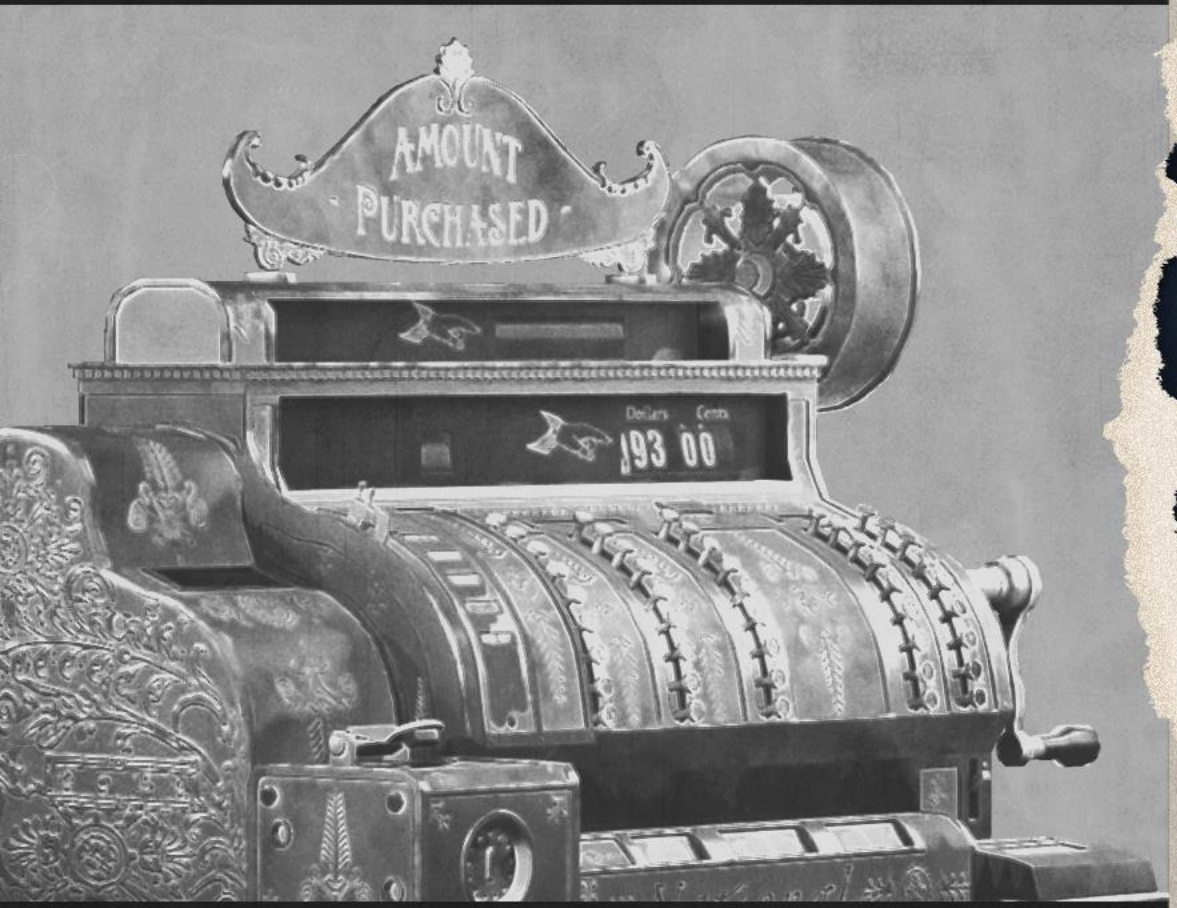
# Hero Prop Diorama

CLASS 542
National
CASH REGISTERS

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UNIVERSITY OF STAFFORDSHIRE

BY KIERON RUTTER

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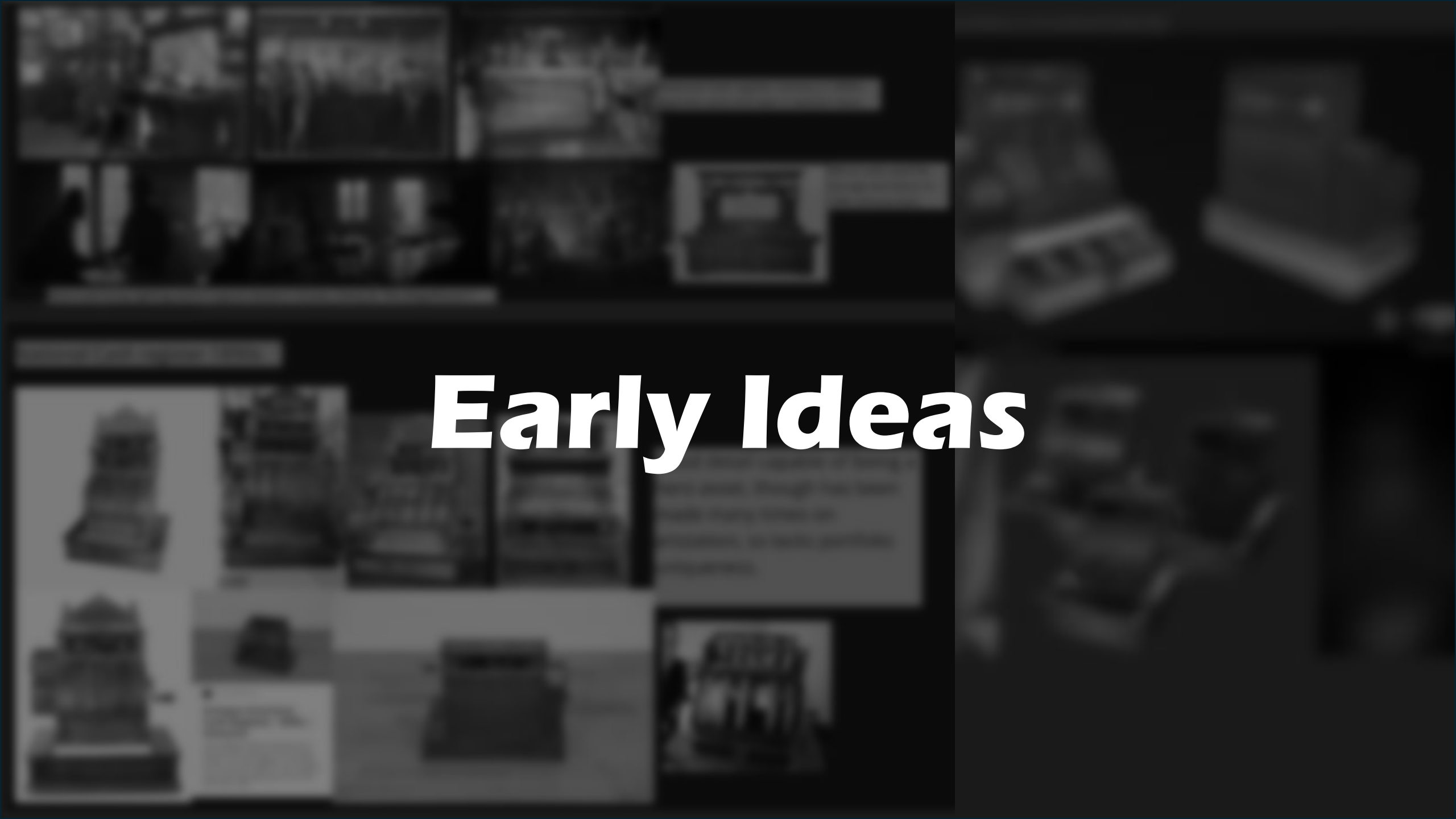
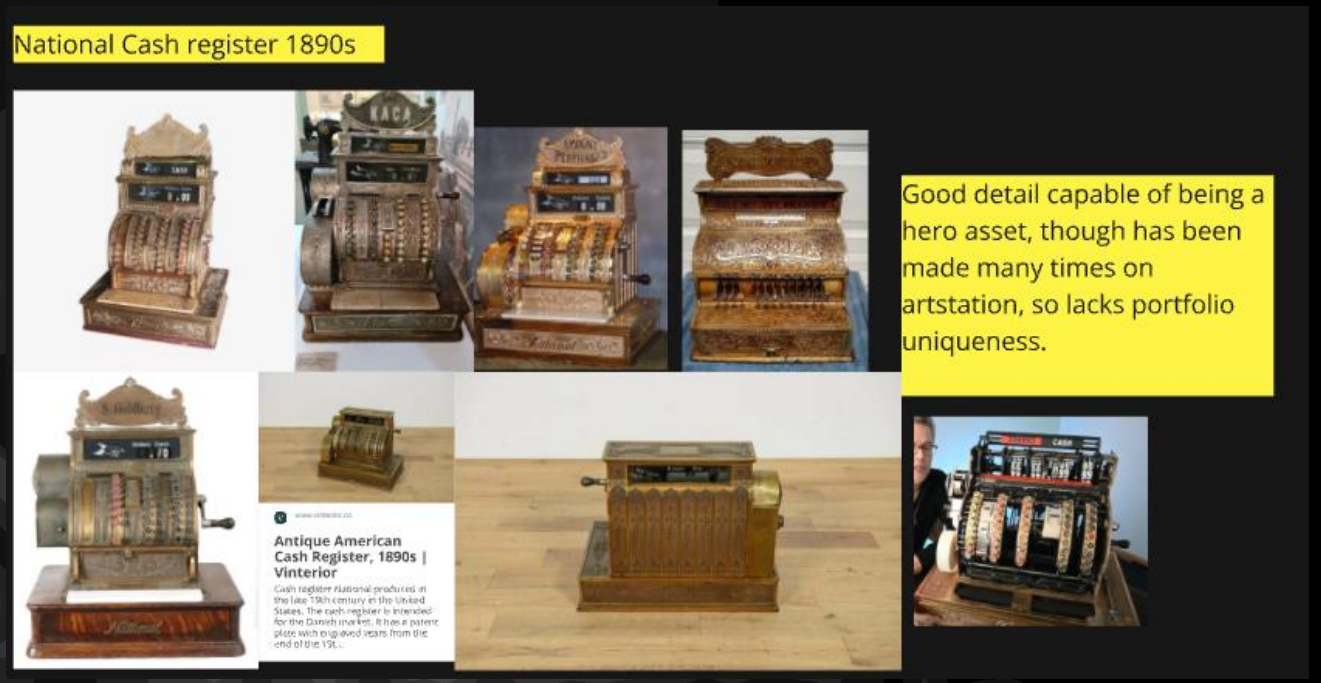


# Early Ideas

When starting the project, I began looking for cash registers within the NCR manual registers during the 1890s as I found these to provide a decent amount of detail to challenge and push my skills further in a mixture of hard surface and high poly modelling.





For early environments I imagined the scene to look dimly lit and dusky, since most NCR cash registers were from the18th century and were commonly found in western scenery via real world images, and movies/media.

Though during the research ideas were shifted towards a more unique design of NCR register as many people had already modelled them on art station and thus wouldn't provide my portfolio any uniqueness, as can be seen from the game research I undertook. Furthermore, I felt that the texture work on the prop would need to be more unique rather than brand new so I began to look for more worn/heavy use types of models in the NCR range.

# Initial Research

# Initial Research

Once the early idea was realized, I began to shift my focus to the NCR model 542, due to its more unique shape and colour variations that would stand out from other art.

The main reason I went for this model over the other variation of cash register was due to make my work stand out among other portfolios. As it provided a more unique shape. This along with the environment will help push the visual identity of the piece.

As the main idea was decided I began to look at environments that were better lit, like sweet shops, as this would allow me to better showcase the hero prop and gave me more ideas for diorama settings and assets. One key inspiration was the opening scene to Charlie and the chocolate factory due to its warmth and variety of colours to draw the eye.

## Real-world environment research

Further developing on the chocolate factory idea, I began to look at real world examples during the rationing period of 1940s to see the realistic composition of scenes in that time. As well as see where light would typically come from in vintage sweet shops.







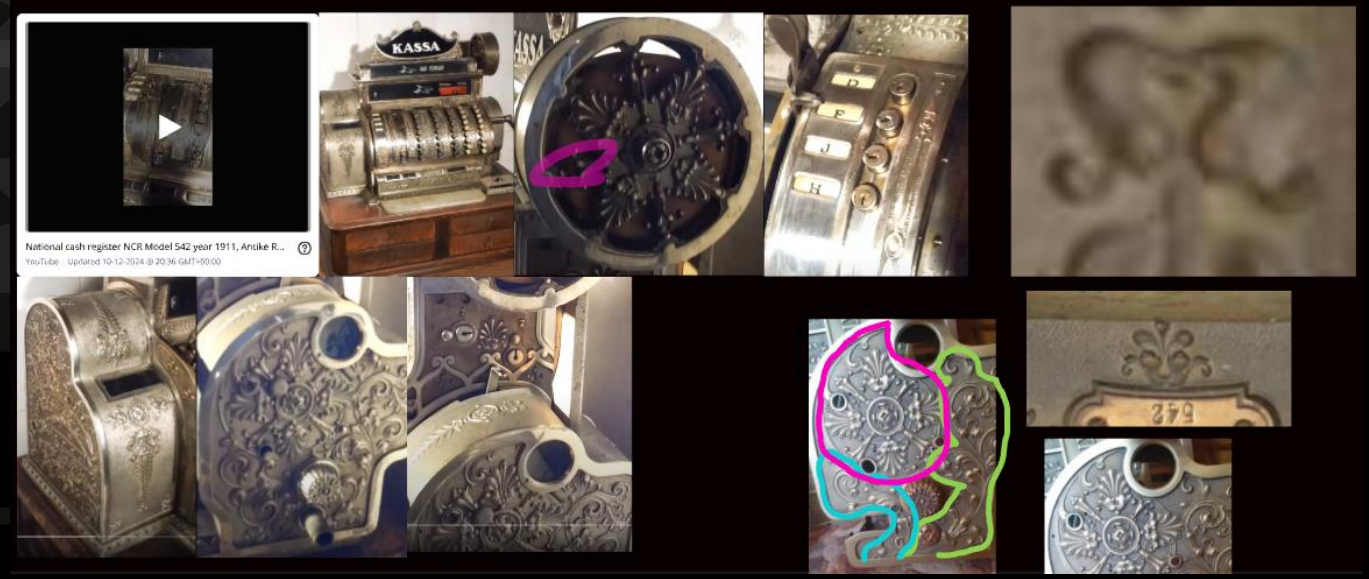



# Main Asset Research

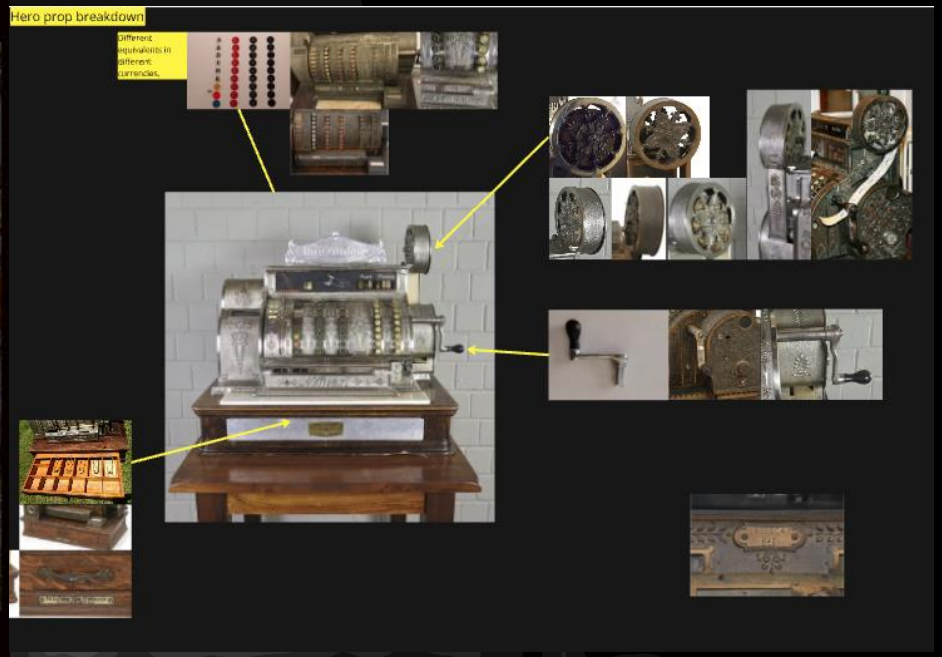
More development of the main idea was undertaken as well finding more variations of the Model 542, using primarily video references and auction sites. I would have tried to do primary research on this however the machines are very expensive and rare to come across now.


This was the main reference I ended up using to create the model, due to how well aged the bronze was on the asset helping promote the idea of a heavily used asset, as well as due to the small changes between each model as this type came with many additional accessories.

Other references were also used to tried and identify some of the ornamental patterns that weren't visible from the main reference, as well as break down further geometry/pieces to how the prop would have been used.

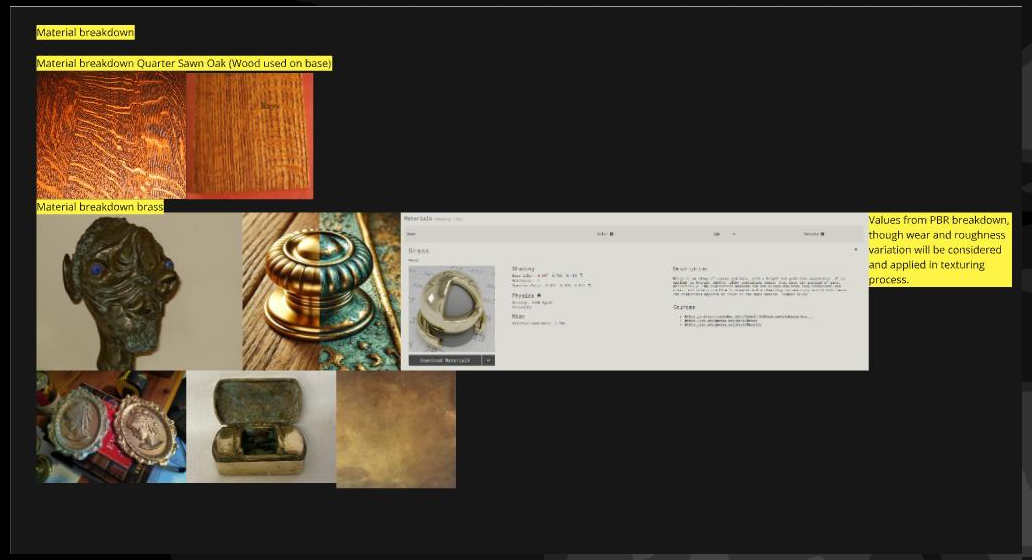


# Additional Initial Research

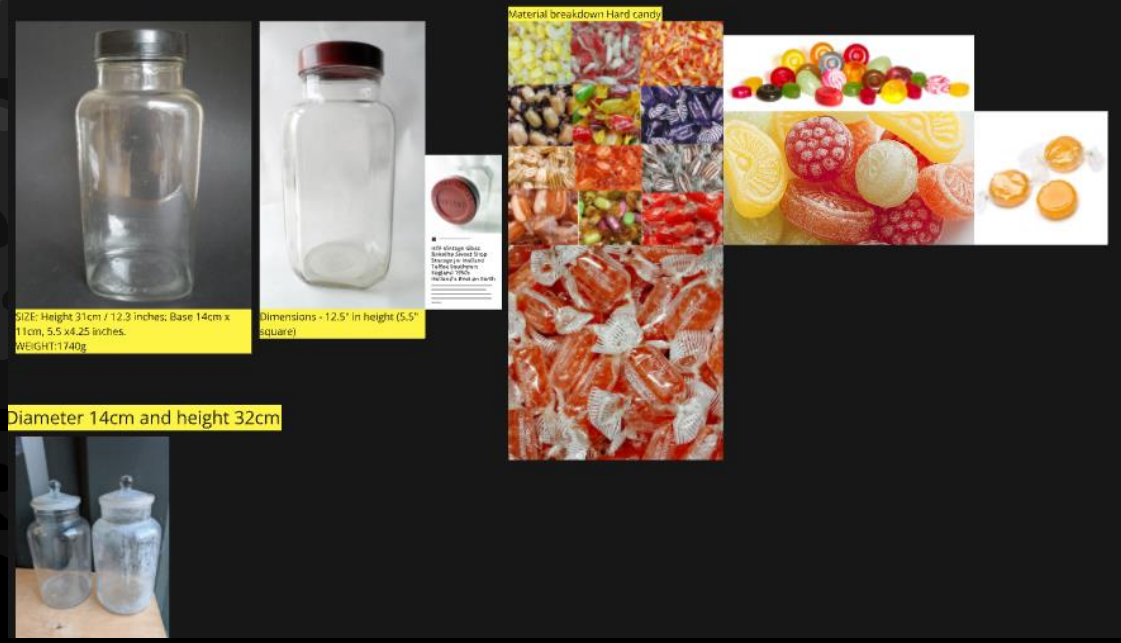

Prop Breakdown using several image gatherings.

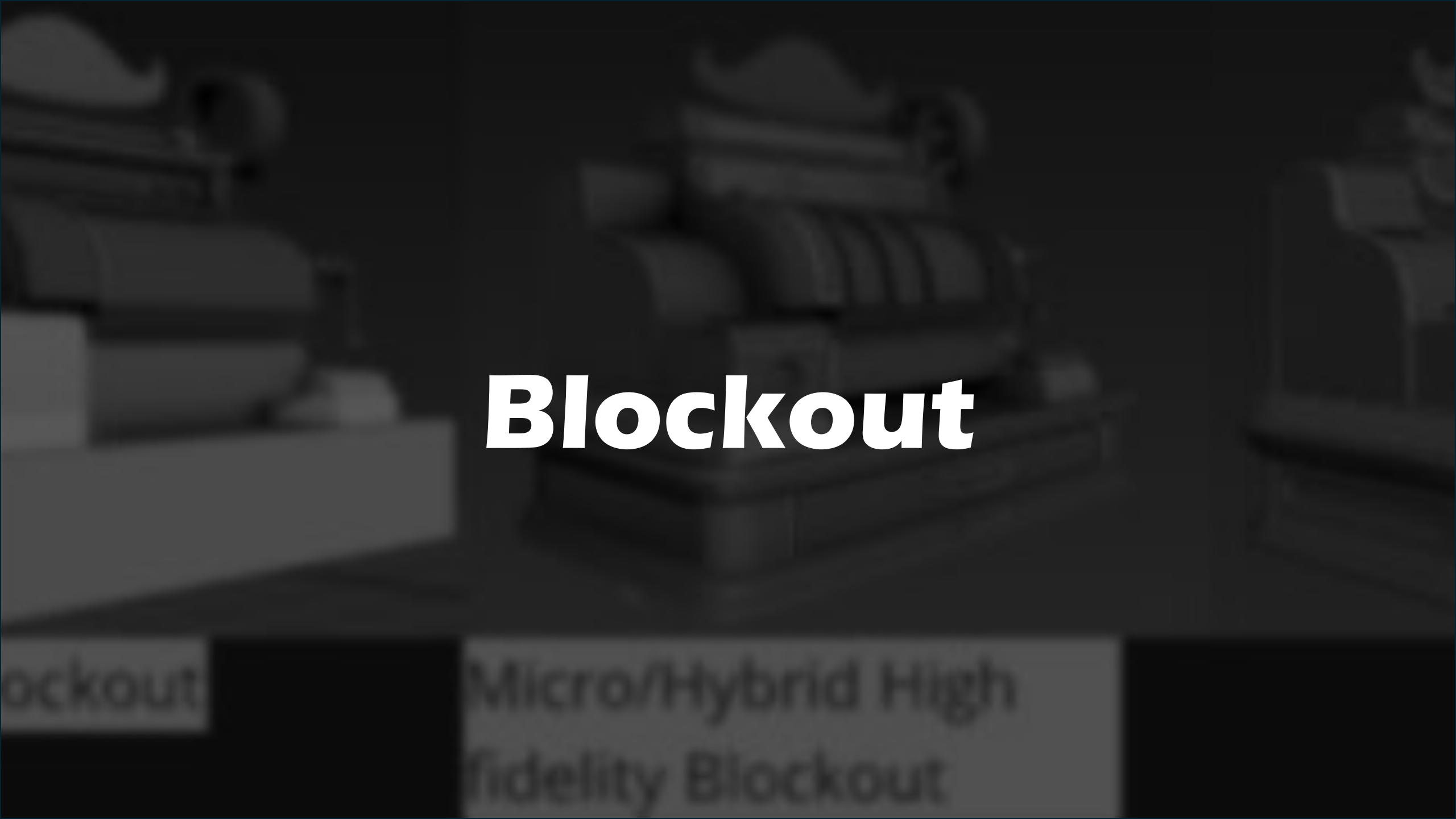
# Material and Background asset research




Alongside the main diorama research, some simple material research was conducted to understand how to tackle the brass-wearing texture of the asset itself and its variety of roughness.

Finally some research was done on some of the background assets that were going to be made for the diorama, including vintage sweet jars and sweet types.

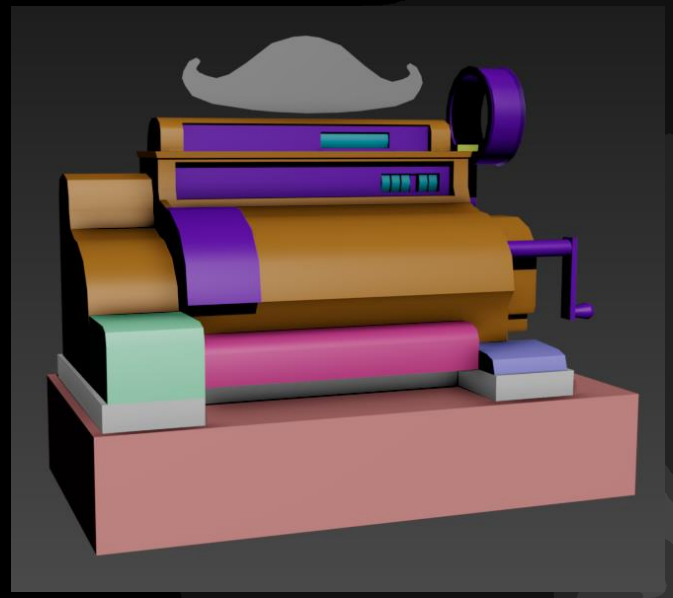


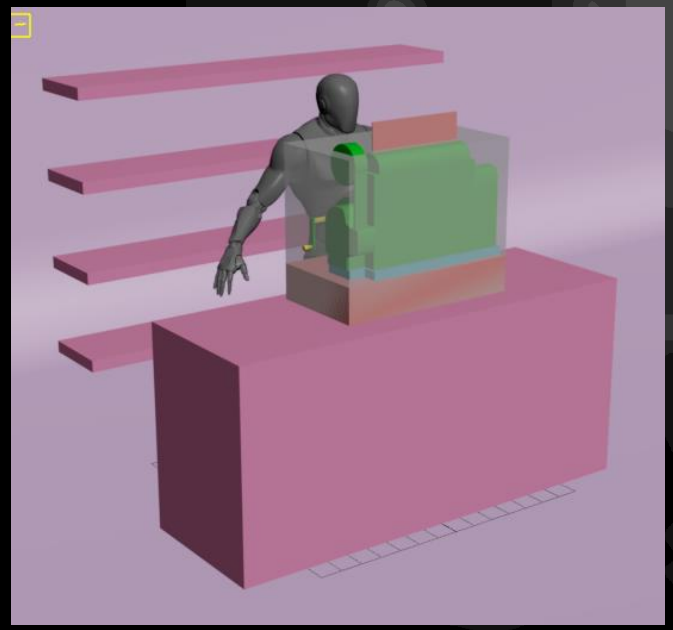

Blockout
ockout
Micro/Hybrid High
fidelity Blockout

## Micro Blockout breakdown

Before starting the blockout I made a simple breakdown of the different parts of the prop, as this would help me define which areas would be modelled in different stages of the blockout.


# Micro Blockout





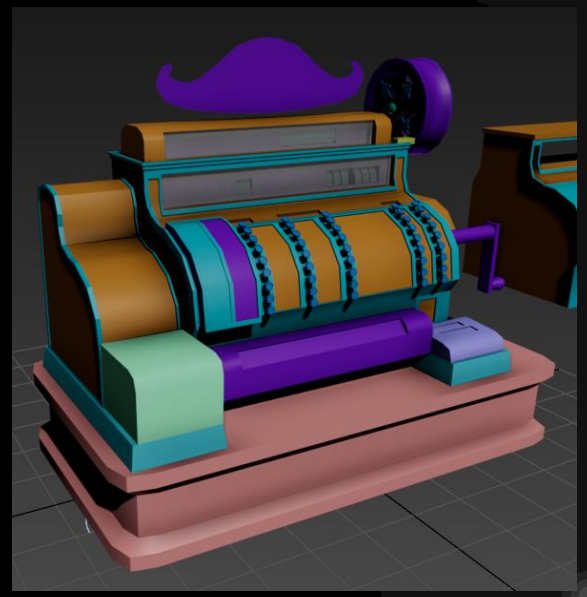
To start modelling the blockout I began with focusing on basics and scale, utilizing the researched measurements of class 542.

Box modelling was used for most of the model, and some plane modelling was used for the signs, as well as using symmetry.

Initially, I started making a default background setup within 3dsmax to get an idea for the scene but this was soon scrapped due to the fact UE5 would handle this better and would be more effective.

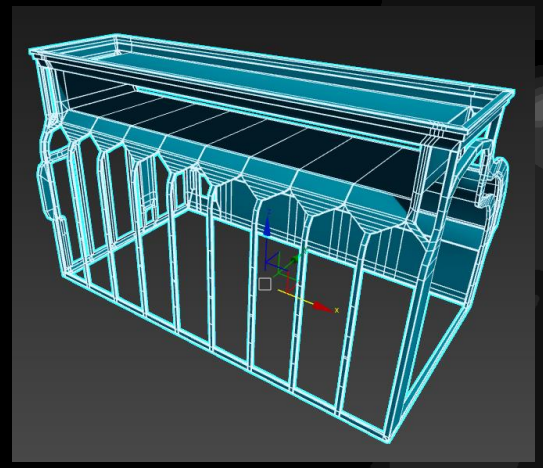
(Grey box was used as a base measurement from research to keep the model within its bounds.

