FINAL YEAR THESIS

Storyboarding, Modeling and Animation of "Through the Window": A 3D Animation Short Film

BY

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This Report Presented in Partial Fulfillment of the Requirements for the Degree of Bachelor of Science in Multimedia and Creative Technology

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DAFFODIL INTERNATIONAL UNIVERSITY

DHAKA, BANGLADESH

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APPROVAL

This Project titled **"Through the Window"**, submitted by Nishat Tasnim Anika, to the Department of Multimedia and Creative Technology, Daffodil International University, has been accepted as satisfactory for the partial fulfillment of the requirements for the degree of B.Sc. in Multimedia and Creative Technology and approved as to its style and contents. The presentation has been held on 26th December, 2019.

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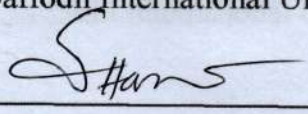

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DECLARATION

We hereby declare that this project has been done by us under the supervision of **Mr. Arif Ahmed, Associate Professor, Department of MCT,** Daffodil International University. We also declare that neither this project nor any part of this project has been submitted elsewhere for award of any degree or diploma.

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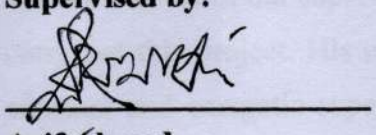

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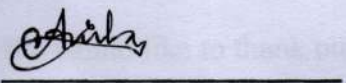

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Finally, we must acknowledge with due respect the constant support and patients of our parents.

ABSTRACT

The way people express their thoughts is changing day by day. 3D animation is one of the new variations of these mediums. As modern technology is in its peak position right now, 3D animation process is now competent enough to express any story with the looks, colors and emotions of any real-life object or character. While our interest was in 3D animation, we also wanted to convey a message through a story relatable to our culture and society around us. So, we chose a story around child labor, which is a complex social problem in our country. It was our goal to articulate the story in a dynamic yet deep and understandable way through the whole process from story building to modeling, sculpting, texturing, rigging, animation, light setup, rendering and post processing. The final output of this project is a video footage that combine all the work that is done hopefully expresses the idea behind making it. We hope, this project will redefine the idea of 3D animation in our country.

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CHAPTER 1

Introduction

1.1 Backstory:

Animation by definition is created by generating a chain of drawings or pictures taken by some sort of simulation procedure for creating movement. It creates an optical illusion through which we are able to see still images or drawings moving. 3D Animation is animating objects in a three-dimensional space, usually created via software which can be rotated and moved like real objects. A motion picture is considered one of the most common methods of presenting animation.

The story we developed titled “Through the Window” was decided to be made as a 3D animation because it was the most efficient way to convey our message. This project was heavily inspired by some animated short films by independent artists and studios like “In a Heartbeat” [1] from Ringling college, “Piston” [2] from ESMA Productions, “Coin Operated” [3] Written & Directed by Nicholas Arioli and “Mr. Indifferent” [4] from BadStache Animation Studio.

“Through the Window” is a one and a half minute long 3D animated short film which contains cartoon style characters in two different realistic environment or sequences. First sequence will be a school environment with adequate lighting and the second sequence will be a small congested old town cheap toy factory environment in dark lighting.

The story of the short film will portray the incidence of child labor in our society. In the first sequence a school boy plays with his new toy car on his way to school and on his way home from school he stumbles upon another boy of his age who was having a hard time making that very same toy car in a factory. This project will bring out the brutal reality of our socio-economic situation in front of people's eyes, about how regardless of age people have to work for minimum wages even when they are school-going age.

1.2 Motivation:

Now-a-days child labor has become normalized in our society. In this project both realities of the lives of privileged and underprivileged children will be shown side by side for comparison. This stark comparison will effectively communicate the circumstances that cost the basic right of education for an underprivileged child to the viewers.

In our society it is not uncommon to see children working instead of going to school just to feed themselves. Some employers make them work so much as though they were adults while they would never let their own children go through the same situations. It is the hypocrisy of the people with lower morals and no ethical standards. This regular but pathetic sight was the motivation behind developing such a story and make it into a 3D animation.

1.3 Objectives:

Objectives of this project are:

1. Create different props models
2. Create 3D characters with attractive, adorable features
3. Create two different environments to portray the story appropriately
4. Texture the models to make them look as close to real objects as possible
5. Rig and skin paint the characters to make them workable models for animation
6. Animate the characters with proper body language and facial expressions
7. Light the scenes properly for the maximum resemblance with real environment
8. Render the animated frames in proper quality and format
9. Color grade and assemble the scenes
10. Add sound effects to enhance the experience
11. Portray the social situation of child labor through 3d animation
12. Create awareness about child labor in a relatable way

Although the output of this project is a 3D animation but it is not necessarily targeted towards children. The target audience of this project are people of age thirteen and up but people of any age can watch the film and enjoy it.

1.4 Literature review:

Several 3D animations have been consulted to offer an in-depth analysis of the best methodology for the film. In the film "In a Heartbeat" Beth David and Esteban Bravo used a specific pattern for the environment in their film. Everything had a “Heart” shaped feel to them. The idea of selecting a pattern and stylizing all the props and environment according to that was inspiring. Some films use semi realistic environment style such as “Piston” of ESMA productions whereas others use super realistic background environment like that of Badstache studios “Mr. Indifferent”. Luke Snedecor & Sarah Heinz at Chapman University created “Preheated” [4] which portrayed a child character, which is a wonderful reference. The animated short film "Alike"[5], directed by Daniel Martínez Lara & Rafa Cano Méndez, used a minimal but stylized background environment with the unique idea of rounded edged buildings. "Watermelon A Cautionary Tale"[6] by Kefei Li & Connie Qin He had amazing animation and lighting but the background props were not much detailed and there were some noticeable mistakes where surfaces which were supposed to collide goes through each other instead. Problems like these inspired us to be looked into to eliminate in our film. 3D animated short film “The Present” [7] was based on a great little comic strip by the very talented Fabio Coala. This film has excellent texture and lighting. Most of these films had a subtle depth of field as per needed in each scene which gives us a challenge to obtain. By studying all of these films and more we have chosen the best combination of designs, textures and environments to portray our story vividly and comprehensively.

CHAPTER 2

Storyboarding, Modeling & Character Modeling

In this chapter the some primary parts of the 3D animation Pipeline is going to be discussed in detailed.

2.1 Storyboarding:

A storyboard is a graphic representation of how your video will unfold, shot by shot. [8]

Storyboarding provides a visual guidance to how the production process would go. It helps to differentiate between the necessary shots and the unnecessary once. It also helped to edit some shots in order to make them more feasible. Storyboarding is the best way to share the collective vision for visualizing the story. It makes production much easier because we know exactly what to do and how to do it. Storyboarding makes the vision sharing with team much easier and helps the production process go smoothly without wasting any time.

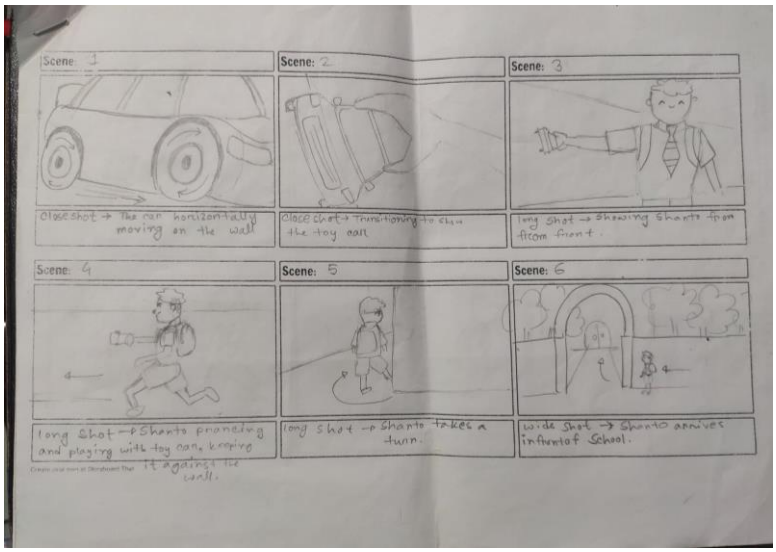


Figure 2.1 Storyboard page 1

In the above picture it is shown that the storyboard is drawn shot by shot according to the shot division. It has little notes about how the shot will go on, what the characters would do and describes a little about the environment.

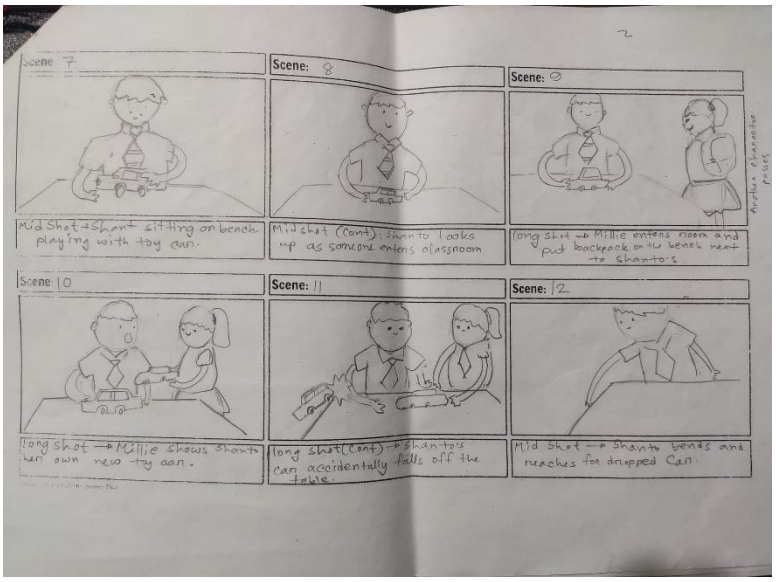


Figure 2.2 Storyboard page 2

The drawings are kept minimal and simple. The idea was to just visualize the shots with as little details as possible. Accurate drawing with a lot of details were unnecessary in this case. So the characters are simple, but in each sections the drawings are made in such way that the actions are vividly understandable.

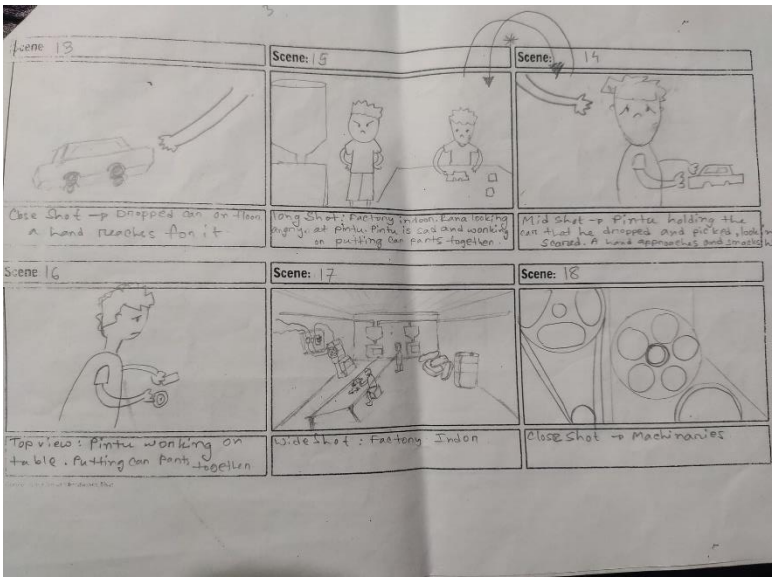
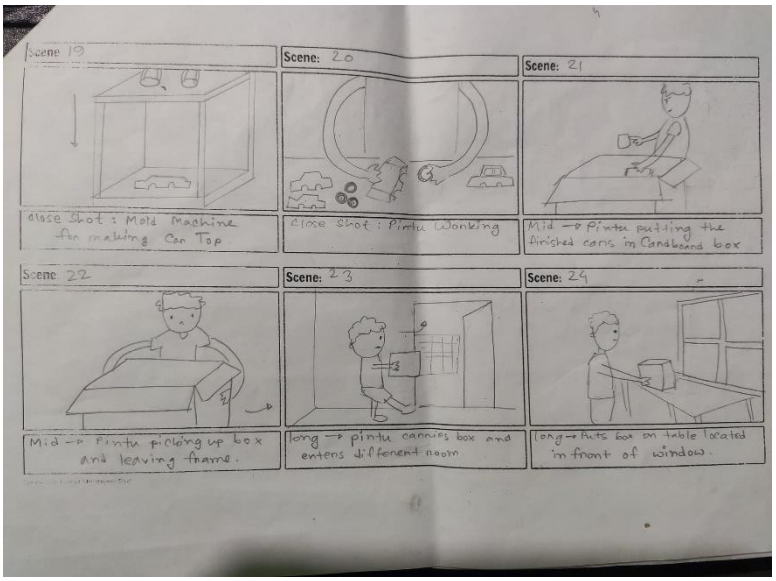


Figure 2.3 Storyboard page 3



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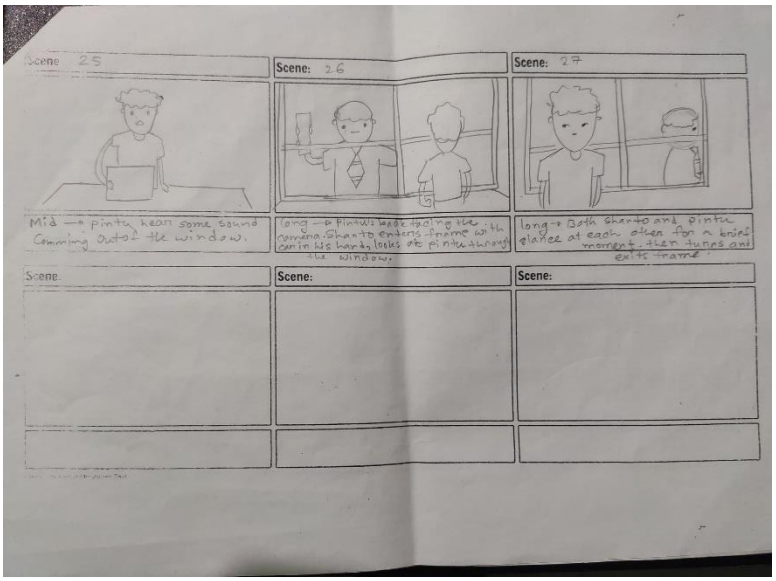

Figure 2.5 Storyboard page 5

Even with minimum drawings with some symbolizations in-between, the storyboard is still able to tell the story and provide a concrete idea about the workflow.

2.2 Modeling:

3D Modeling is the process of creating the faces of an object in 3 dimensional space within a 3D software. There are a few types of modelling which includes Polygonal and Nurbs modeling. But for this project we chose polygonal modeling because it is more popular and more familiar to us. We chose Autodesk Maya 2018.6[9] as our modeling software. In this modelling process standard primitives like boxes, spheres and cylinders are used and modified to make various models. For modification, tools like extrude, bridge, combine and deformers like bend, lattice etc. are used. While modelling all the props and characters it is strictly followed that all the polygons should be in quads. Because The description of the models I made are given below.

2.2.1 Swing Set:

The swing set was made for the playground outside of the school in this project. The entire model is divided into three parts e.g. stands, chains and seats.

The stands are made out of polygon cylinders. They are bent in the middle with the bend deformer tool accessed from linear deformers in the Deformers dropdown menu while Modeling is selected in the shelf menu. Another cylinder is used across the bent cylinders which makes the beam that holds the swings.

For the chains a primitive polygonal torus was created. Then it was scaled down to make a more oval shape. It was then duplicated and rotated 90° and translated a little so both of the torus stays intersected. The first torus is then translated and duplicated several times. The same is done with second torus. Duplicating all these makes a formation of chain. All these are then grouped together and kept aside.

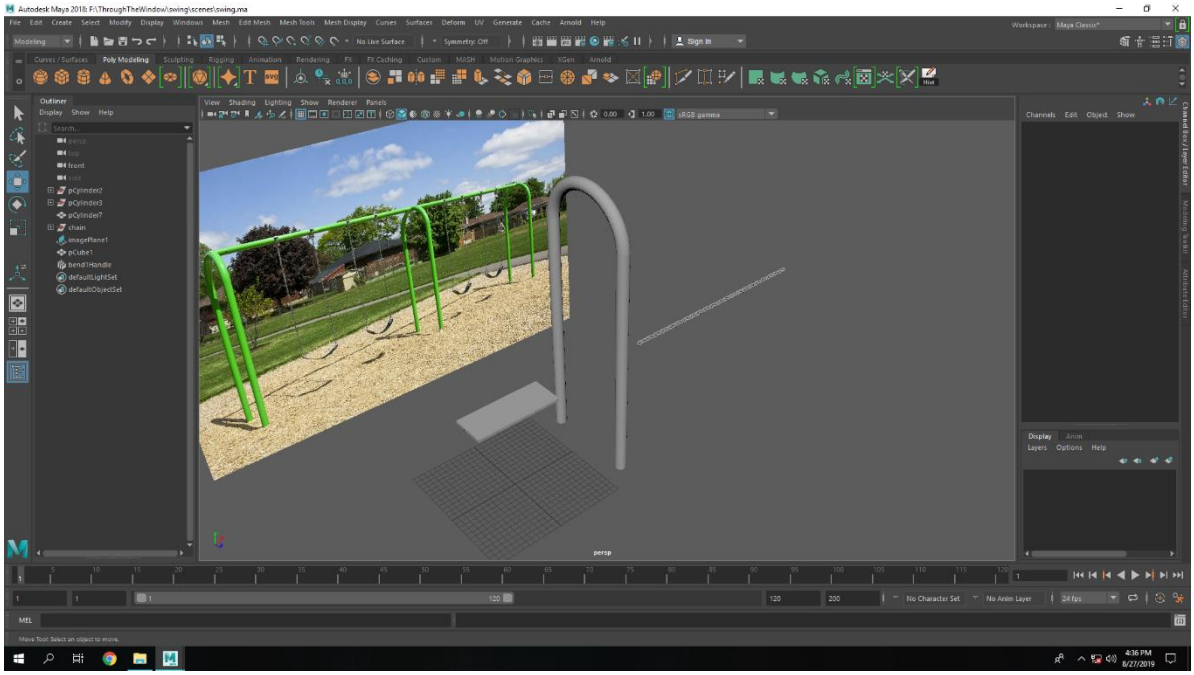

Figure 2.6 Swing model parts

Seat is made out of polygon cubes. First a cube is scaled down to make it flat. Another cube is then scaled and extruded to make the straps. The ring that connects the seats and chains are also made out of primitive cube.

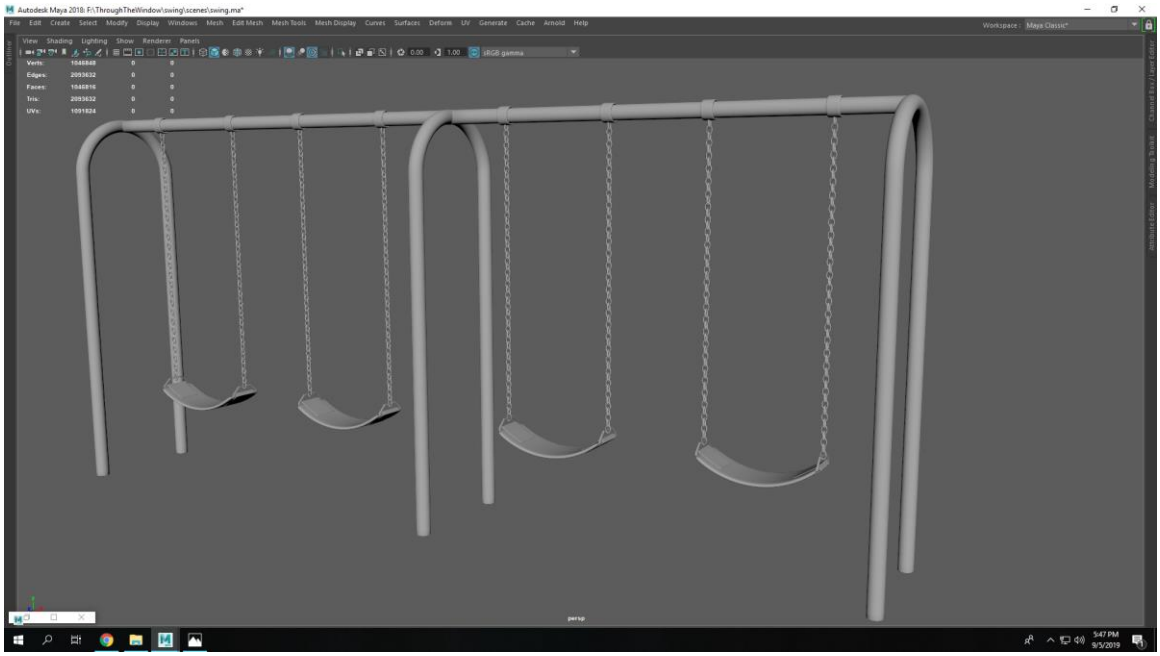

Figure 2.7 Swing set model

Using the default subdivisions of the primitives made the model heavy. High poly models like this cannot be used in a complex scene. That is why the subdivisions was then limited to 8 to 10 in each primitive polygon to make the swing set into a low poly model.

All of these are then assembled together to make the whole swing set that matches the reference picture.

2.2.2 Slide:

The slide has two parts, the ladder and the sliding part. For making the ladder a box was taken and it was scaled up to 24 centimeters in the y axis. Then it was duplicated to make the other side of the ladder. For the steps another box was created and scaled up to 7.5 centimeters sideways. It was then duplicated 5 times to make all the steps to match the height of the ladder. The steps and sides of the ladder were then grouped together and rotated 30°. for the slide itself a box was first scaled 7.5/2.5/3 centimeters and translated to the top of the ladder. The by adding edge loops and extruding the side faces a basic shape was created.

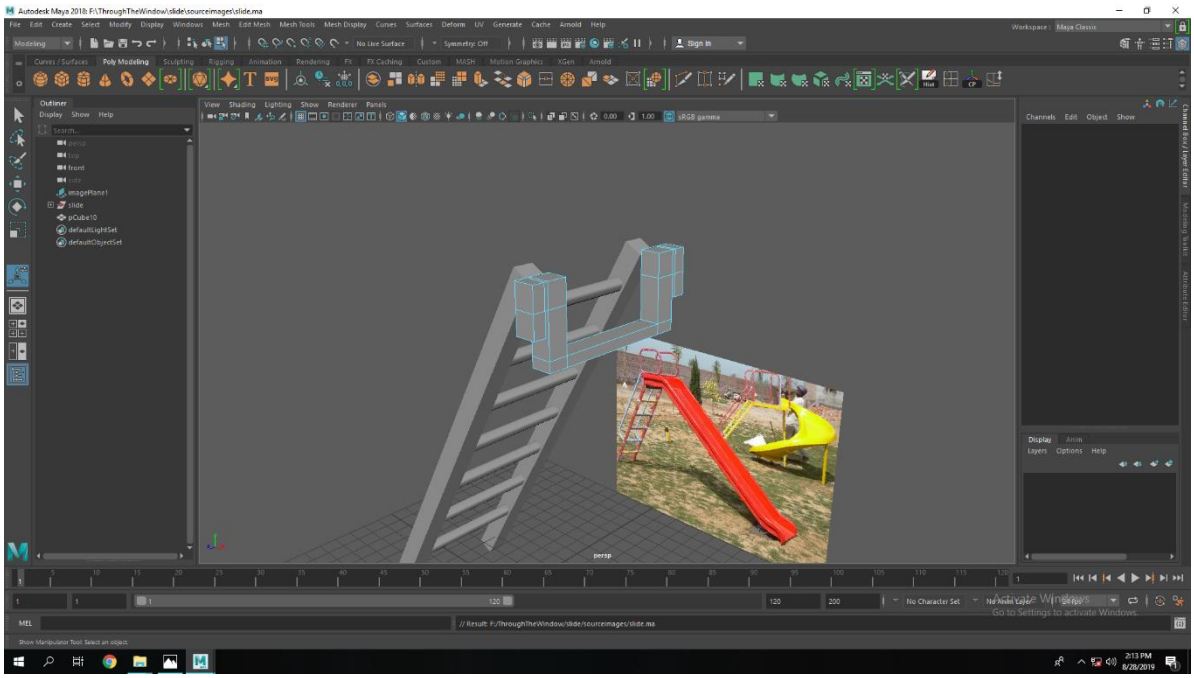

Figure 2.8 Slide model basic shape

After that the whole thing was extruded from the front and translated and rotated so that a concave slope is created. From the railing a pCylinder was taken and extruded and bent and duplicated once finished to fit the purpose.

