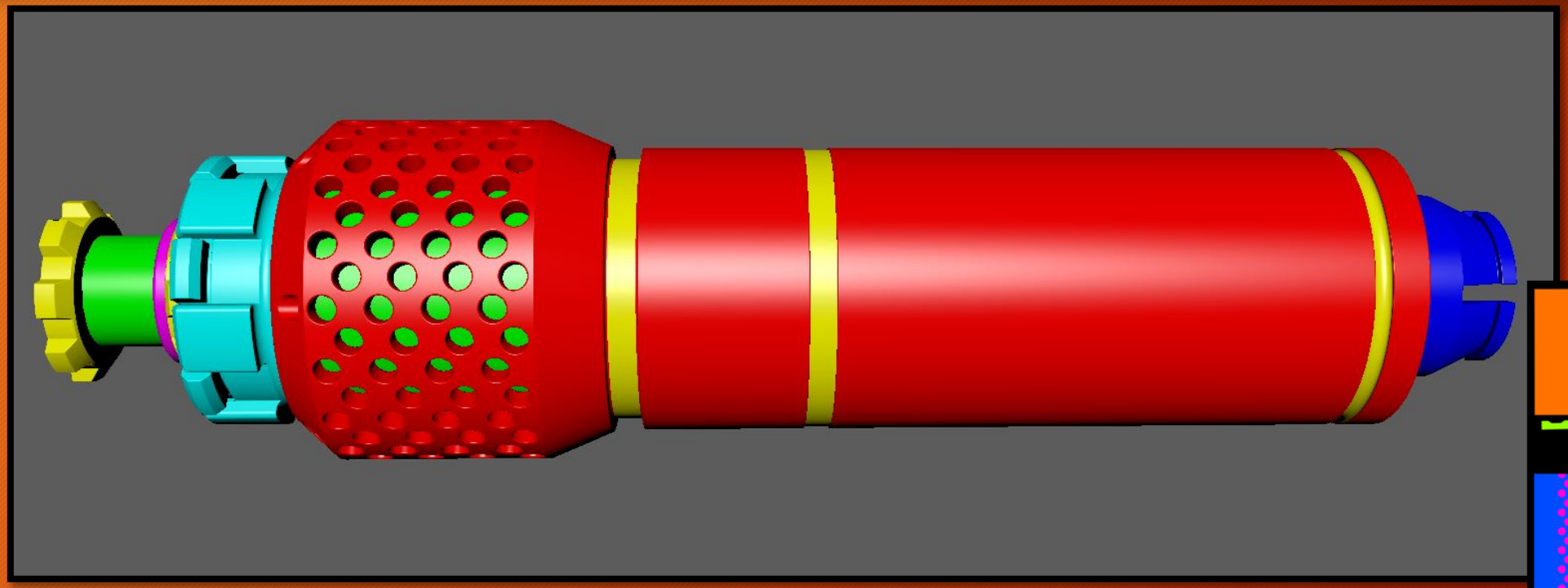


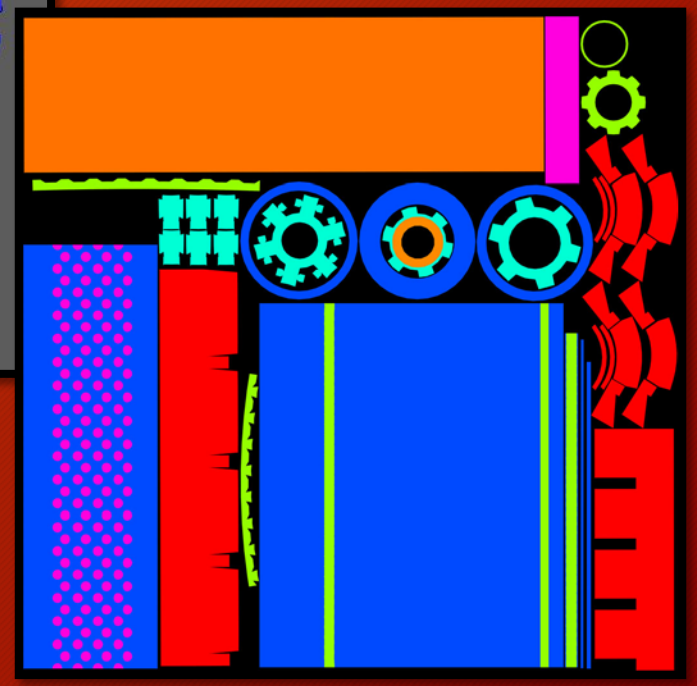
Low Resolution with Normal Map



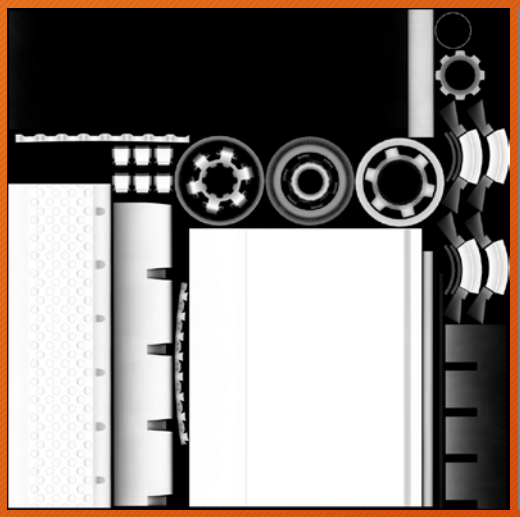
Final Low Resolution Model with Normal map and AO map applied. It is very important to ge the normal map and AO correct before moving on to baking supporting maps and texturing. You will have a lot of fixing to do and have lost work and time if you don't.