# Macro/Hybrid Blockout development 1

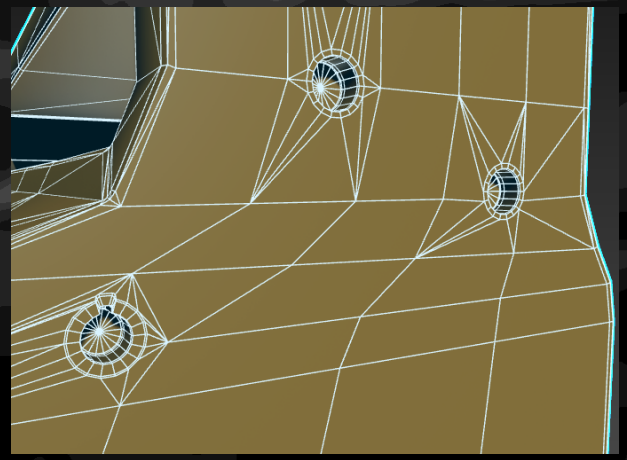


Since the modelling stage mostly skipped the macro area due to the model itself using a large number of primitive shapes.

For the trim modelling specifically, I first used extrude and detaching modelling, via the edit poly, but later found a more efficient non-destructive method using spline tools to generate topology along vertices.

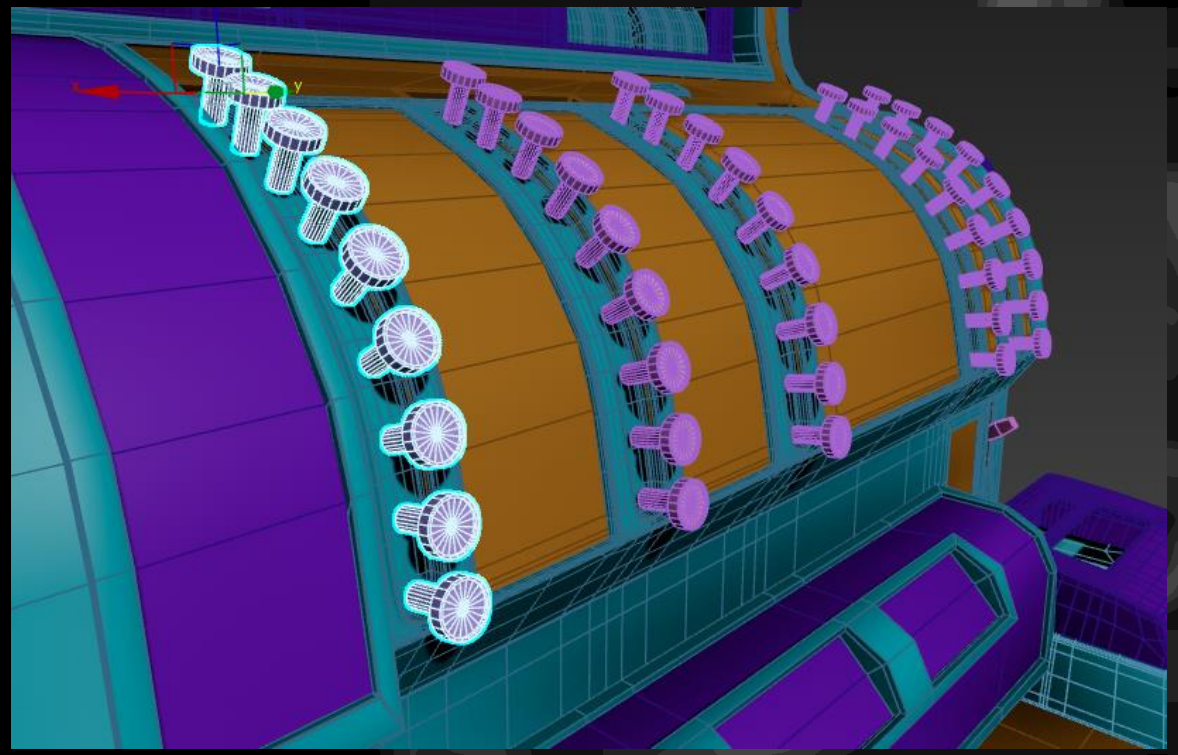


However, the main trim did still use extrusions due to its unique shape compared to the rest of the trim models.



Another technique was Boolean, mainly for inserting holes, and then tri fanning was used to reduce polycount whilst maintaining shape.

# Macro/Hybrid Blockout development 2



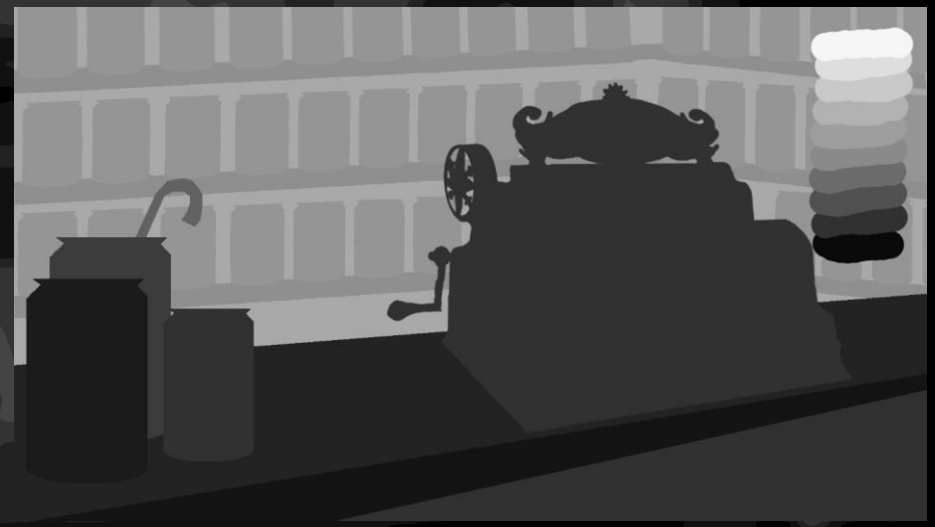
As for modelling the buttons, this was done using an array modifier alongside a high interpolated spline following the initial curve of the main trim, due to how the array works this was then converted to an edit poly and instanced along the row to make the workflow more efficient in the unwrapping stage.

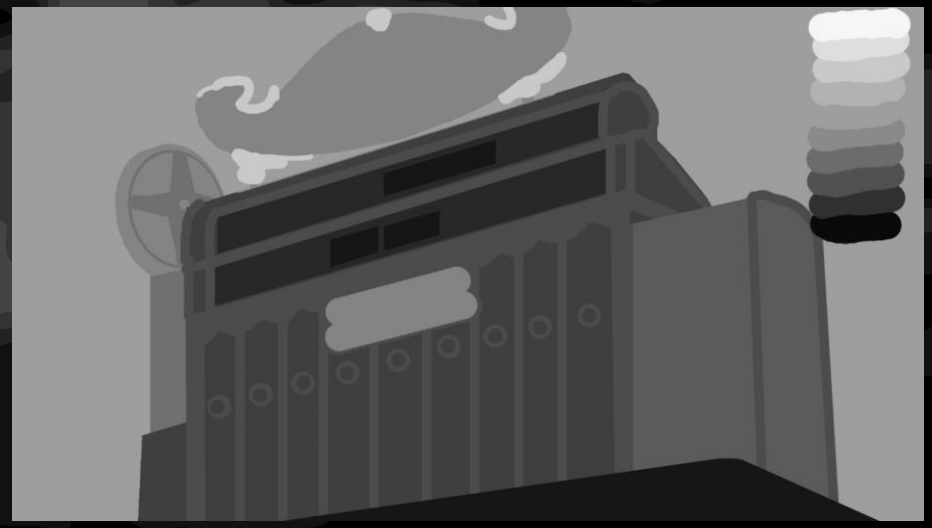
The hybrid also had to be made capable of turbosmoothing, adding edge loops to help support that modifier.


Value Paints/Lighting
MK1

# Value Painting

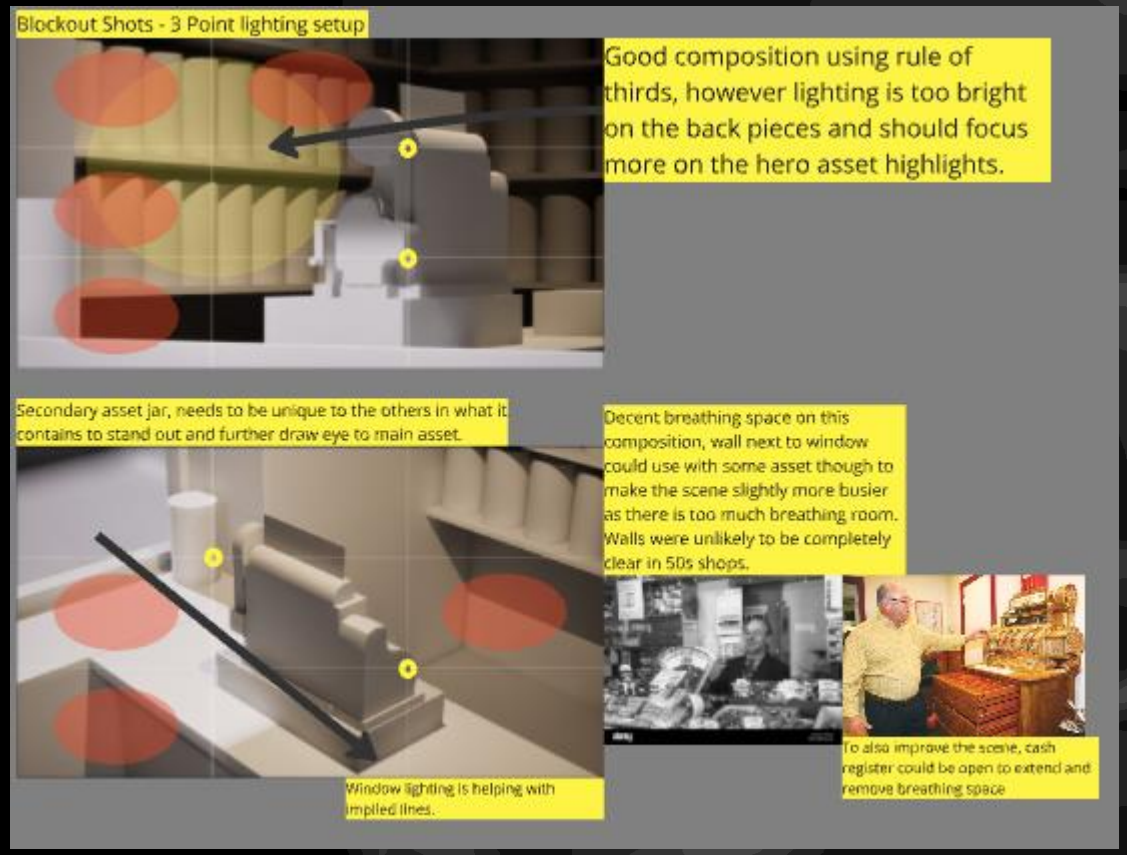
Before creating the first lighting setup I was tasked with making some value paintings to help better my understanding of form and importance in a scene, this was done using photoshop and basic values to help organise some compositional shots.

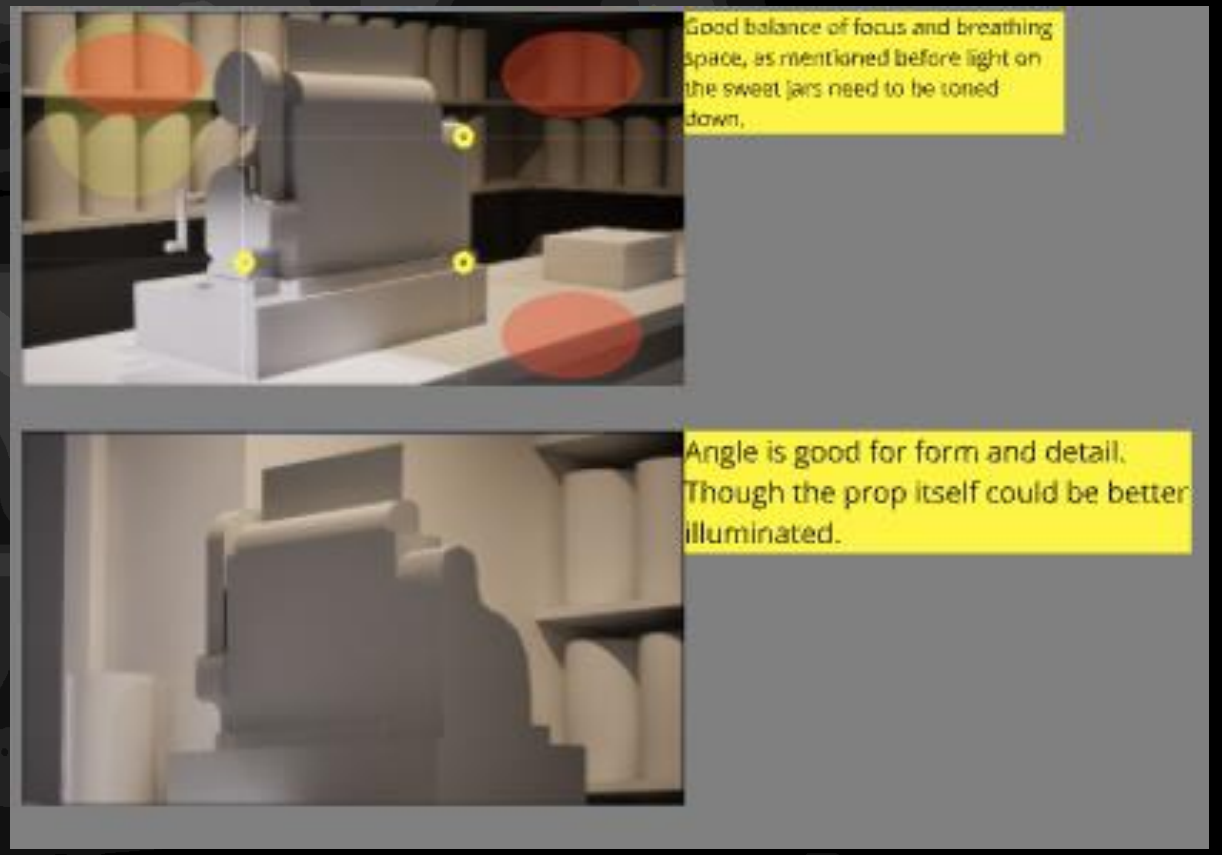




# Lighting MK1

After creating the value paints, I began making the ue5 lighting setups using the micro model (at the time the hybrid wasn't complete), using mainly 3 point lighting and my value paints as a reference to look back on.



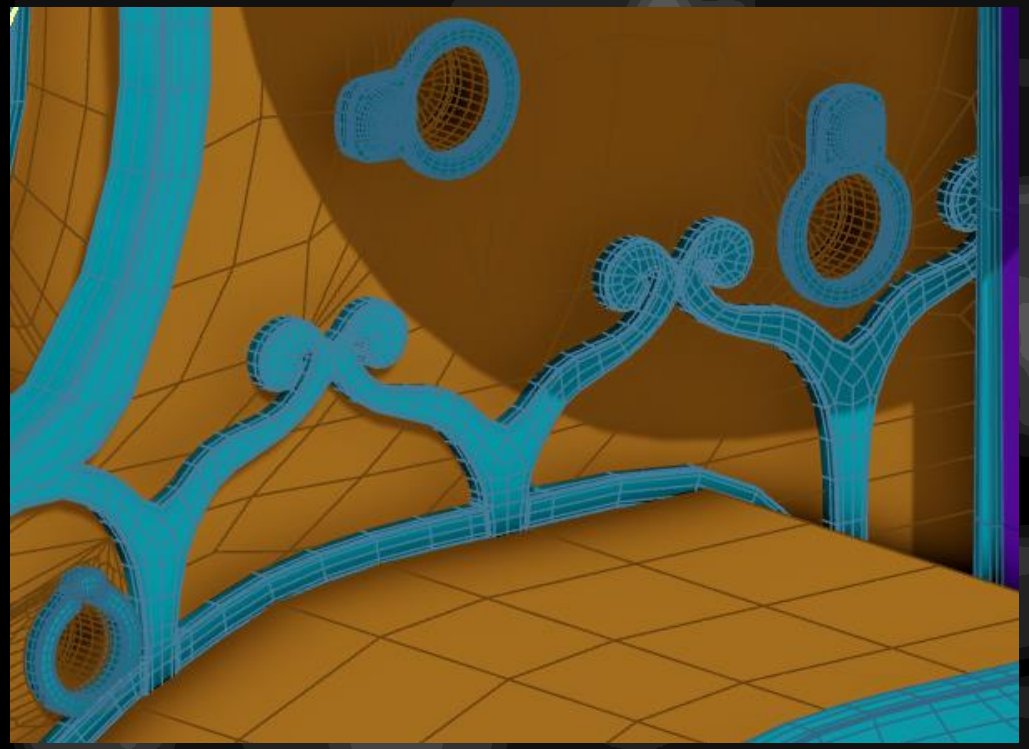

The main Idea I wanted to go with was to have some natural light pooling through the window as I felt this would be a good natural implied line.

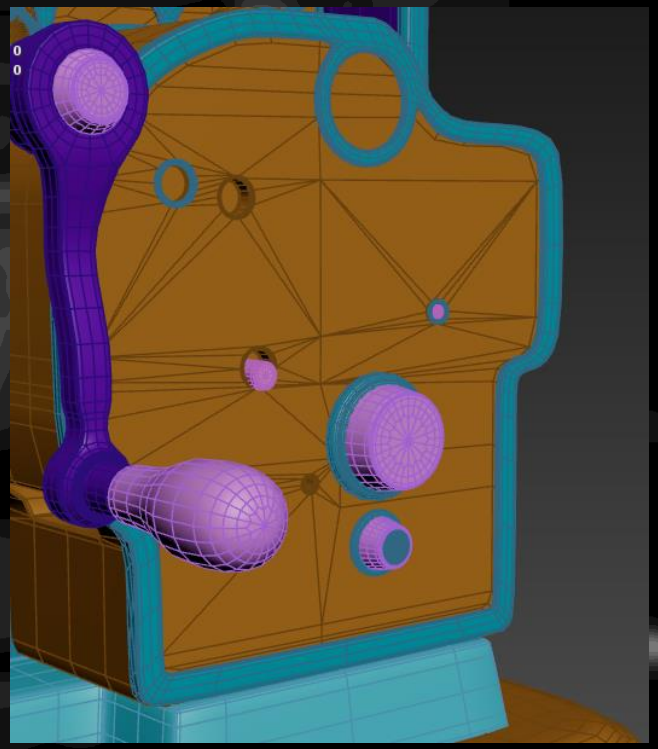
I later found this needed to be iterated due to the sheer amount of extra background assets that would need to be modelled.


Turbosmoothing & LODS

## Turbosmoothing

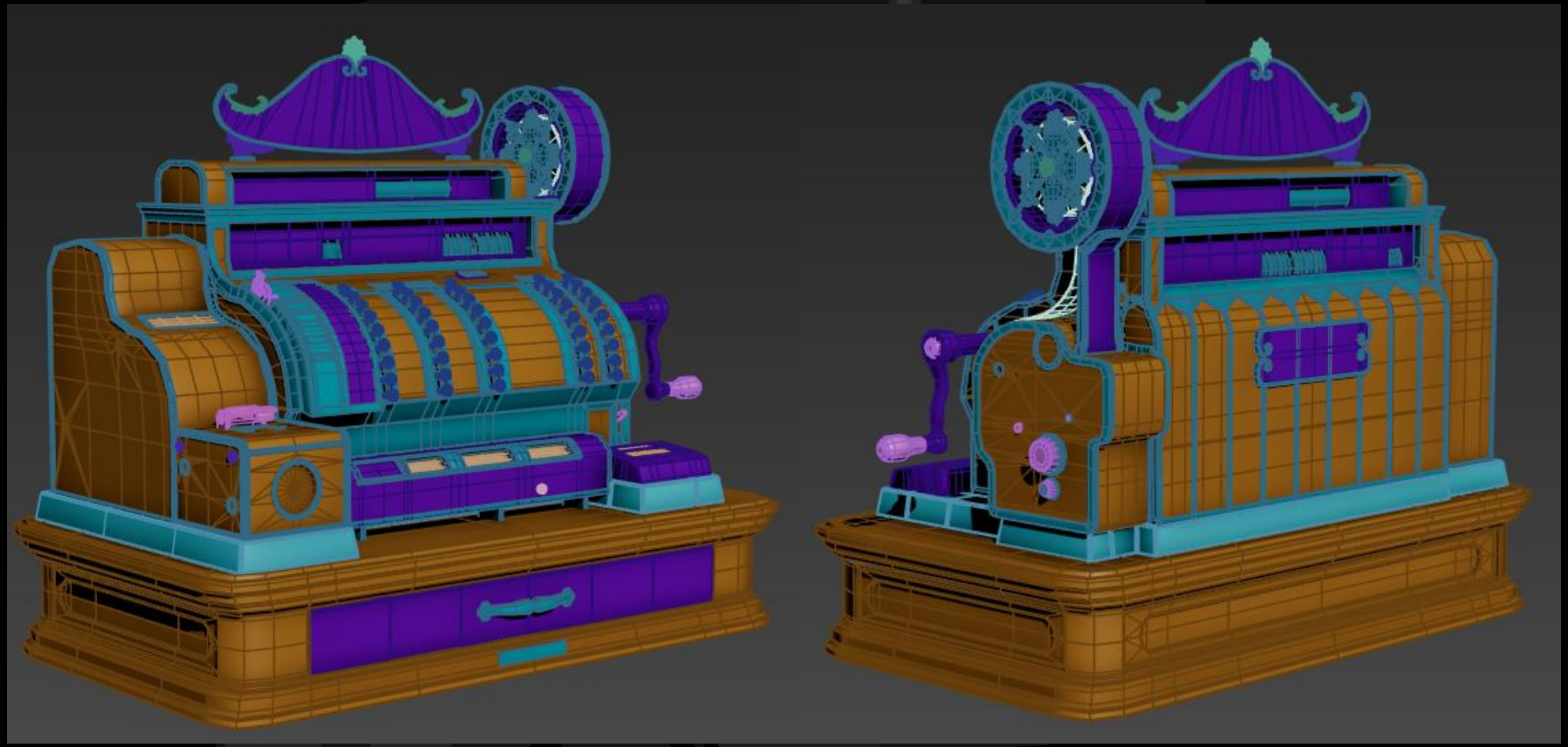
Once the main hybrid had been modelled I began working on making a turbosmooth variant of it, which required me to add edge loops using chamfer modifiers or swift looping as mentioned before. This significantly increased the polycount but made the model more capable of being imported and sculpted in zbrush during the high poly.





The main reason I worked this way was to be non destructive during the retopology phase, having a mid poly setup to maintain the silhouette alongside the highpoly.

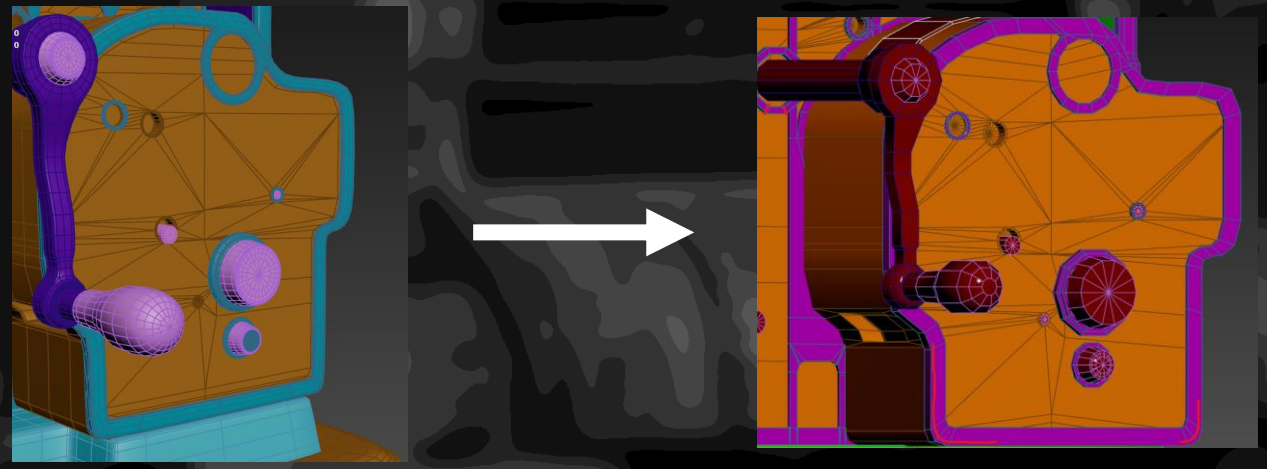
# Turbosmoothing

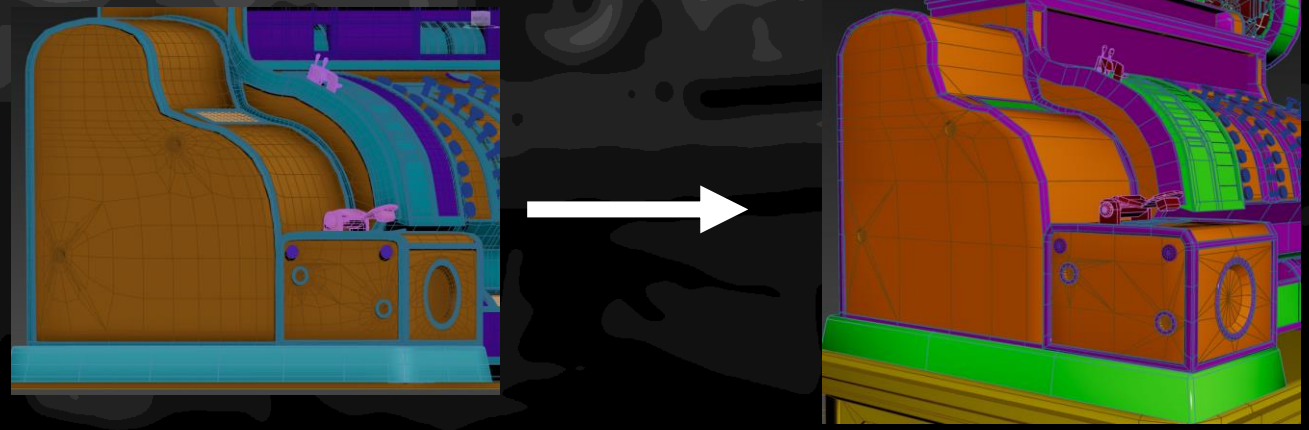


Total
Polys: 544,610
Verts: 277,083

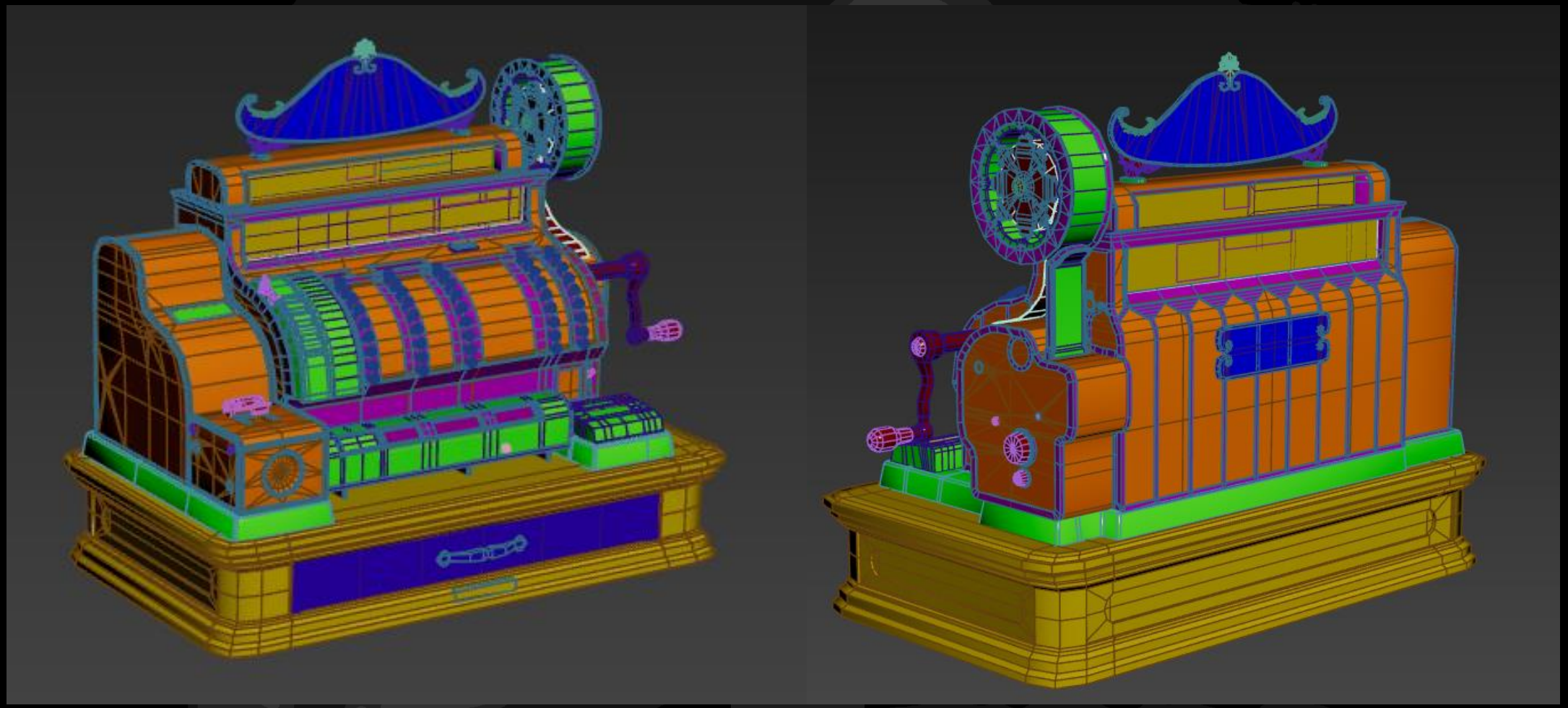
## Retopology

Now the turbosmooth was done the next step to work on was the retopology phase, this was done by using the mid poly and removing most of the edge loops present, as well as removing loops in radial areas that didn't need them to maintain the silhouette.