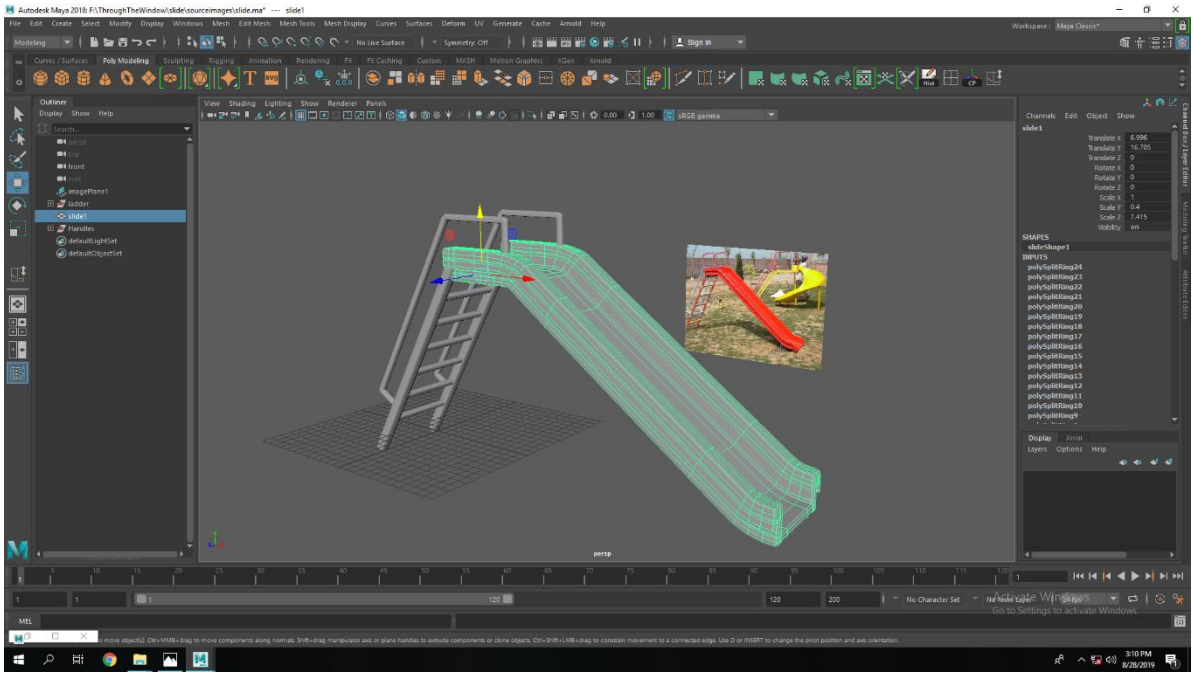

Figure 2.9 Slide model

2.2.3 See-Saw:

This one was a very simple model. For the see-saw body a pCube is scaled to match real world. Some pCylinders were used as handles. For the stand, pCylinder was scaled up and then bend deformer from deform> Non-linear> Bend was added. This made only one half of the hole stand. It was then duplicated using Duplicate Special. After deleting the forward-facing faces of the two halves, the vertices are then merged together to make the whole stand.

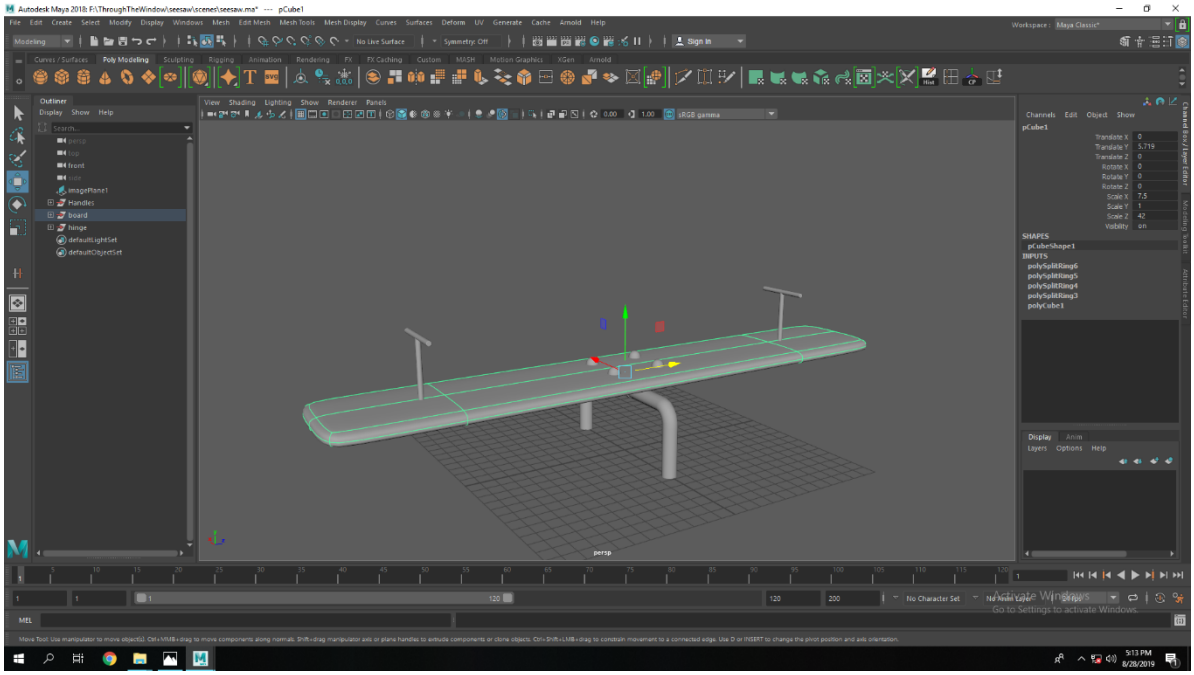

Figure 2.10 Seesaw model

For the hinge that attaches the see-saw bench and stands, a pCylinder was simply extruded in specific edges to make up the shape. Com pSpheres are cut in half and placed to look like the screws on the bench.

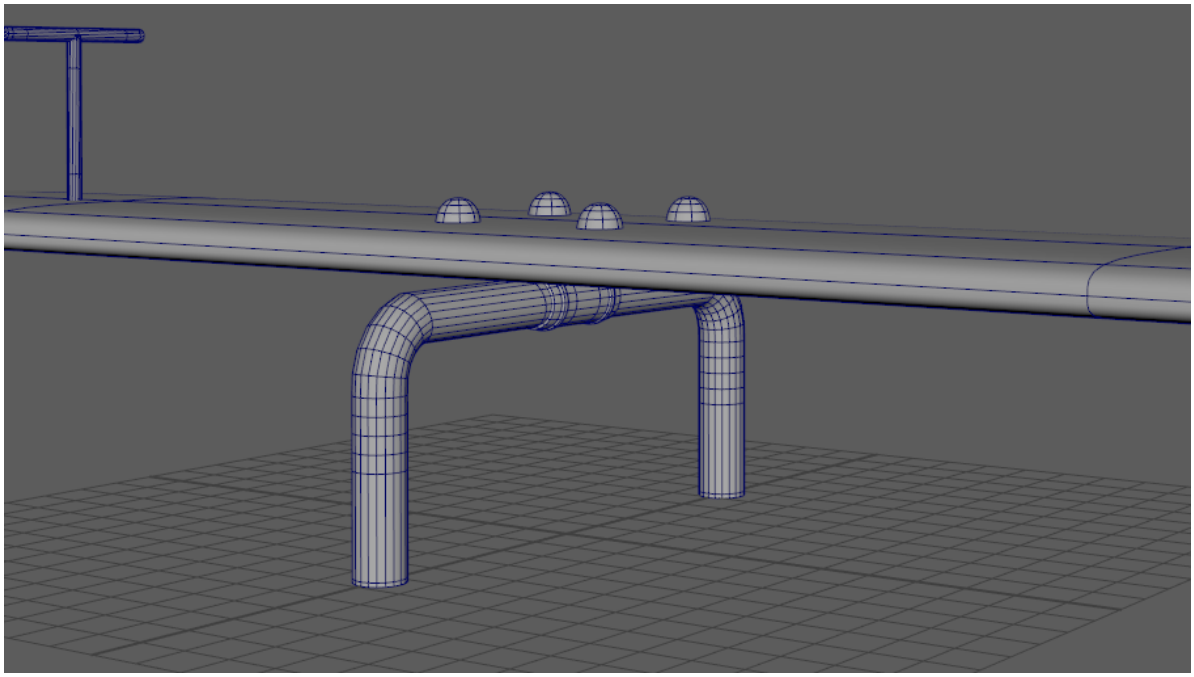

Figure 2.11 Seesaw model hinge

2.2.4 Lamp Post:

Lamp post was basically made with a pCylinder. Edge loops were added from Shift+ right click > insert edge loop wherever there were crease and crevices. Then the faces were selected there and extruded out wards or in wards to make them look like the reference. when the main post is done, a pCylinder id taken, place where the pipe that holds the light should be. It is then scaled to measure then extruded and rotated to make a curved model. A pCube is morphed into the light holder by adding some edge loops and translating the vertices. it is given a more rounded shape.

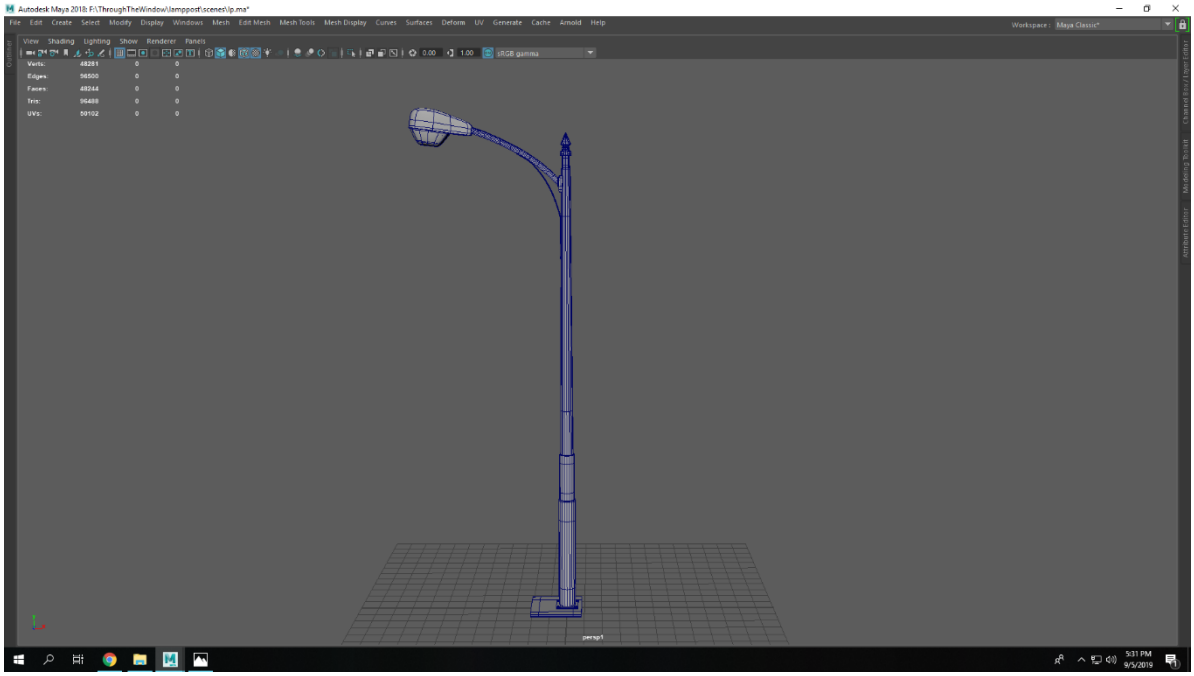

Figure 2.12 Lamp post model

For the light itself, a pSphere is taken and top half faces of it is deleted. then with the help of Grab Tool from the Sculpting shelf the shape of the light is match with shape of the holder.

Additionally, some pCubes are added to the bottom of the model to make the base of the post. Screws are made by extruding low poly cylinders. The whole model is then smoothed by pressing 3 button on keyboard.

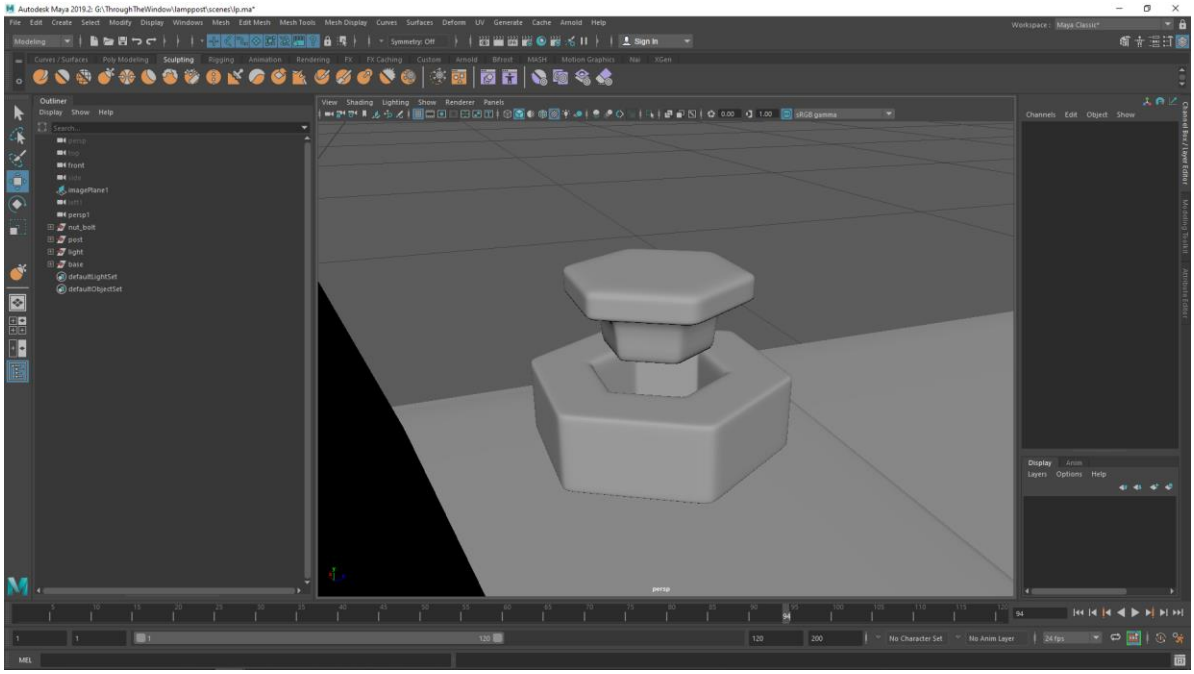

Figure 2.13 Lamp post Nut-bolts

2.2.5 Dustbin:

The dustbin was made keeping the typical Bangladeshi public dustbins in reference. The Body of the Dustbin has a simple cylinder shape. So, a pCylinder is taken and the two face of it is simply extruded inward and translated down to make a hollow but shelled bin.

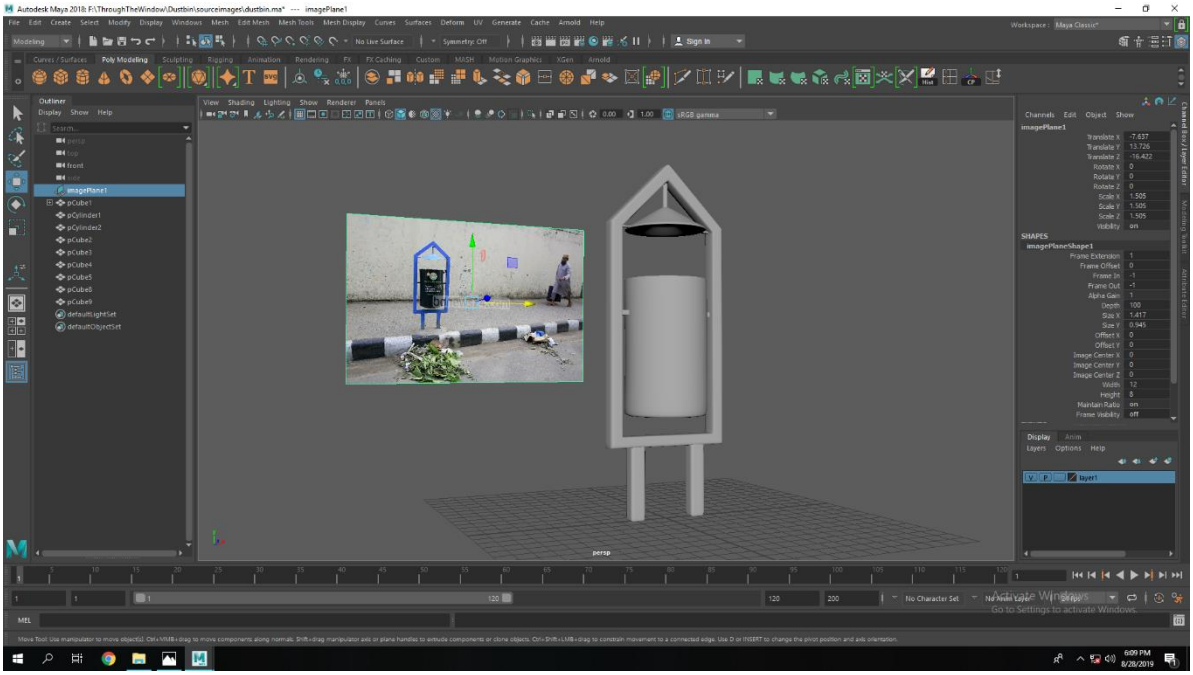

Figure 2.14 Dustbin model

For the Frame of it, a pCube is created. Fist the opposite faces along the z axis are extruded slightly in ward, then the inwards faces of the opposite side are selected and bridged by selecting the Bridge command from the Modeling Toolkit. This bridges the corresponding edges together and made a rectangle frame with a hollow in the middle. As the dustbin has a pointy top achieving that required a simple trick, on the top part of the frame and edge loop in the middle was added. For keeping it right in the middle select an edge then alt + right click > Edge Ring Utilities> to edge ring and split. After adding that edge loop in the middle simply selected the vertices and translated it in the y axis. For a more refined look, some more edge loops were added to every corner and smoothed by pressing 3 on keyboard.

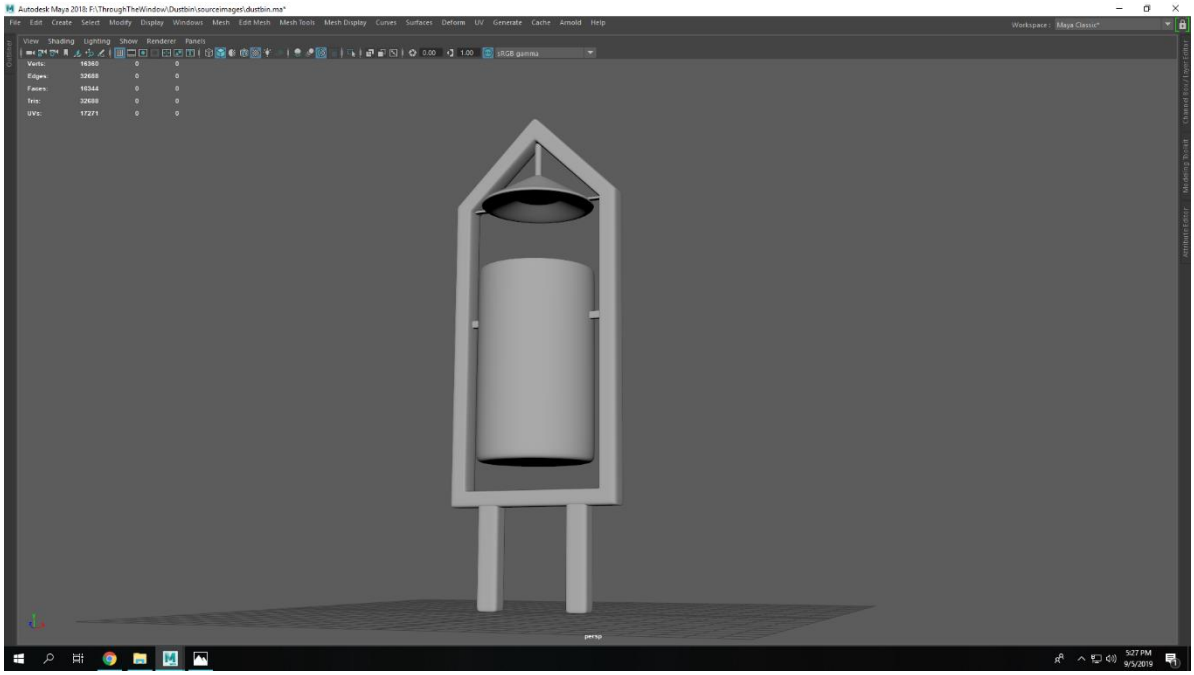

Figure 2.15 Dustbin model bottom view

The legs and the metal pieces that joins the bin and the frame together are made pCubes by simply deleting the faces that will remain hidden. For the lid of the bin, a pCylinder was created and scaled down in an almost flat shape. It was extruded and scaled upward from there to make a conical shape. The small top of the cylinder is then extruded a long way to make that long part of the lid that is attached to the frame. It is also smoothed.

2.2.6 Fence:

The fence was also and easy model to crate. First a pCylinder in bent using the Bend deformer. The envelope curvature low bound high bound parameters were needed to be tweaked to make the desired shape. While using the bend deformer it needs to be kept in mind that the part of the object that needs to be bent has to have a lot of segments. Without any segments bend deformer does not have a node to work with. The more segments are there the smoother the

bent part would be. But using low number of segments also work if the model is smoothed after making.

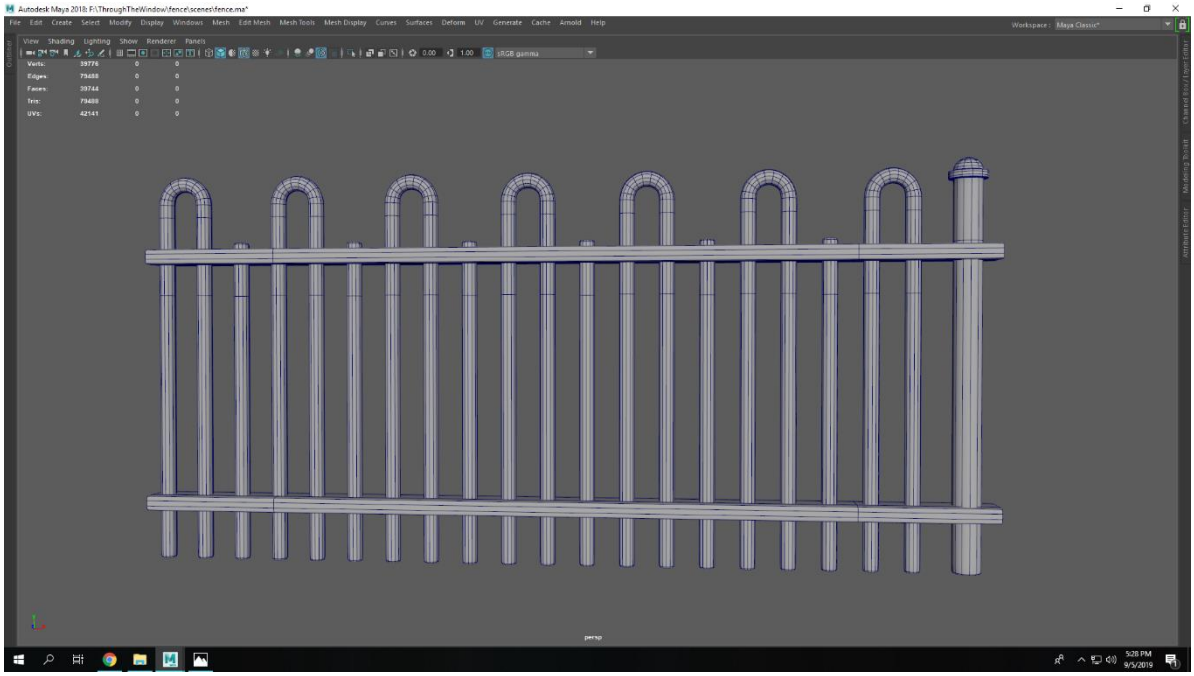

Figure 2.16 Fence model

The fence in the reference picture had two types of rods – one was bent and another was a single straight post. They were arranged in a way the in the middle of two bent pieces there were a straight piece. For this reason, the bend pieces were first placed within a single box of the grid from top view. Then it was duplicated pressing Ctrl + D on the keyboard. It was then translated to the next grid keeping a grid space for the straight post. Then Shift + D was pressed several times which placed all the bent posts on equal distance so there was a space for a straight post in between all the single posts. Then the straight post was place in the middle of the first two bent posts and duplicated similarly to sit on to their designated place.

For the beams that hold all the posts together a pCube is simply scale dup to fit them then duplicated once and they placed one on top and one on the bottom. Some of the edges of this model was removed to make it more low poly. Smoothing gives it a high poly look without all the added polygons that make a model heavy.

2.2.7 Signal post:

The signal post was an extra prop made for just in case. It had a simple post unlike the lamp post but the actual signal lights and the casings were a bit challenging to make.