Setup Materials on your High Poly For an ID Mask. This allows for easy paint masking in Substance Painter

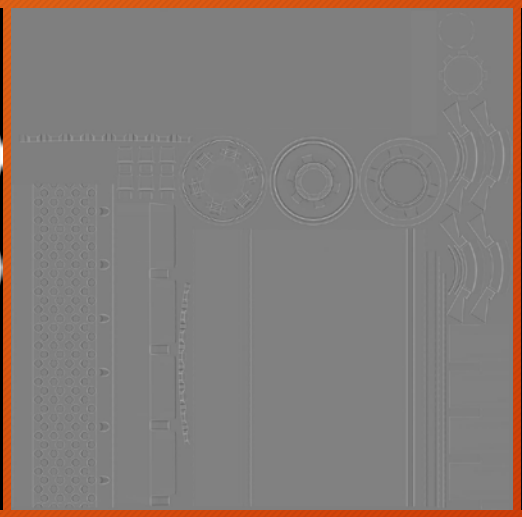




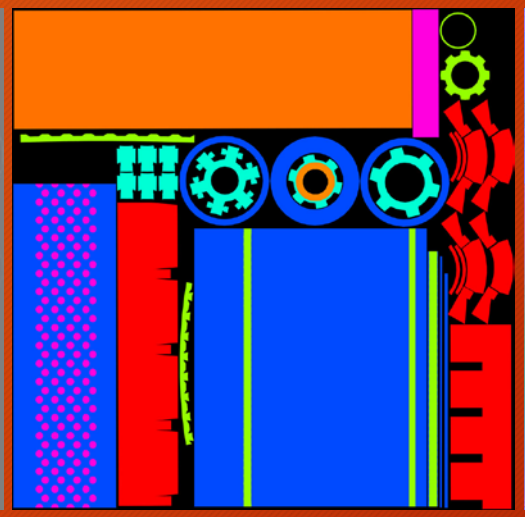
Baking Out Supporting Maps to use in Substance Painter



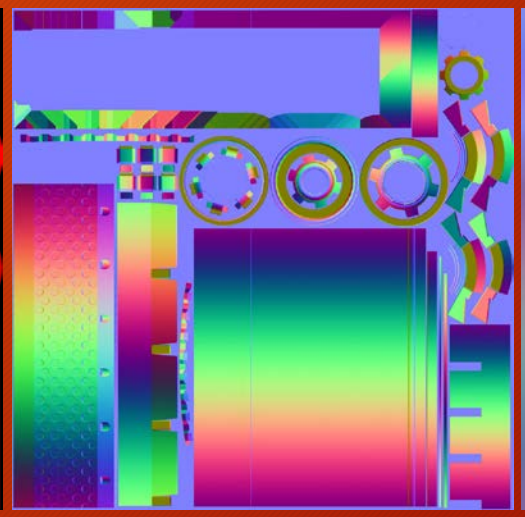
Ambient Occlusion (AO)