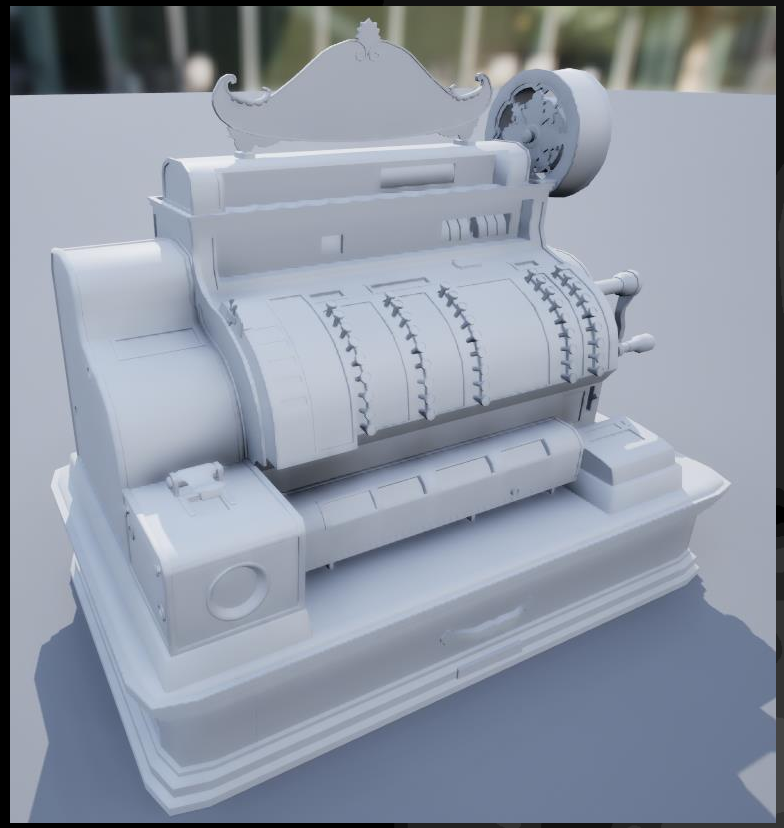
# Retopology



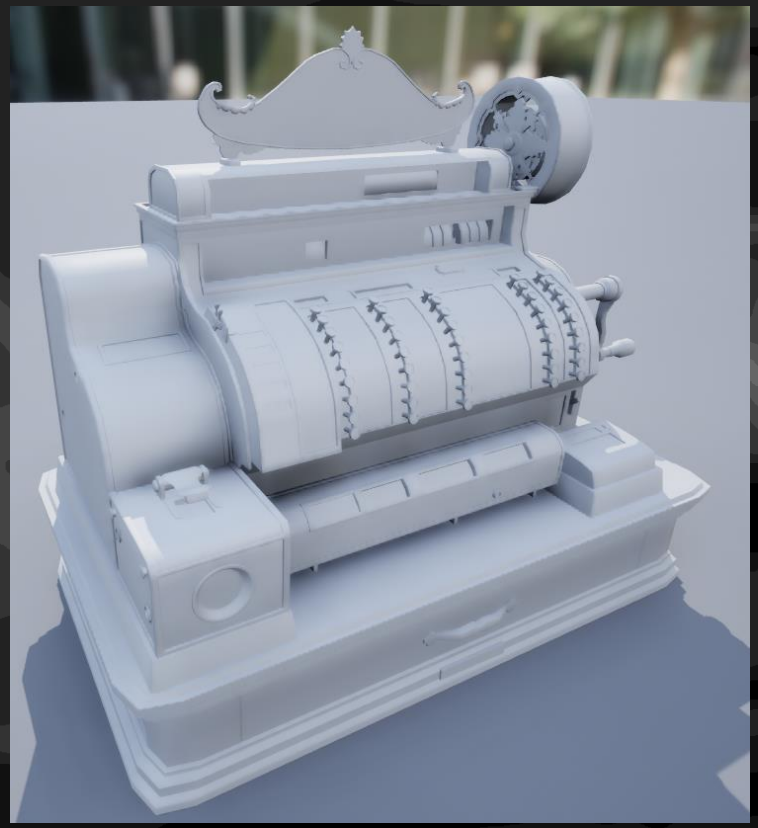
Total
Polys: 24,690
Verts: 26,062

## Manual LODs Experimenting

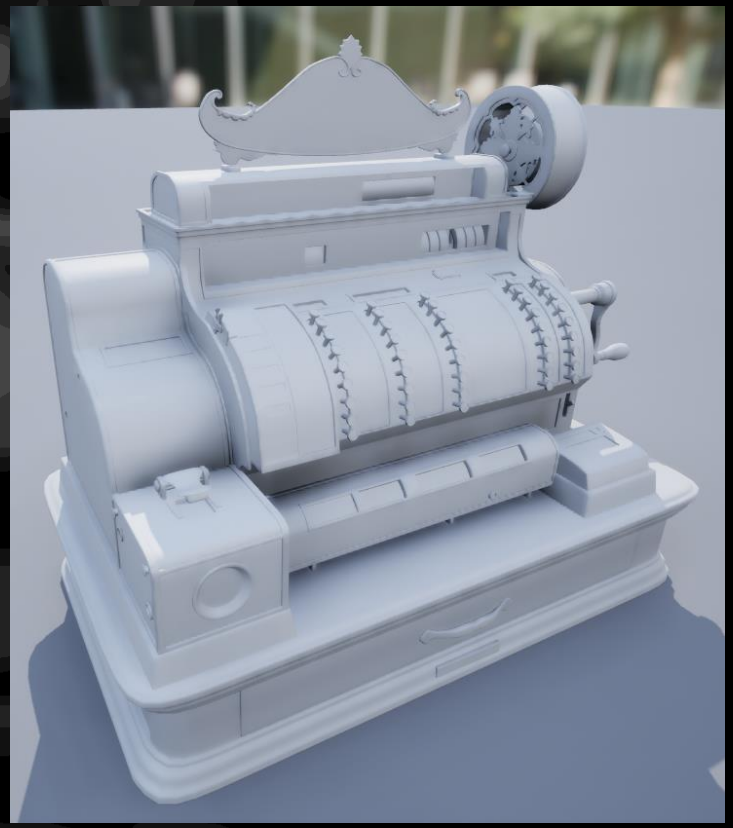
Though this part didn’t make it into the final model, LOD importing and experimenting was made using the retop, high poly and mid poly assets in unreal engine 5, allowing the model to render and change form depending on the distance the camera was.



LOD 2



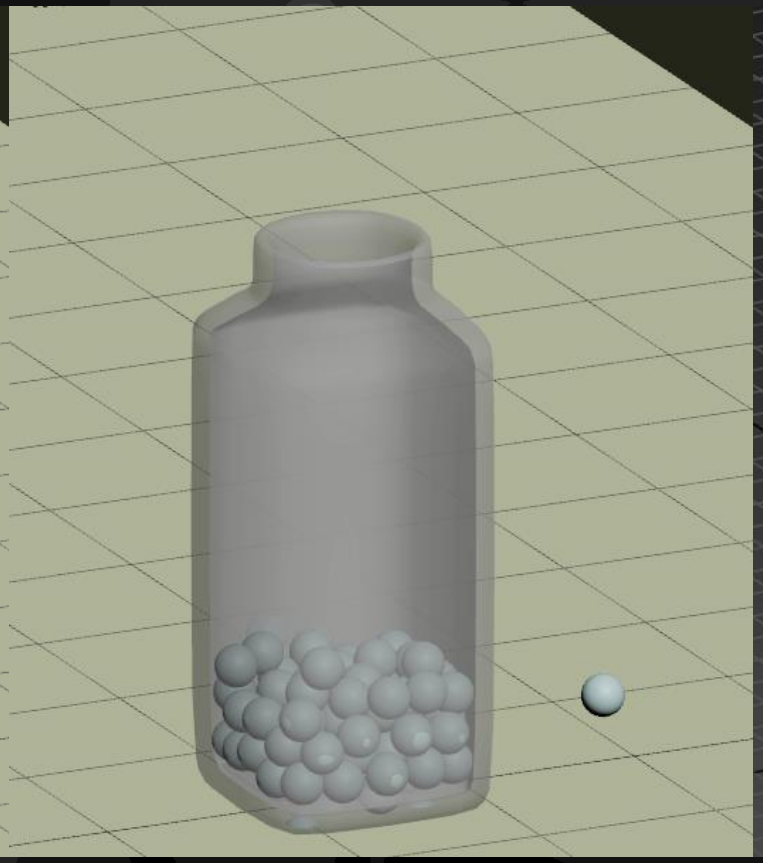
LOD 1

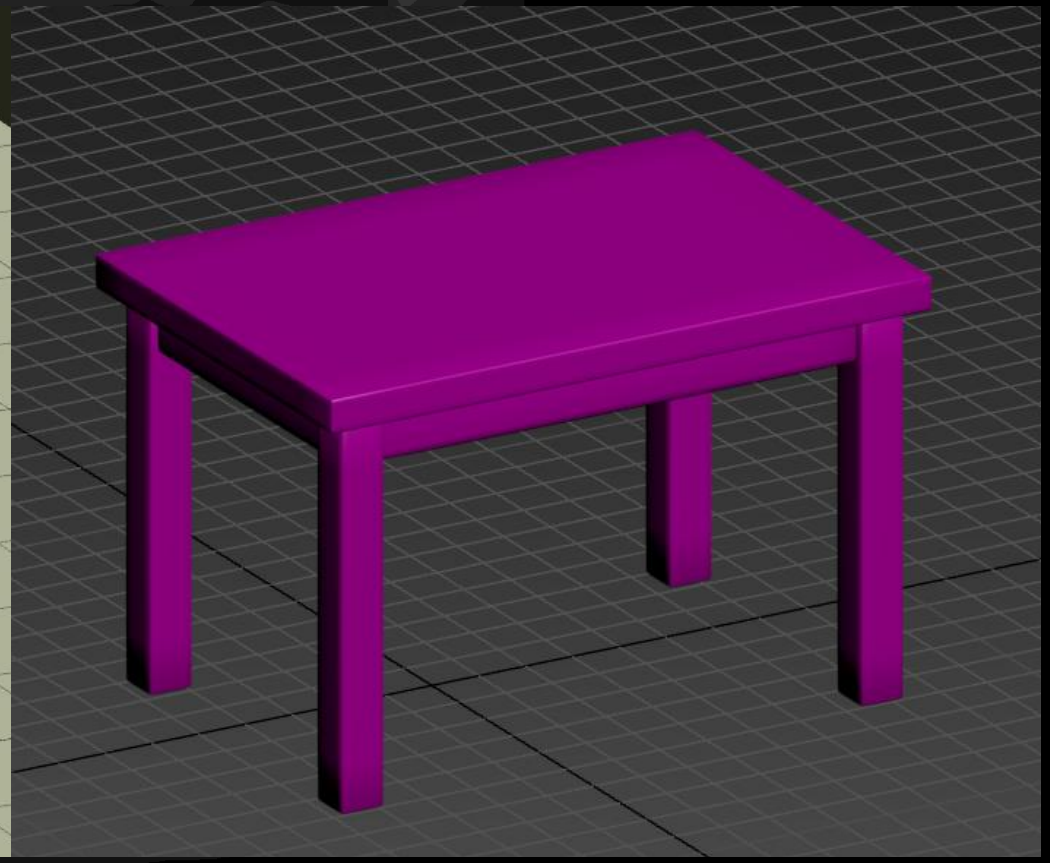


LOD 0

## Background asset modelling

For the background assets I mainly used turbosmoothed variants of the model due to needing to capture the nice curvature of the glass in texturing, as well as using 3dsmax's MassFX, allowing me to simulate physics and fill the jars with various objects, which was far more efficient than manually placing them by hand. Each object was instanced for easier unwrapping.



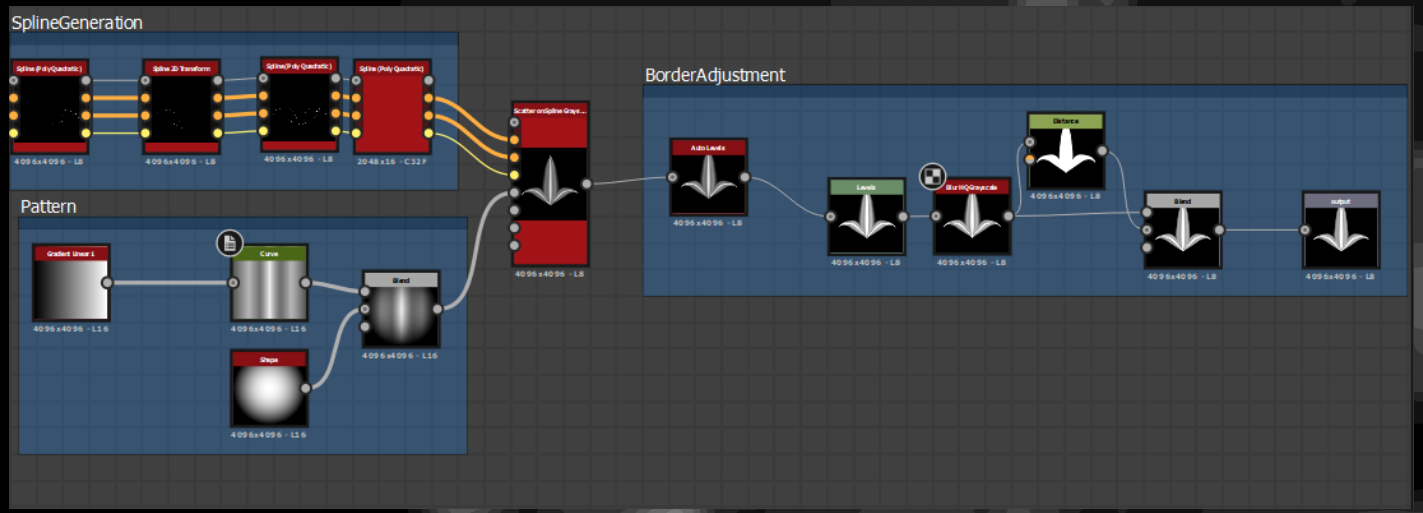


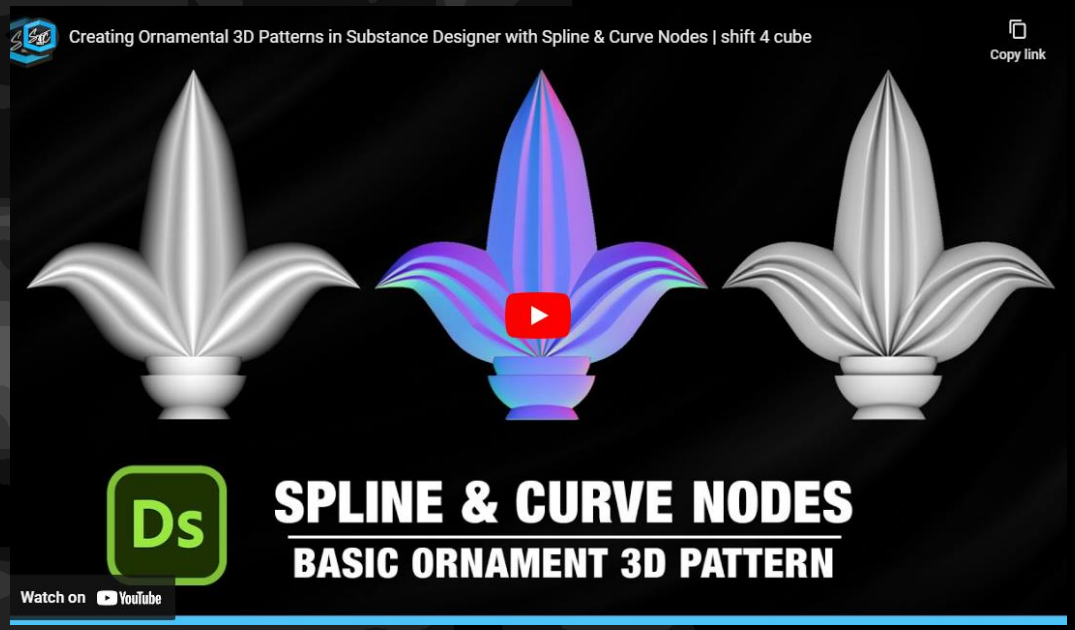
Cleanup for any clipping objects was then undertaken, as for the table asset, this was basically primitive turbosmoothed cubes.

# High poly & Substance Designer

# High Poly 1

To start the high poly, I began with creating an alpha library since the model used a large amount of ornamental designs, this was done through 4k alphas made using splines in substance designer.



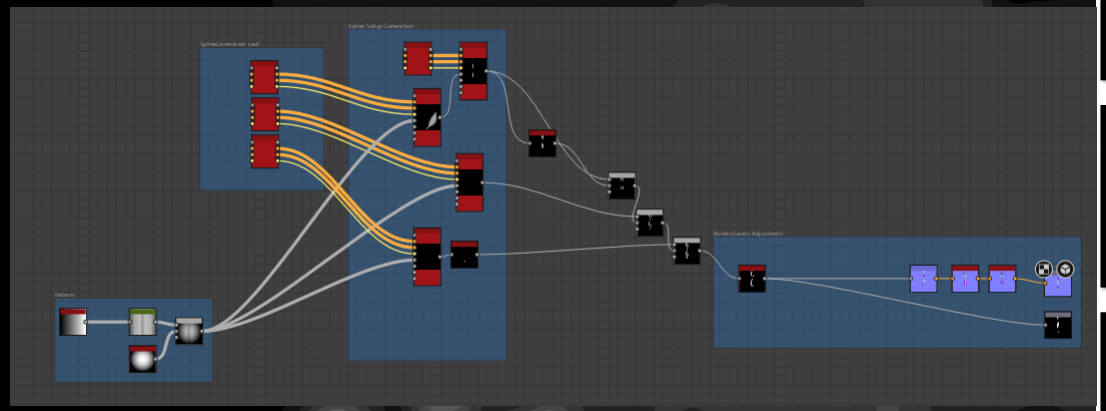



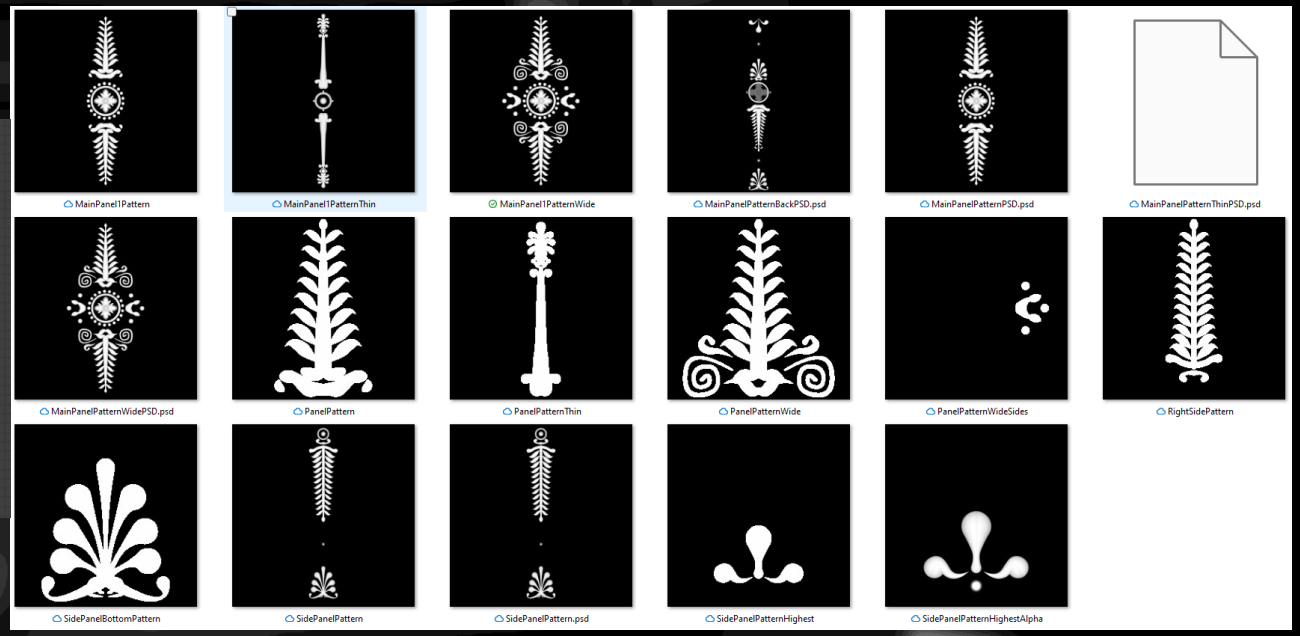

https://youtu.be/L5J2GFmbUfk

Initially I followed a tutorial on the basics of spline alpha making and then modified them to better suit my project.

# High Poly 2 – Substance Designer/photoshop

Building upon the original tutorial I began creating many alpha library's for each pattern in my project, sometimes photoshop was used to create and compose some larger 8k alphas to help get the measurements and layouts executed correctly within zbrush.






These were mainly done using the scatter on spline node alongside a spline path and a custom shape to make the slight indentation gradient.

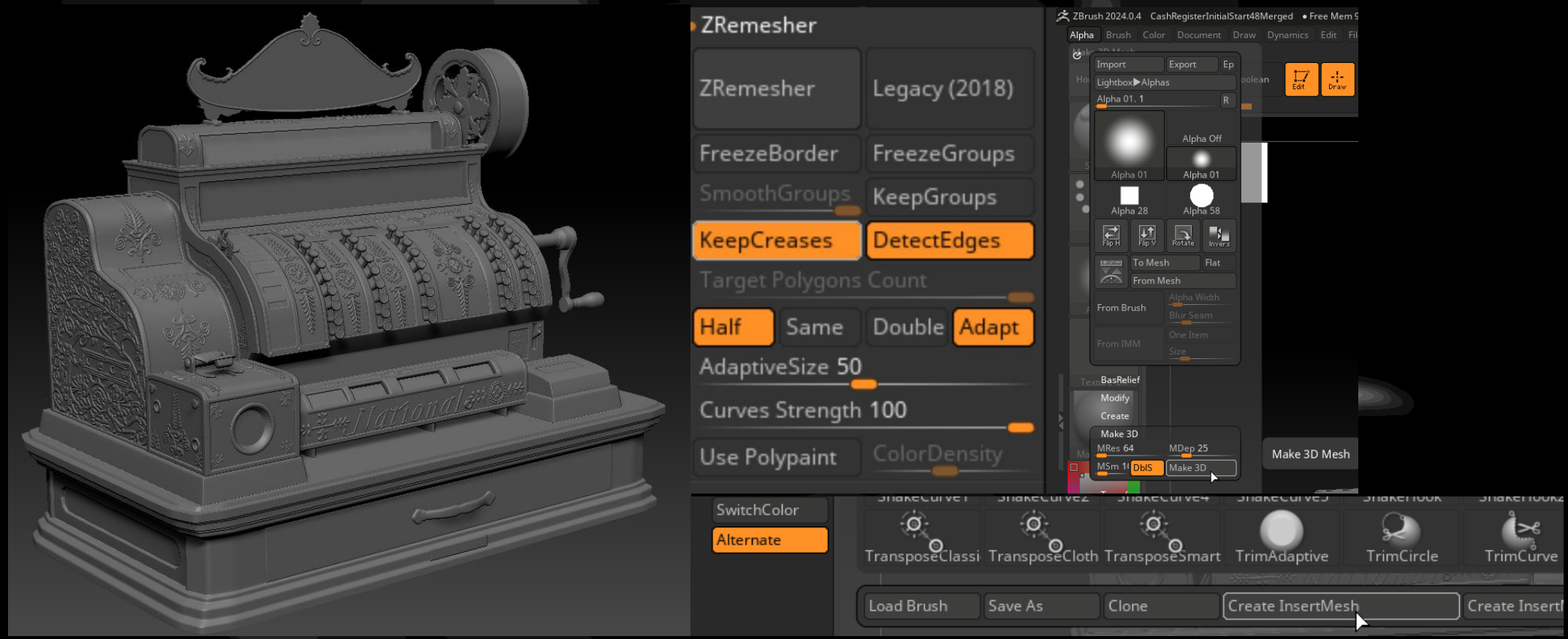
## High Poly 3 – Substance Sampler

For some of the larger patterns visible in the model, this was done using a combination of substance sampler and photoshop. Sampler was used to extract height data from some references I had gathered and photoshop was used to fine tune and edit the values to better suit alpha purposes.

# High Poly 4 – Substance Sampler

Once the alphas were made, they were imported into zbrush using the Make3D button, and then zremeshing them to have a lower poly count whilst keeping its shape. The settings used was keep creases and detect edges.

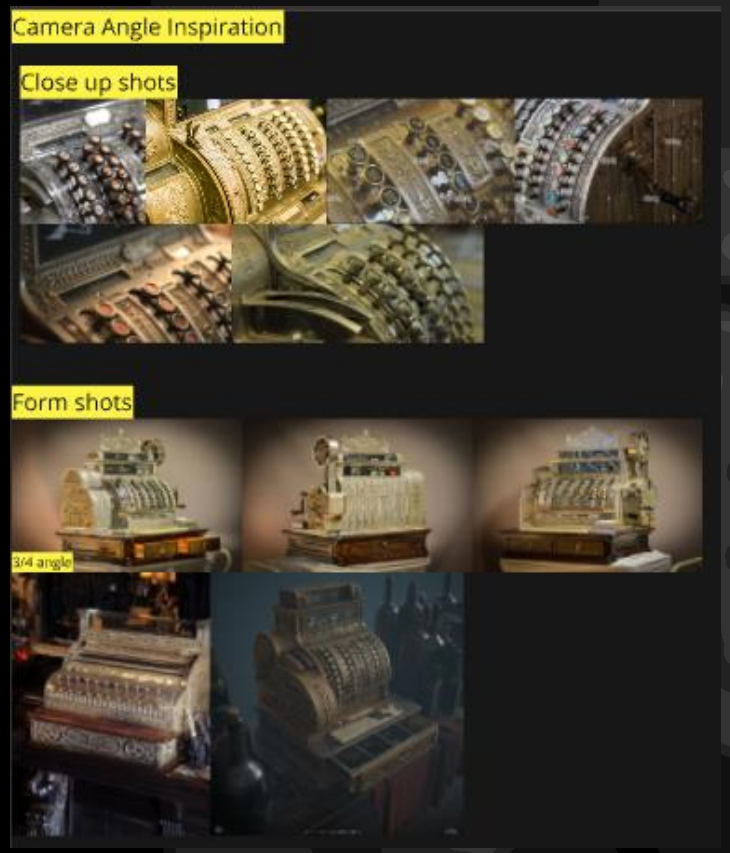
Once the alpha was turned into a 3D object it was then flattened on one side to make the alpha wrap more accurately to the mesh, and then was created into an insert mesh brush to be placed along the mesh where needed, using 100% projection strength.

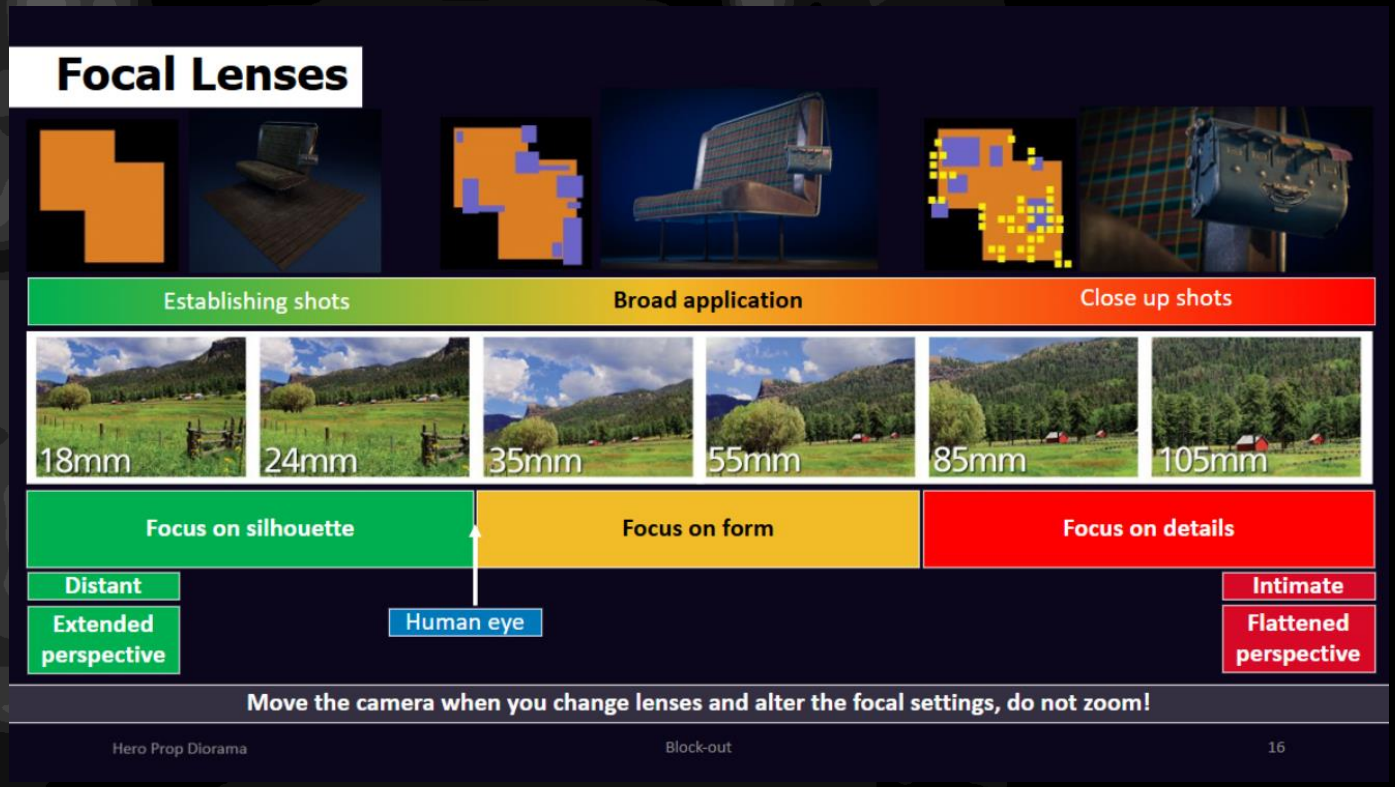



Lighting MK2

# Lighting MK2 – Camera angle research

Following some of the classwork guides to focal distancing, I began to gather camera angles inspiration based on different shots.

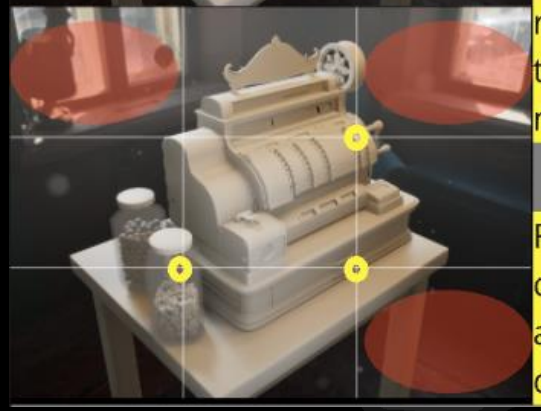


# Lighting MK2 – Variation 1

After getting the main model done, I went back into ue5 to revise my lighting and composition with the main goal of reducing the amount of background assets needed, this was done using a HDRI found on polyhaven: https://polyhaven.com/a/photo_studio_loft_hall to help fill the background scene. Atmospheric fog was also used to help sell a dusty effect in the scene, along with a Niagara floating particle system to try and sell the imitation of dust.