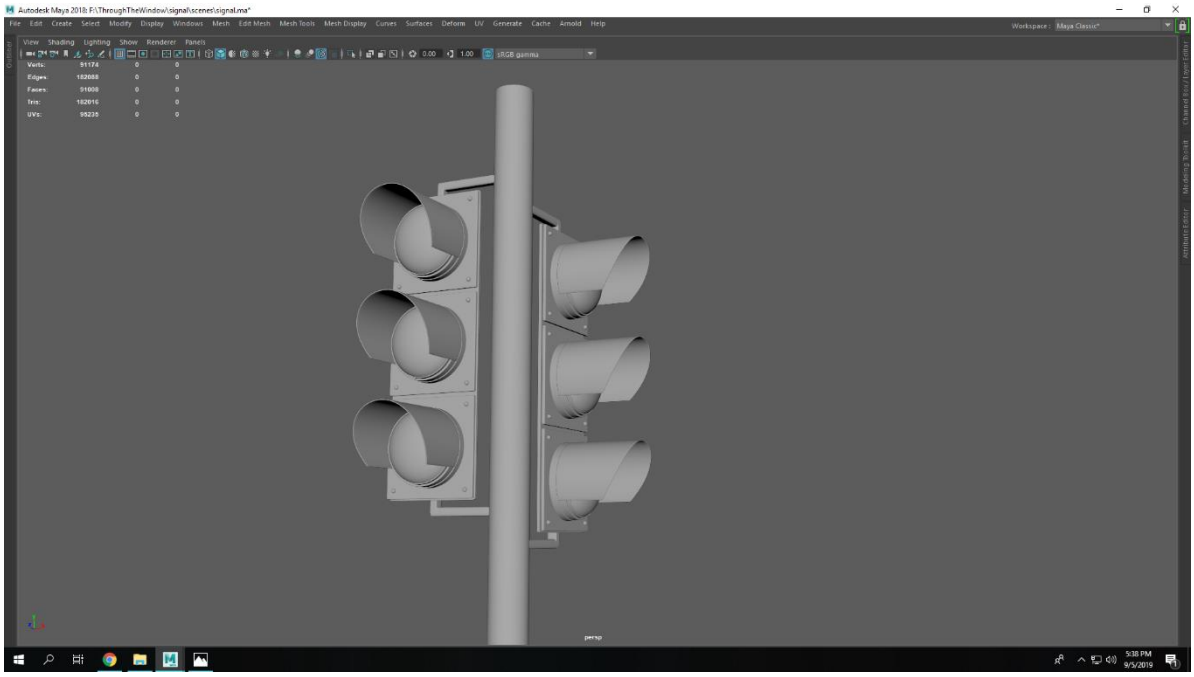

Figure 2.17 Signal light model

The light holder was a pCylinder scaled to be flat first then the front face is extruded to make a holder for the light. The light was a hemisphere created by deleting half of all the face of a pSphere. For the hood, a pCylinder was flatted and extruded a little inward once. Then after deleting the unnecessary faces, the remaining faces were then extruded outwards. For the perfect shape, with Soft Selection Tool the vertices on each ends of the hood were translated in wards. It gave the hood a more cap-like shape. Then all the pieces of the light were assembled together.

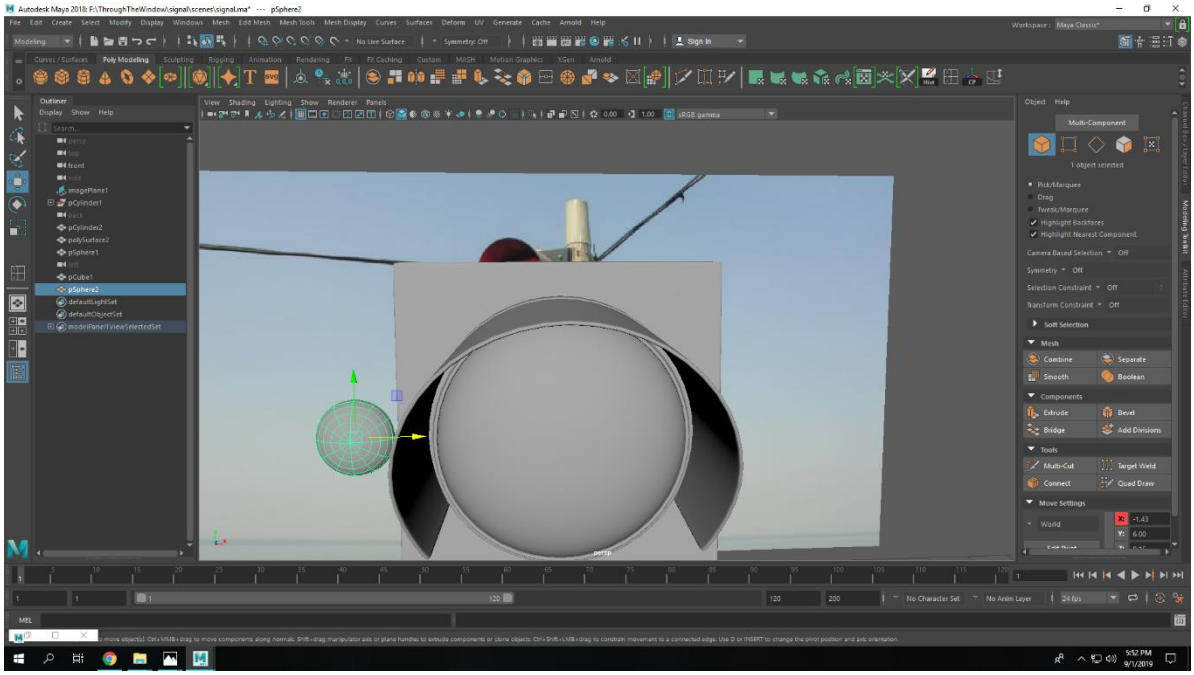

Figure 2.18 Signal light close up

2.2.8 Clock:

This model was made by scaling and extruding a pCylinder. The clock has a flat base. The clock face had a crease where the glass may sit. The glass was made from a pSphere which scaled down to make almost flat with very little depth. The reason behind taking a sphere instead of a cylinder was that a sphere had a concave top. I wanted to give the clock a more roundish shape.

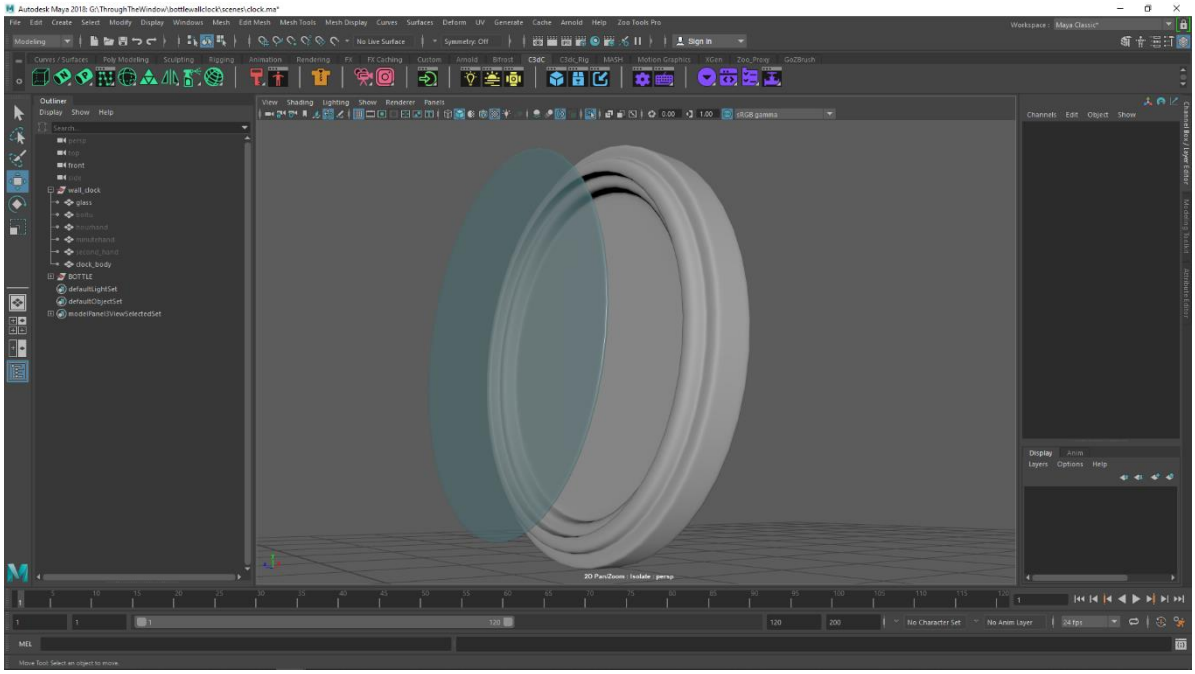

Figure 2.19 Clock glass model

This clock had three hands like any normal clock. The hour hand was the easiest to make. A cube is scaled like a flat rectangle and that is basically it. The hour hand is the shortest hand. The minute hand is a longer and slightly tapered version of the hour hand. So, the hour hand was Duplicated and scaled to make this.

For making the second hand a pCube was taken and scaled down. By adding edge loop some segments were created. Then the top face was extruded to make a long part that would be the pointing part of the hand. It was scaled down a little to make a tapered look. This was the longest hand.

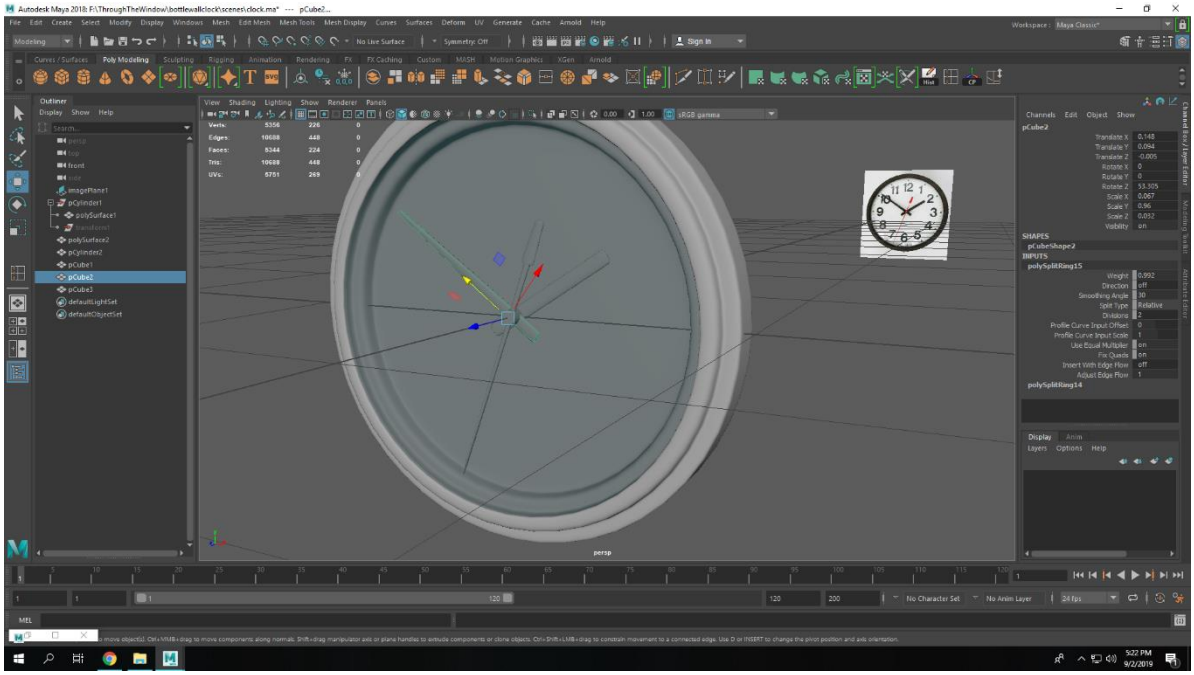

Figure 2.20 Clock model with hands

all the hands were set on top of another, hour hand on the bottom, minute hand in the middle and second hand on the top. Their pivot point was moved towards the end of the hands. As hand on clocks pivot around the clock with their pivot point slightly offset from the middle. To mark the mechanism that hold the hand together on the center of the clock, a small cylinder was added.

2.2.9 Pencil box:

Pencil box was a two-part model**.** The top part was made from a pCube. Edge loops were added then by Extrude command the hollow of the box was modelled.

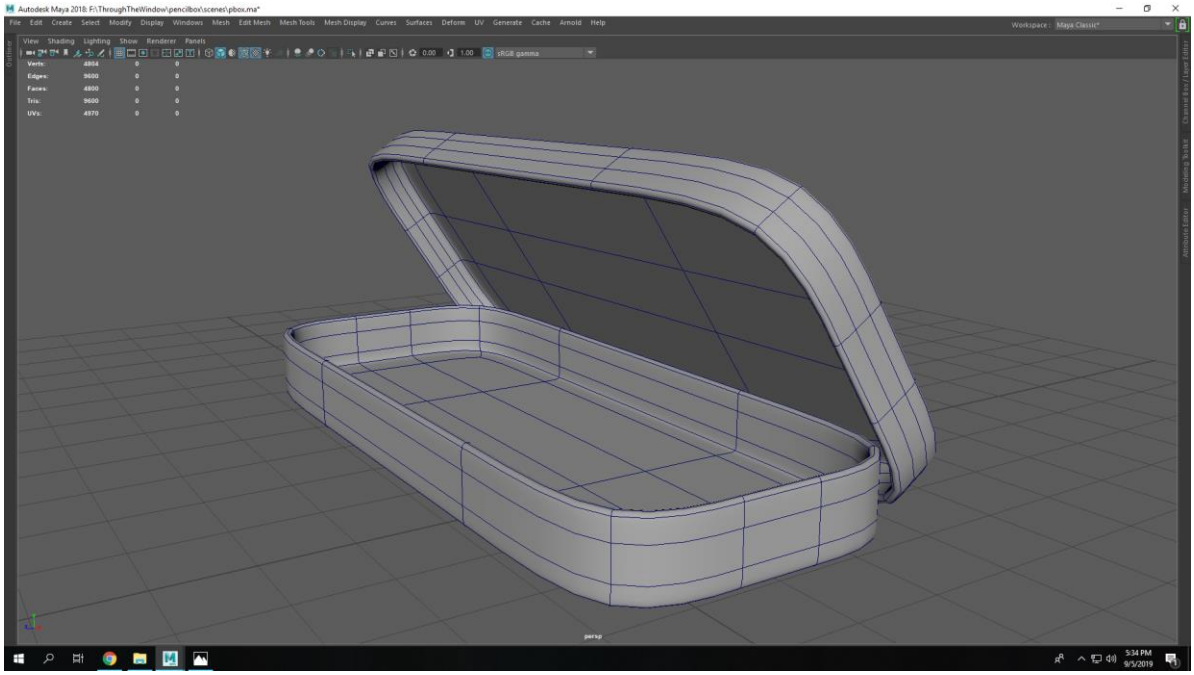

Figure 2.21 pencil box model open

After the lid was made it was duplicated and Rotated 180° in the x axis. It was scaled down a little so that the top part of it fits under the lid. After placing both top and bottom part on top of each other a simple pencil box was modeled.

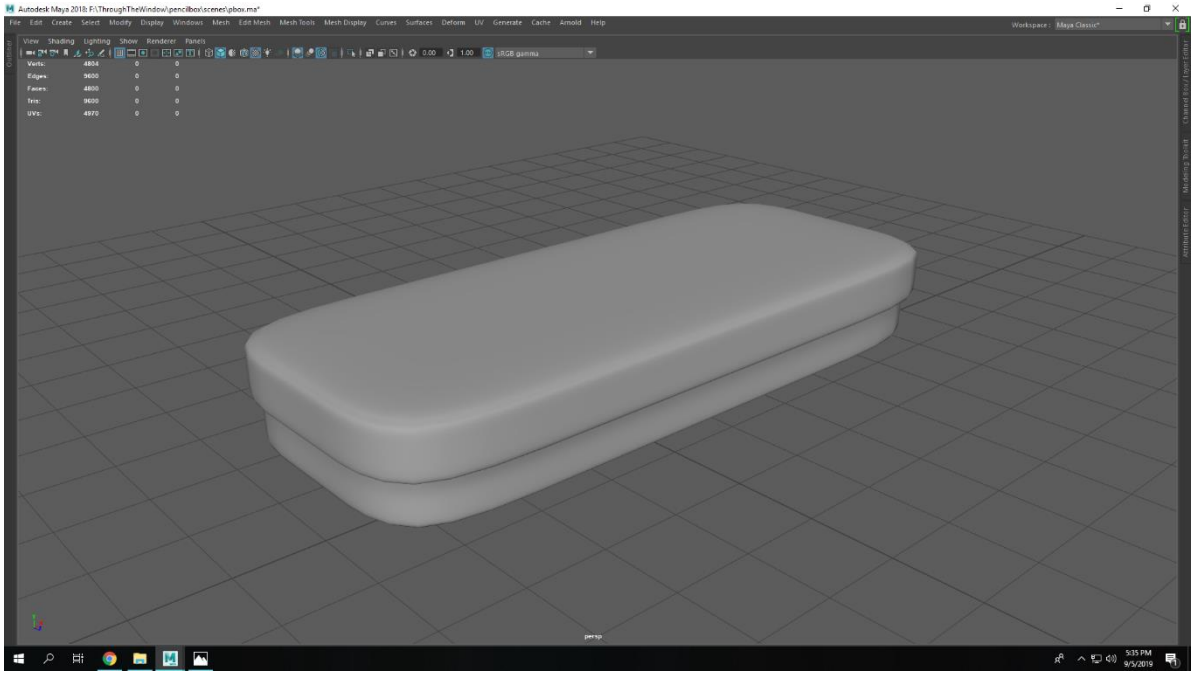

Figure 2.22 pencil box model closed

2.2.10 Water bottle:

As this was another extra prop it did not require much detail. That is why a simple water bottle reference was chosen. It has a simple cylindrical shape with a dodecagonal lid.

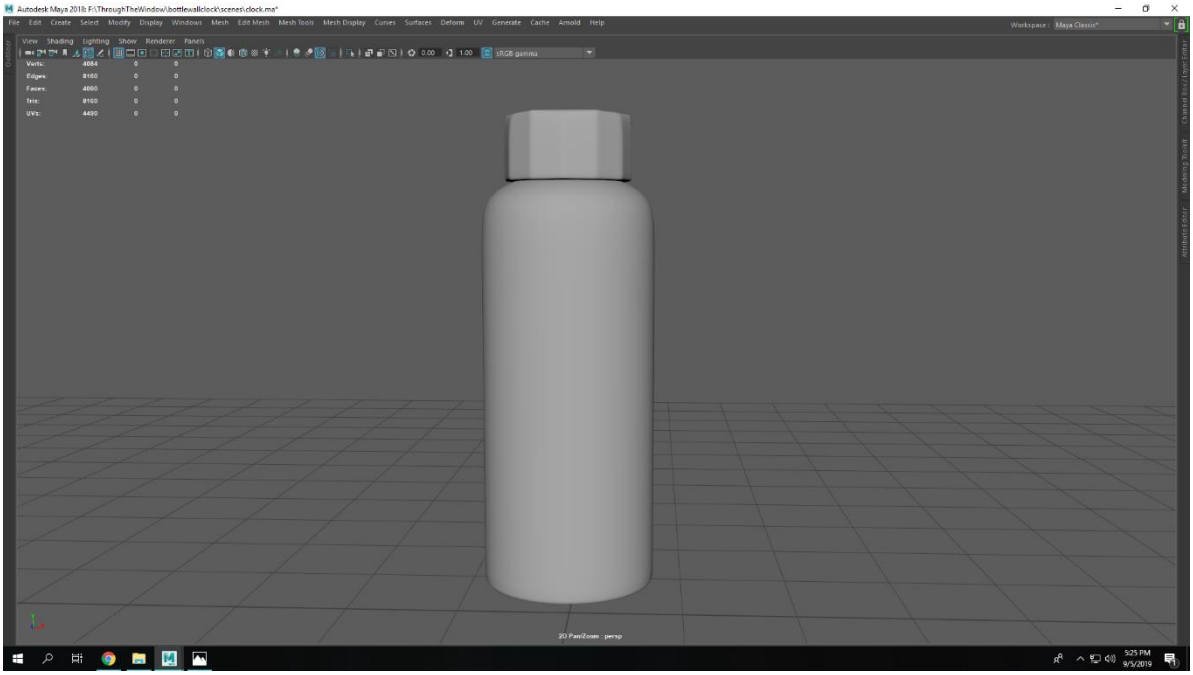

Figure 2.23 water bottle model

To make the body a low poly cylinder was taken. A loop was added to bottom for support and one on the top. The top face was extruded inwards then translated a little in y axis. Then it was extruded downward again to mimic the opening. Every other edge ware deleted to avoid triangulated poly. When smoothed this lo poly cylinder makes a perfect smooth cylinder shape.

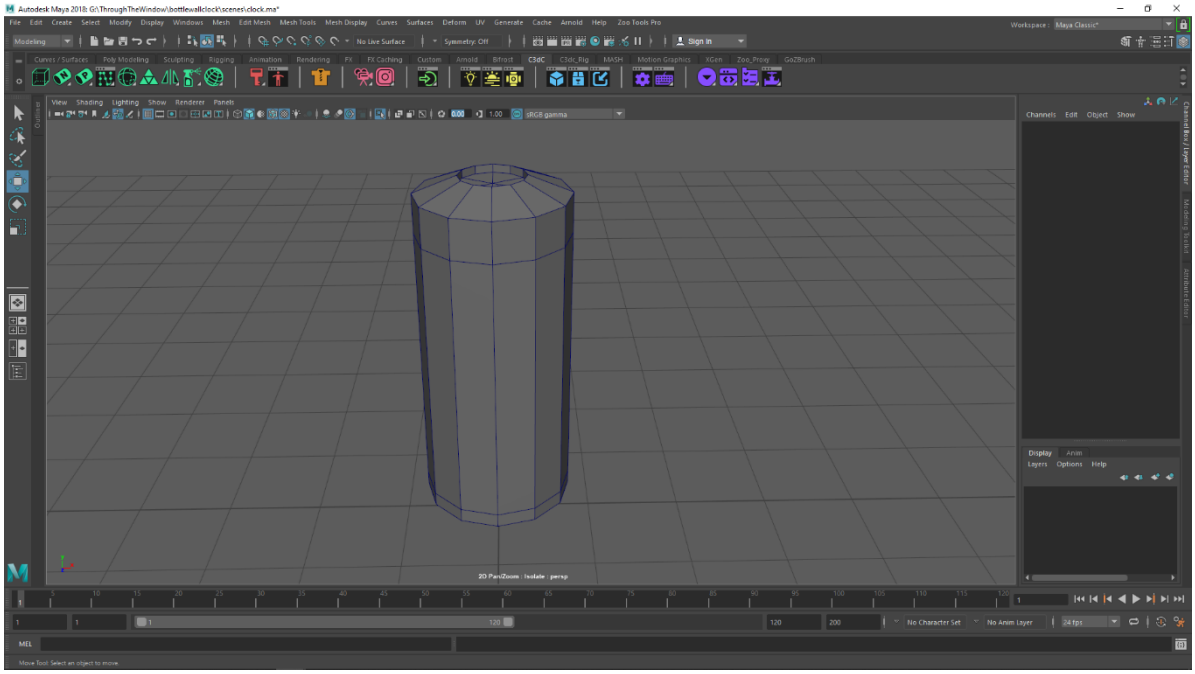

Figure 2.24 water bottle model primary shape

The lid was also made from a cylinder which had 12 subdivision axes. For retaining the shape even after smoothing two supporting edge loops were added to each subdivision edges.

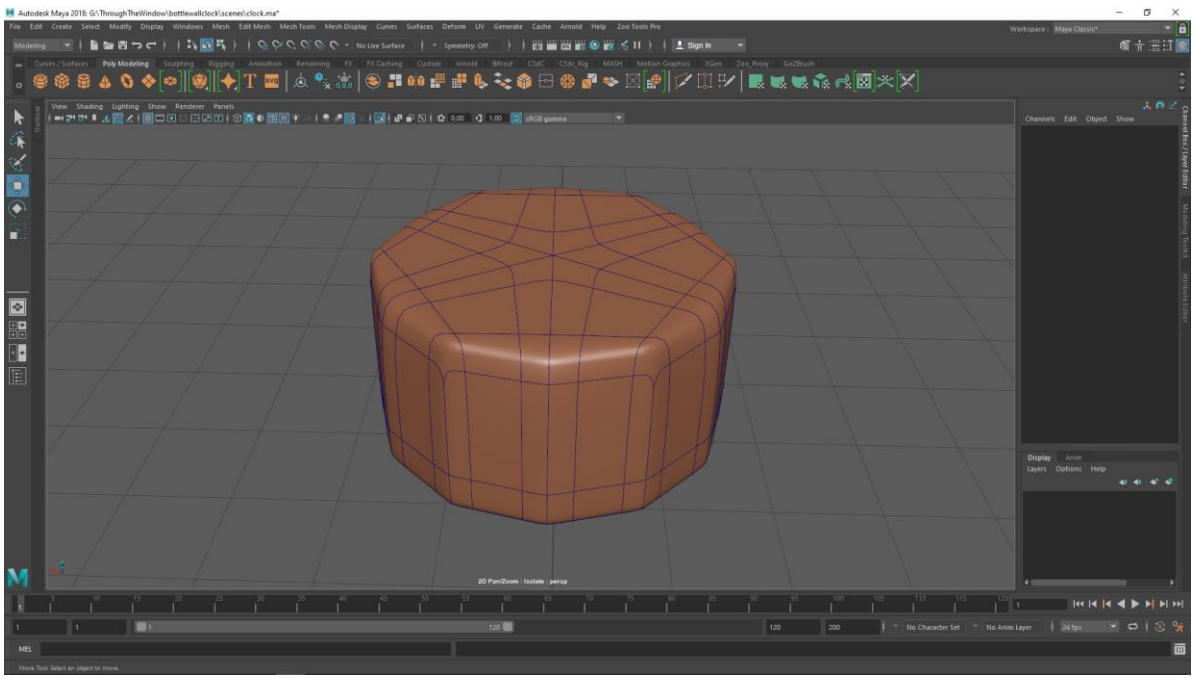

Figure 2.25 water bottle lid

2.2.11 Buildings:

I tried to keep the buildings as simple as possible because they were back ground props and if they became heavy models, scene assembly would become hard and software may crash due to heavy load. So, the main body of the buildings were just pCubes. Their top and bottom faces were deleted as they will not be visible in the render.