Curvature



Color ID

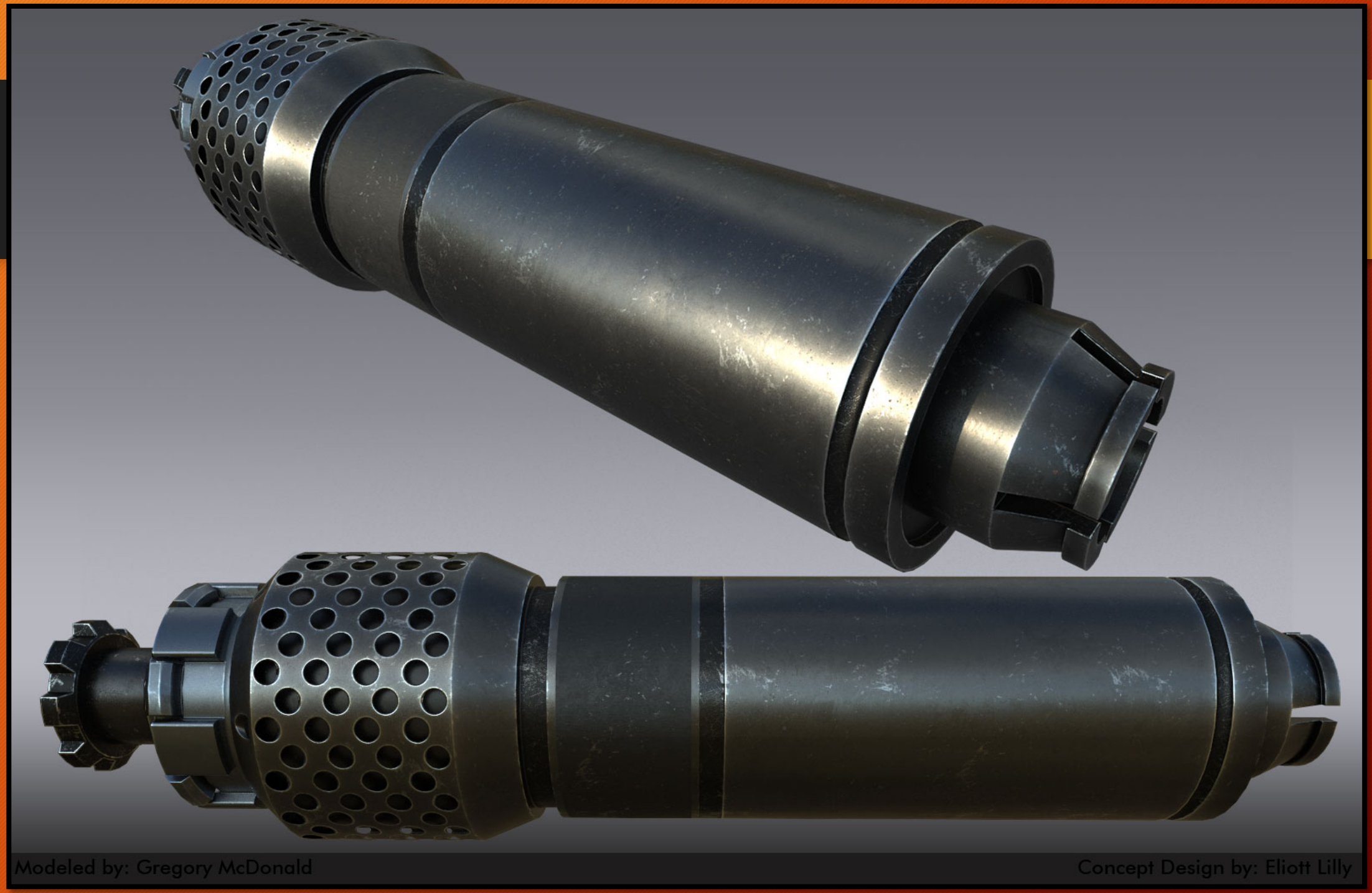


World Space Normal

Position

Final Substance Painter texture

This took 5 minutes to texture



Modeled by: Gregory McDonald

Concept Design by: Eliott Lilly

Thank You For Your Time

- Any Questions?
- Feel free to visit my website at http://www.mcgergs.com
- My Facebook page http://www.facebook.com/artofgregorymcdonald
- I have a tutorial coming out soon on Mastering hard Surface Modeling!
- Keep and eye out for it on Gumroad.com.