Silhouette shot, showing most of the asset using a focal length of 18mm and a isometric angle to show a more unique silhouette as well as giving enough breathing space in the initial image using rule of thirds.



This shot also used a cropped image ratio of 4:3 to help cut away parts of the HDRI in the background and focus more on the silhouette.

Focal points on the shot mainly focus on the right, with some minor attention to background assets in the diorama piece.

Implied line

Detail shot 1, focussing on the sliding piece of geometry and the buttons in the background, a small area was left blank for breathing space along with a high focal length of 105mm. High focus was used to draw attention to the sliding piece and buttons further away, only showcasing the first row as other would be similar.

This took inspiration from similar cash register photography, as it provides good composition and highlight details on some of the main functions of the machine.

Detail shot 2, using a focal length of 105mm, and a wide squeeze factor to show some of the pattern details buttons and handle pieces all in one shot. Once again, a small amount of background was left to give some breathing room.

# Lighting MK2 – Variation 2, Post feedback

Now the first variation had been done, feedback was given by my lecturer and I acted upon it, changing and adding extra background assets to conform with the rule of thirds. As well as rotating the object itself to make the scene look more unkept and remove obvious parallel lines.

Matthew Feedback for lighting

1. Zoom out on form shot, next to corner
2. add another jar for rule of three.
3. Change depth of field in detail shot to focus more on slider and buttons.
4. Tilt camera slightly left on Handle focus shot and use depth of field to focus on that.
5. Shift table to make parallel lines not appear

Post feedback lighting setup

# Unwrapping

## Unwrapping breakdown

Before starting the unwrap I began by creating a breakdown of the asset and how I would split each UV island.


Main Body UV
Trim UV
External Buttons/Filigree/MISC UV
CashDraw/Base UV
Secondary Body/Screens UV
Signs and UI UV

YC
SH
SP
RE
CY
AR

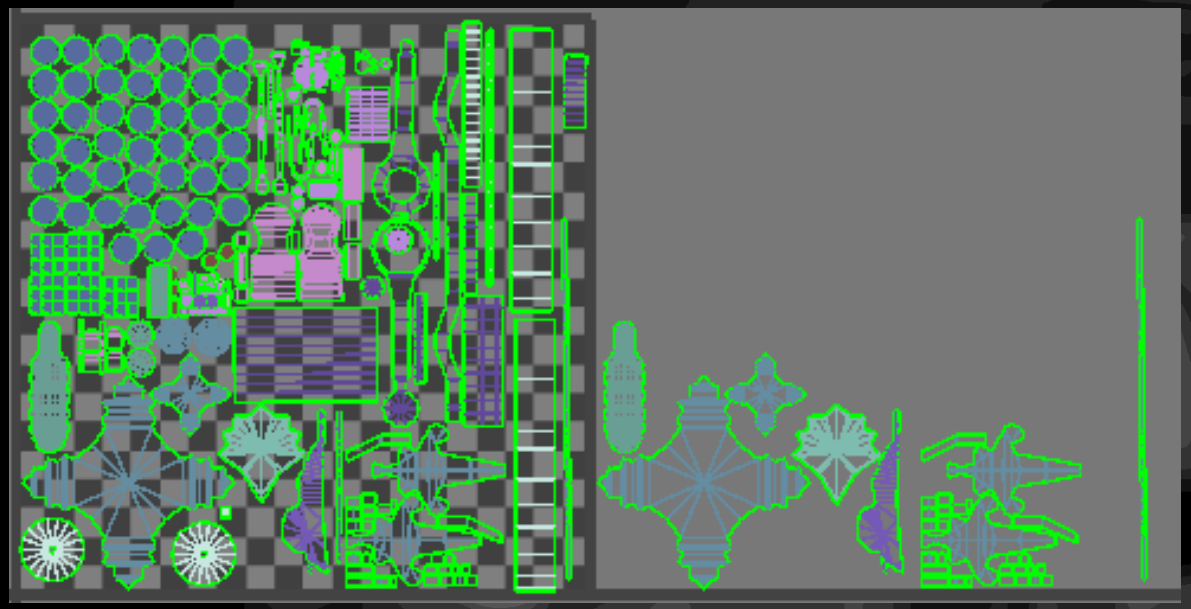
Bake first Cash holder on left

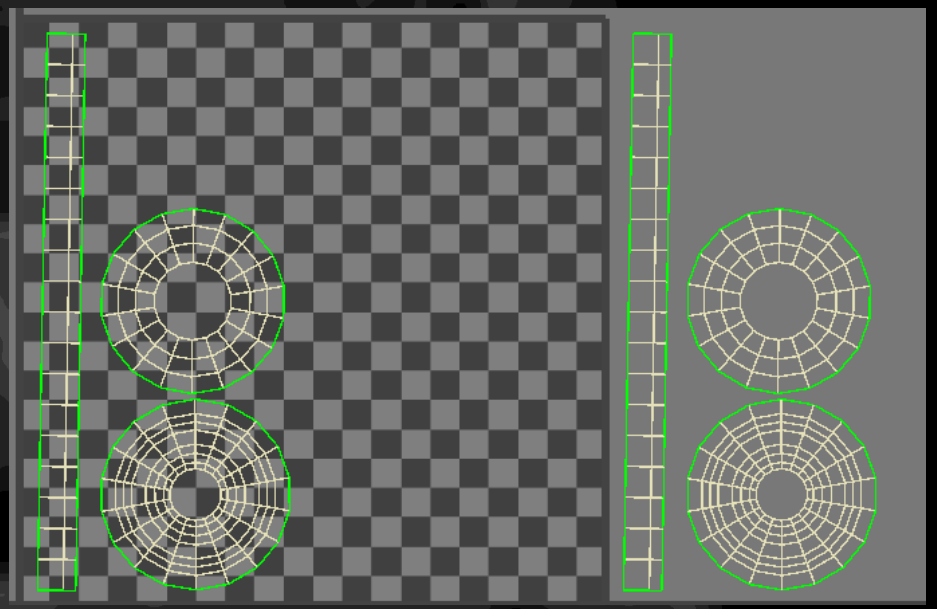
Bake Bottom left Piece of filigree

## Unwrapping

When unwrapping two main techniques were used-

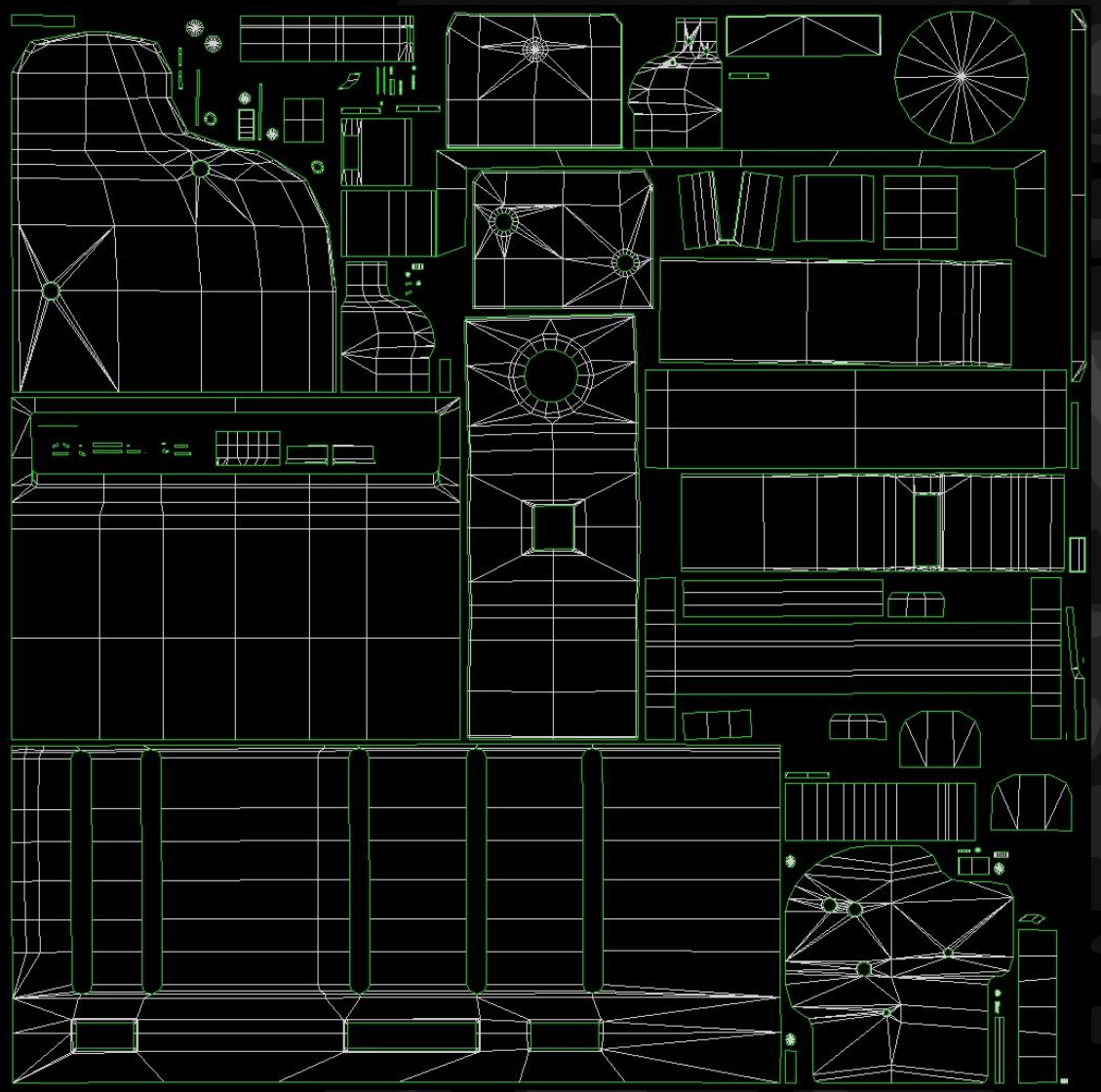
- UV stacking
- UV instancing

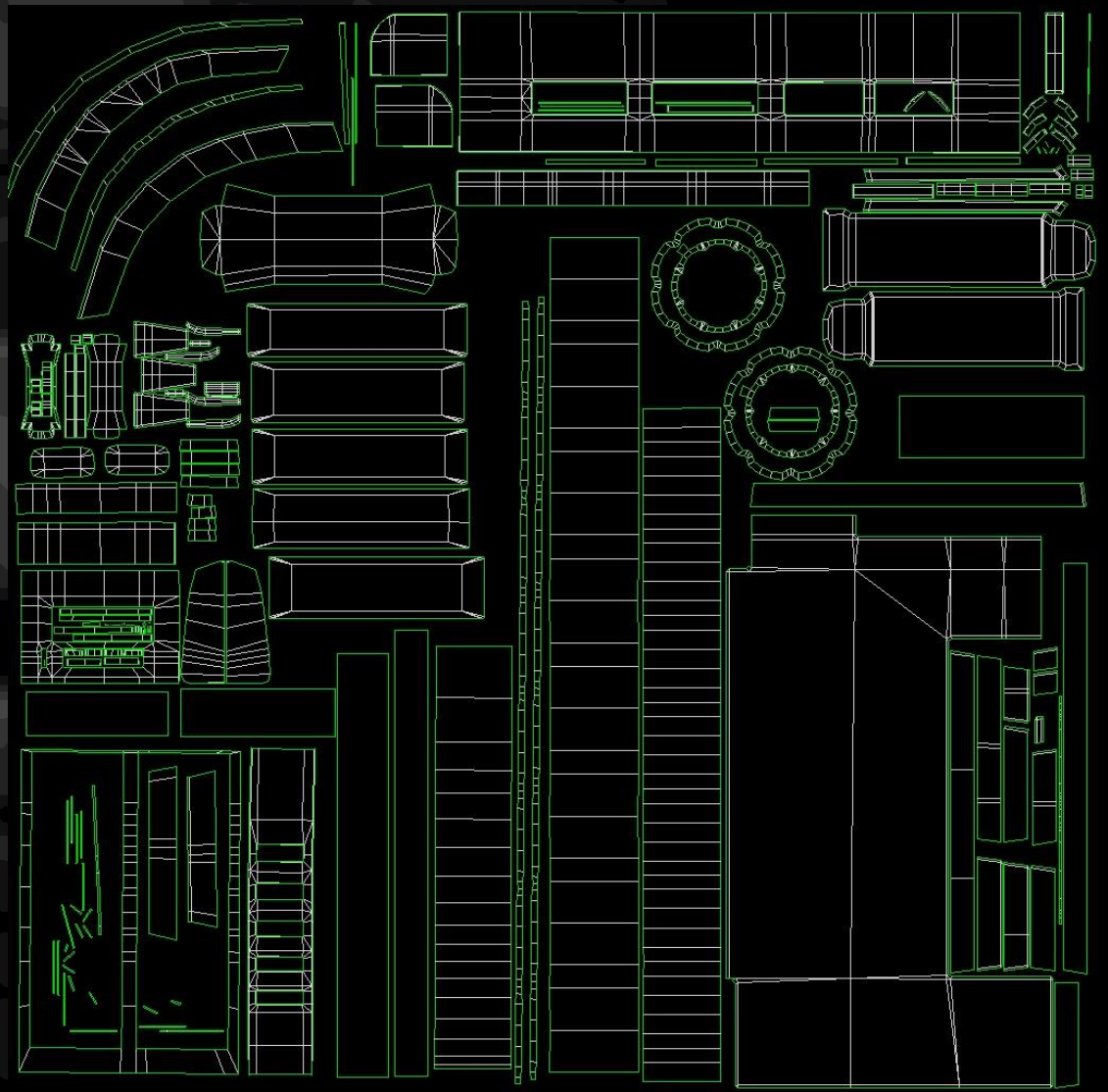




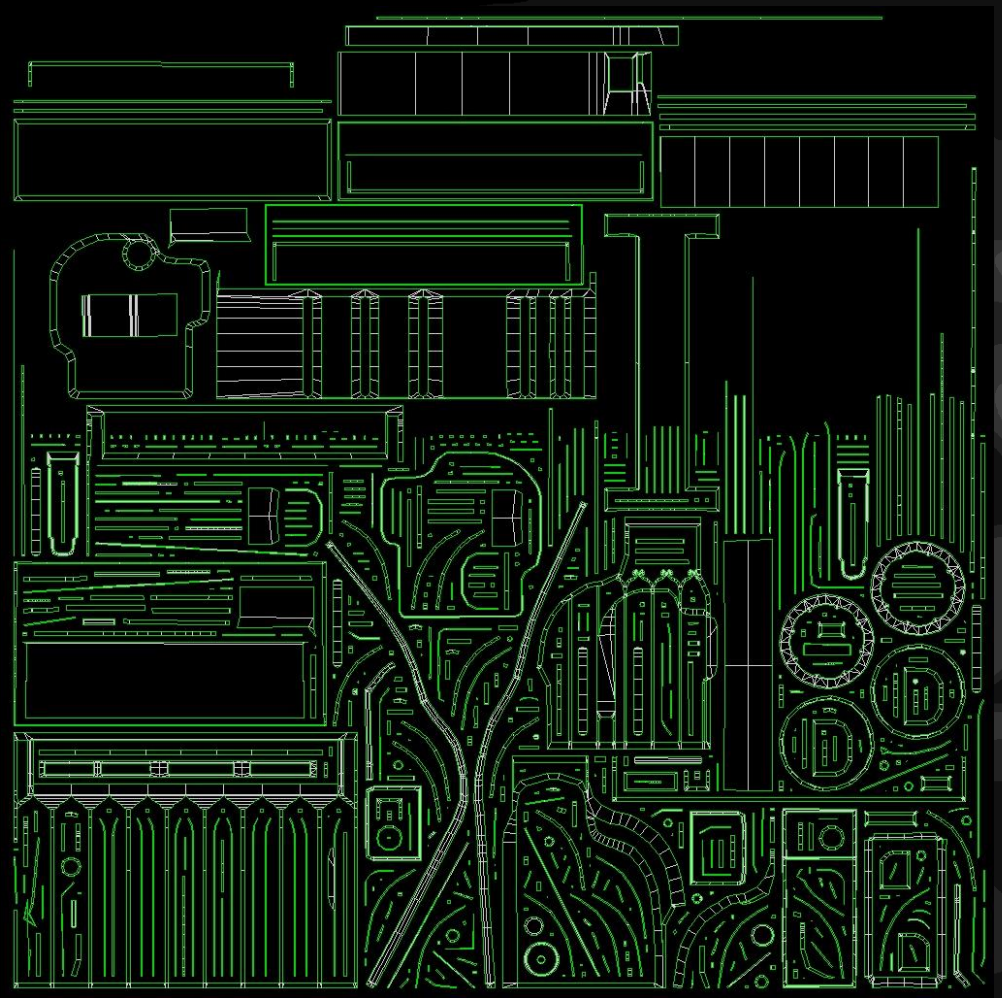
UV instancing was used for when the object shared identical topology to other assets on the model, allowing for a sped up workflow by cutting corners. And UV stacking allowed for saving on texel density in the unwrap by using identical islands off of the UV space. This also helped for creating textures for ornaments that I was unable to make in the high poly. This especially helped with the sweet unwraps as they used stacking and instancing and relied off UE5 to calculate the overall shadows.