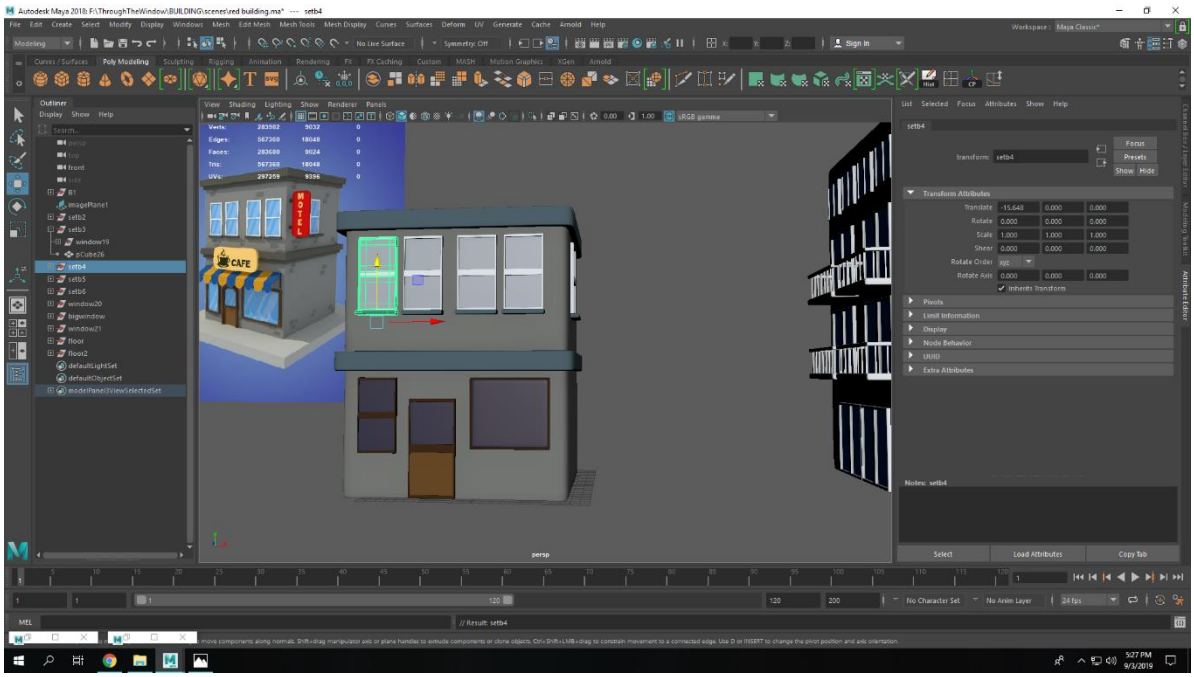

Figure 2.26 Building models window

Low poly cubes were also used to make the simple windows. The cubes had supporting loops so they don't lose shape when it is smoothed. The glasses are also similar pCubes. some windows have creases for glasses. They were created with the same add edge loop and extruding process.

Doors were also made in the same way. Some buildings had balconies. The floor of the balcony is a cube. The railings are skinny cubes arranged serially.

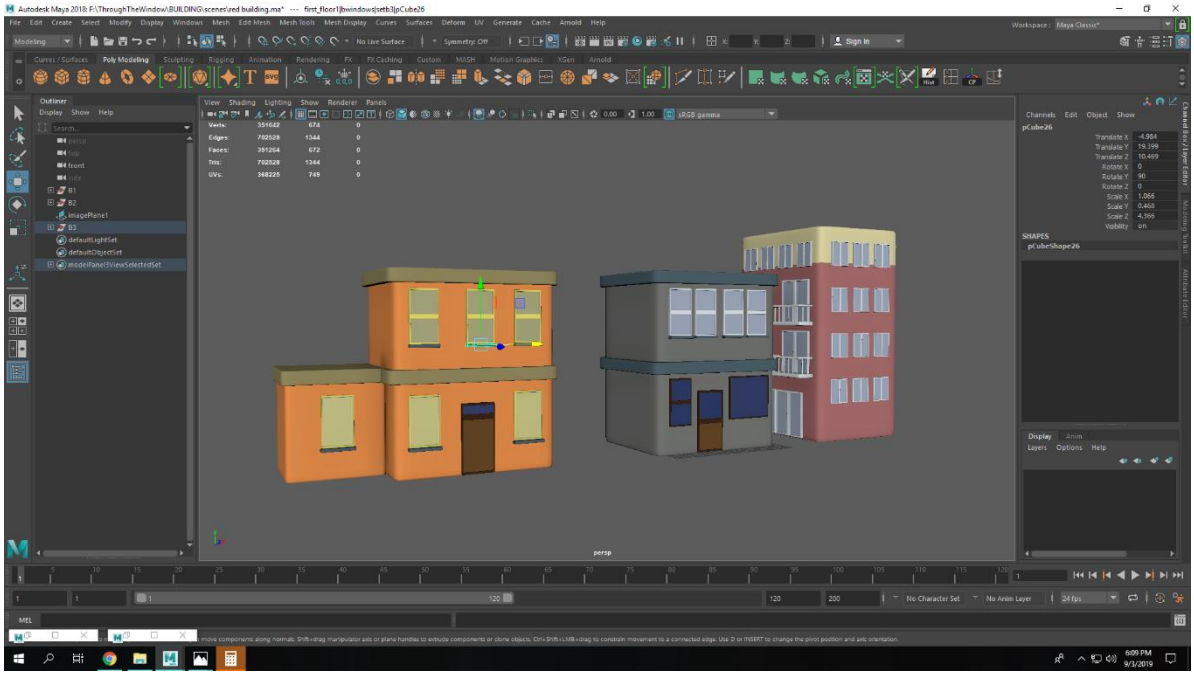

Figure 2.27 Building models window

Different buildings had different window and door shapes but all of them are made in the same way.

2.2.12 Window:

This window was the main window that appears on the title of this project. It is a four part window set. Each window sill has a set of four glasses. first the Frame that holds the window sill is modelled from a cube. Edge loops are added in equal distance. Then the faces I between them are removed by bridging the opposite faces together. Then for the window sills another cube is taken and similarly edge loops are added vertically keeping same amount of gap in all four sides for each glass. Then the faces were bridged to make space for the glass windows. The glass windows are poly cubes. As this is an old factory window so the window needed some personality. For this reason some windows were broken. To create a glass break effect “Multi Cut Tool” was selected forum the

modeling toolkit. With this tool some random edges were added on the glasses. This created some random polygons which were bridged together that made the broken glass effect. The window handles were made of some boxes which were modified along their vertices.

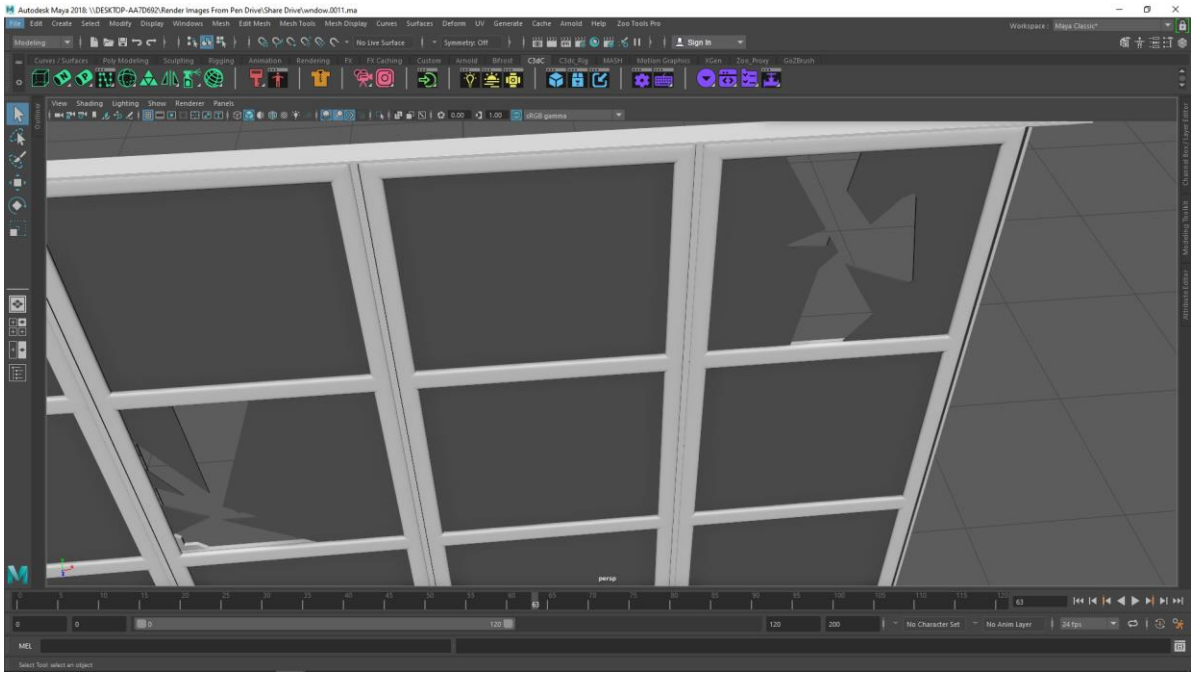

Figure 2.28 Factory window broken glass

2.2.13 Table:

This table appears in the factory scene where pinto works on it. It is a simple model mad with a few poly cubes. One long cube on the top and six eight legs underneath it. There are four support beams attaching to every pair of legs sideways and another long support bean that attached all the other beams in the middle. The same table is duplicated to make another table and scale down a little for fitting purpose.

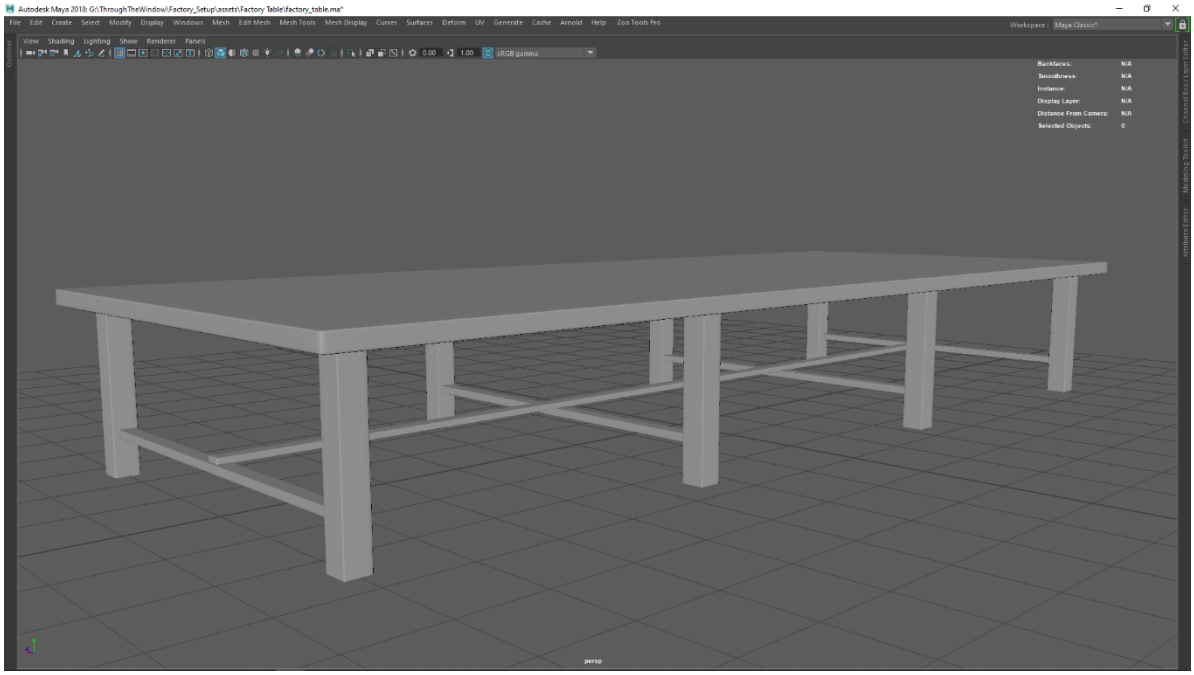

Figure 2.29 Factory Table model

2.3 Character Modeling:

Four different characters were needed in this film. One of the three child characters and the main child character for the factory scene was named Pintu. Every character had their own personality and style. Pintu is a poor child laborer so he is supposed to have a skinny figure. Character creating has a separate process. A character model is separated into different parts - head, torso, legs, arms, feet and hands.

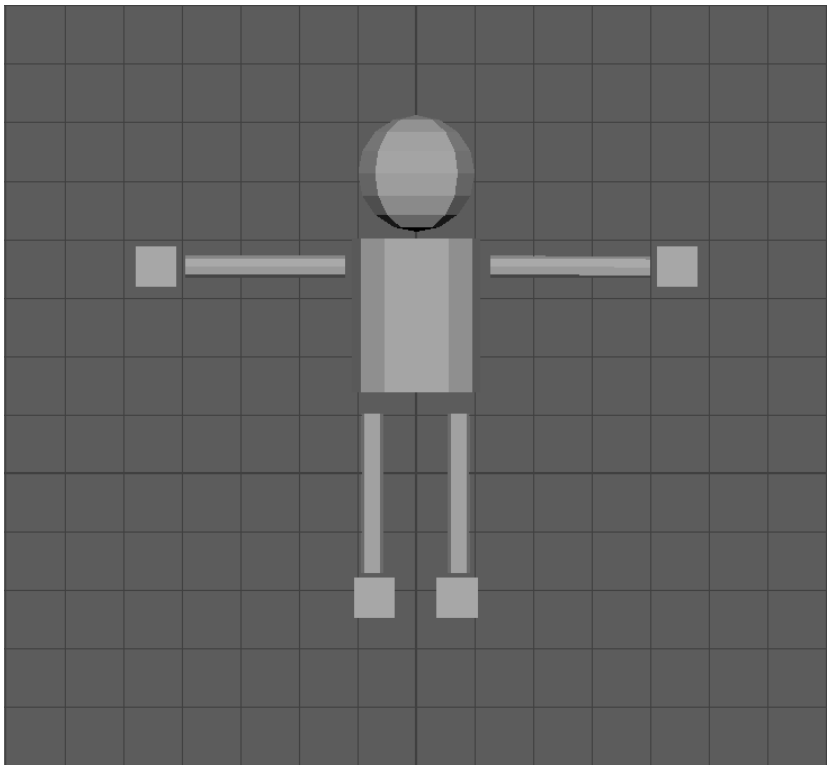

Figure 2.30 Primitives used for each body part

The torso is made out of a pCylinder with 8 subdivisions, head was made of a pSphere with 12 subdivisions, arms and legs were created with pCylinders with 8 subdivisions. Feet and hands are made of pCubes.

At first the reference images of Pintu was imported in the background of the front and side viewport in Maya.

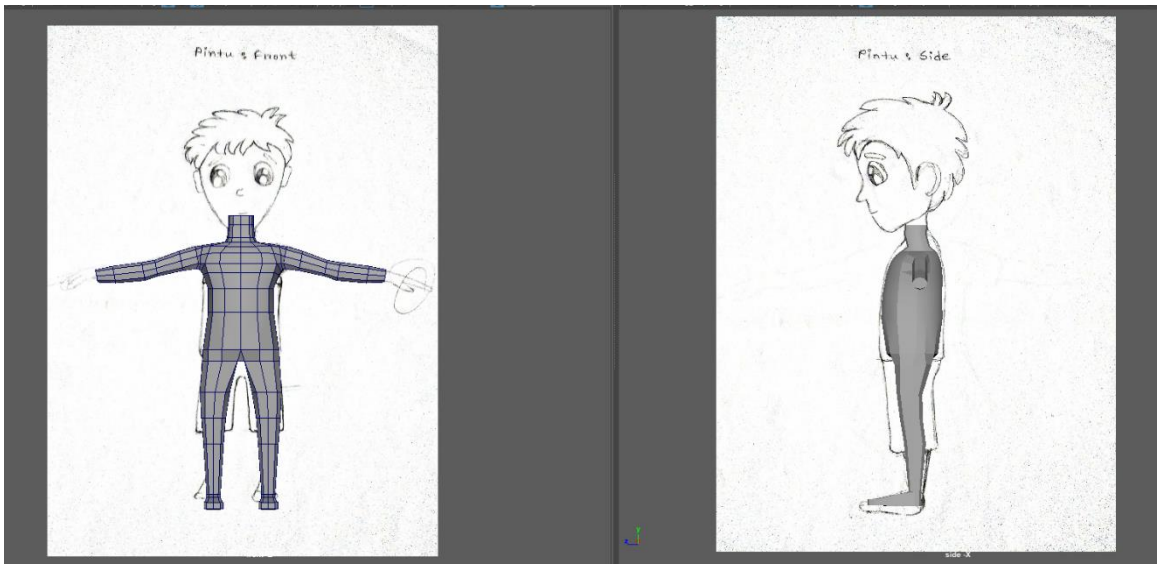

Figure 2.31 Importing reference image to viewport and match the model with it

Character building process starts with the torso part. First the cylinder is shaped to match with the reference picture by adding edge loops wherever it is necessary. This process includes the transform and scale commands mostly with “object x” selected in the symmetry menu from the menu bar. When modeling the character, it should be kept in mind that the model needs to match with only one side of the reference image. Because after one side is perfectly matched the faces of the other side are deleted from the middle. Then selecting the faces of other side, the pivot point is moved and snapped to the center of the grid by pressing d and x on the keyboard. Then from the dropdown edit menu duplicate special option is selected and value of scale x is set to -1 and applied. This duplicate and mirrors all the faces and positions them to 0 point on the grid as the pivot point was previously set there.

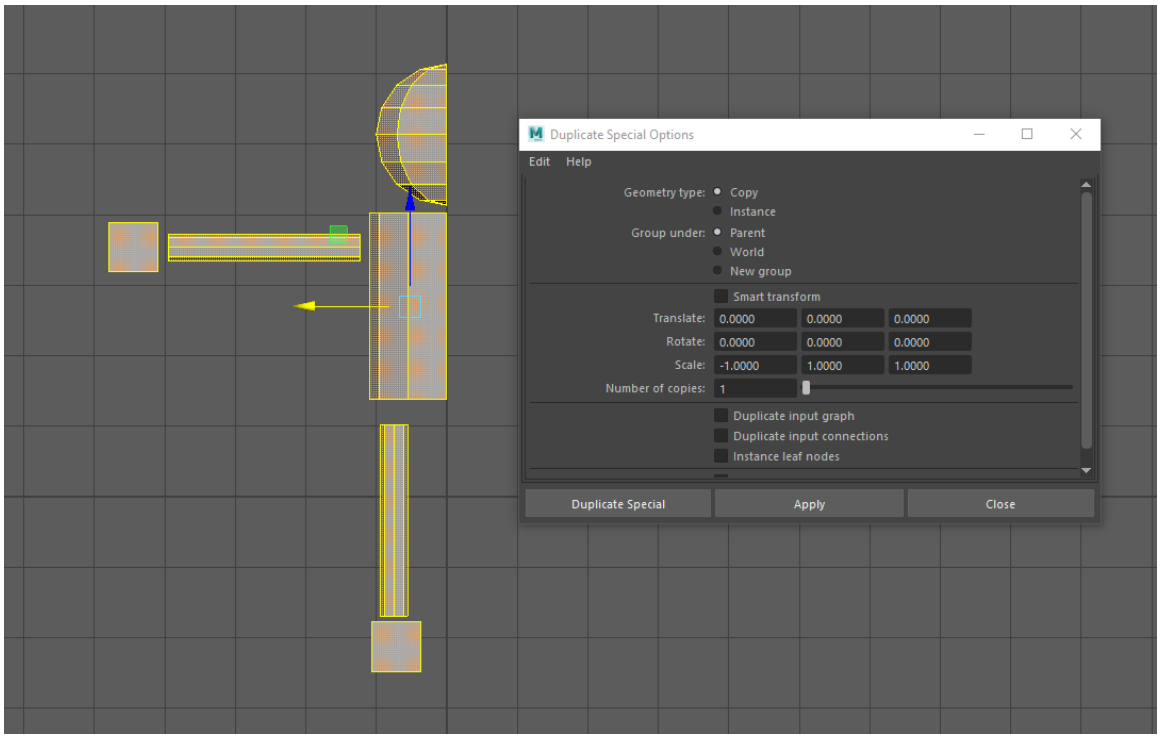

Figure 2.32 Using Duplicate Special command

The two sides are then combined together and their history is deleted. Then when the vertex selection is on all the vertices that are facing each other from both sides in the middle part of the model is selected by dragging and then they are merged together by selecting merge vertices operation by Shift + Right mouse button>Merge Vertices;>Merge Vertices.

After the body is shaped it is time to make the arms. For this a pCylinder is created and then after positioning it correctly with reference image the top and bottom faces are deleted and the shape is perfected by adding more edge loops and positioning and scaling the edges. Similarly a leg is also made with a pCylinder. After the arms and legs are modeled, they are joined with main torso. As the arms and legs have 8 sides each, 8 faces are deleted from the torso where the arms and legs are positioned. Then edges are connected by snapping or bridging them together. Same procedure is done with the legs. Similarly, the hands and feet are created from pCubes and joined with arms and legs. After this part is done then the whole thing is duplicated specially and vertices merged again to complete the model. Finally, the head is shaped from A pSphere. for modeling the eyes, nose and mouth area, faces are deleted in their respective areas and vertices are positioned to make a circular shape. As in real human face all the lines are circular, similar formation needs to be followed to make the character for the optimal expression delivery. So, the eye sockets are made by intruding the edges and bridging them in the end. For mouth and nose edges are also intruded and an opening is kept where the mouth should be. Faces are extruded for the nose area and vertices are dragged and placed to make a good-looking shape for the nose. From the mouth opening edges are extruded inside the mouth to create the mouth cavity.

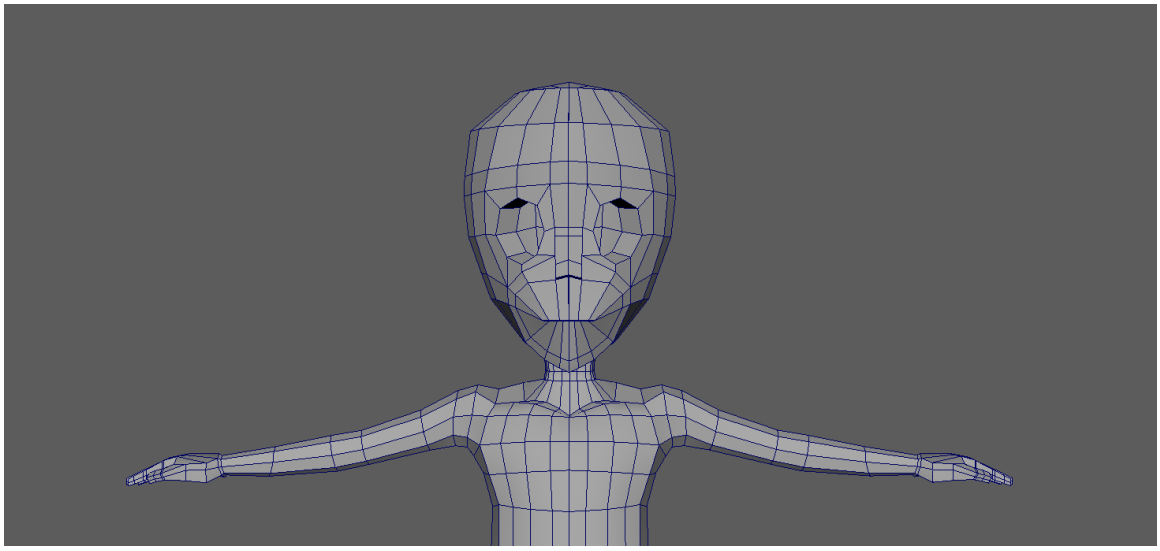

Figure 2.33 Arranging polygons in a circular formation on the face

Ears are extruded from the sides of the face. Eyes are made of pSpheres then placed and duplicated. Teeth and gums are shaped with pCubes. The tongue is made from a low poly sphere. They are all then placed in side of the mouth cavity.