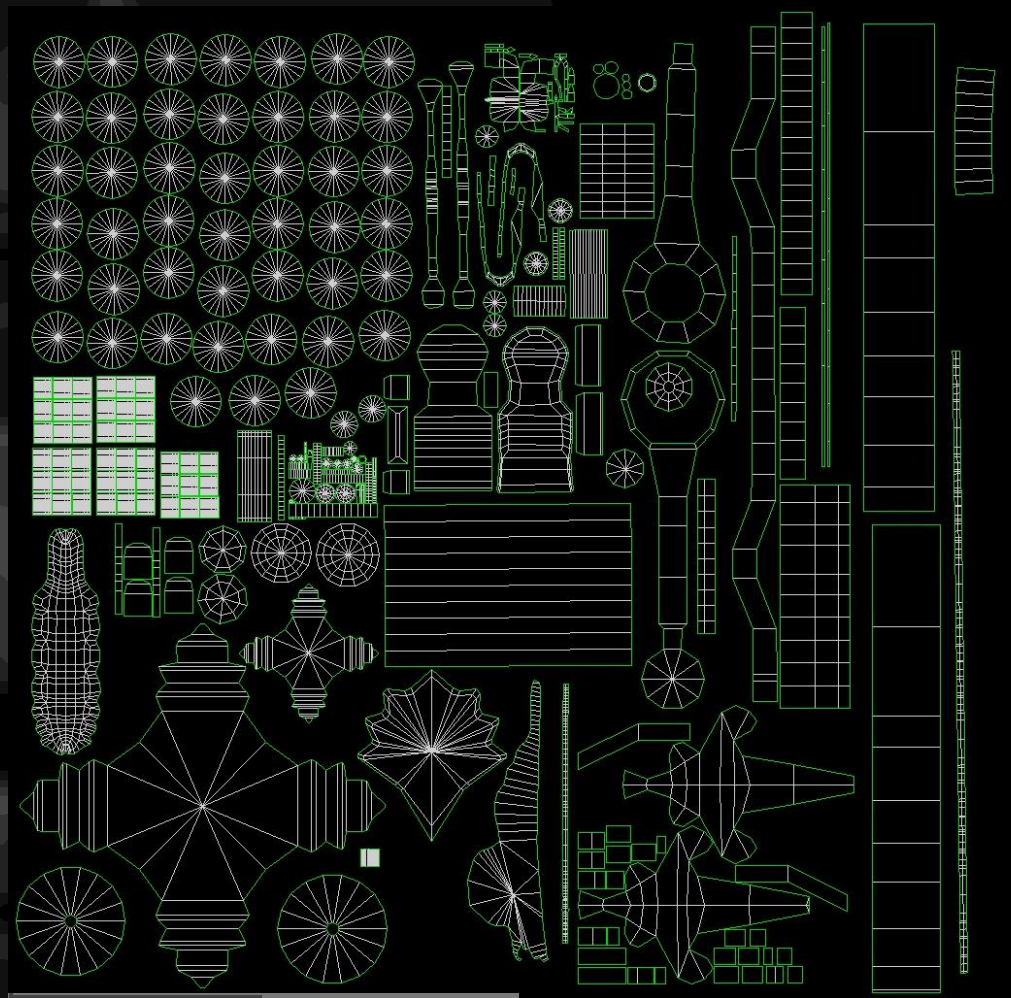
# UVs – Main and Secondary

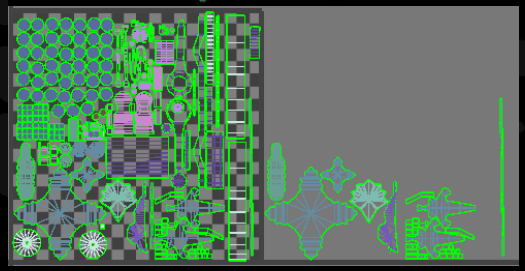




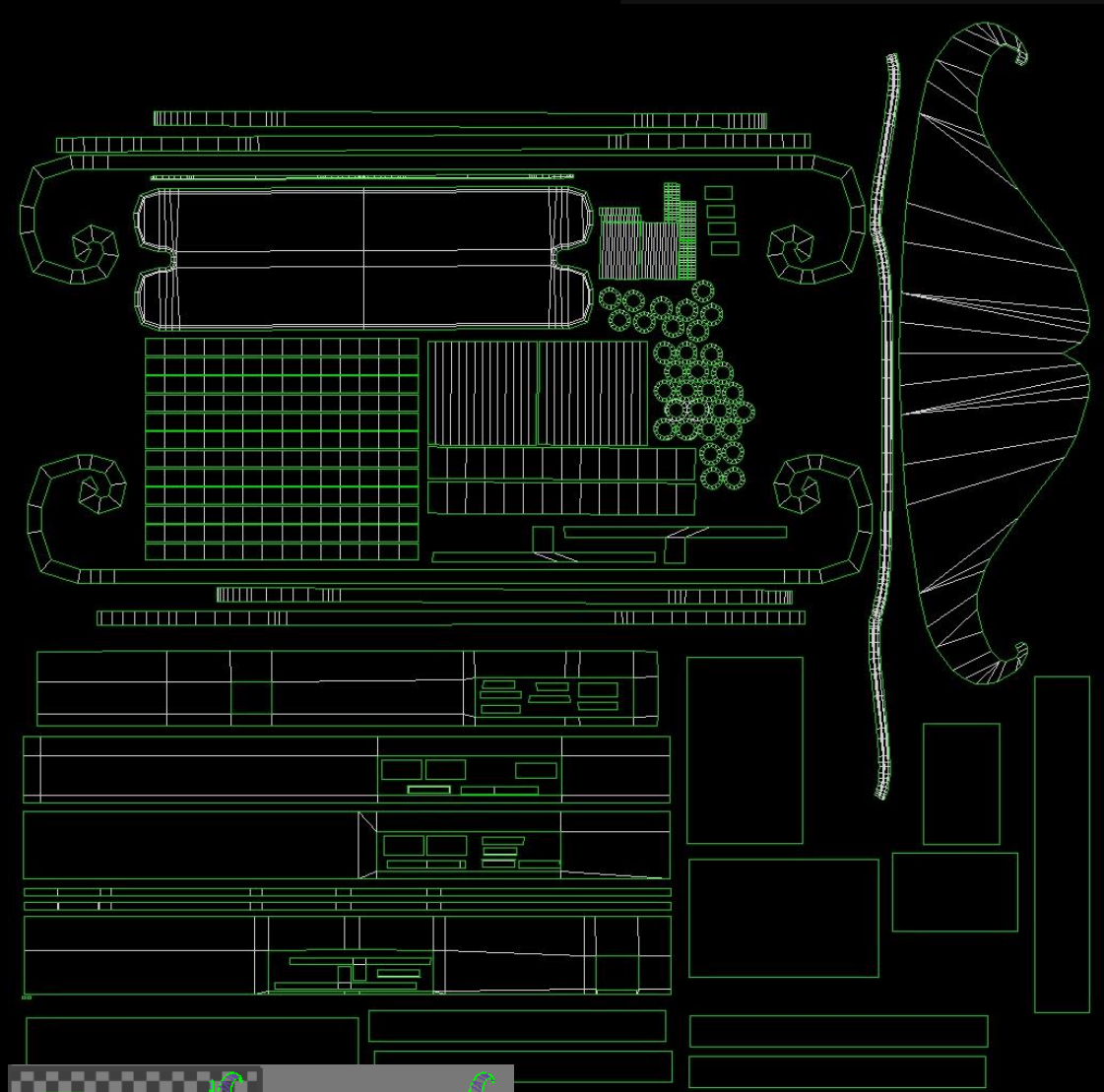
# UVs – Trim and Button

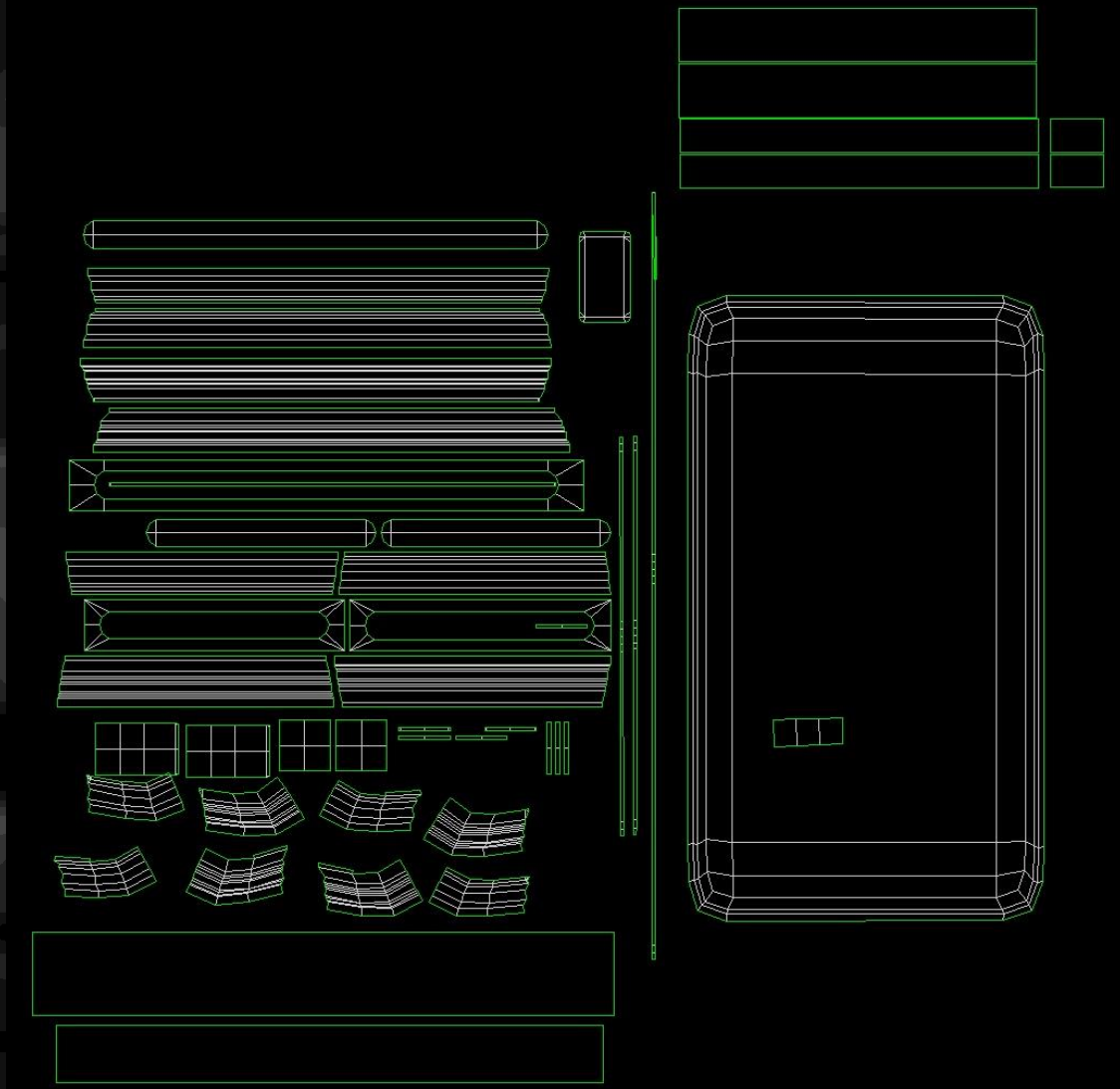


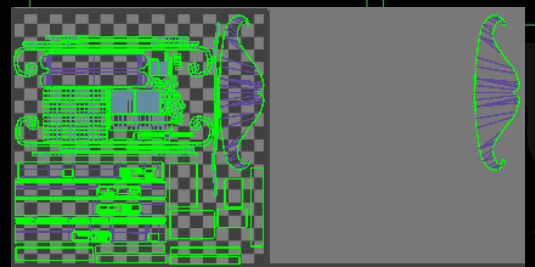




# UVs – Sign and Base

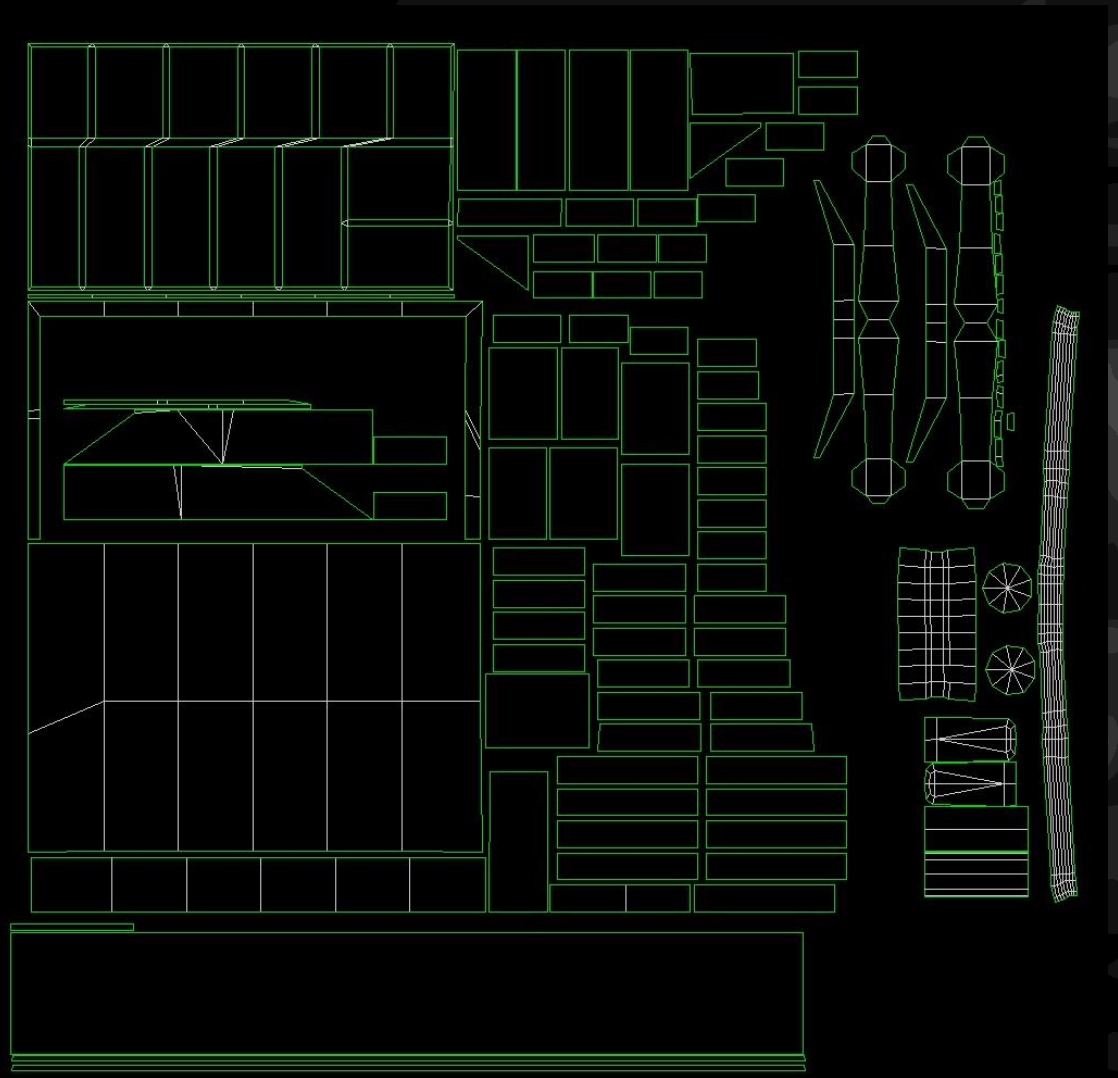


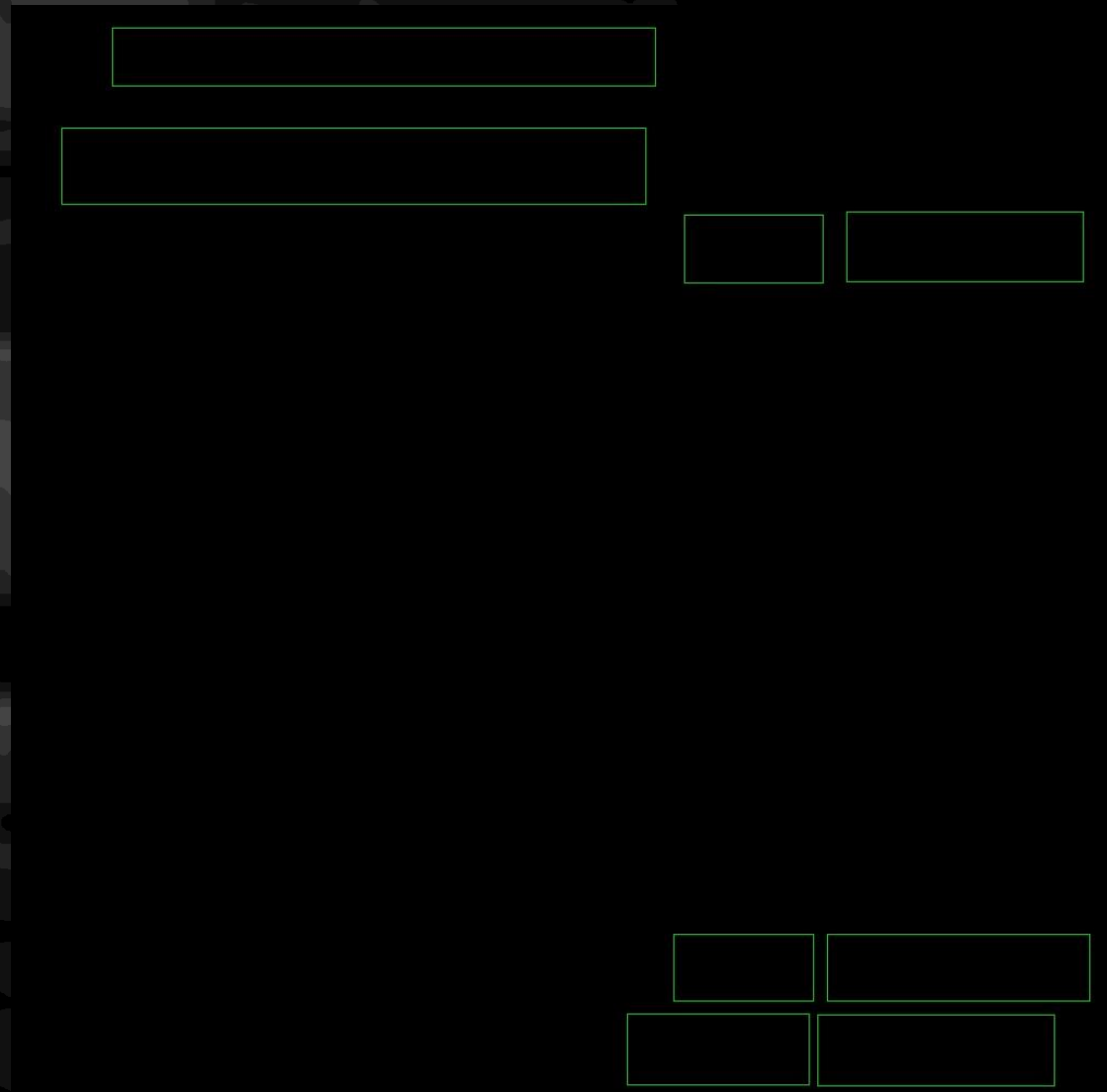




(Texel density and space was considered originally however for final renders glass needed to be in a separate channel

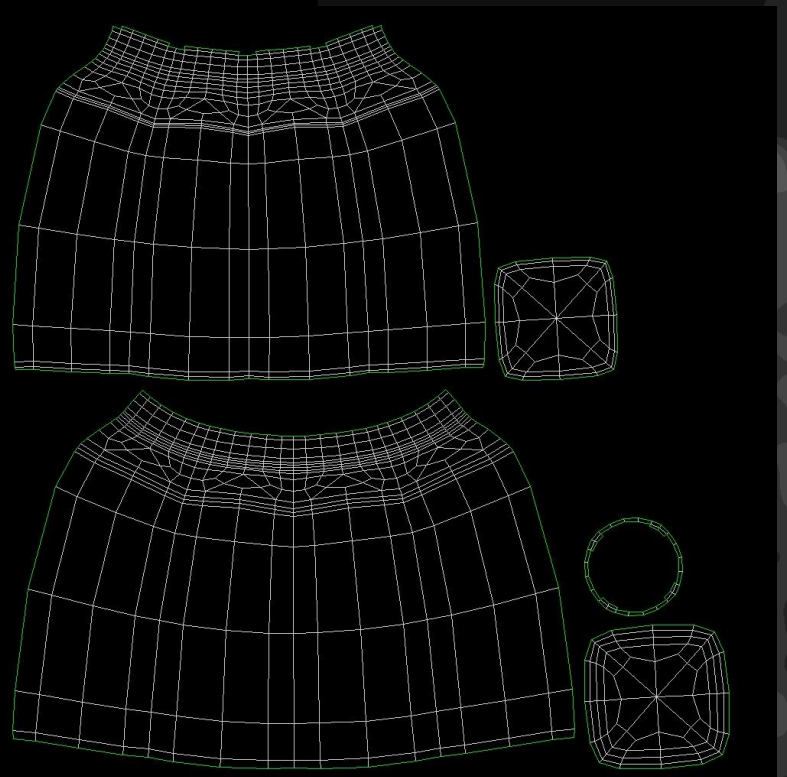
# UVs – Cash draw and Glass (Originally one channel with Base)

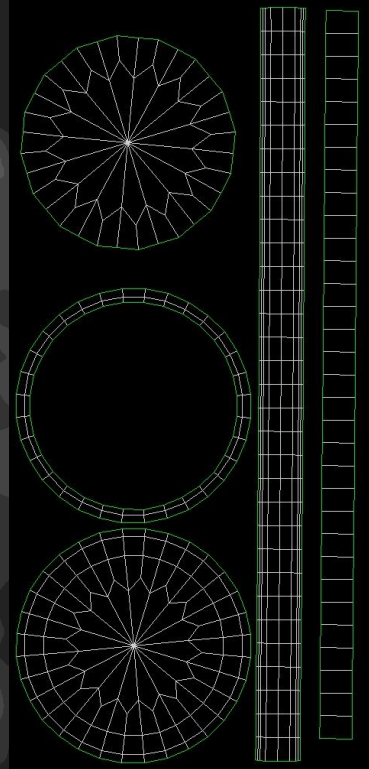


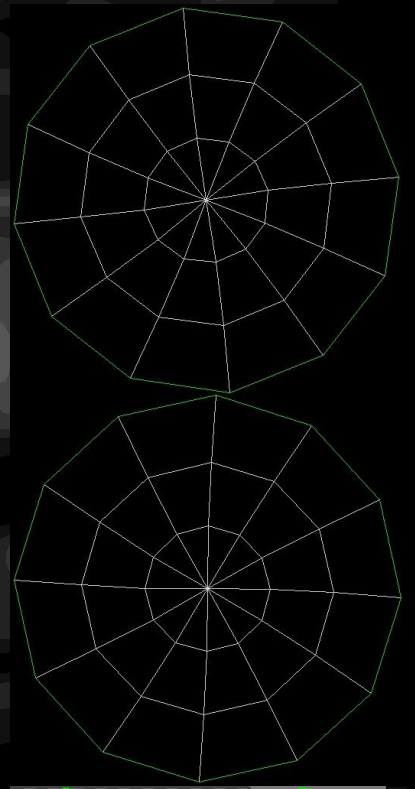


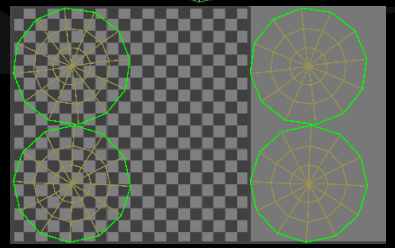
(Texel density and space was considered originally however for final renders glass needed to be in a separate channel

# Background UVs – JAR 1 & Sweets

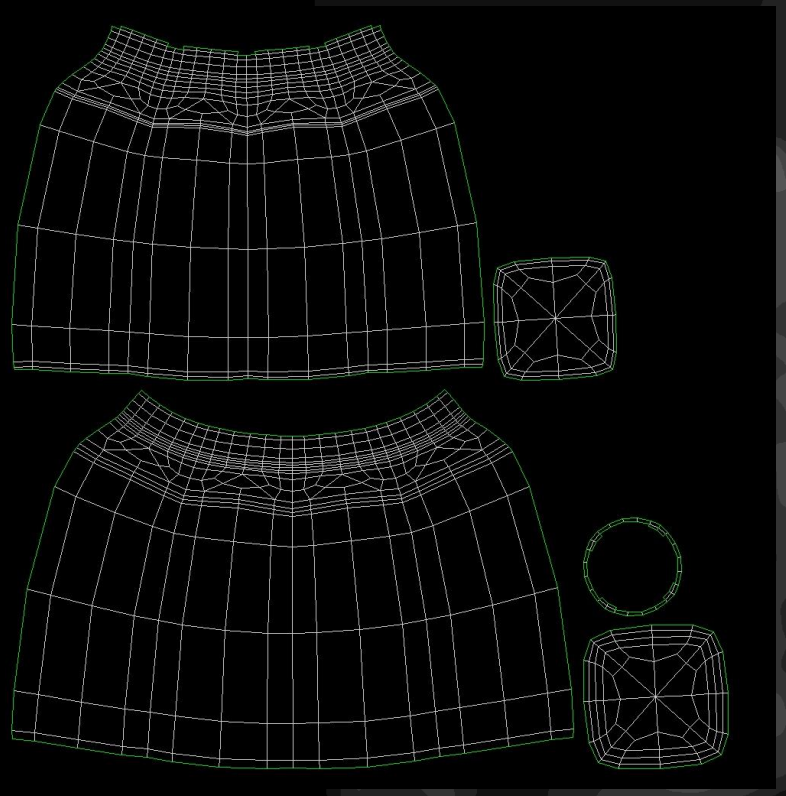


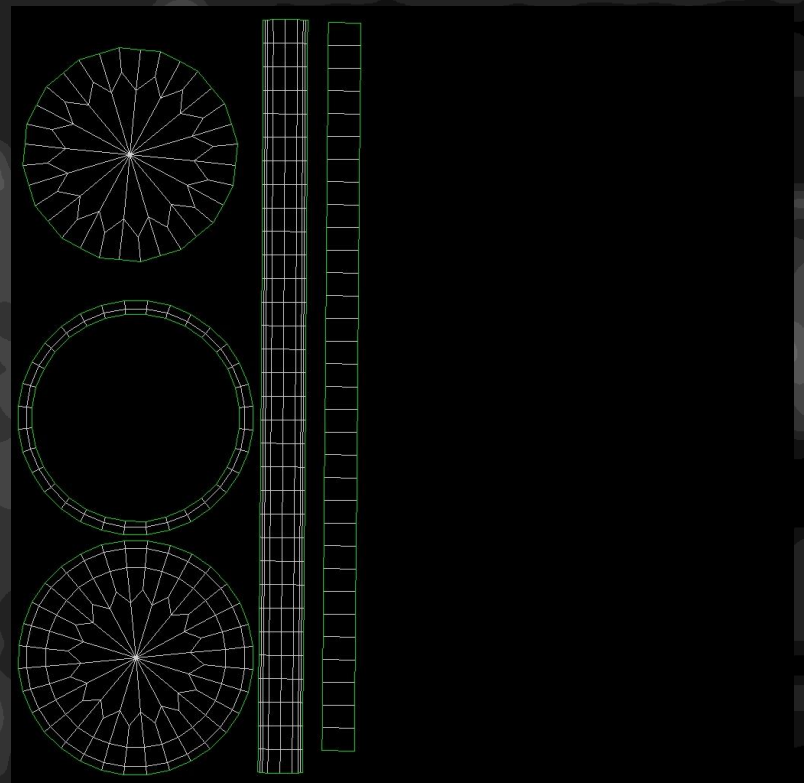


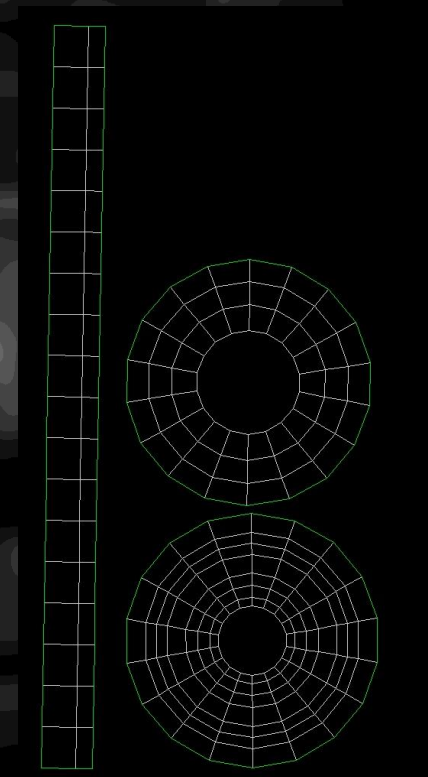


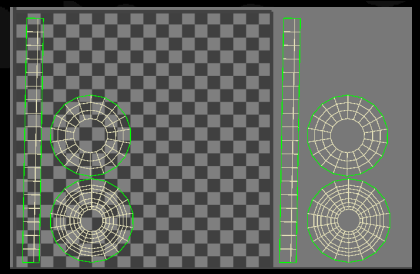


# Background UVs – JAR 2 & Sweets

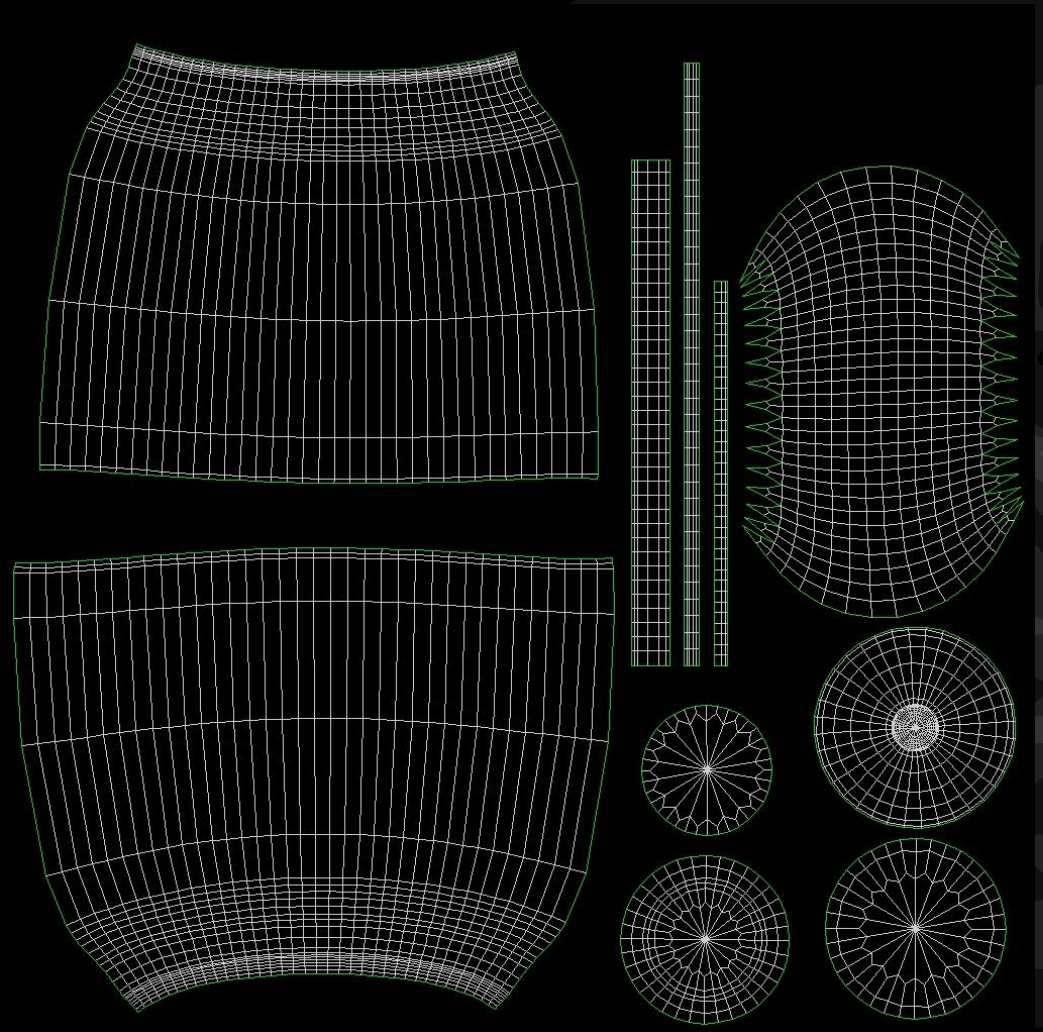


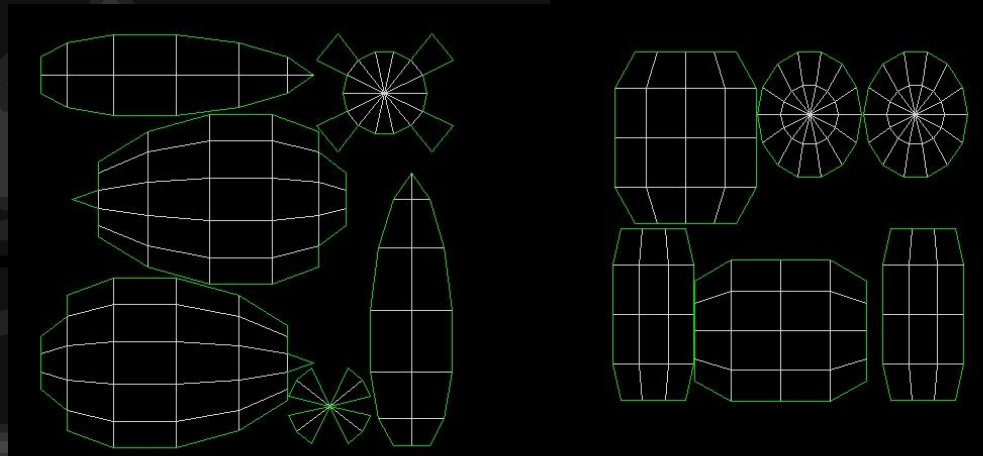


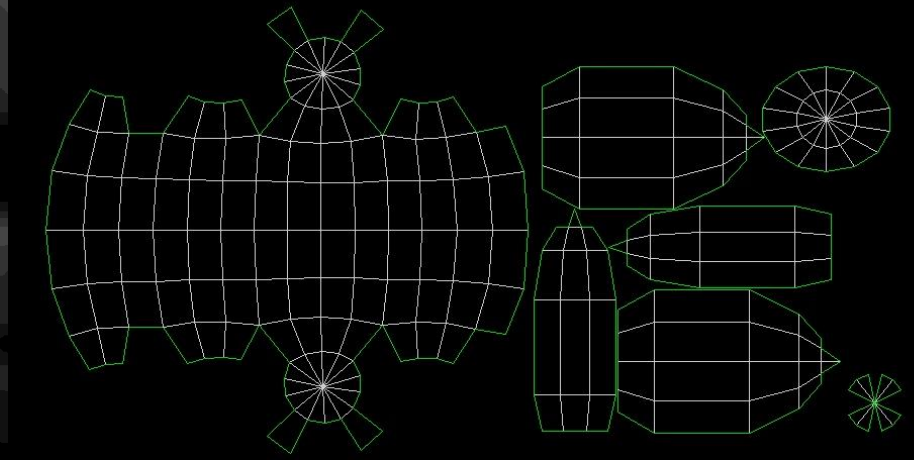


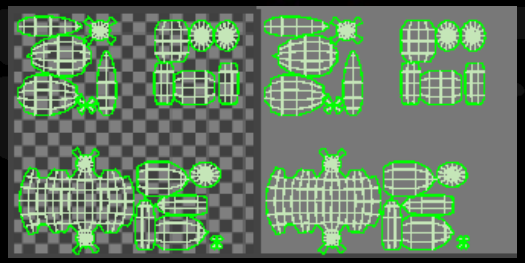


# Background UVs – JAR 3 & Sweets

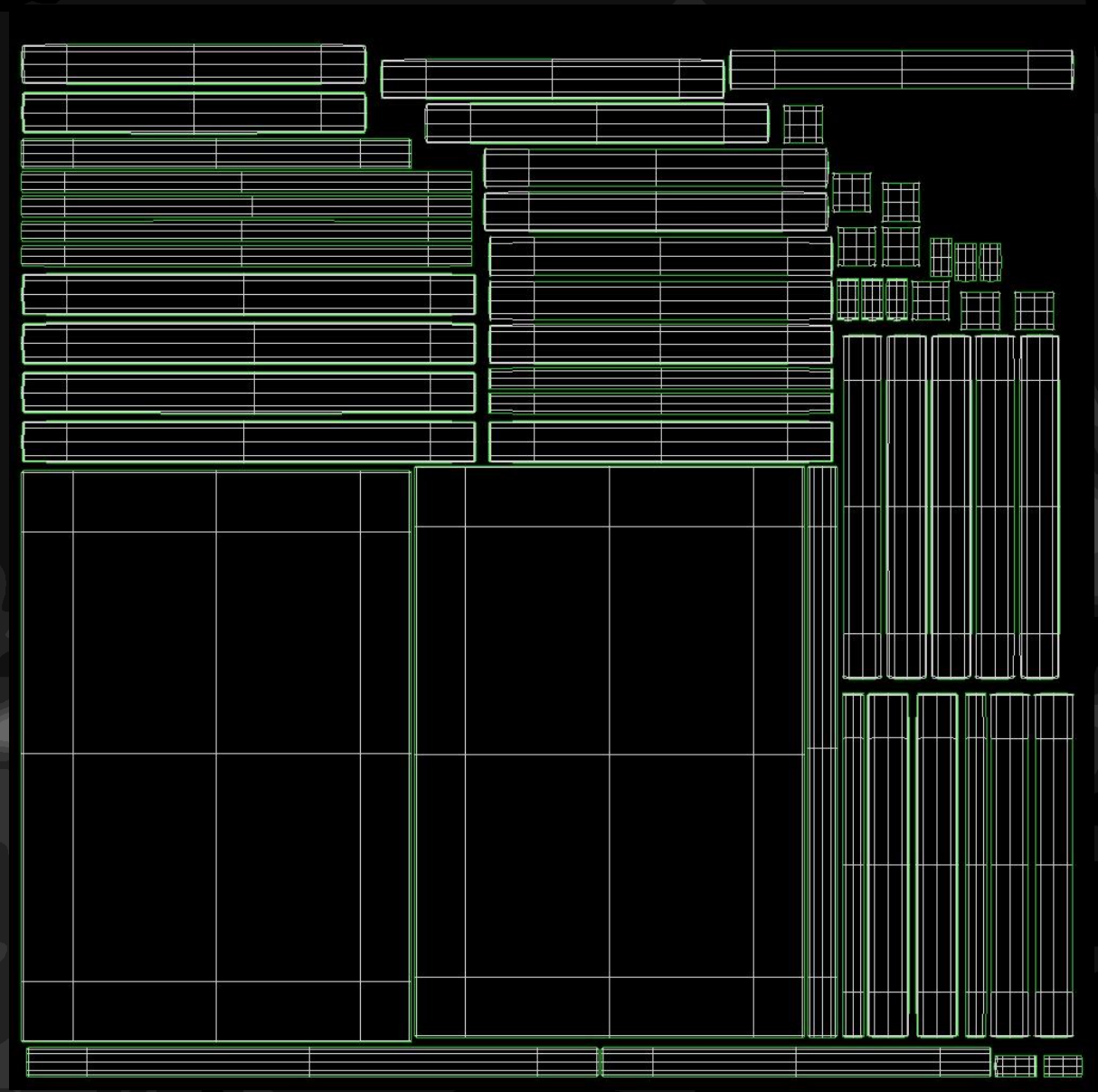




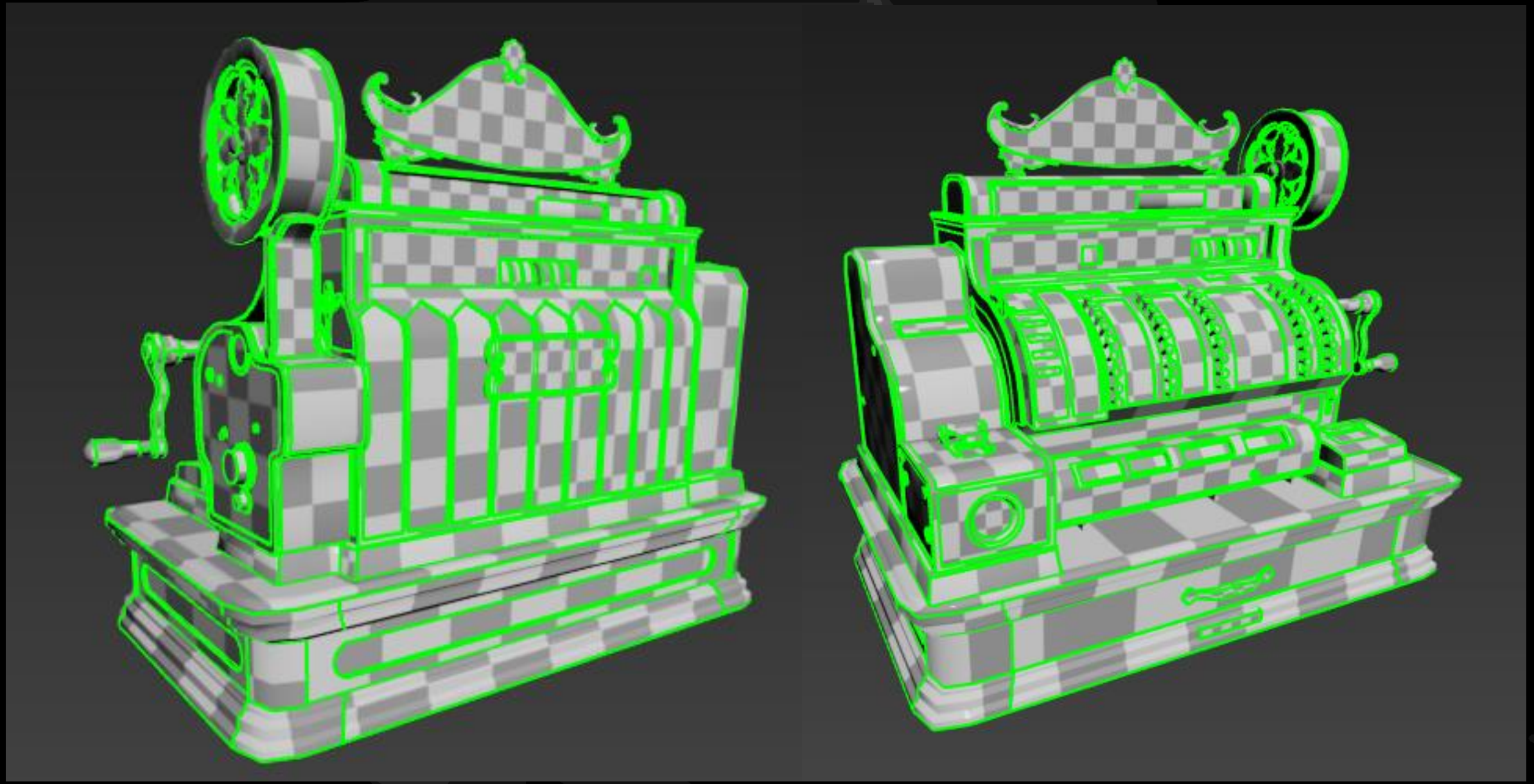




# Background UVs – Table



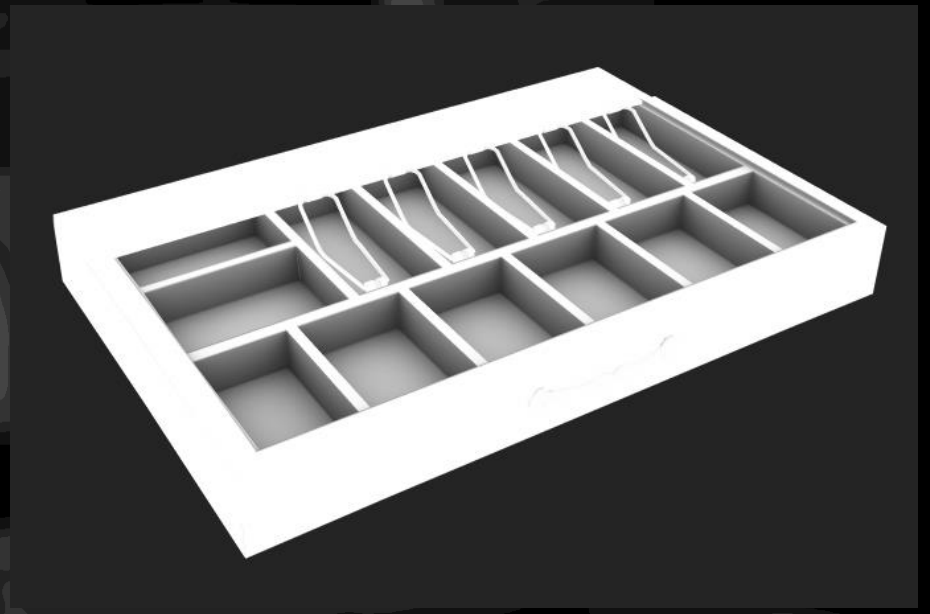
# UVs – Texel Density




# Texturing

## Texturing – Start and baking

To start texturing first I imported the HDRI from polyhaven into substance painter to keep the lighting somewhat similar between projects, and began by baking my model down in 4K.