2.3.1 Character Costume:

The costume differed form one character to another. They were designed to accentuate the characteristics and background of the character. For Pintu, his costume described his poorness. He just wore worn out tank top and shorts.

To create the costumes, first the character body is duplicated on place. Then it is extruded to make it bigger than the body and all the unnecessary faces are deleted. It gives a primary shape of a garment. For each piece of garment, the body needs to be duplicated separately. This process provides enough polygons to model the garments perfectly.

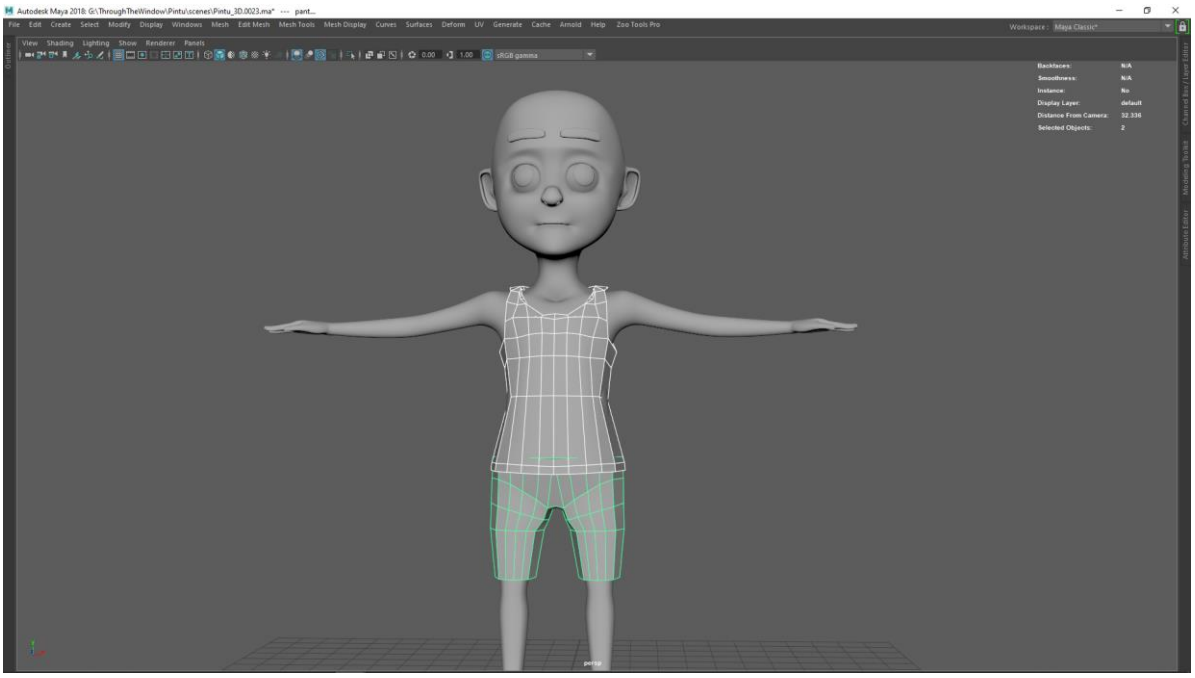

Figure 2.34 Character costume basic shape

After the basic shape is created, it is perfected with the help of different Sculpting tools from the “sculpt” shelf. Using the “Grab tool” and “Smooth tool” the costume is fitted along with

the character body. It is then smoothed to eliminate rough edges. Just like the main body of the character, the costume also needs to be symmetric.

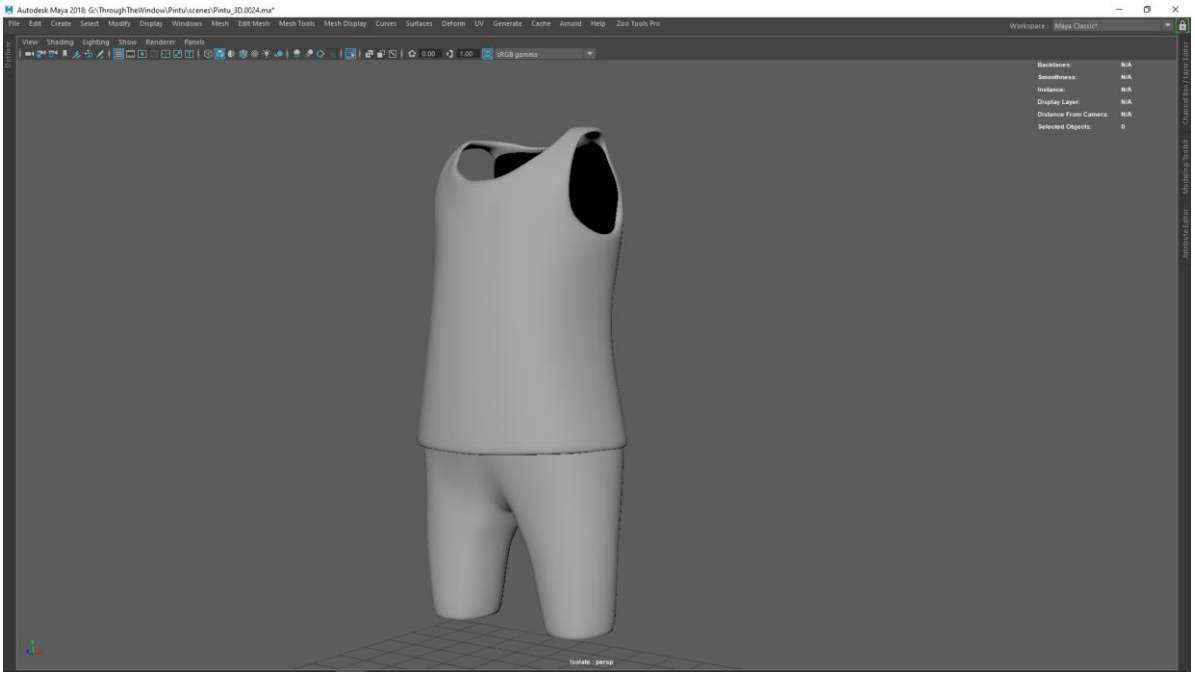

Figure 2.35 Character costume final shape

2.3.2 Hair:

Hair modeling needed some research. A lot of methods were tried until fixing on the final process. In this process firstly some faces from the head are selected and extruded. These were then separated from the main body. After smoothing the edges, it gives a base for the hair. After that pieces of hair are made out of low poly spheres. These spheres are firstly scaled to make flat oblong shape then with “Grab tool” it is shaped to match the desired shape of hair.

There were three male characters and one female character. They had different hairstyles depending on their characteristics.

Shanto being a privileged school going child, he has neat hair. So, on the base of his hair modified sphere hair pieces were placed starting from the side of his head. the hair continued only a few inches to the back of his head because after that, the hair base covered the rest of the head. Matching the hair end was a tedious job but it became easier after a few tries.

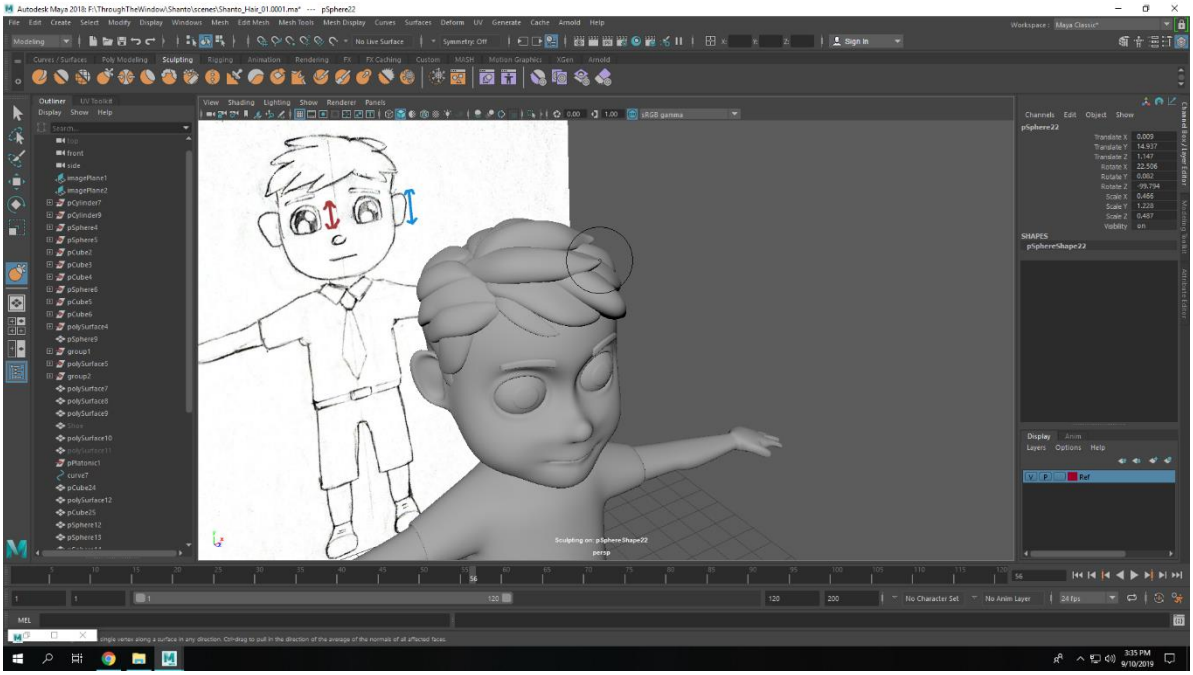

Figure 2.35 Character hair top view

Figure 2.36Character hair back view

Millie was also a privileged child. For school her hairstyle was two ponytails. Her hair was made in the similar process of Shanto's. Firstly her bangs in the front were modelled nicely. Then only one half of her hair on the top part her head was modelled.

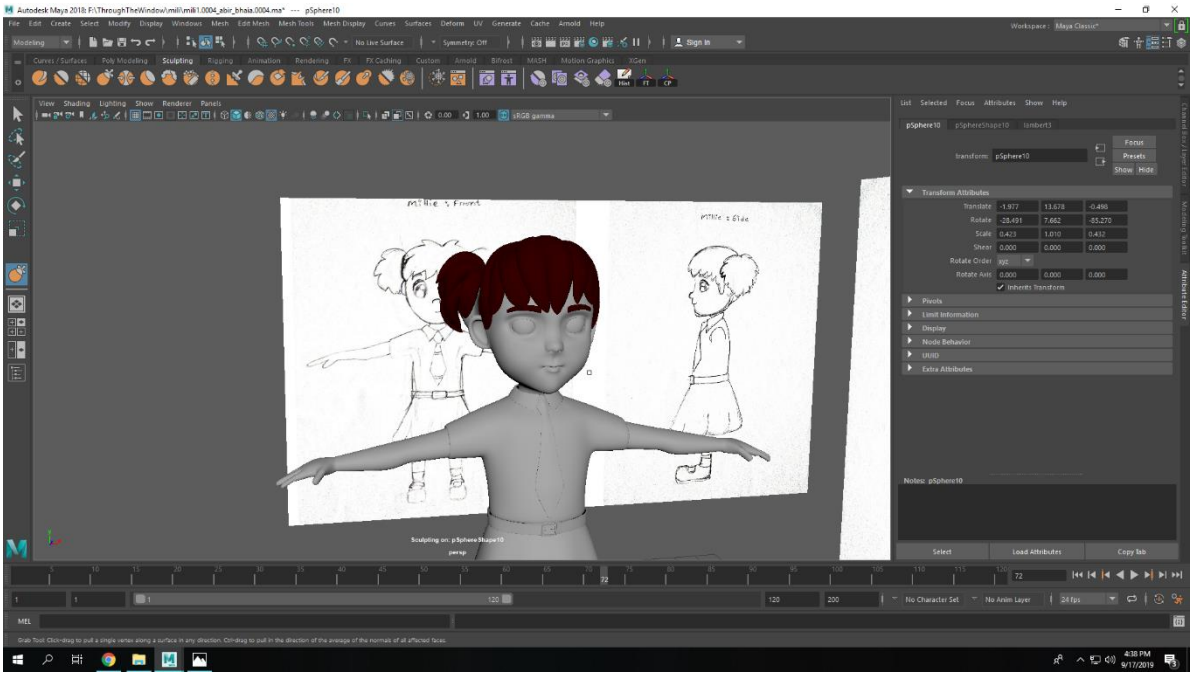

Figure 2.37. Millie hair modeling

The pony tail was creating by stacking one piece of hair on top of another. It was then duplicated on the other side using "Duplicate Special".

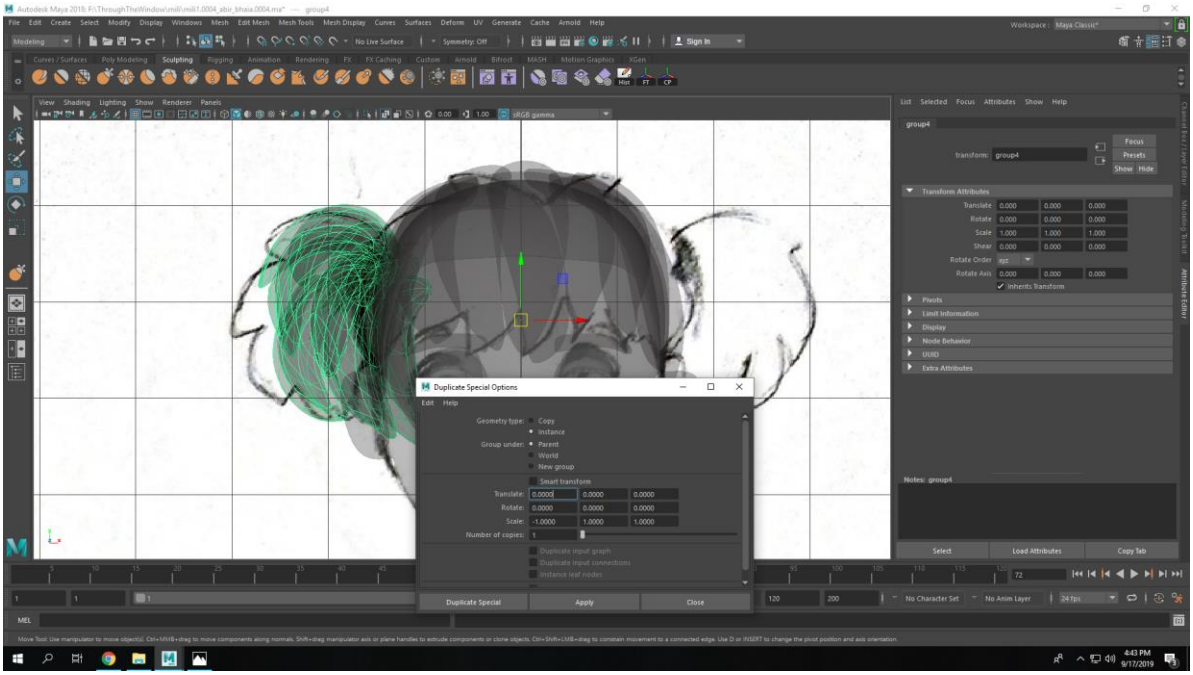

Figure 2.38 Millie hair duplicating

A hairband was added to ponytail which was also made of that same sphere which was used to make all the hair. A great deal of sculpting was necessary for Millie to look cute.

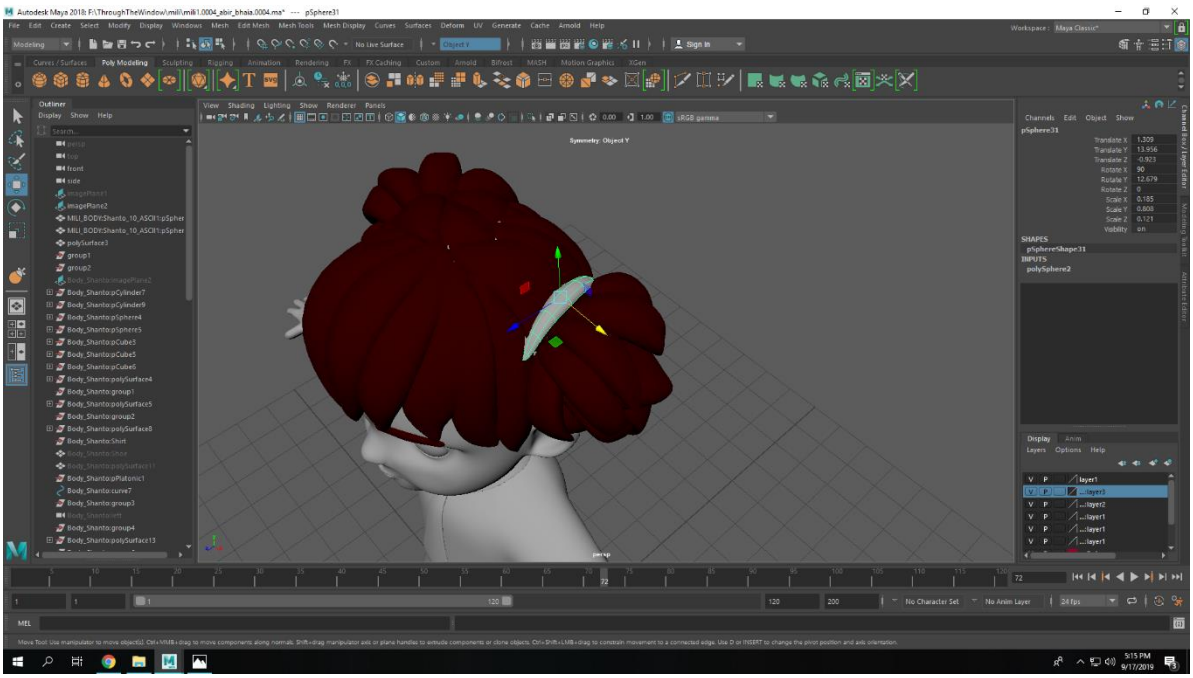

Figure 2.39 Millie hair band

Pintu was a poor boy who did not have anyone to care for him. So, his hair was supposed to be messy. Although his hair was modelled in the similar process of the other two but it was kept in all direction. His hair also continued halfway towards the back of his head.

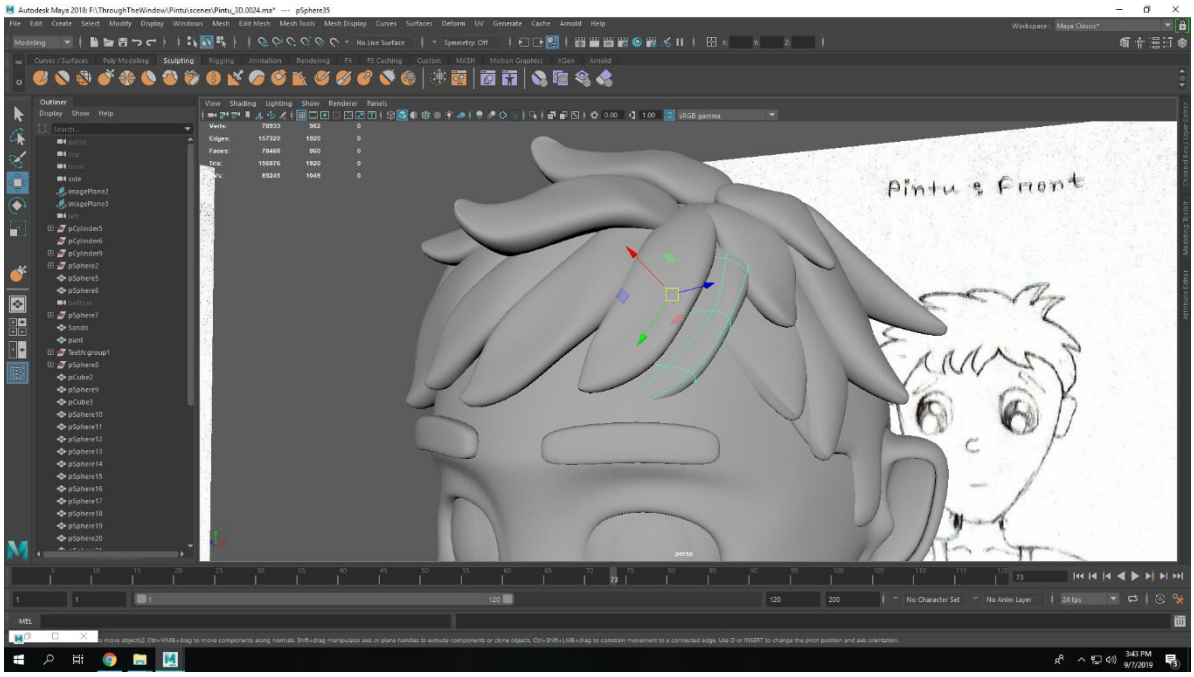

Figure 2.40 Pintu hair front view

Figure 2.41 Pintu hair back view

For the other older character Rana , much attention was not given because of the unimportance of his character. Just the hair base wat modified with the sculpt tool a little to give it a simple shape.

CHAPTER 3

UV Unwrapping, Texturing & Animation

After the modeling process is completed, the UV unwrapping and texturing process begins. This process needs to be done before the animation process starts. This chapter will discuss about the processes briefly in an informative manner.

3.1 UV Unwrapping

Unwrapping is one of the popular methods for doing UV of any 3d object. UV means representing a 3d object's surface with a flat 2d surface. It's used to texture 3d objects easily. This process of creating a UV map is called UV unwrapping.

Here the U and V represent two axes of the 2d space. And in the 3d space there are three (X, Y, Z) axes which represent 3 different directions.

3.1.1 Clock:

First selected the clock, then chose the right edge which needed to be cut for making the seam. To make the cut, open the UV editor from Windows > Modeling Editors> UV Editor. Then with the right edge selected, press SHIFT + X to make the cut. After cutting all the necessary edge to unfold the clock, press CTRL + U while shell mode is selected in the UV Editor. That unfolded the clock properly but sometimes it needs to be optimized in order to unfold perfectly. Optimize tool can be found in the UV Toolkit > Unfold > Optimize.

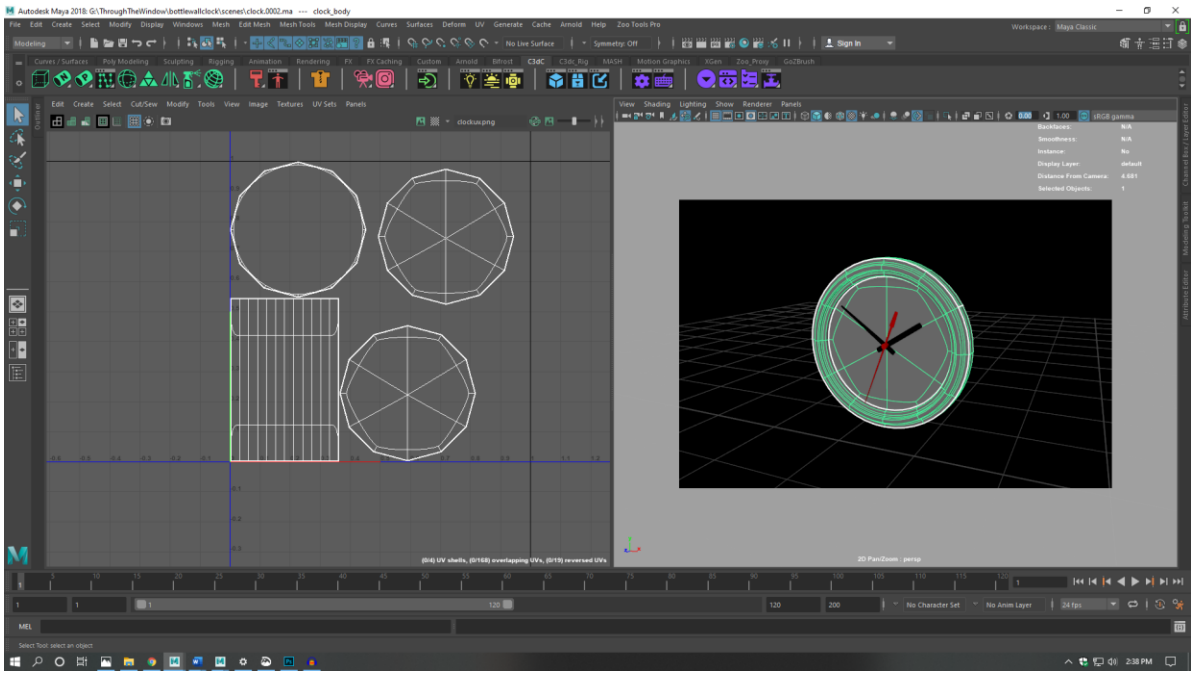

Figure 3.1 UV Unwrap of clock

3.1.2 Lamp Post:

The main body of lamppost being a cylinder the unwanted bottom face was deleted and only one was cut made on one side of the post to unfold it perfectly.

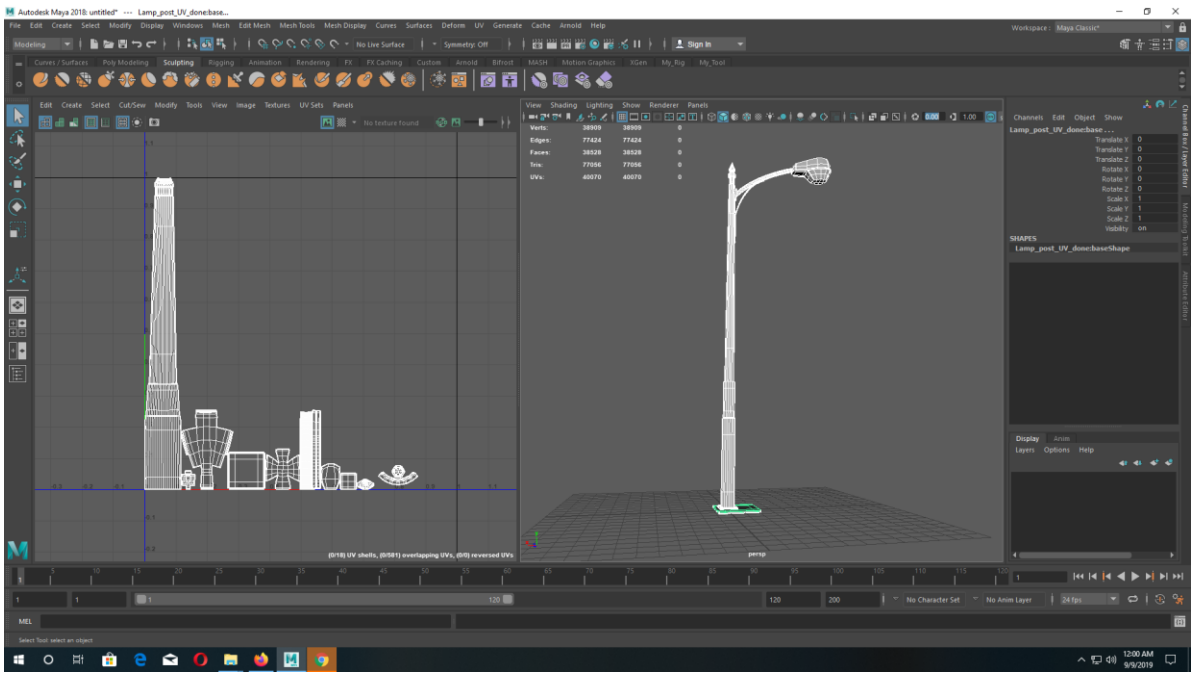

Figure 3.2 UV Unwrap of lamp post

Rest of the model was made with cubes so they were cut along the edges where the least amount of seam should be necessary or visible. All the shells were then unfolded and layer in such way that the resolution of each shells remain the same because this model needed to be textured in “Substance Painter” [10] software.

3.1.3 Signal Post:

This model had part with most of the faces deleted. So there were not many cuts needed to unfold UVs.

As the lights, holders and their bases are identical, so in order to save space in 0 to 1 space Stack and Orient Operation was used to stack some of those same unfolded UV shells. It’s located in UV Toolkit >Arrange and Layout >Stack and Orient.

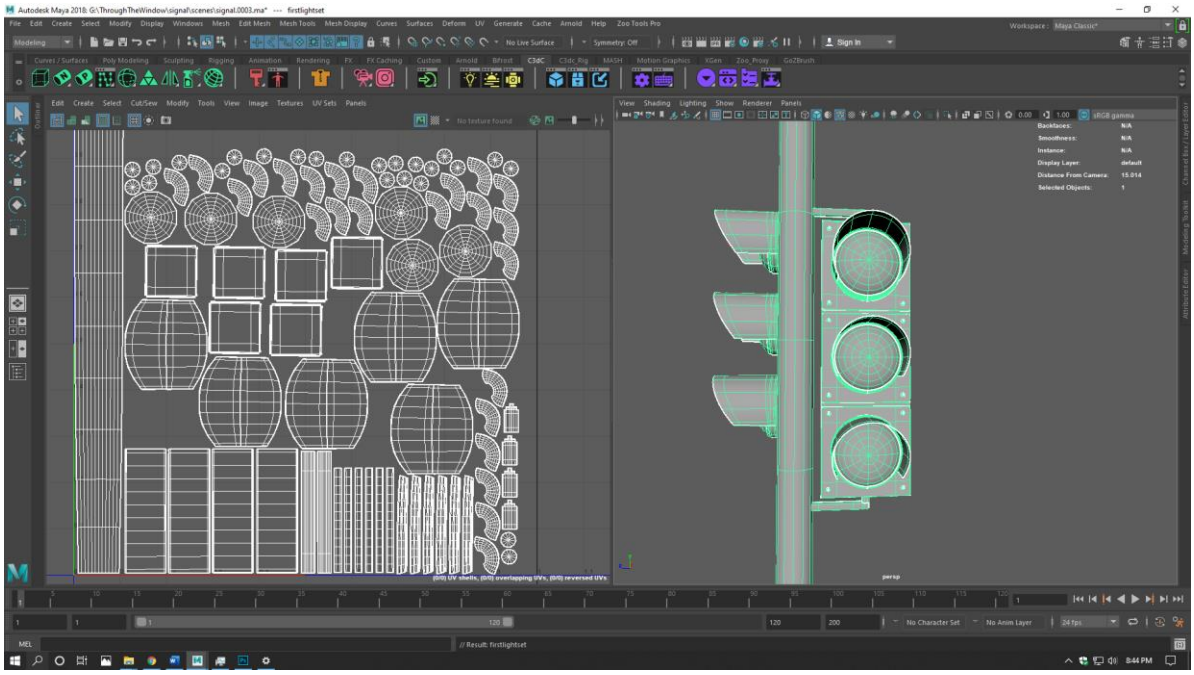

Figure 3.3 UV Unwrap of Signal post

3.1.4 Dustbin:

The round outer and inner bottom of the bin were cut first. Then on edge on the side of each cylinder were cut, every edge of the cylinder was then cut. One edge on the inner side of the frame was chosen to be cut and one edge of every corner. The legs and small attaching pieces were cap less rectangle that needed on only one cut on one edge to unfold.

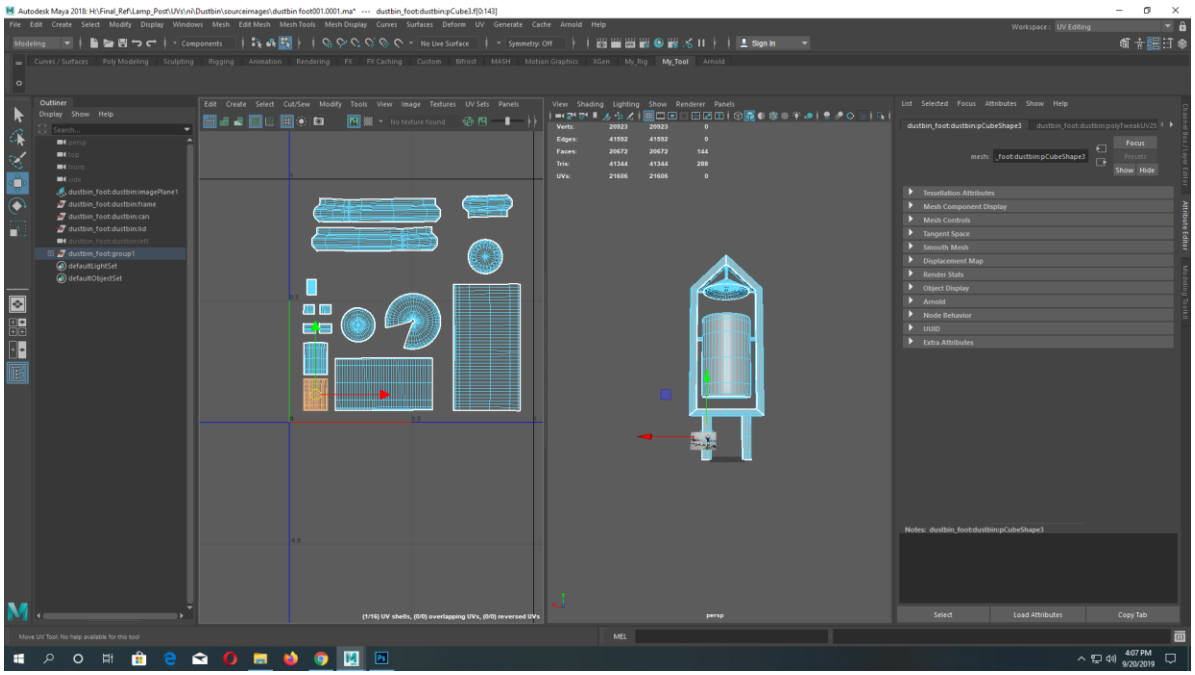

Figure 3.4 UV Unwrap of dustbin

3.1.5 Table:

The table only consisted cubes which were all unfolded in the same process. The long top was given the most surface area and the legs were stacked in the layout.

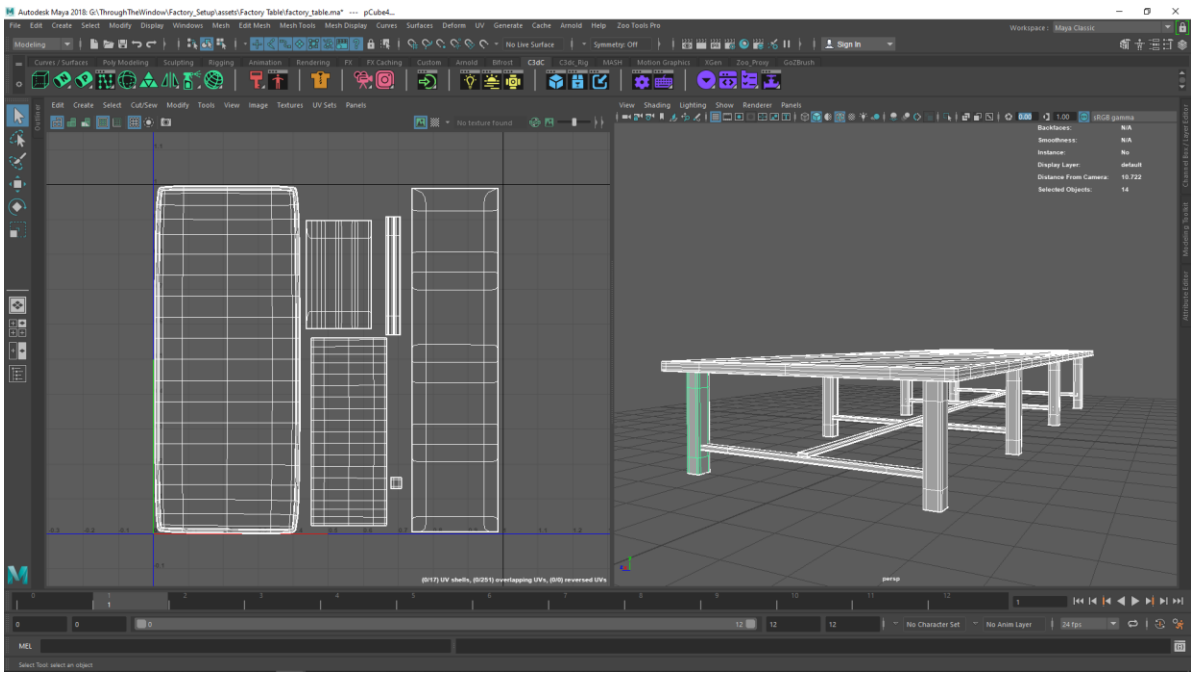

Figure 3.5 UV Unwrap of table

3.1.6 Character UV:

Character UV unfold may seem tough but it is actually quite easy. First there needs to be cut made in every single joints. Started by cutting the edge around the thighs where the thigh join with the torso. Then the arms are cut along the edge that joins them with shoulders.

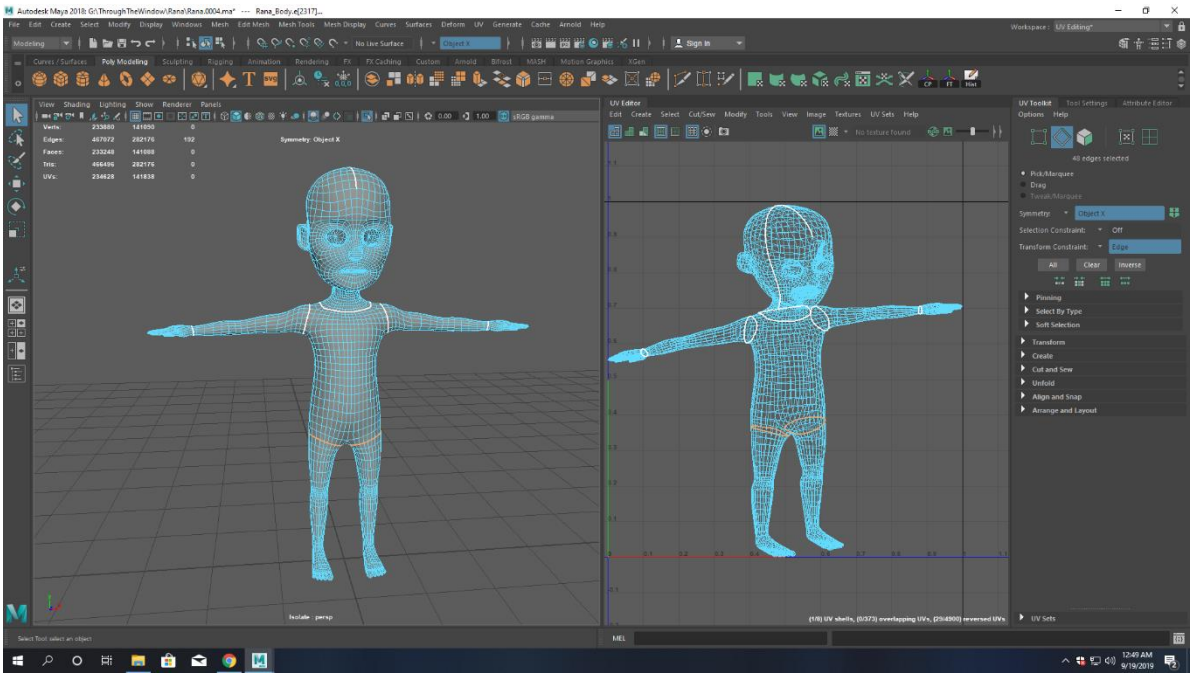

Figure 3.6 UV Unwrap of character

After that the head is separated by cutting around the neckline. Hands are cut along the wrist and the feet are cut along the ankles. For the flattening the head a cut is made behind the head starting from the hairline.

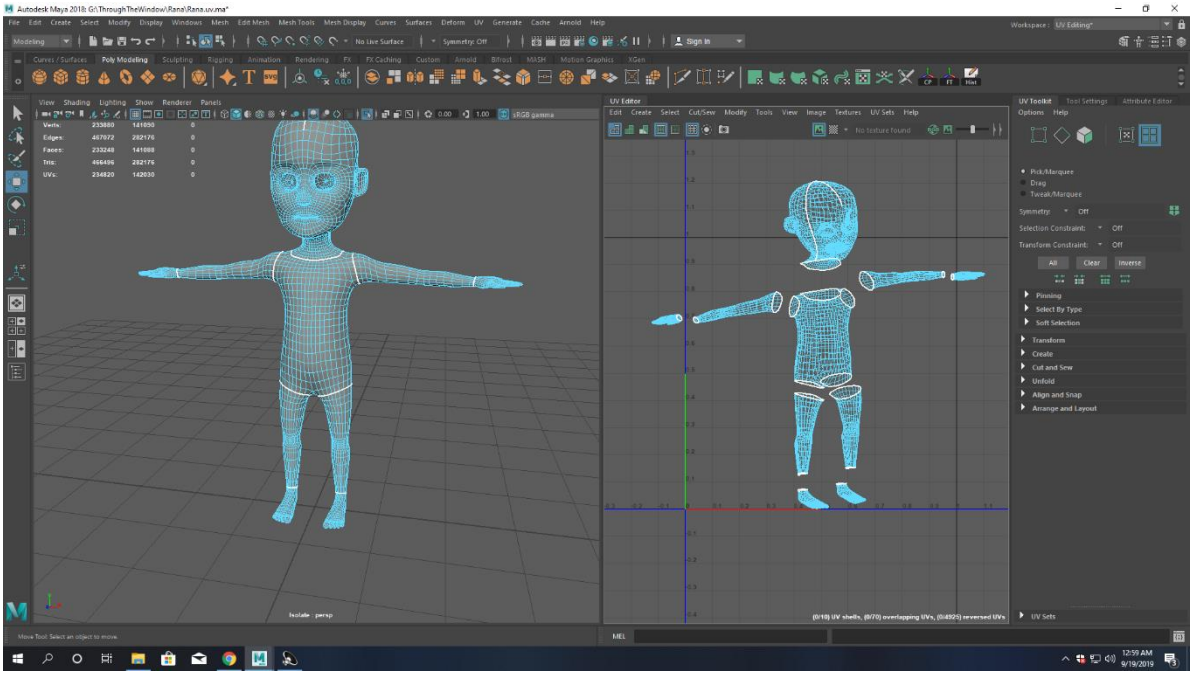

Figure 3.7 UV Unwrap of character making seam

After the making cuts were done it was time to unfold the UVs. It was unfolded following the steps previously mentioned. Then the layout was done manually to make it easier for texturing later. The default lay out did not maintain any patter which would have been a problem while texturing. In manual lay out process the parts of the body which have similar textures are put close to each other.

Eyes, Teeth and tongue were also unwrapped and kept in different 0-1 space.

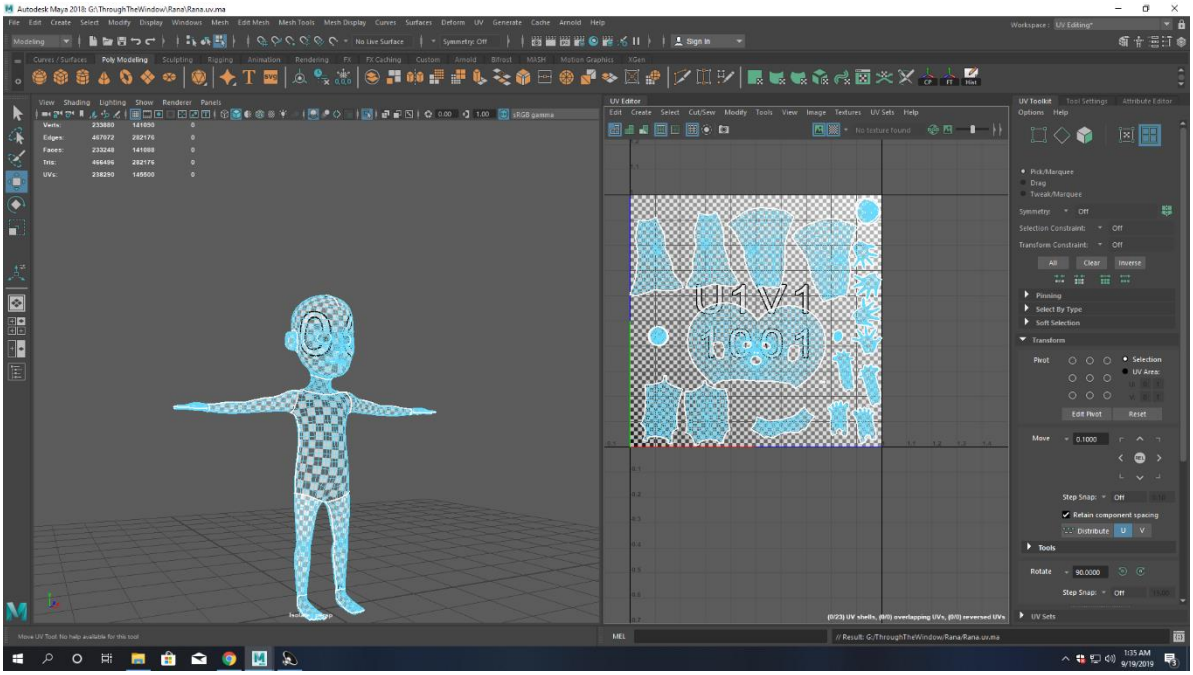

Figure 3.8 UV Unwrap of character unfold and lay out

When it came to unwraping the costumes, it was done one by one. First the shirt was selected and edges along the sides were cut. When unfolded , it easily spilt into two equal symmetric halves. Similarly the pants were unfolded. In this case all the clothes were kept in the same 0-10 space in the uv editor to save some space.

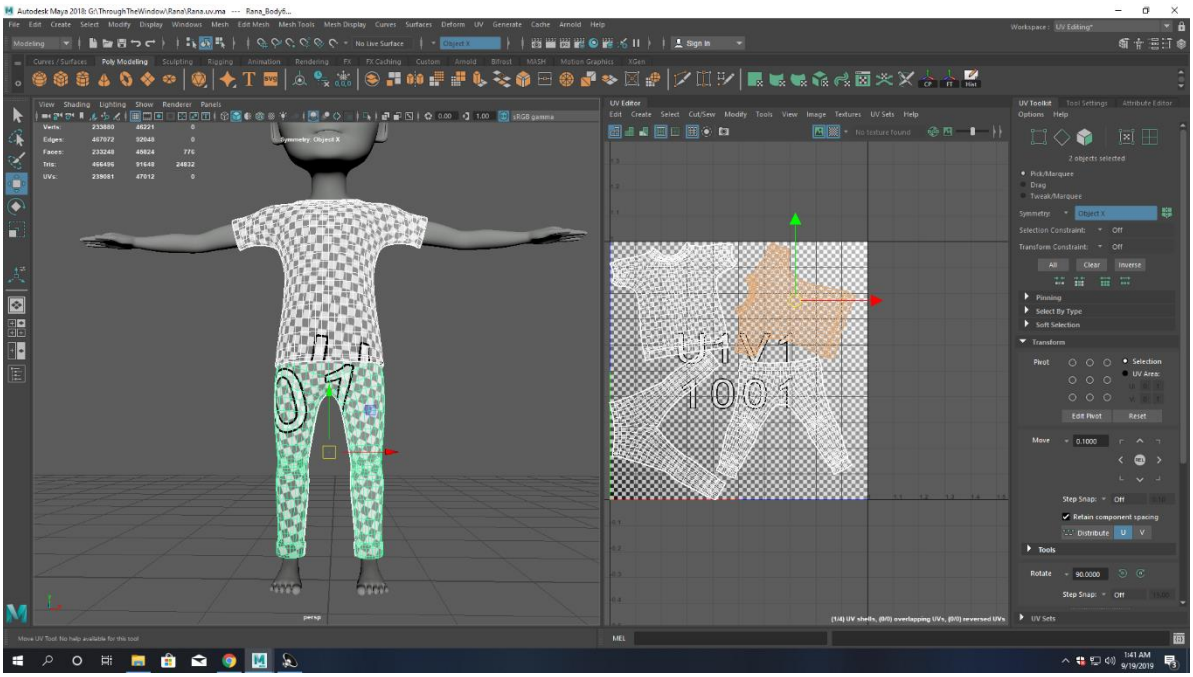

Figure 3.9 UV Unwrap of character costume

3.2 Texturing:

Texturing is a method of creating high quality detail surface texture or color information on a computer generated 3d model or graphic. For my project we have used Adobe Photoshop to texture most of my models. It works layer by layer and makes texture easy.

3.2.1 Clock:

First the image of the unfolded UVs were collected from UV Editor > Images > UV Snapshot. It is usually saved in png format. This image is then opened in Adobe Photoshop [11]. A picture of the clock face is collected from freepik[12] and placed on the UV space of the clock face in Photoshop. For the rest of the clock body it was kept black. Then the image was exported from Photoshop in the highest quality. In Maya an aiStandard Surface material in assigned to the clock and in the "Diffuse" section this image is assigned as a map.