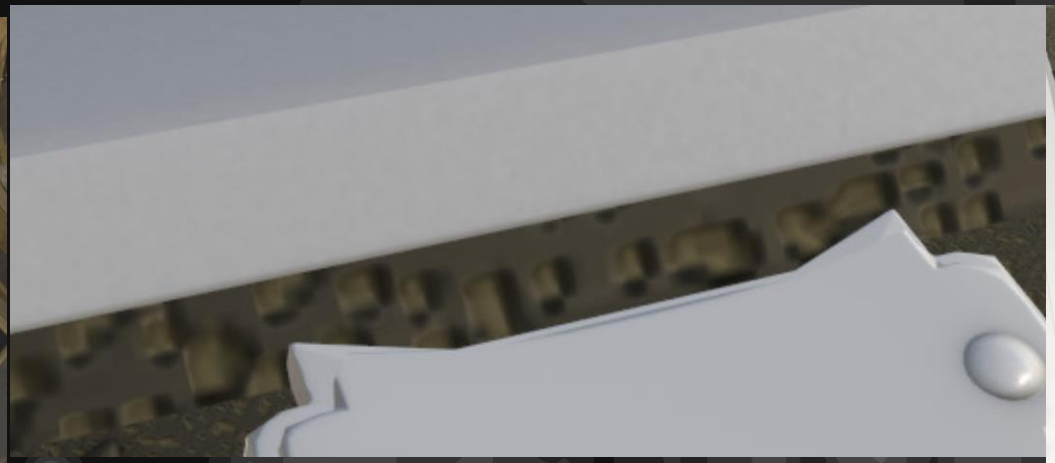


When baking I made sure to turn on self occlusion by mesh name as this would allow objects that would be secluded by shadows to bake without them.

## Texturing – Baking fixes

Along the baking workflow I found areas that needed to be fixed resulting some stretched Uvs or weird pinching Islands. Other areas had some texel density issues resulting in blurry pixelated areas on main parts of the mesh.

Poor seam – Fixed by bevelling edges in Low poly



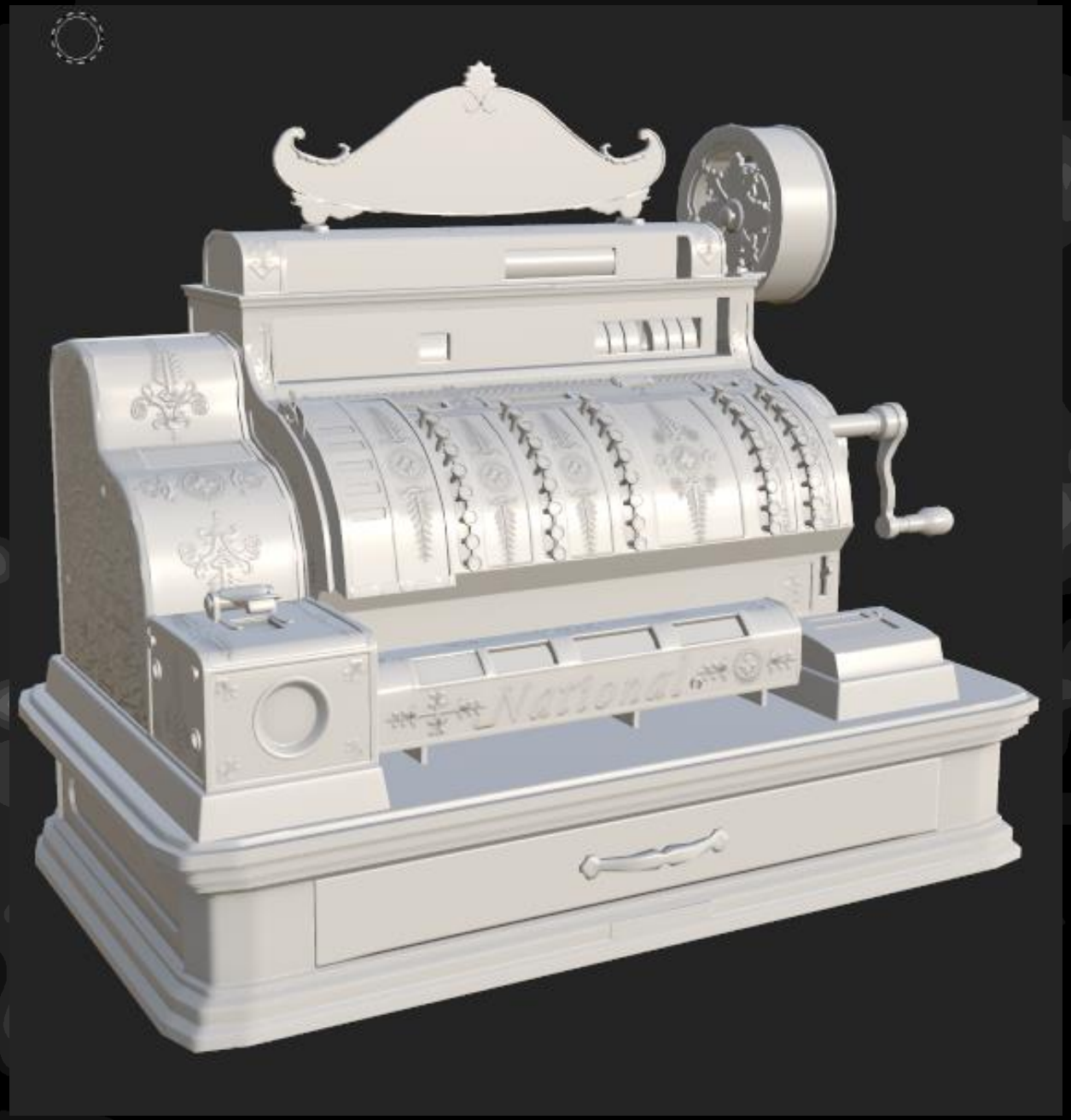
Texel density

Overlapped poly in UV.

Overlapped poly in UV.

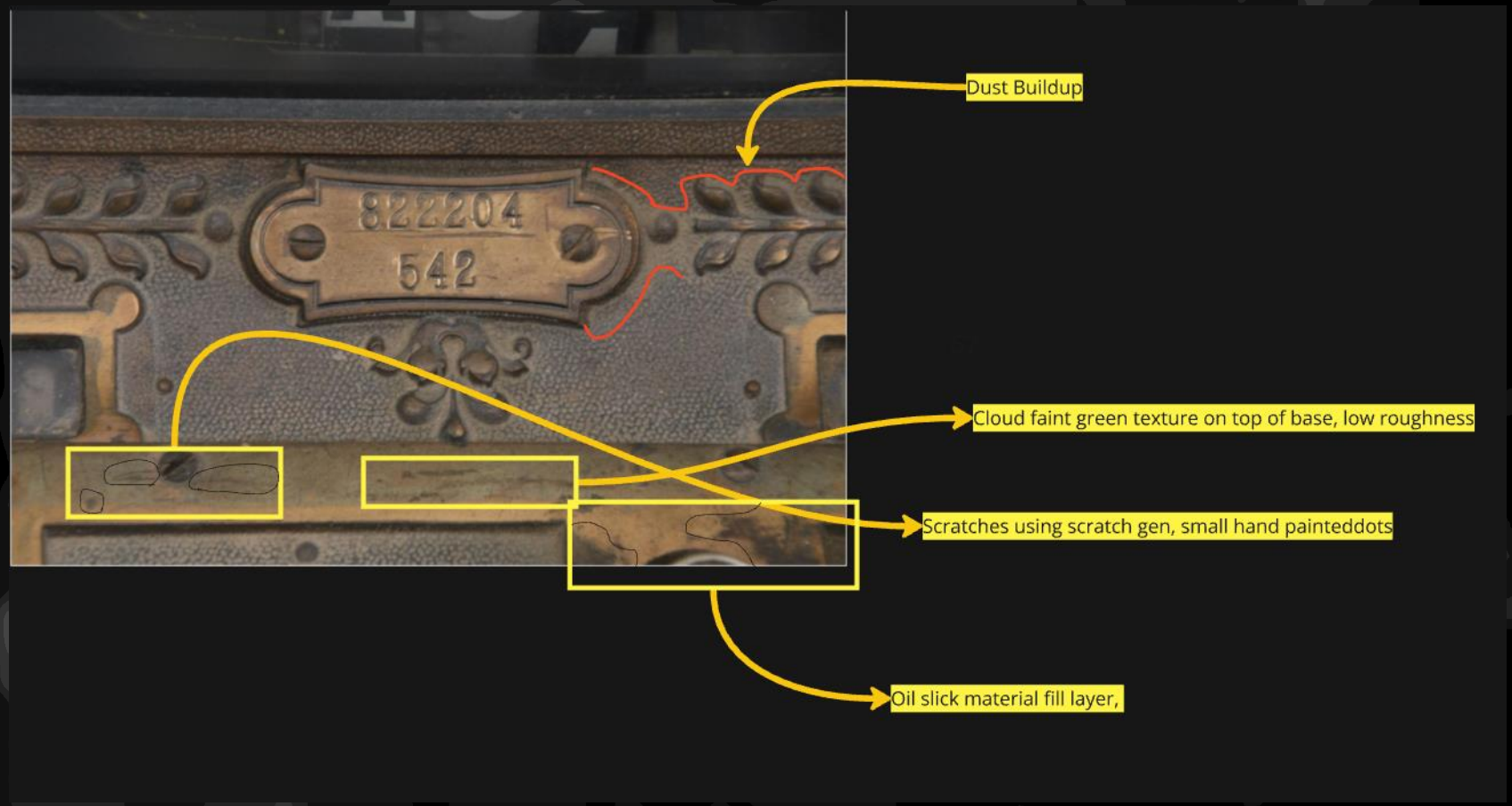
High poly too rounded – Reimported with creases for better bake.

# Texturing – Bake



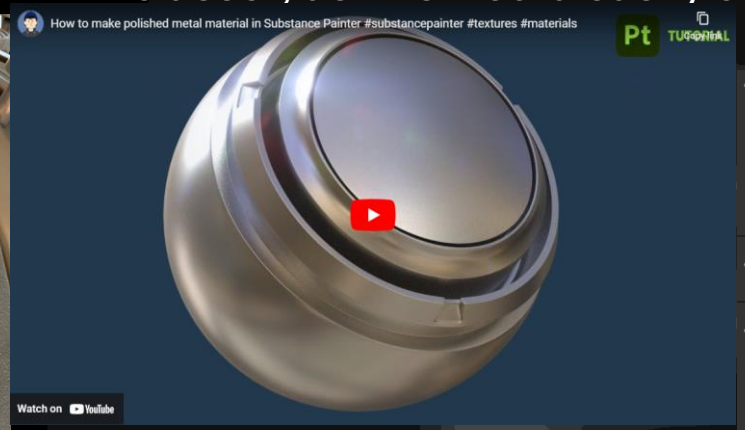
## Texturing – Trim Material breakdown

To help me gain a better understanding of the roughness and wear of the main reference I began making a basic breakdown of what I could see on the front panel of the object so I could replicate it across the rest of the mesh.

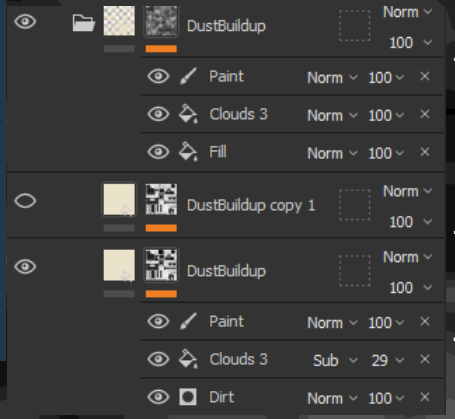


# Texturing – Main Material 1

To cut down on the workload, I made smart materials of the main materials I would be using within the asset, as this would easily carry over to other objects with minor tweaking needed.

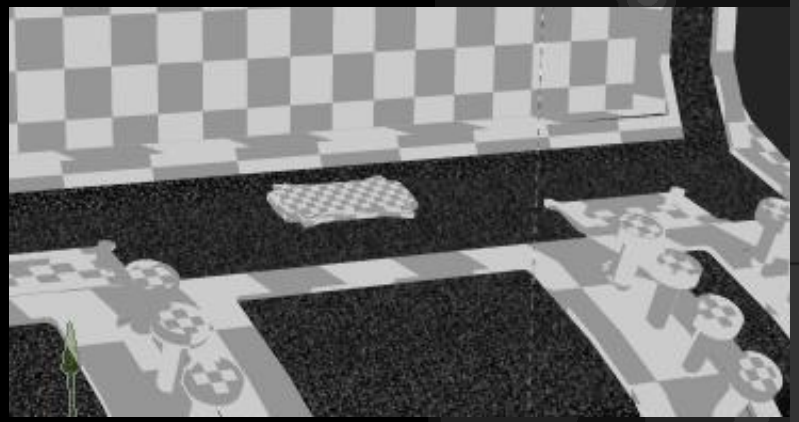


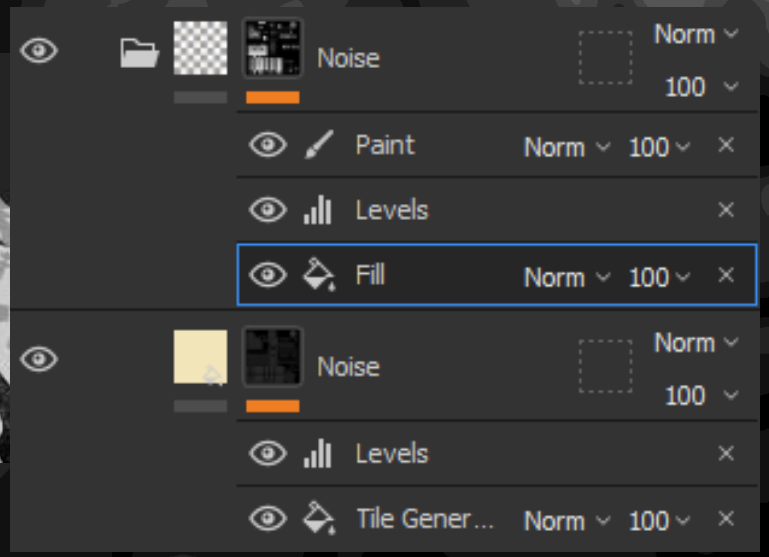

https://youtu.be/WeKDdS6H5Oc




For the main metal material I ended up using a technique found online for metal polishing, allowing me to add highlights of polish to the extruded areas of the baked surface through thickness maps.

This material also used some dust buildup using fill layers with noise and curvature generators.

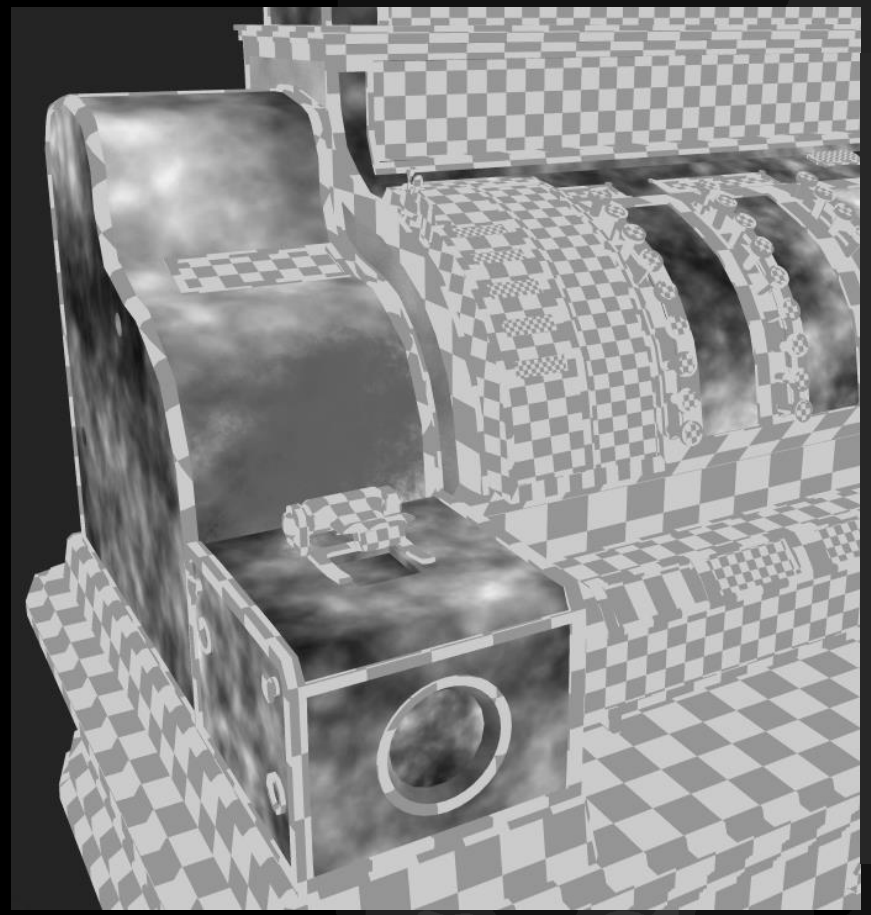





To add noise I made a tile generator behind a black mask and added levels to change the contrast of them, these also used a height map which blends into the normal map, to add depth to the main material. This was then masked out by thickness map in a folder to make sure it didn't affect the main ornaments of the piece.

## Texturing – Main material 2

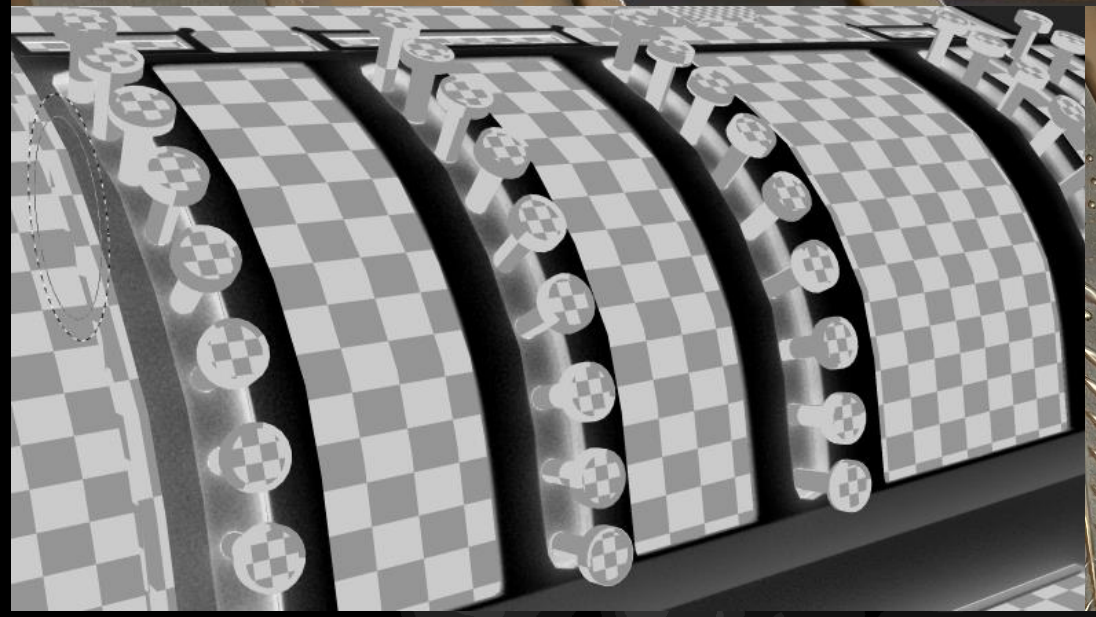
For the rest of the main metal material I mostly used edited generators like dirt buildup, alongside a subtractive paint to clean up areas of dirt that would be cleaned in the real world, since generators tend to give very consistent results.

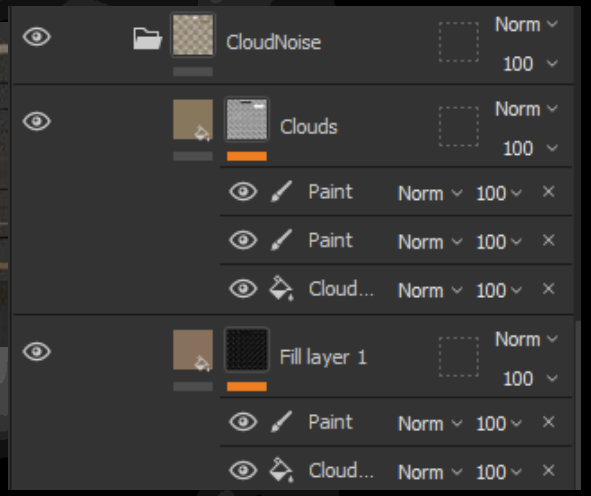


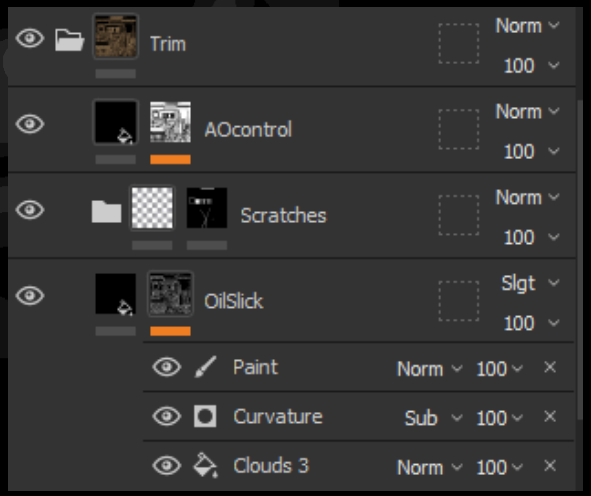

After the main metal material had been finished it was organised into a folder and made into a smart material for easier use across over texture sets.

# Texturing – Trim material

For the trim material this mainly used a simple base, metallic and roughness and was broken up by more roughness maps such as clouds and BnW spots. An extra curvature map was also used to give the trim some edgewear. Some general ao was used too to help deepen the shadows of areas around the buttons, and general scratches were used as they could be seen on the main references.





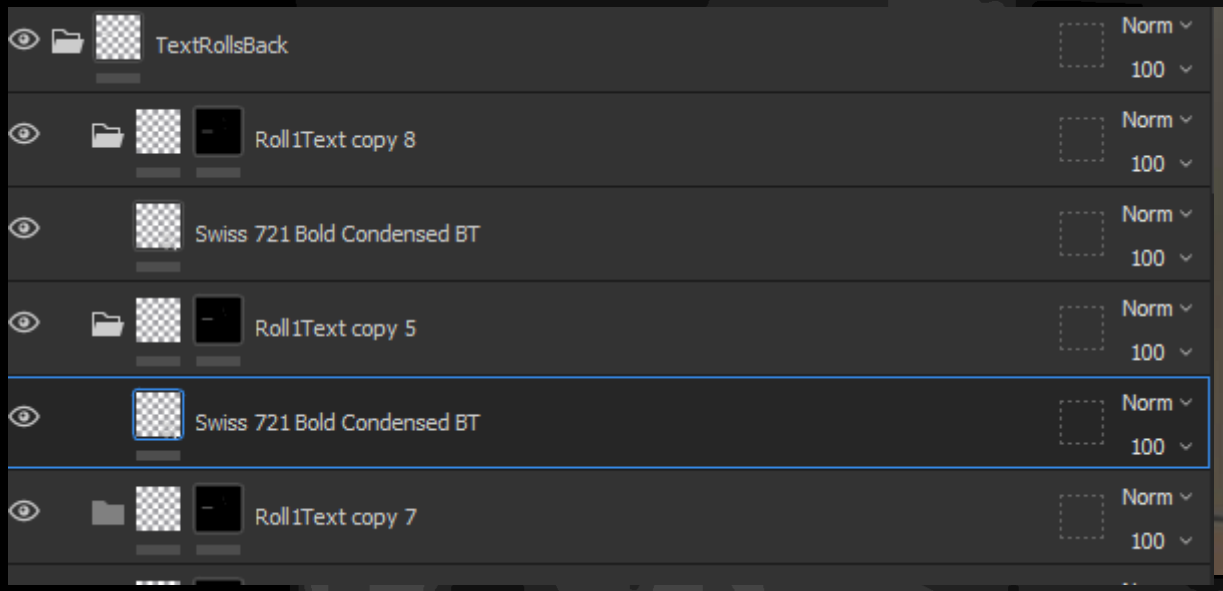
## Texturing – Buttons

As for the buttons, these were created using two types of font, one of which I found on a font website to better resemble the original. These were then added by using warp projection and projecting the first row before duplicating each into a folder for efficiency. (Huxlee Vertical)


As for the white buttons, a default font in substance painter was used.

# Texturing –Cylindrical Projection UI

When approaching the UI cylinder wraps, I found the most effective way was to use cylindrical projection, as this would allow me to use a font layer and quickly edit it and rotate if any adjustments needed to be made, this also made the other rolls significantly easier to make with only using one layer per roll.




# Texturing – Height Painting

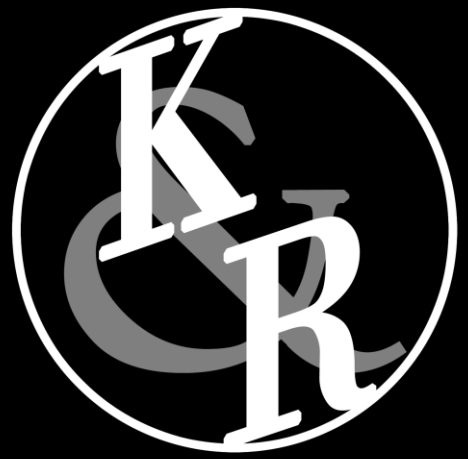

Some areas of the model didn't have high poly equivalent ornamental patterns due to their shape, to solve this I used height painting layers in substance painter with multiple values to eventually get a good resemblance of the original ornamental designs.

Additionally, some of the designer alphas were reimported with a mid Gray value to help texture the wheel ornaments, as warp projection provided easier control with the ability to use vertices transform similar to 3dsmax's FFD modifier.

Height painting was also used to add patterned texture depth onto areas that weren't included in the high poly.

## Texturing – Custom Alphas

Finally during texturing, I made custom alphas for both the main asset and background assets, including making my own logo for the sweets inspired by my Initials and M&S. Alphas for the sign were created using some basic photoshop skills and levels to bring out the black and white alpha from the text.

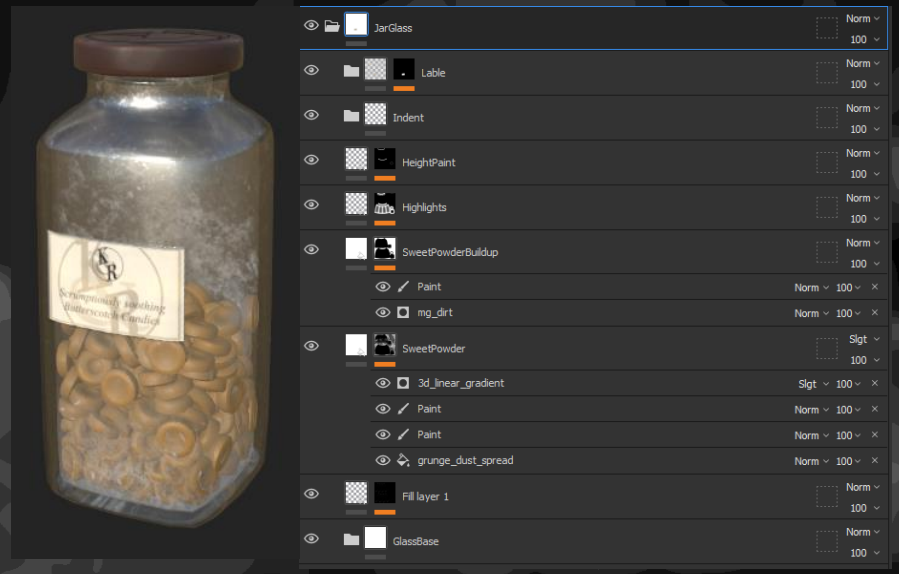







# Texturing – Glass

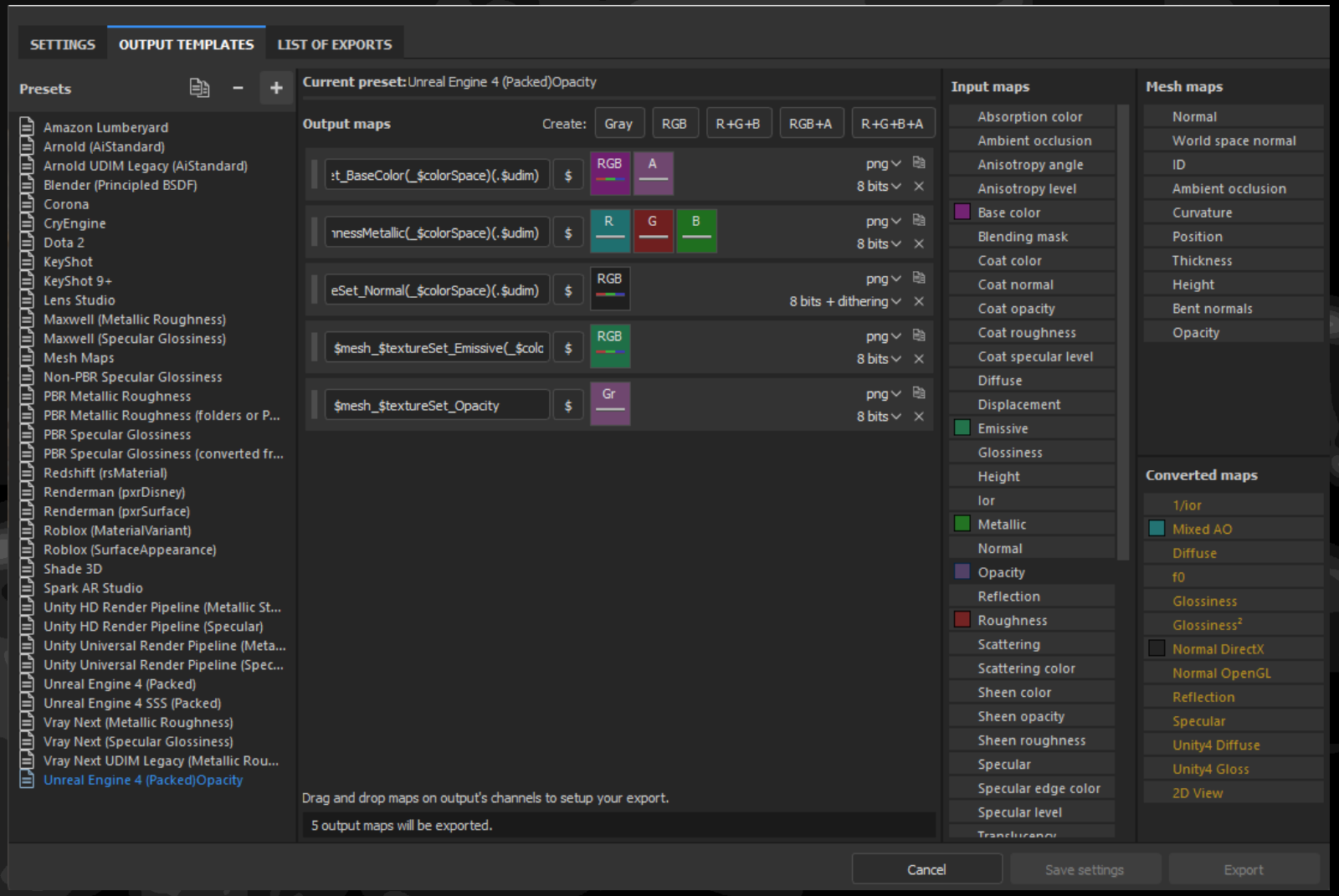
For the glass texturing I used two main methods, one of which used the glass visor material as a base and added roughness maps on top of it while using PBR with alpha blending.



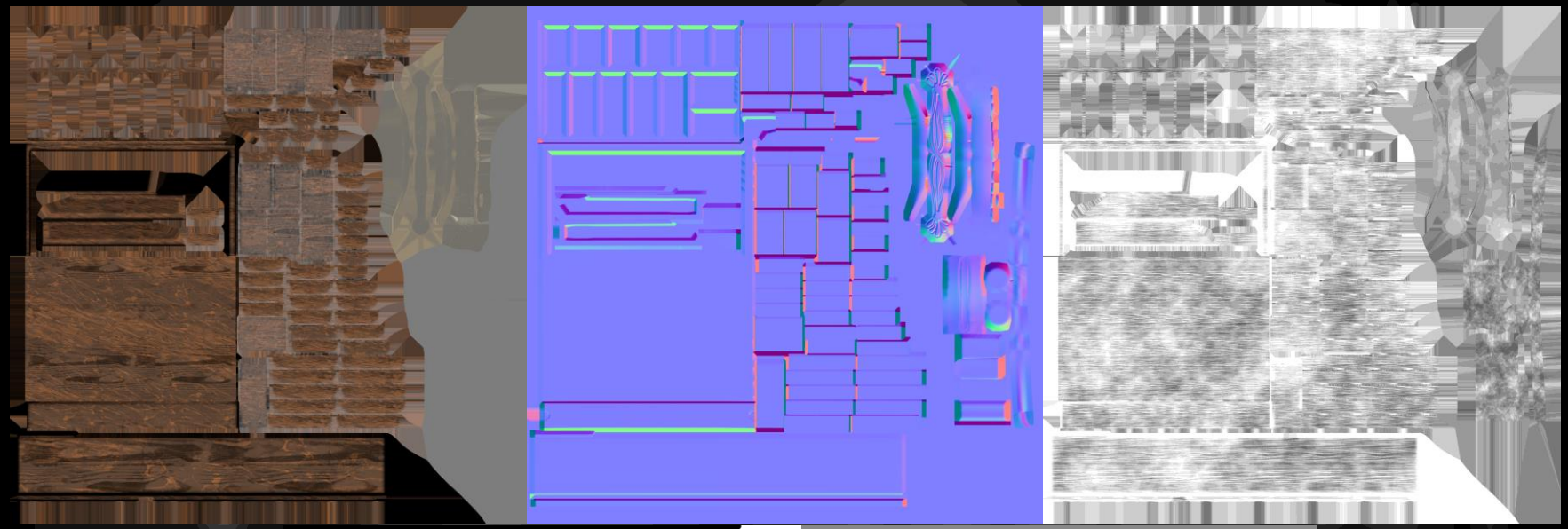

The other method used a simple opacity layer with a mid grey value and then used some fast noise with a subtractive fill cloud blend.


# Texturing – Exports

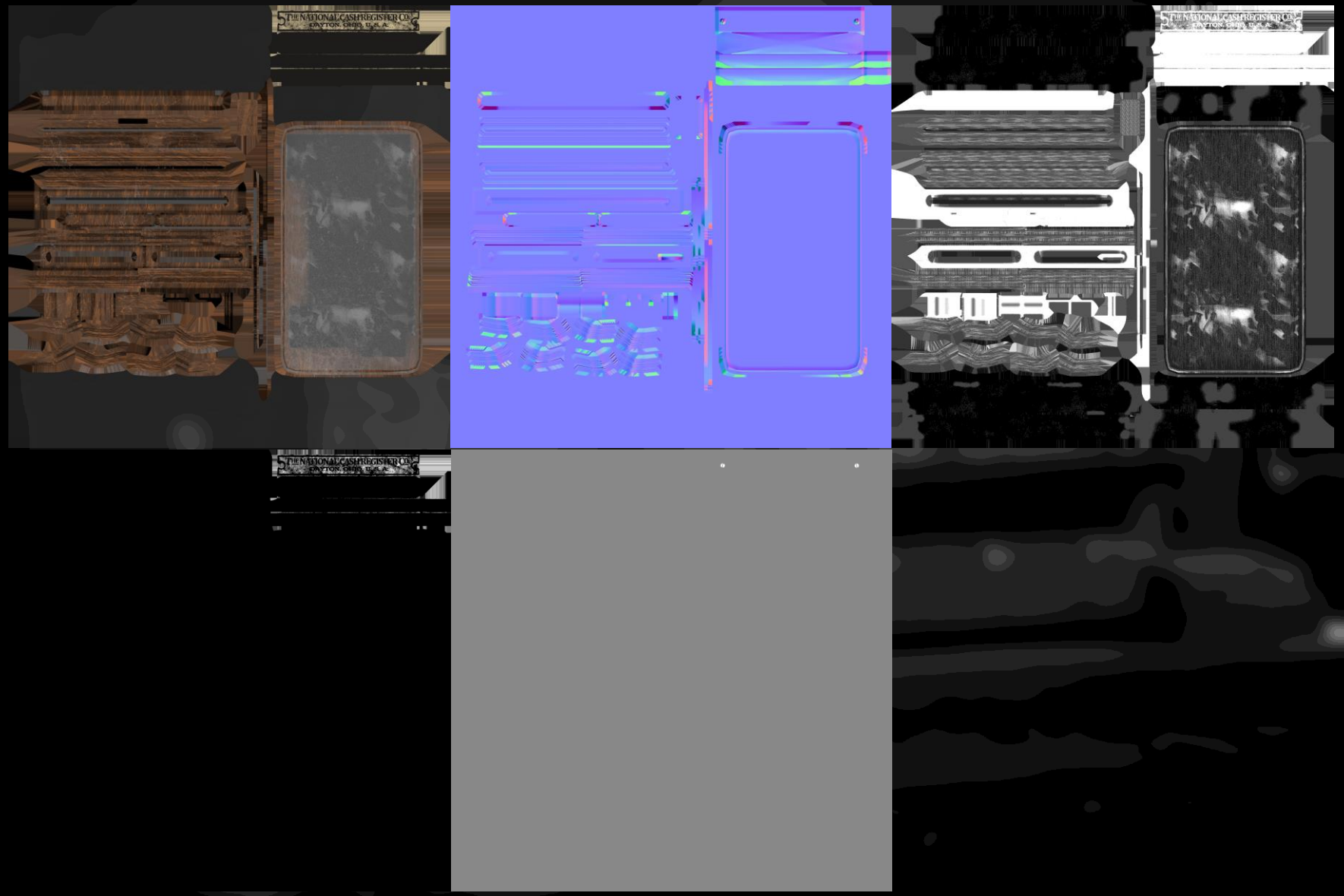
When it came to exporting the material, I needed to slightly modify the UE4 packed package to include opacity maps.



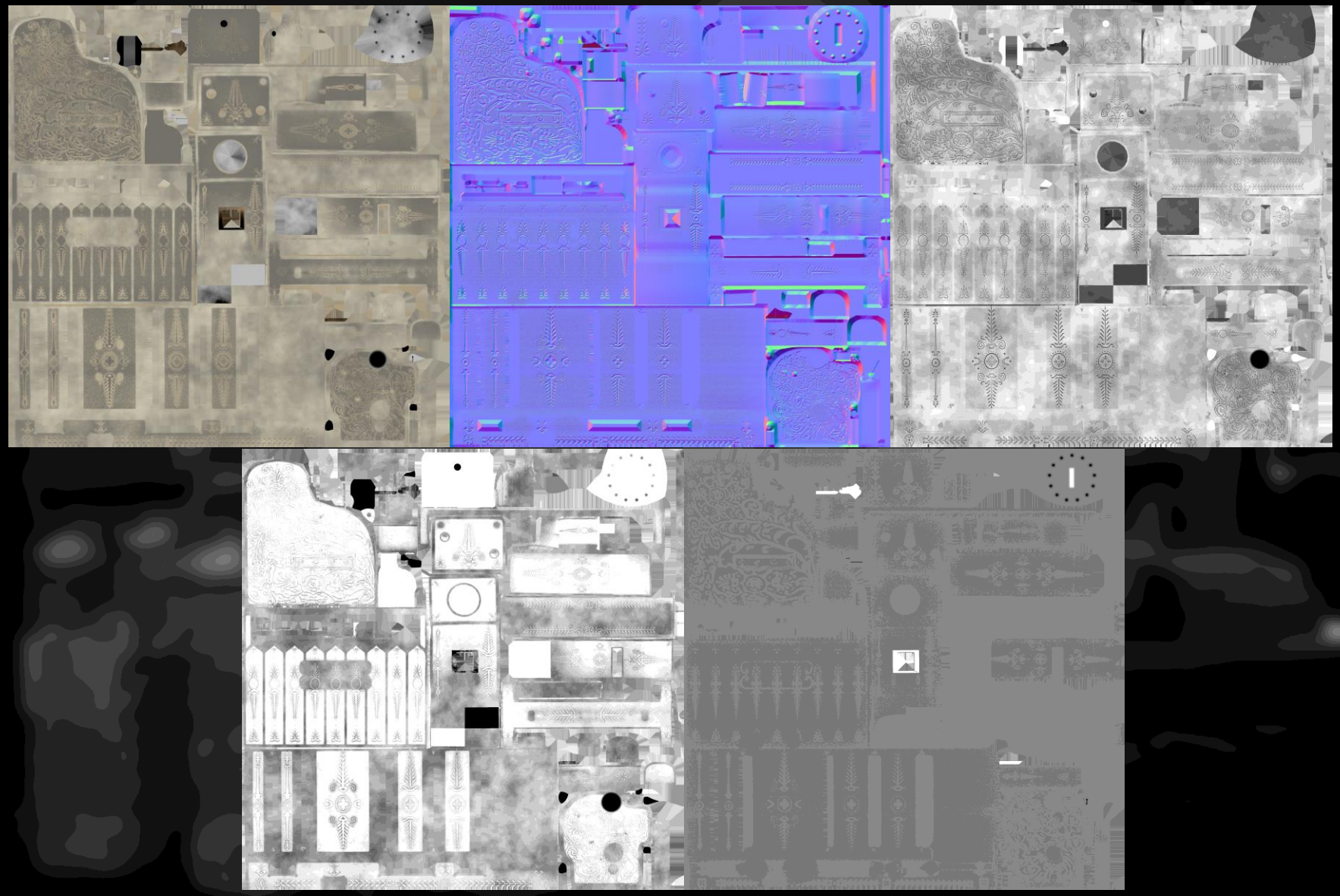
# Materials Till – Cash Draw



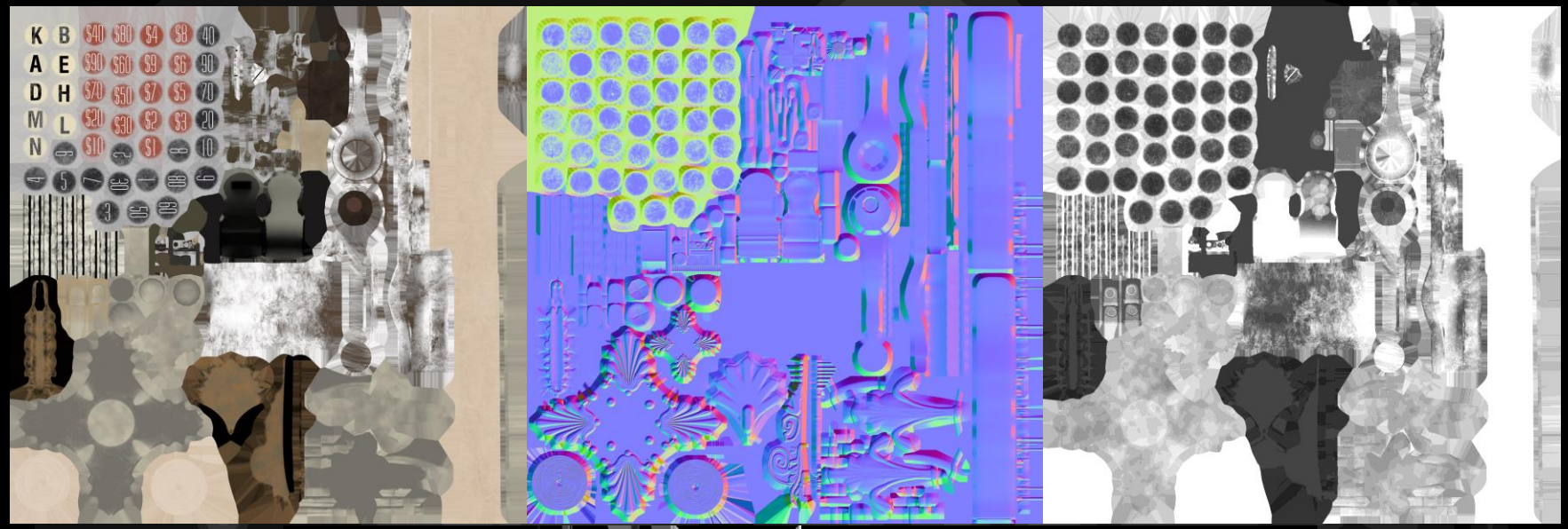
# Materials Till – Base

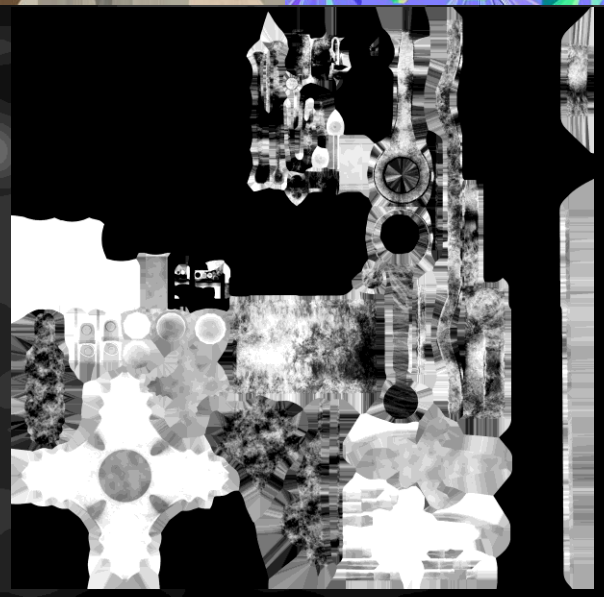


# Materials Till – Main Body

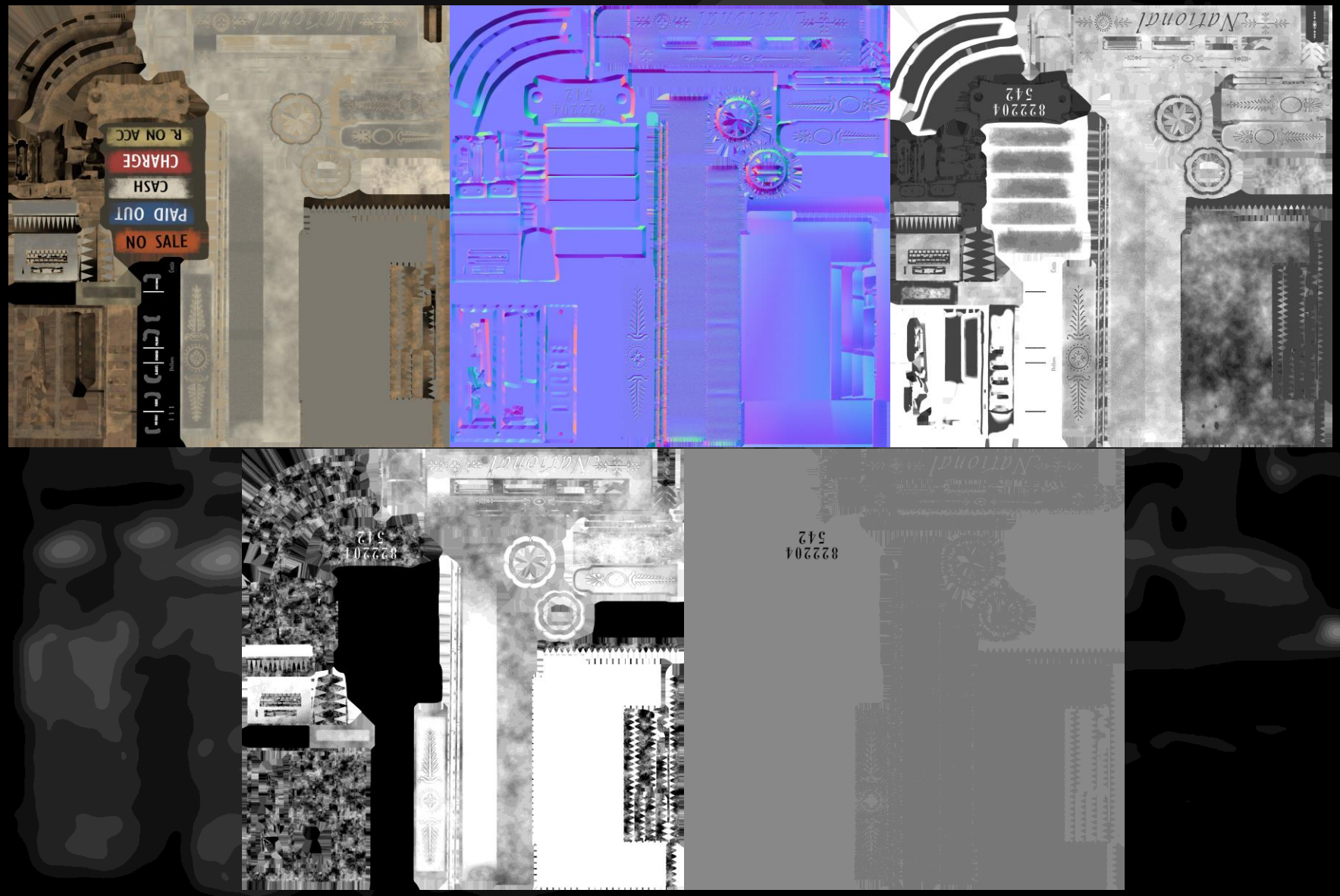


# Materials Till – Misc

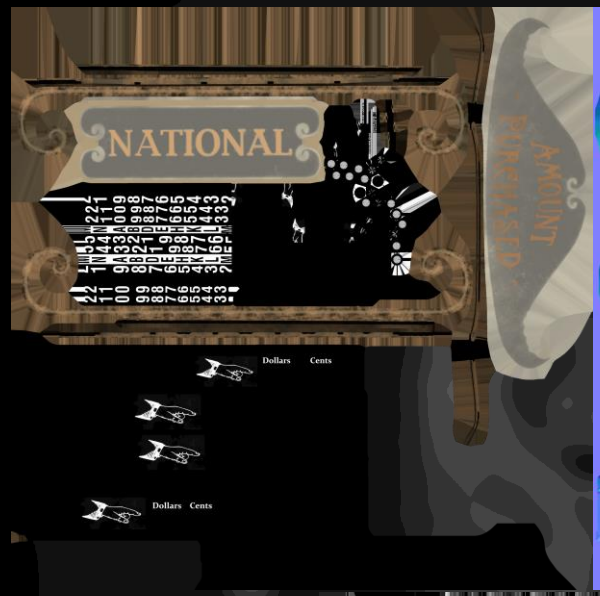


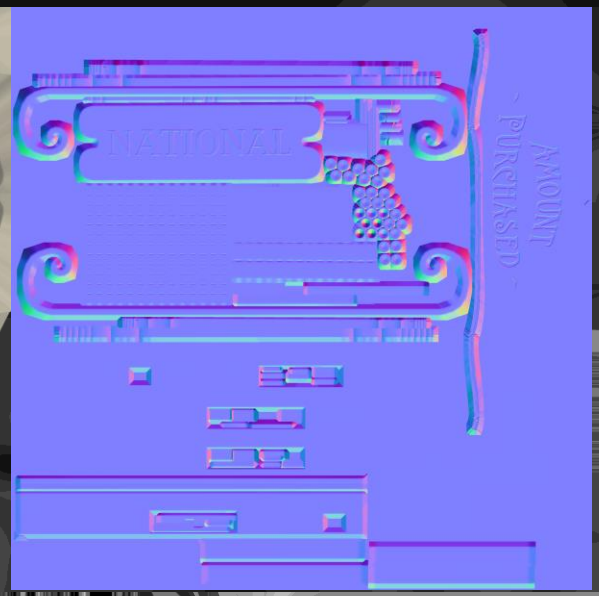



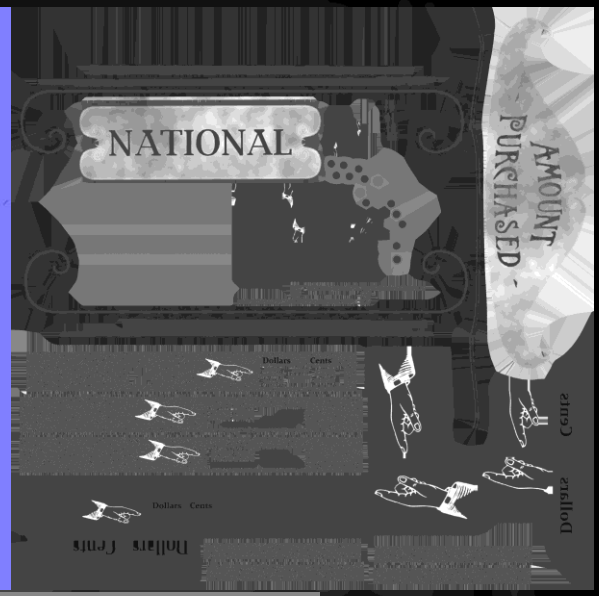
# Materials Till – Secondary

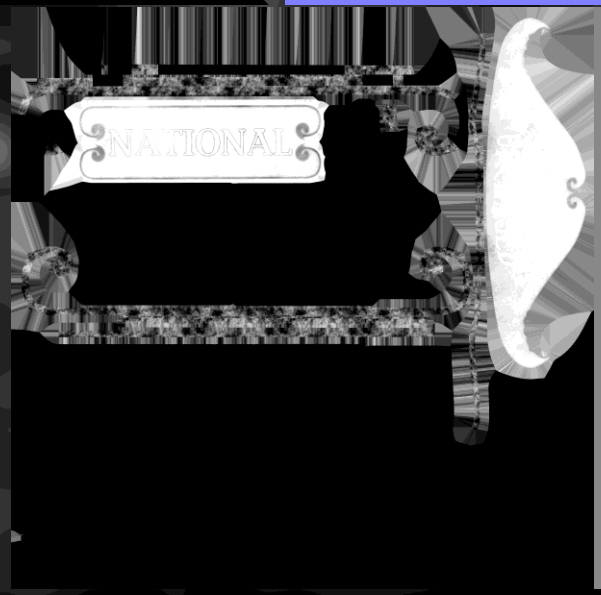


# Materials Till – Sign UI

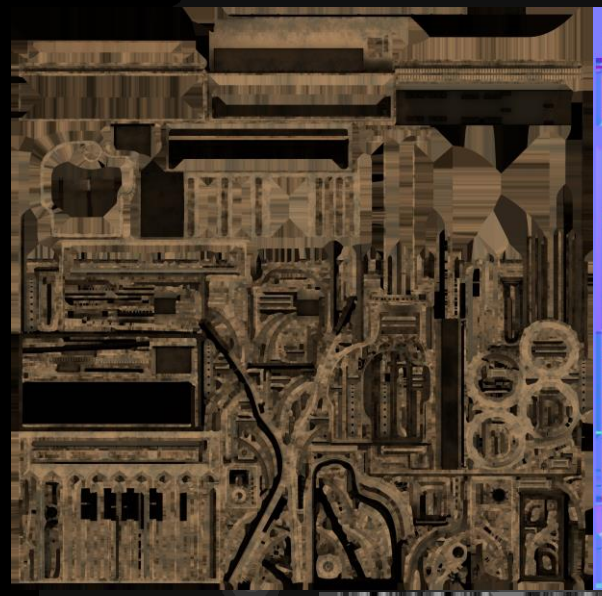
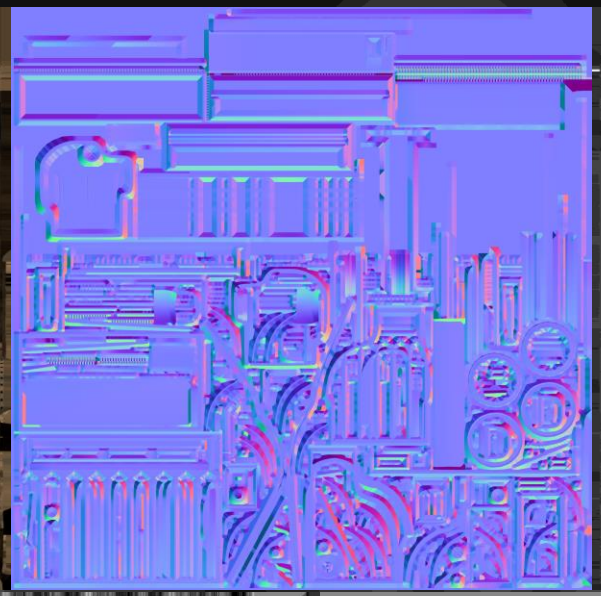
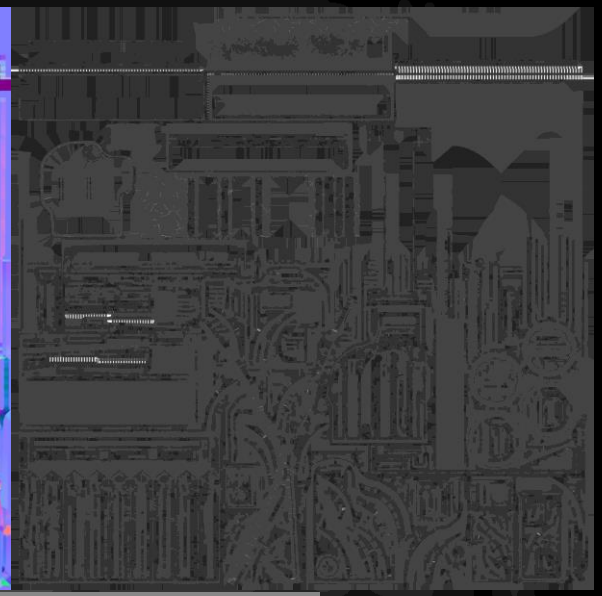
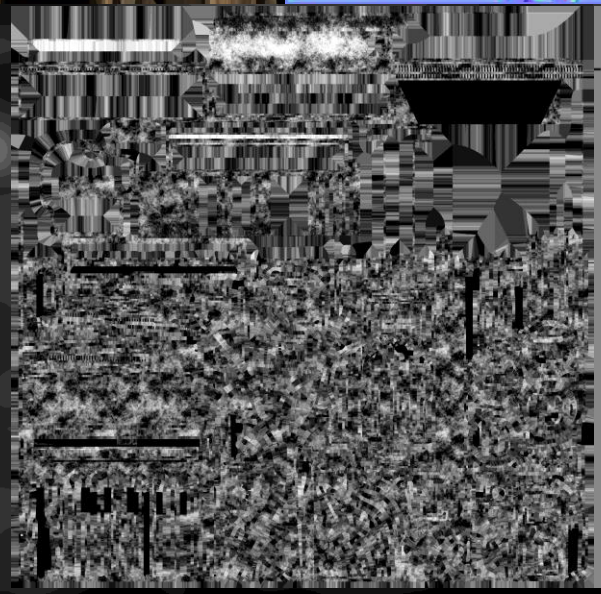
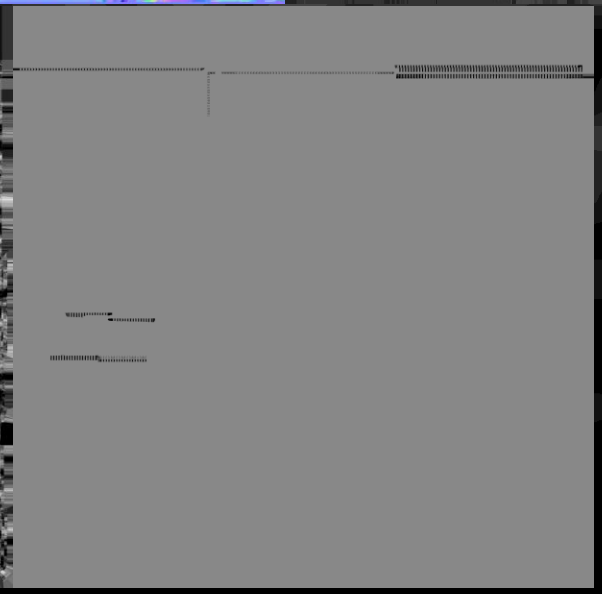