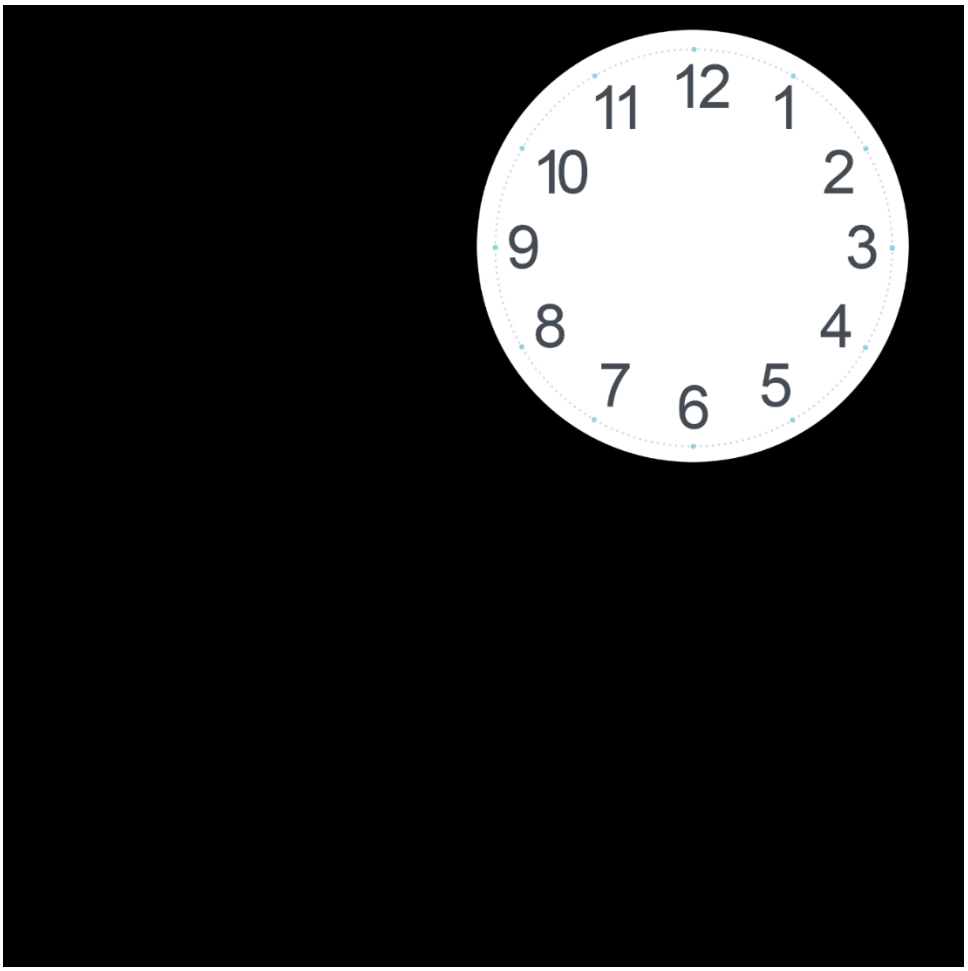

Figure 3.10 Clock texturing

3.2.2 Water bottle:

The water bottle texturing was done exactly in the same process as the clock. Some PNG images of the character and the title was downloaded and placed then the background was painted in Brown.

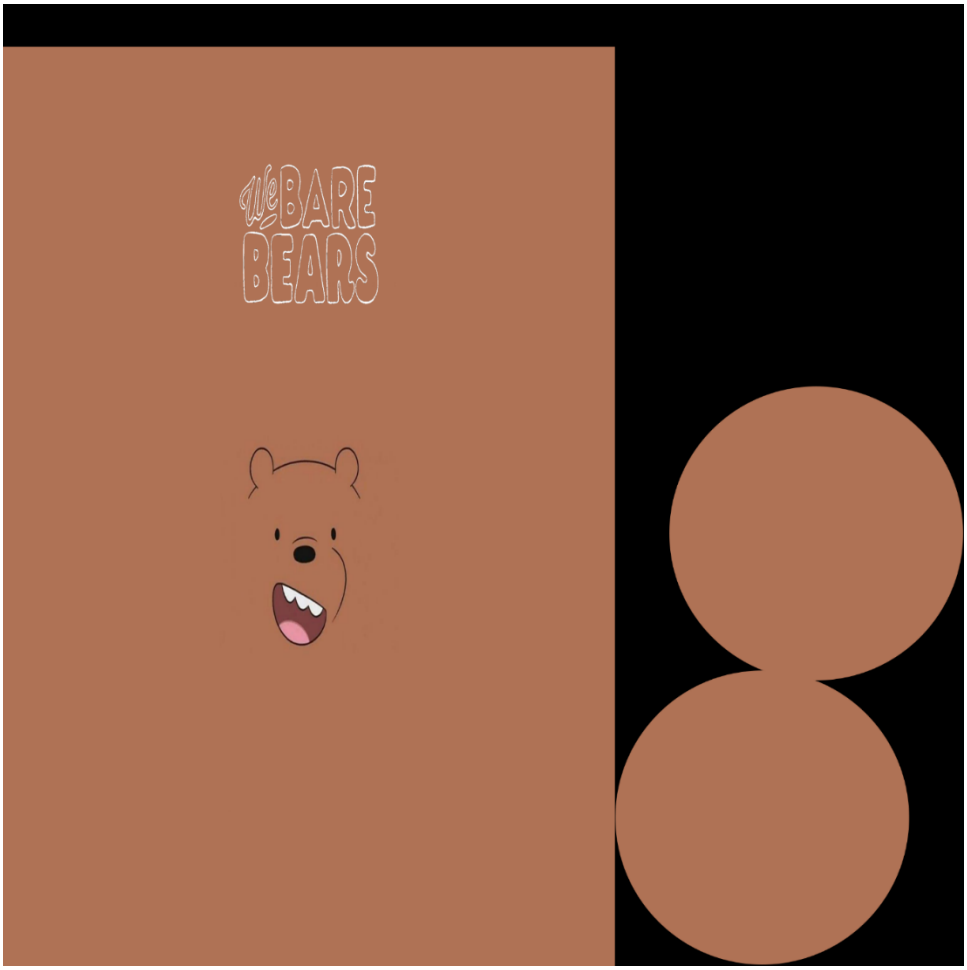

Figure 3.11 water bottle texturing

3.2.2 Pencil box:

Pencil box UV snapshot was collected in the same way as the other models. In photo shop first a cartoon image was placed for the top of the box and for some accessorizing some polka dot texture was added. And the back ground color was kept Canary Yellow.

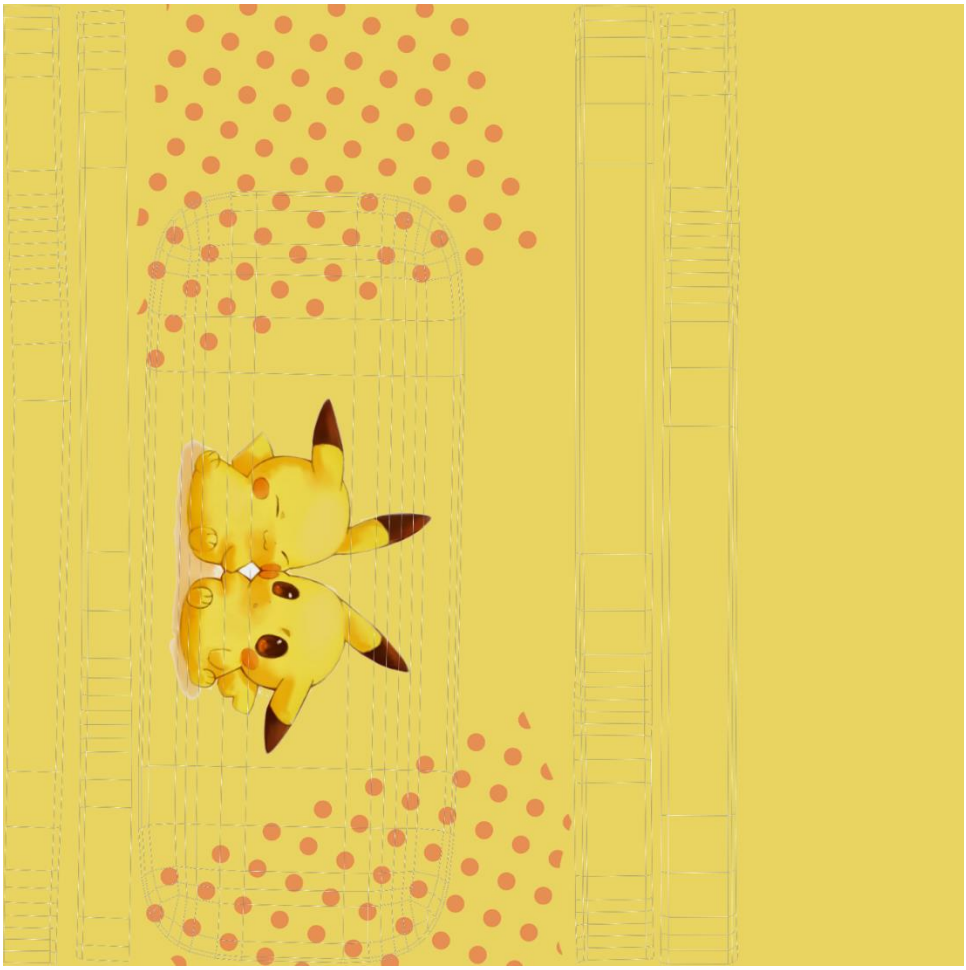

Figure 3.12 pencil box texturing

3.2.4 Character:

Texturing characters is different from the other models. First the body was textured in Photoshop. After importing the snapshot a skin tone is selected for each character. Pintu being poor and dirty, his skin tone was darker. So the skin tone color was pasted on a layer by pressing Ctrl + Backspace. Then on another layer, some markings were painted where the elbows and knees should be. Some extra color was also added to knuckles of the fingers. For the face the Tzone and cheek area was painted in a lighter color for some highlight. Lips were color in a Mauve Brown color. As Pintu was supposed to be dirty, some dirt was added to his texture. With a rough looking texture brush and selecting a dark greyish color, some strokes were added where the dirt's should be like the legs, feet, under the feet, hands and also cheeks. Adding dirt to the texture gives Pintu's character more depth.

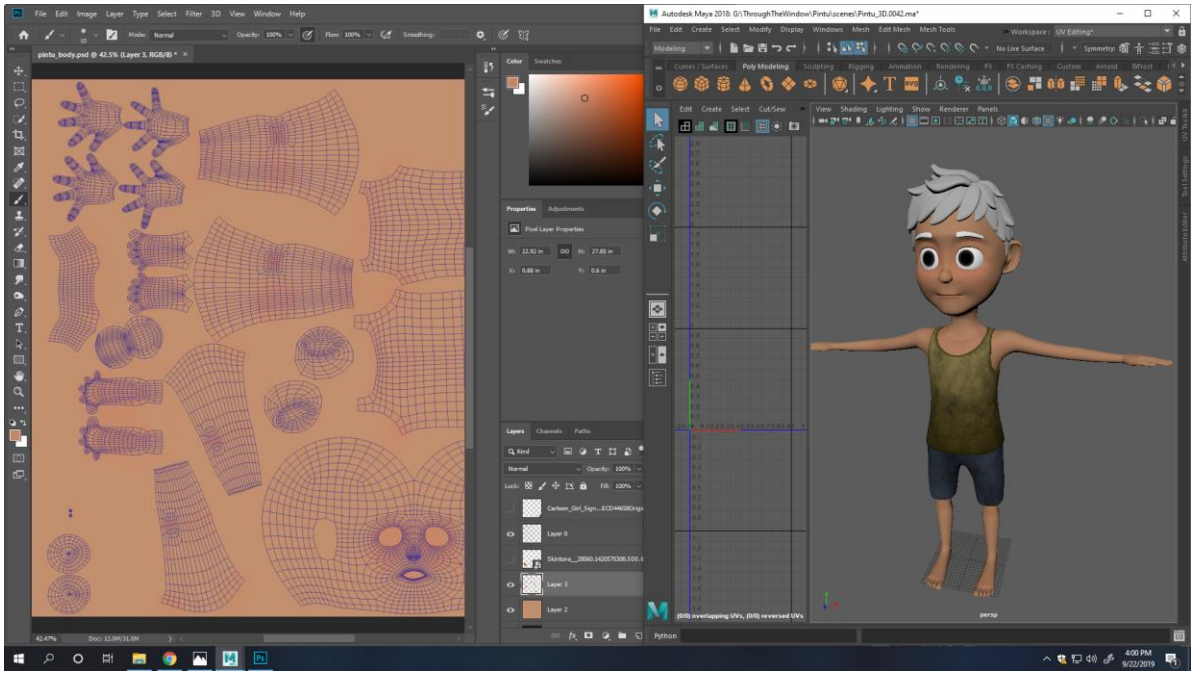

Figure 3.13-character texturing Pintu

As the elderly character Rana also works in the same factory as Pintu, it was only logical to add dirt to his feet too. All texturing of his rest of the body was done the same way with a different skin tone. While texturing it was necessary to check the texture in Maya by assigning them to the character's body. It helps figuring out where there it needs to be corrected and which places need more detail.

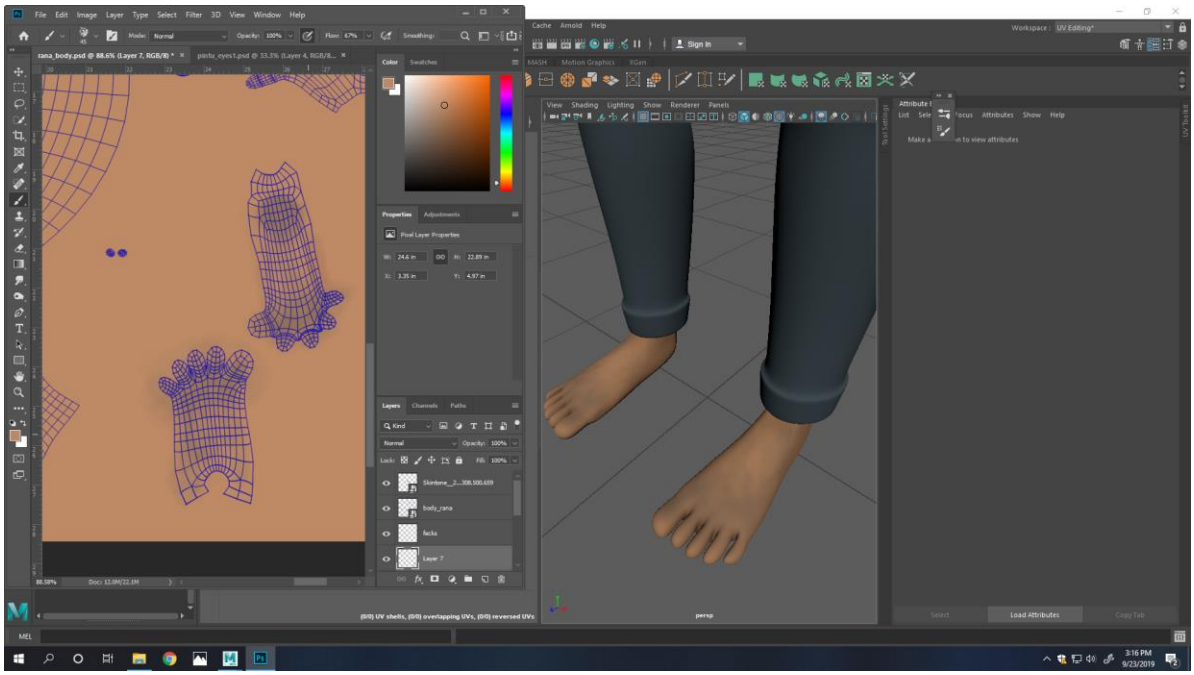

Figure 3.14 Character texturing Rana

Shanto and Millie were supposed to be clean so they had clean texture with lighter skin tone. They had pinkish areas painted around their Nose Bridge and cheeks. Also some highlighted area painted in a lighter hue of their skin tone under the eyes and tip of the nose. Their elbows and knees were also painted in darker pinkish colors. Some freckles were also added to give them a rather cute and appealing look. While texturing it needs to be kept in mind that maintaining layers in Photoshop is necessary. Each effect should be in a different layer. This keeps all the effects separated and makes it easier to manipulate, control and edit them.

While painting it should be noticed that the in even strokes should not go near the edges of the UVs because otherwise the texture will not be seamless.

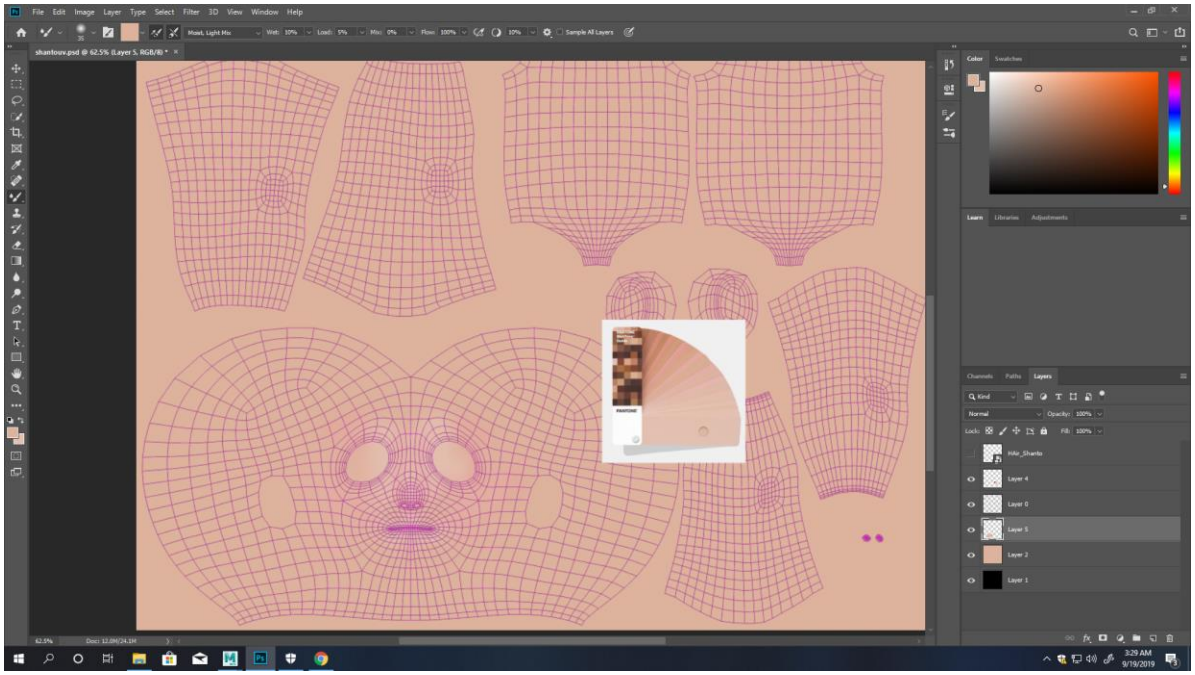

Figure 3.15 Character texturing Shanto

Dresses were textured using a lot of layers. First the base colors were selected. Then some graphic design was added and some fabric textures were collected from the internet. These were stacked in layers and then overlaid or multiplied to make desired effects. The costumes which needed some dirt was made dirtier by painting with rough brushes.

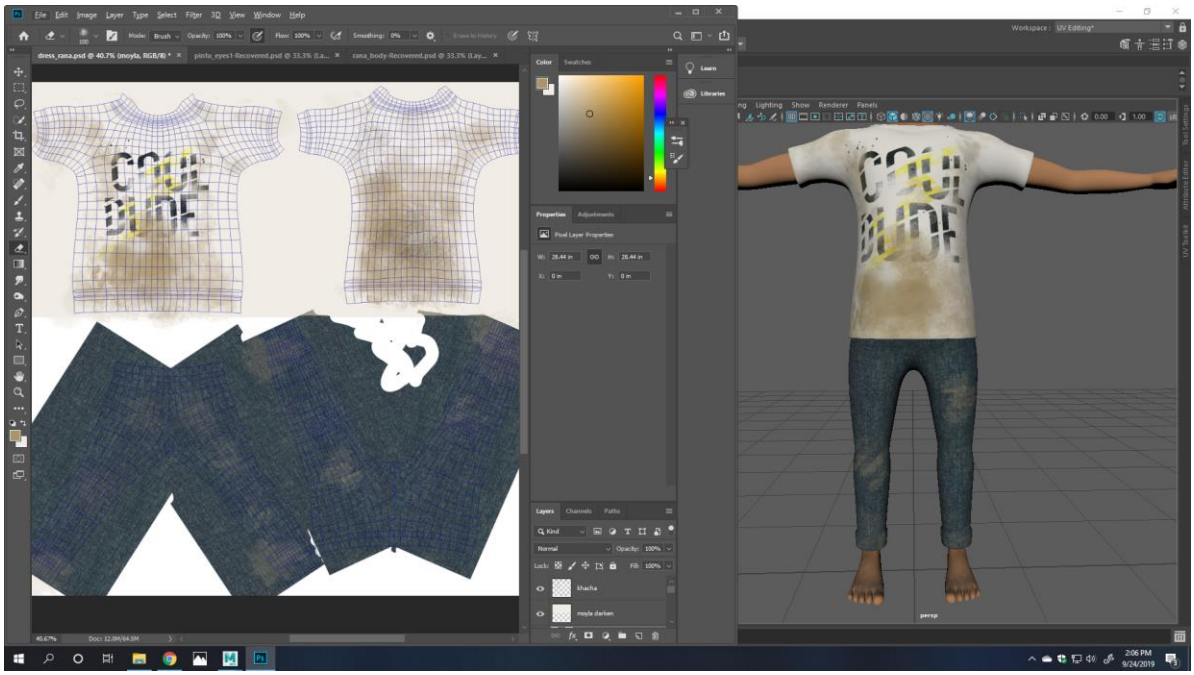

Figure 3.16 Costume Texturing (1)

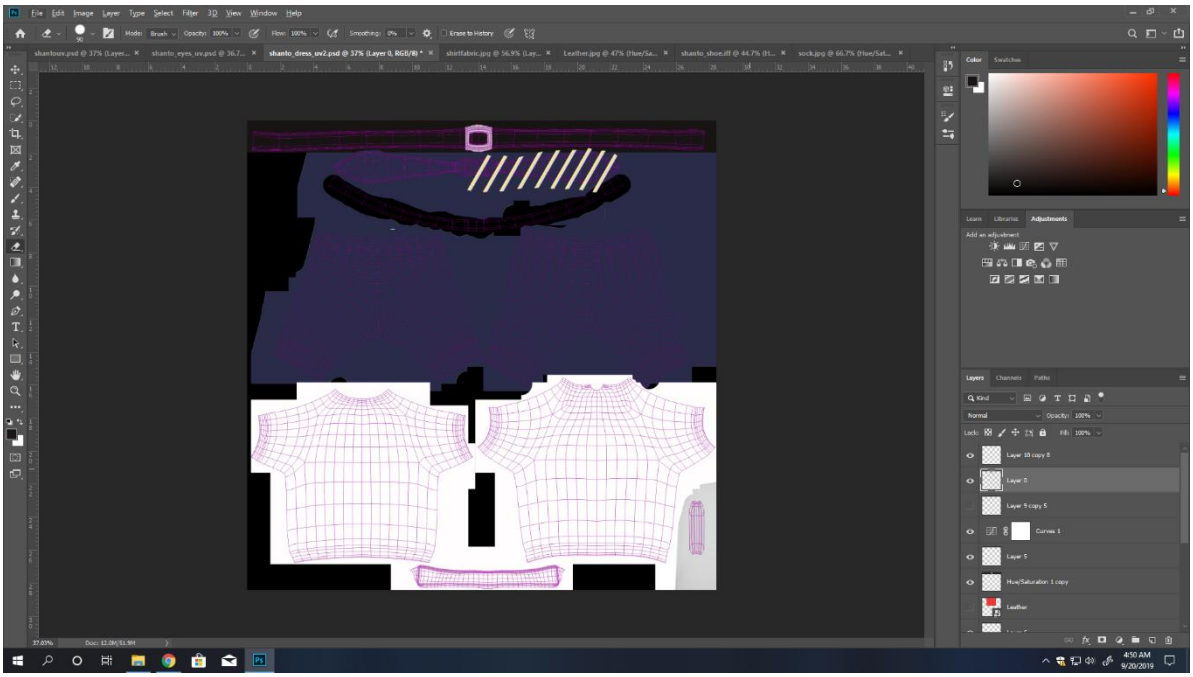

Figure 3.17 Costume Texturing (2)

Teeth, shoes and extra accessories al were textured in the same way. For the eyes, a pupil texture was collected and edited and then placed on the UV and the size was modified matching with each character's eye shape.