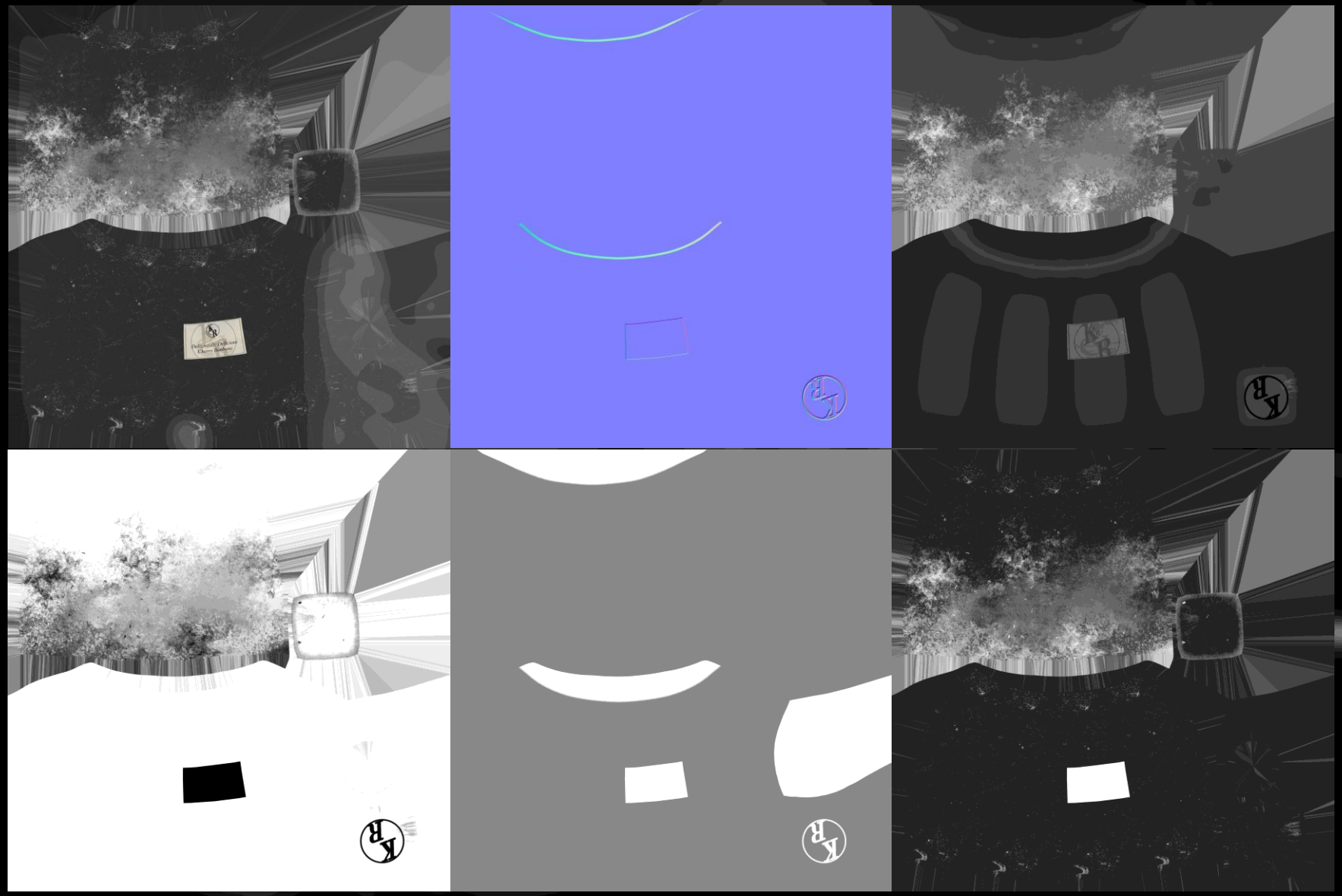



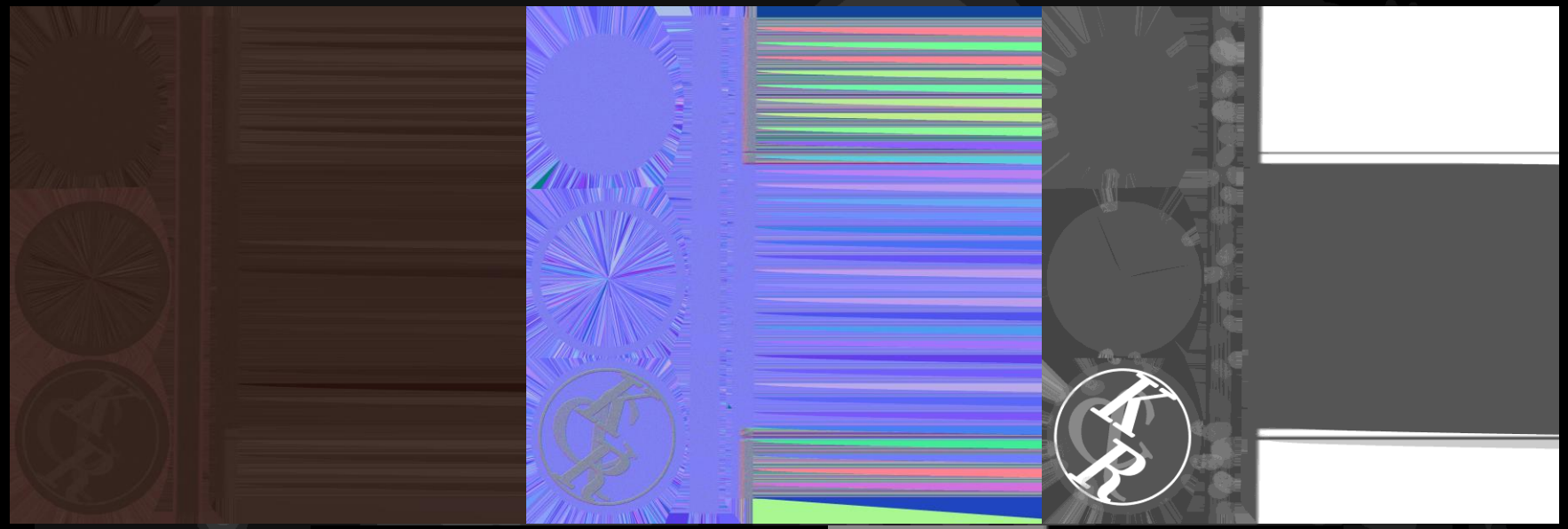

# Materials Till – Trim

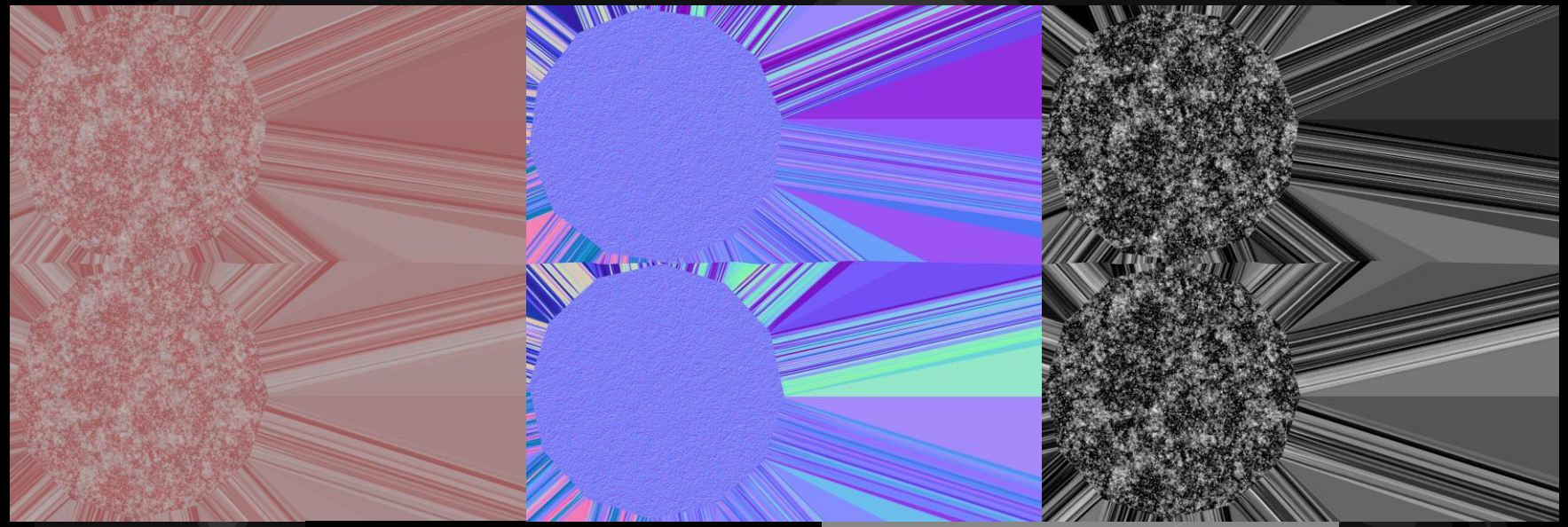
# Materials Background Asset – Jar



# Materials Background Asset – Lid



# Materials Background Asset – Sweets 1



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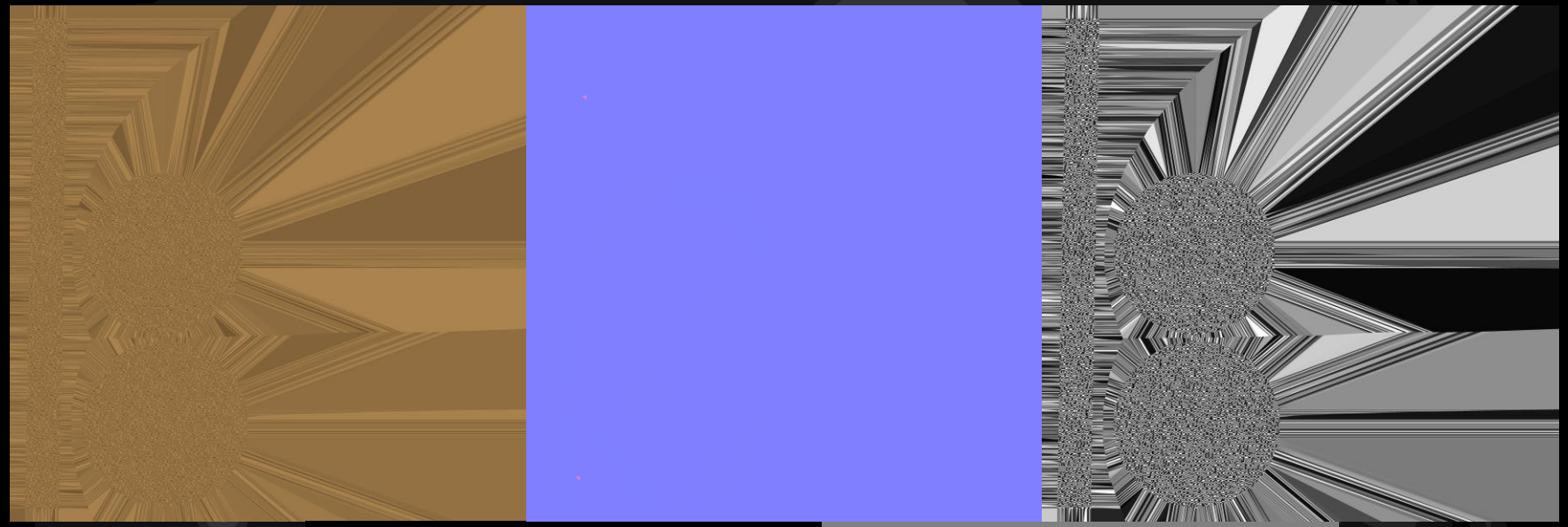
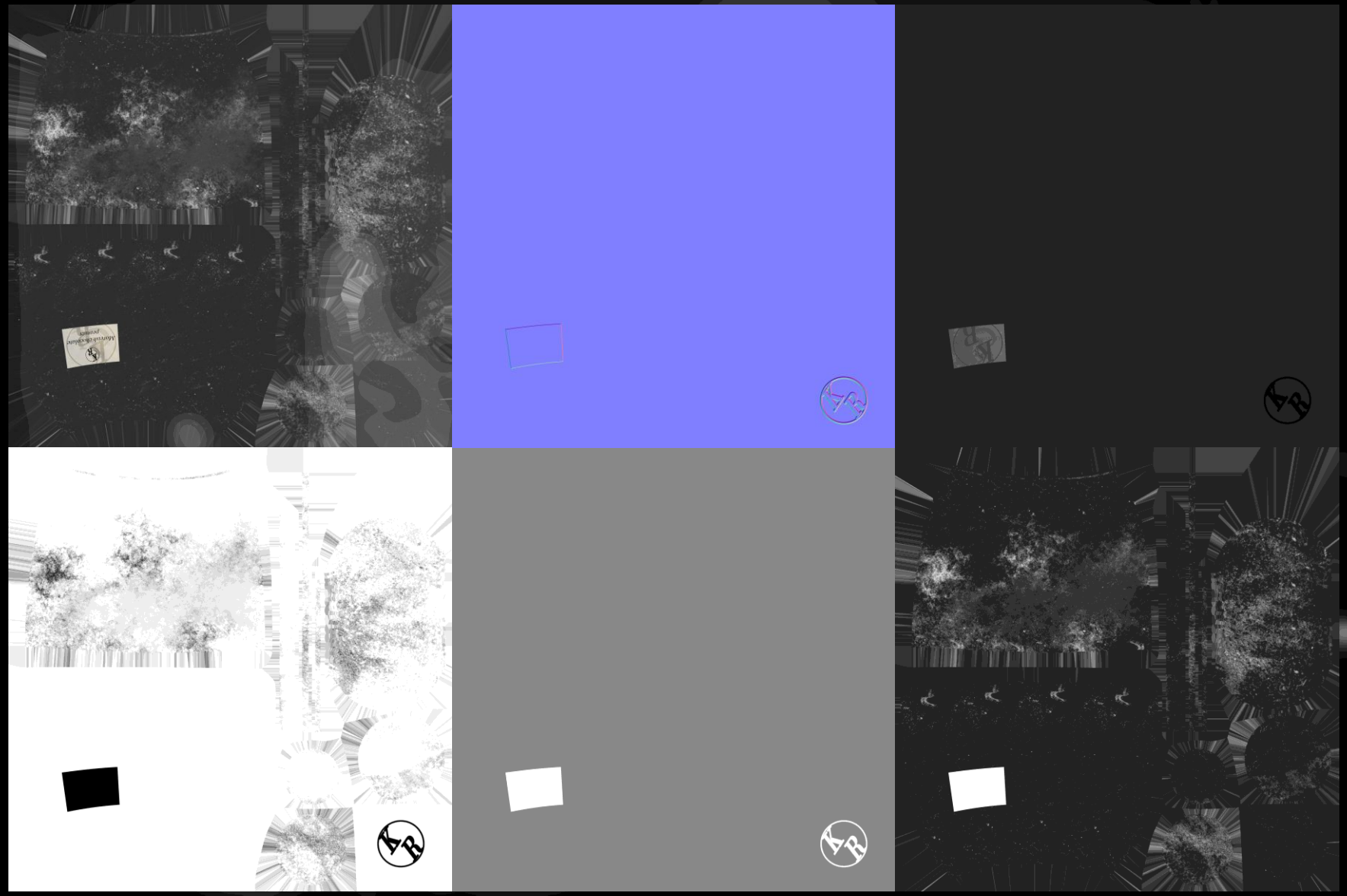
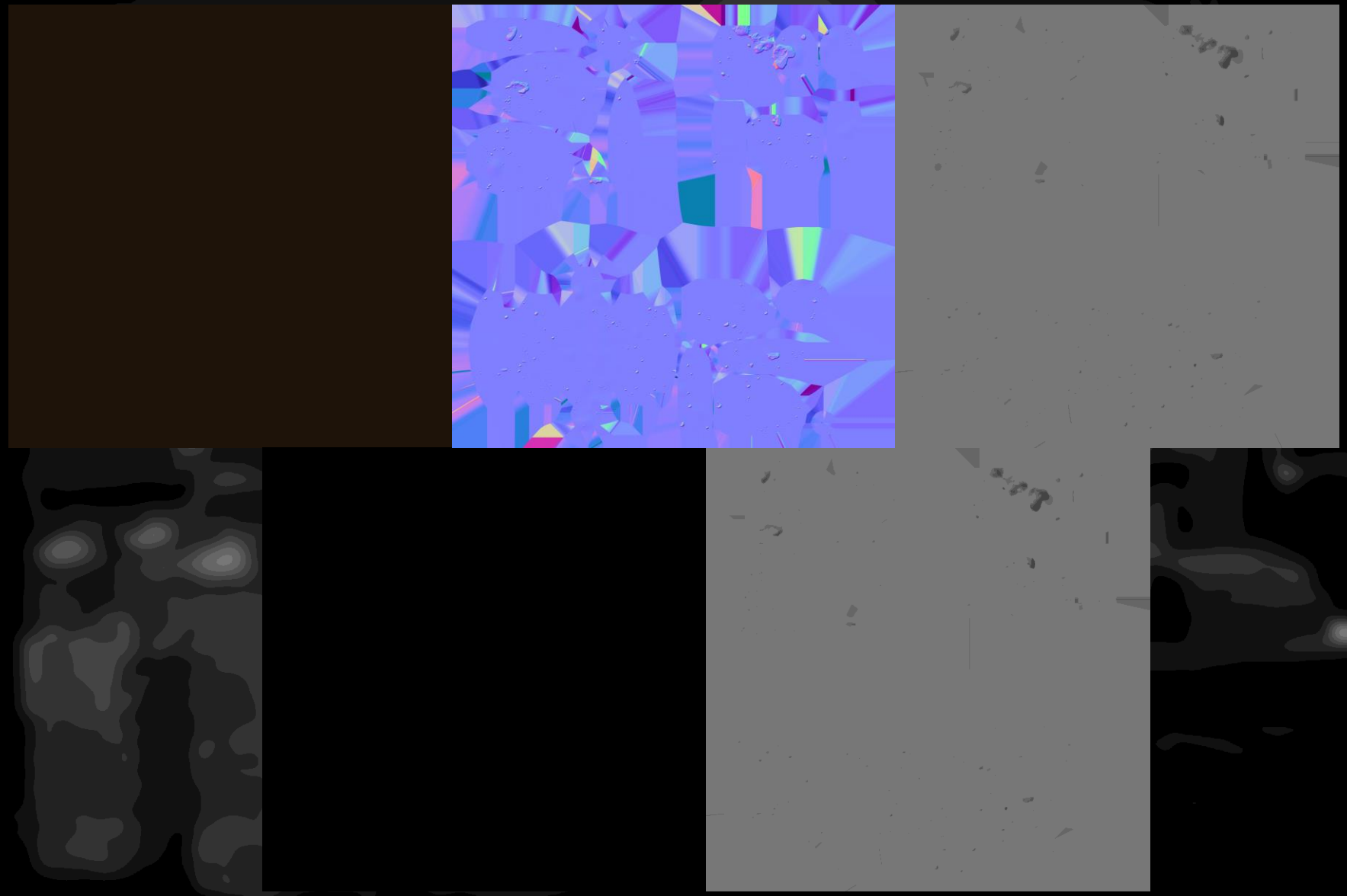


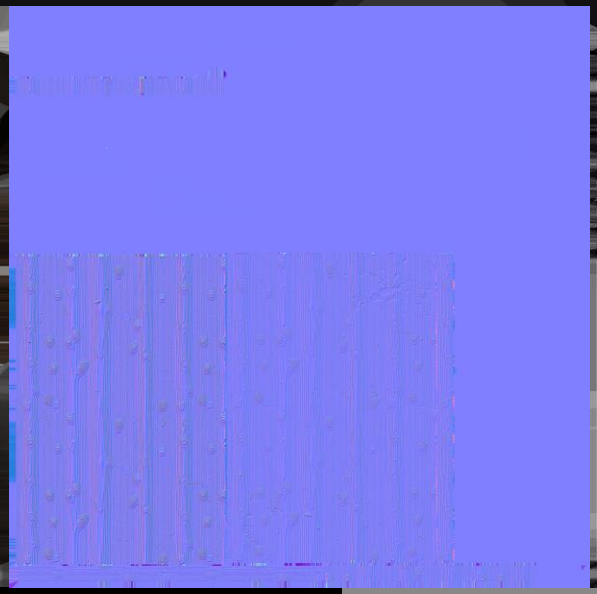
# Materials Background Asset – Jar 2

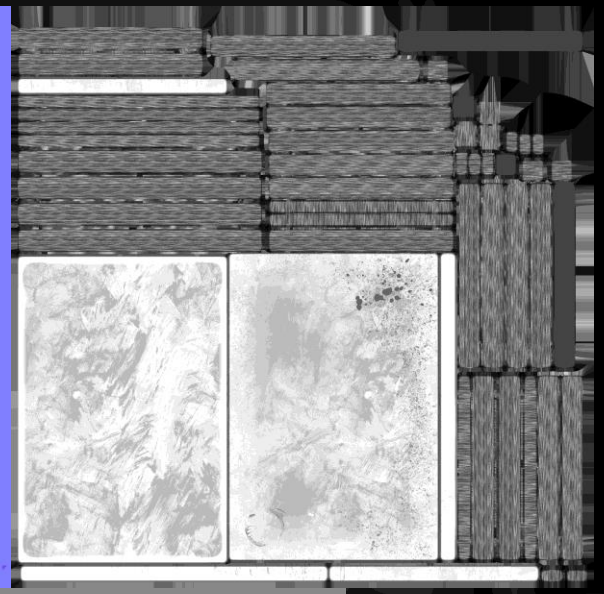


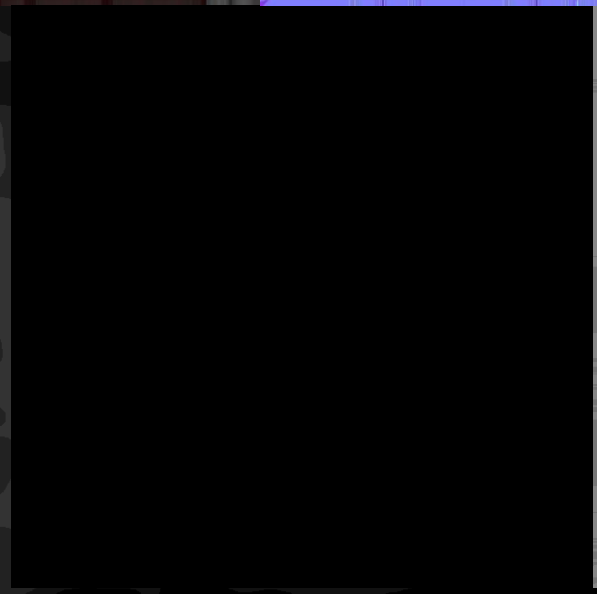
# Materials Background Asset – Sweets 3

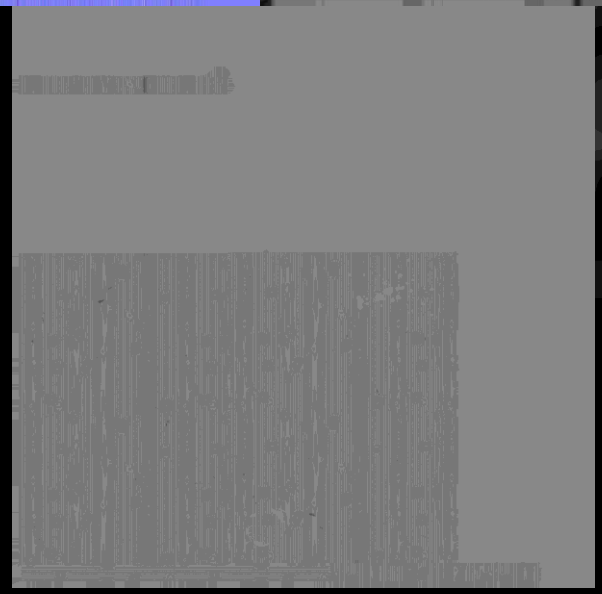


# Materials Background Asset – Table









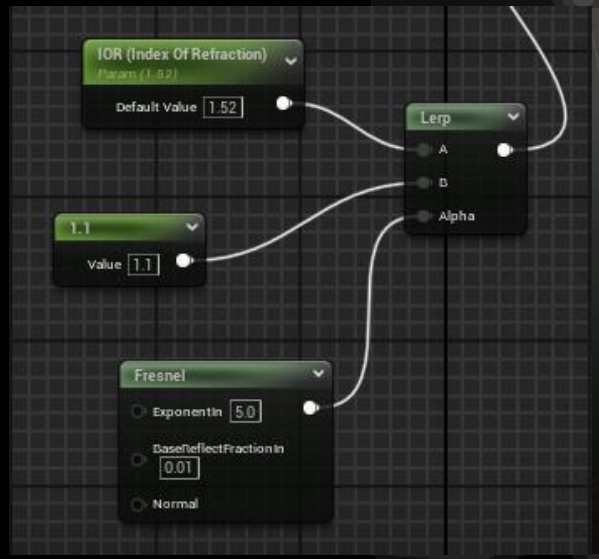

Final Render setups

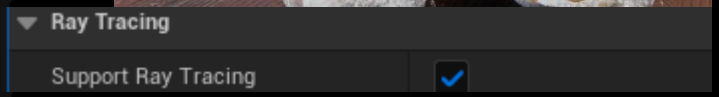
# Final Render Setups - Glass Materials

Once the models were textured, I began bringing them in one by one to make sure the material inputs were working correctly.

One area I struggled with was the importation of glass materials appearing without any distinctive shapes, this was solved by ticking on ray tracing for translucency, resulting in more accurate reflections.

As well as this, index of refraction needed to be enabled to add a layer of thickness between the glass planes.



## Final Render Setups - Glass Materials 2

For the plane glass in the prop itself, I ended up having to separate the base and glass into two separate texture sheets, as UE5 struggles to render both transparent and opaque materials in one material.

I did find a fix around this however this resulted in some noise using AA dithering.

Old method – Temporal Dithering


New method – Separate UV sheet


# Final Renders

# Final Render Setups – Lighting Tweaks

Some final tweaks I made to the scene were as follows:

Changing the fog to have a bluer tint to help contrast with the golden values of the mesh.

Using LUT tables to help adjust the saturation to be less vibrant compared to previous versions (LUT tables using photoshop sliders and adjustments).

Slight camera tilts and movements to help focus on texture work more than the bakes.

Slight exposure changes to overexposed imagery.

Current LUT levels used in level for main context shot)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93 00
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PAID OUT
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AMOUNT
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Dollars Cents
A93 00
NATIONAL


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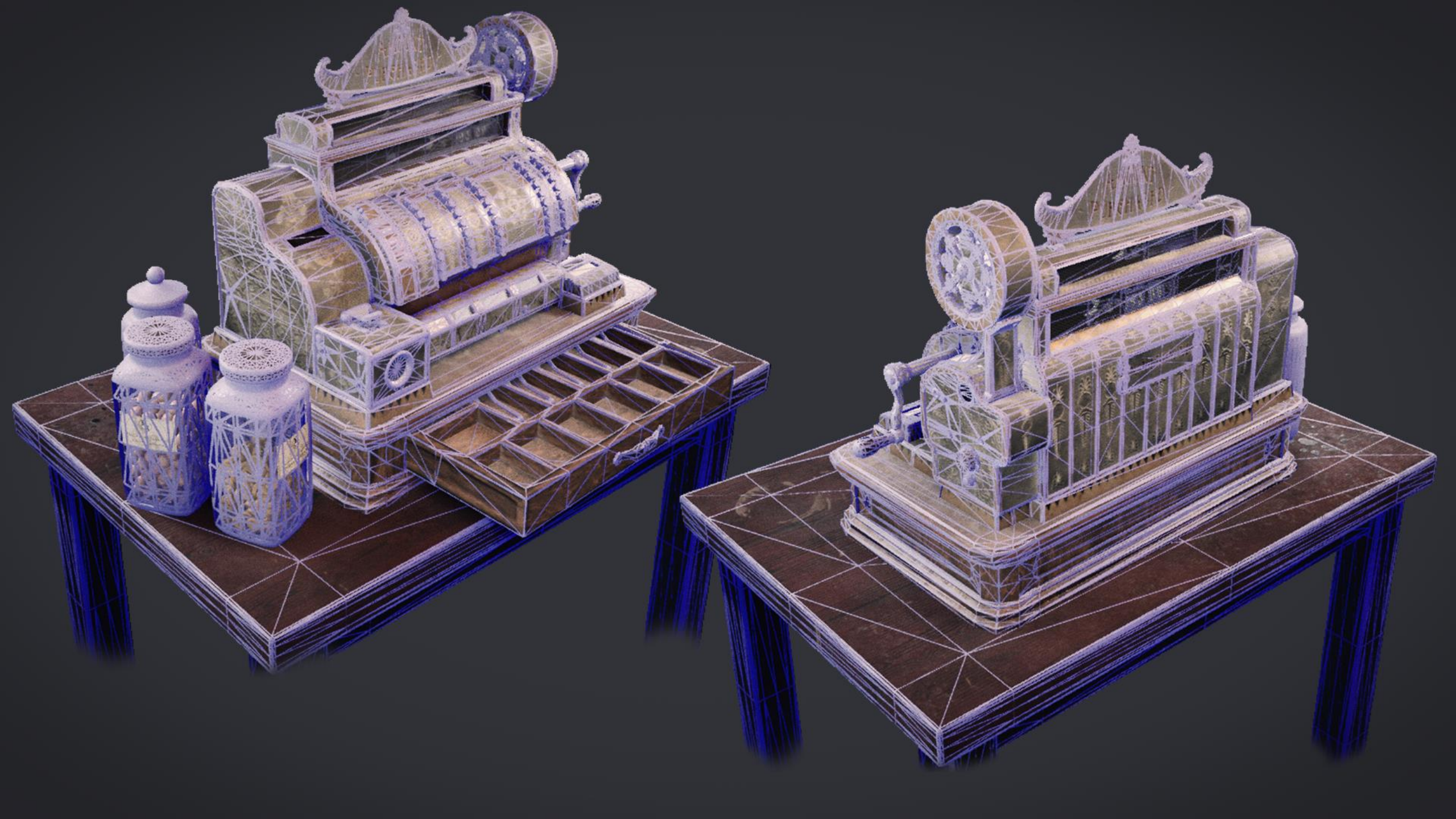


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BY KIERON RUTTER