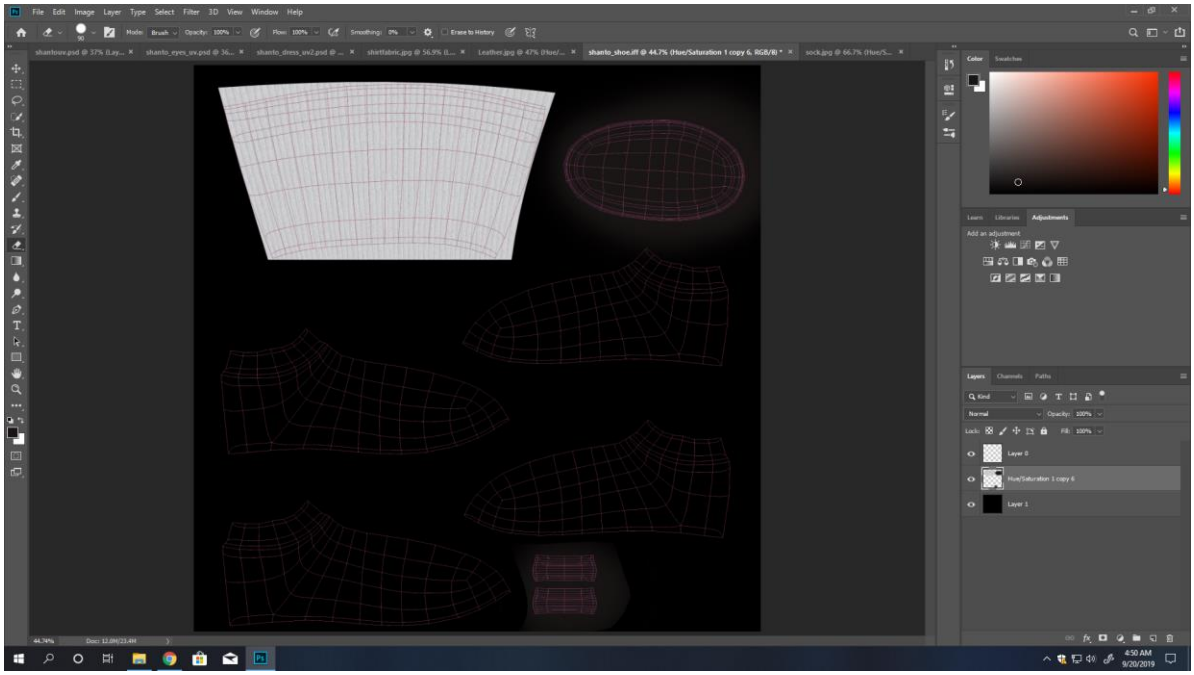

Figure 3.18 Costume Texturing (3)

3.3 Animation:

3D Animation is the process of using motion to any 3D model to make it perform an action. In this film 3d animation was mostly implemented on characters. There were about 24 scenes to animate. For animating first, the scene needs to be ready. There should not be any extra models in the scene. It's preferable to use replicas or primitive references for the necessary elements of the scene where the animation would take place as shown in the following figure.

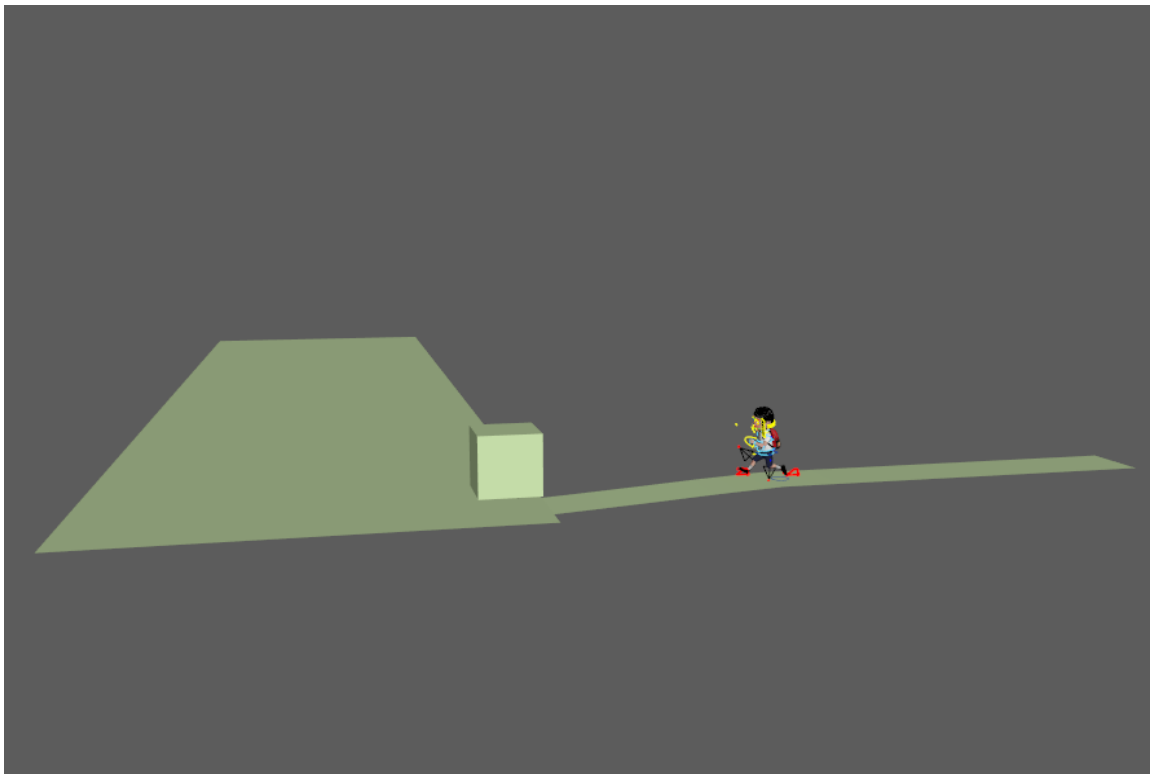

Figure 3.19 Using proxy primitives and referenced character in an animation scene

After the scene is ready the preference is changed from windows > settings/preference> preference. In this animation tab weighted tangents need to be turned on and default in and out tangents should be set to flat and stepped respectively. Weighted tangent allows the animations to slow in slow out while flat and stepped tangents keep the animation blocked for the initial stages of animation.

When the scene is optimized and ready to be animated the character and models need to be referenced into the scene from files > create reference. Referencing keeps the original data of the characters the separate from the data of the animation scene. After the model or in this case, character is placed, animation begins.

Animation is done by using the controllers of the character model which were created in the rigging process. These controllers allow us to move or deform any part of the body as per requirements. Different controllers are assigned to different parts of the body and they all have different functions. Sometimes controllers have some common basic functions set in the channel box for ease of animations. These controllers are basically translated and rotated to give the character a pose. In the beginning of animation firstly the key poses of character are set then are in-between key frames are placed. This process of animation is called “Pose to Pose”.

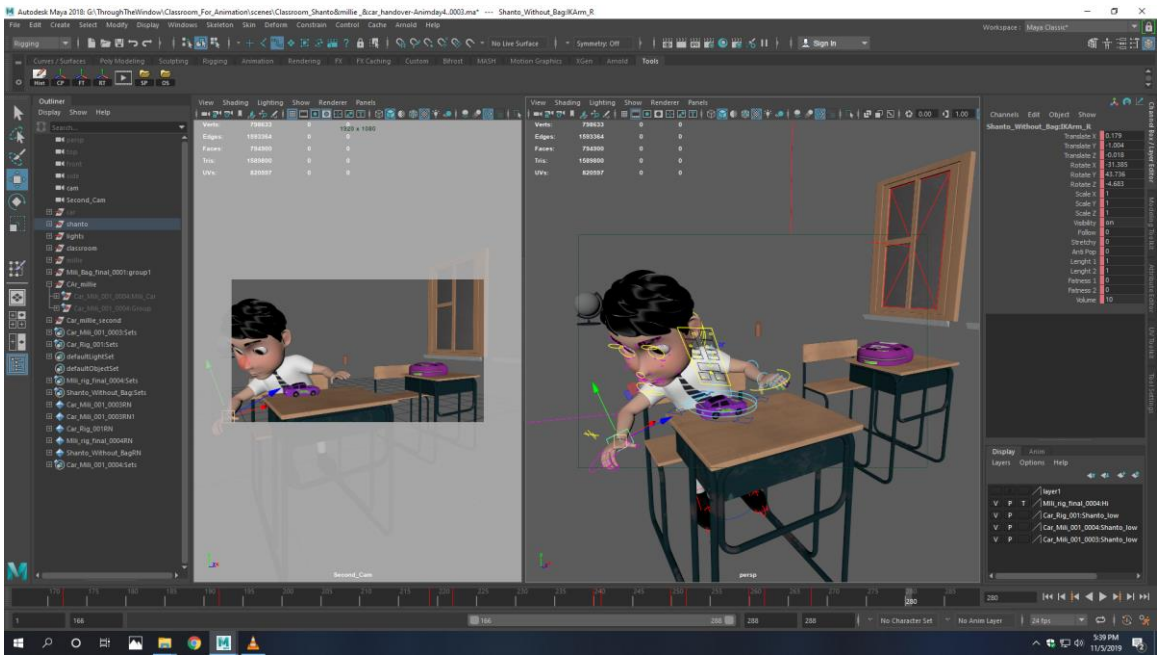

Figure 3.20 Pose to Pose animation

To create realistic animation and expressions real life references were needed. So, video

references where created for this purpose. Video references also aided in the timing and spacing part of the animation.

Figure 3.21 Creating video reference for animation

After the pose to pose blocking was done the in-between poses were animated for better results. After a satisfactory result the part of polishing takes place. In this phase some of the movement and actions of the characters were offset from the graph editor. This creates the realistic movement of characters as when a part of the body moves first the part attached to it follows it.

Timing and spacing is very important in animation process. A 12-frame allowance was firstly selected for each key frame. Then with the in between were added in every five frames. After polishing there were key frames in almost every key frame.

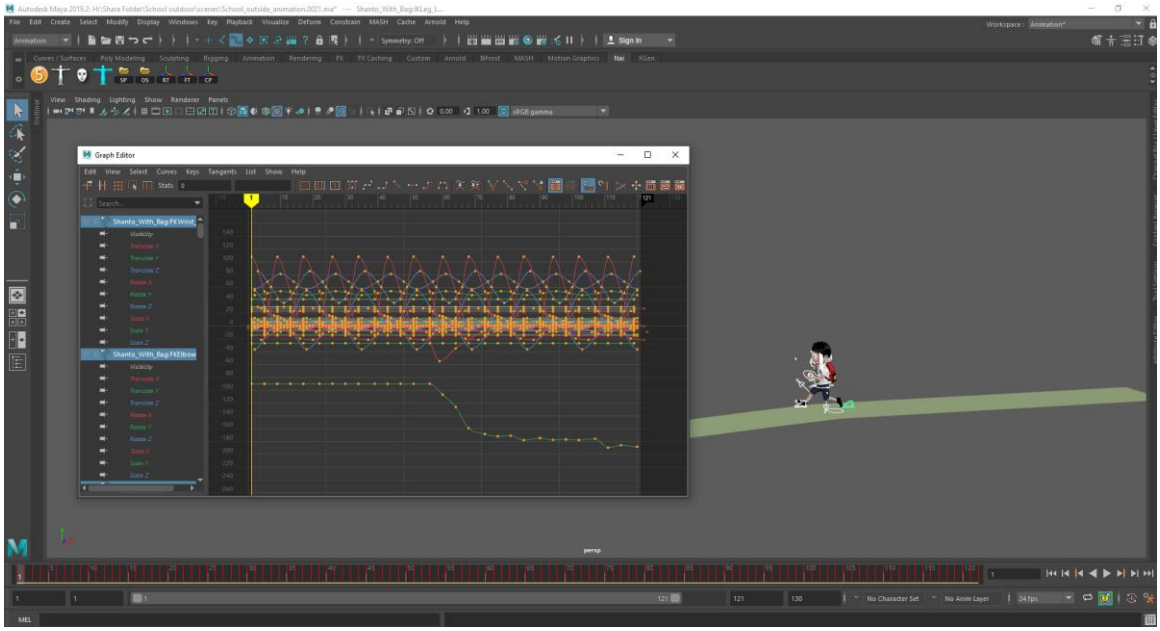

Figure 3.22 Key frames after polishing

In Through the Window there were different kinds of animation with different requirements. In some shots there was just the character animation without any other prop while in some other scenes the characters had animations with one or more other props in hand. This demanded various techniques of animation process. Some of the variations are briefly described below.

3.3.1 Animation with one prop in hand:

In some scenes the characters hold at least one prop in one hand. The props need to move along with hand seamlessly. To make that happened the props needed to be parented with the main character. Sometimes the prop in hand needs to be changed with another duplicated in order to avoid complication. This can be done by easily turning off the visibility on the connected prop and turning on the visibility of the free prop with keyframes like the car in Millie's hand in the following picture.

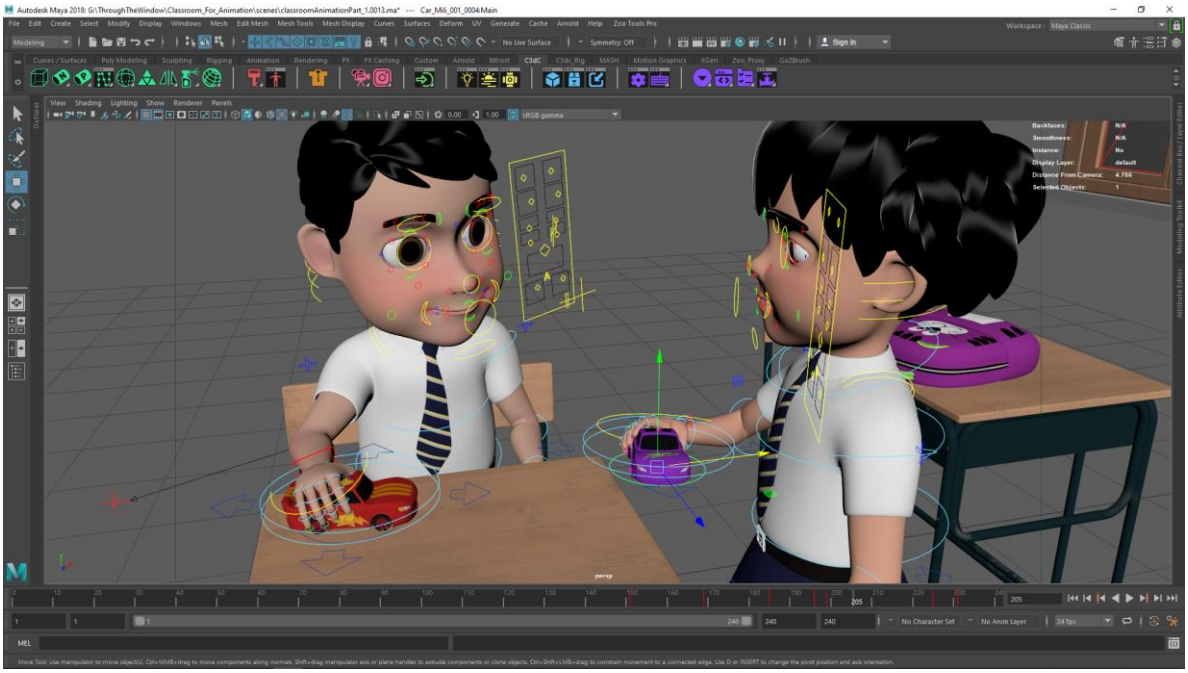

Figure 3.23 Animating with prop in one hand

3.3.3 Both hands on the same prop:

When animating a character carrying a prop with both hands then first the dominating hand in parented with prop. So when the box moves the prop will move. Then the prop is parented with the other hand. Sox when the first hand moves the box moves and when the box moves the other hand automatically moves. This method synchronizes the both hands perfectly and makes animation process much easier. Locators may also be used in this process.

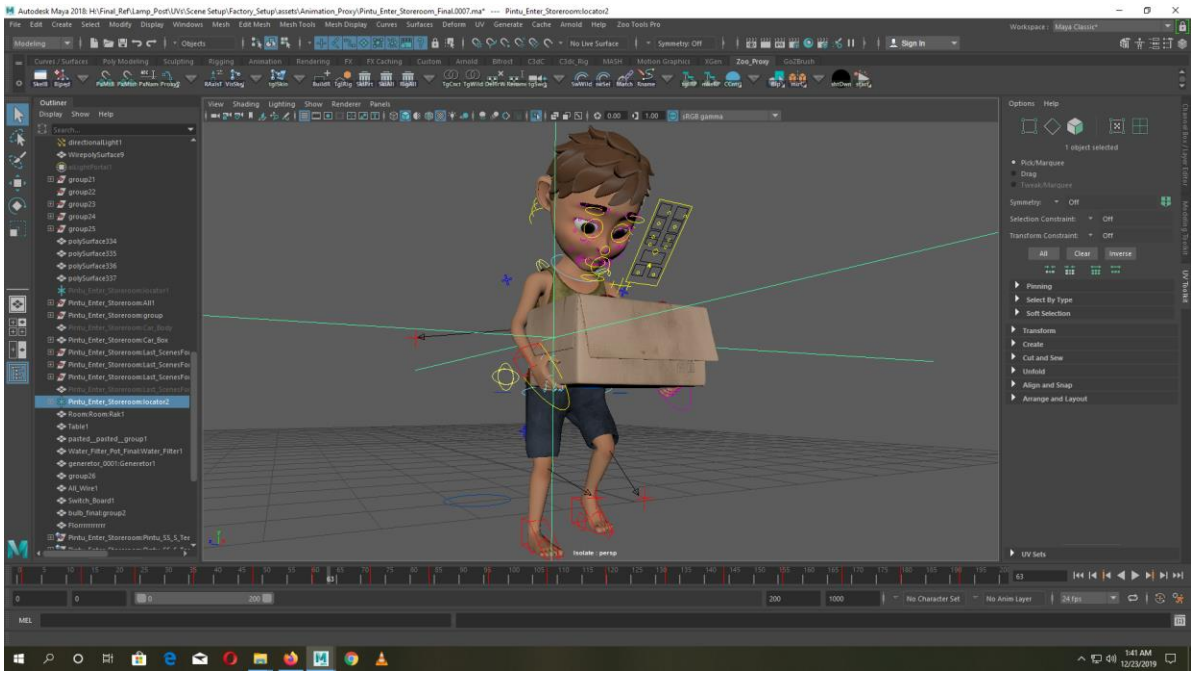

Figure 3.25 Animating with one prop in both hand

3.3.4 Hand controller:

Some of the controllers that are automatically created by the rigging plug in "Advanced Skeleton" [13] provide default parameters in the channel box. Some poses can be easily achieved with these. Like the hand controller shown in the following picture. It has option for each finger to curl separately and the hand to curve or stretch. These parameters are helpful for grabbing any props while animating. This type of options is available in foot controller, mouth controller, eye controller and eye brow controllers.

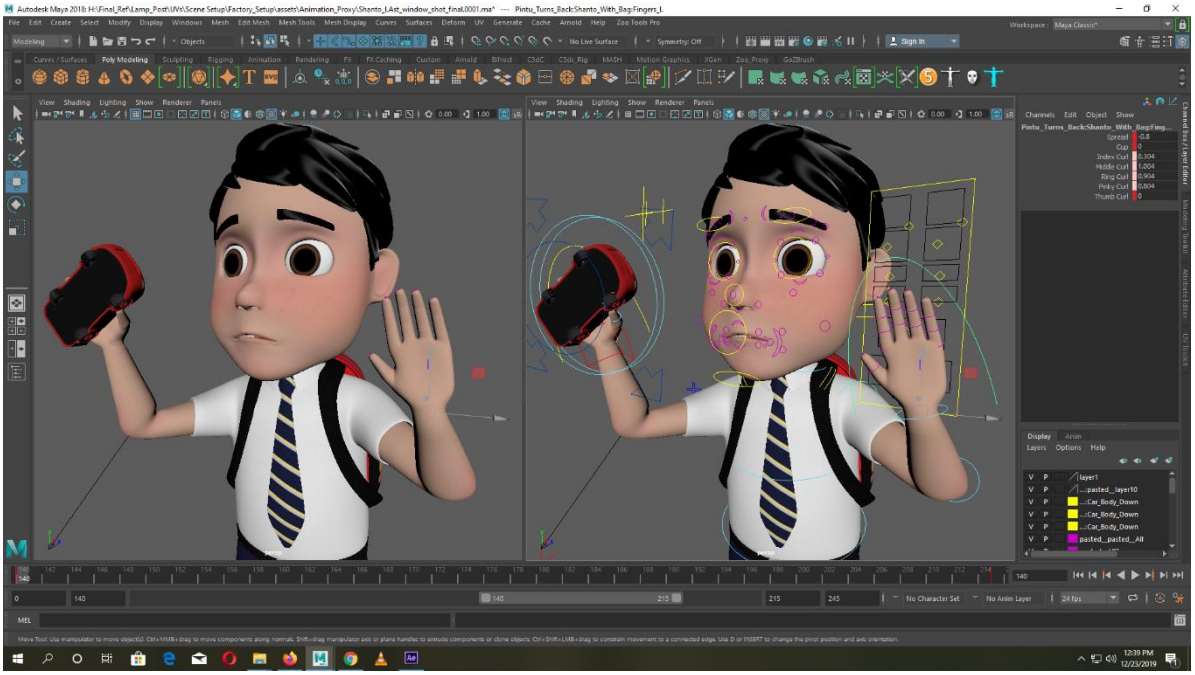

Figure 3.26 Animating with hand controller parameters

3.3.5 Facial Expressions:

Facial expressions are crucial in the animation process. These describes the emotions and lets the audience understand the story more and empathize with characters. For bringing the characters to life facial expressions are given by playing with face controllers.

Figure 3.27 Animating facial expressions

They have a separate box and can also be modified manually.

While animating it was kept in mind that the face of the characters should be appealing. And no change can be brought suddenly. Expression should deform the face gradually. The timing of the keyframes are carefully placed. Some anticipations are brough up by offsetting each feature. The way the brows rise, and the fawn happens should all co relate. It is also important to provide each animation enough time so that the audience can capture the changes and the mood of the scene.

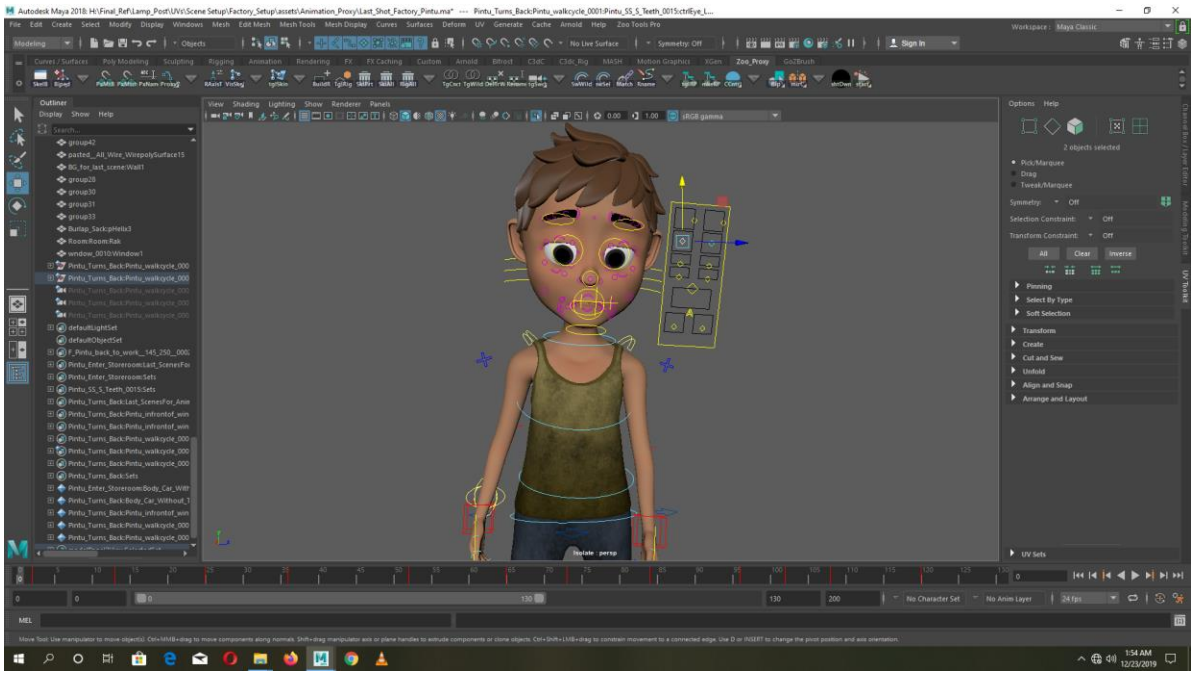

Figure 3.28 Animating expression matching with posture

CHAPTER 4

Limitations and Challenges

4.1 Limitations:

A lot of intangible limitations were faced while working on this project. These limitations affected the output of our project in one way or another. Some of these are discussed below.

The most intangible limitation was the lack of experience. There were some experiences in all the steps in this process but the proper pipeline was never followed. Also, the scope of skill implementation was also limited. When it came to such a big project with a proper pipeline was to be followed, we fell short on experience we fell short on experience which affected time management and finding solutions to problems faced.

3D animation is a form of art which combines a lot of other forms of art. For initiating a project like this a lot of things from the artistic angle needs to be considered. Such as the color palette of the film, the looks of the characters, forms of different models, postures sense, perspective sense, a sense of composition etc. For this reason, a strong hold on fine arts category is much needed. Unfortunately, this skill is inadequate. Being a student work there were no fixed budget for this project.

4.2 Challenges:

As this is a group project it was important that all the members work together with close proximity so that whenever any member faces a problem they can reach out to other members. This makes problem solving much easier and obtaining approval faster. Living in different homes at first there were no fixed spot where all four members could work together but eventually a room was rented and the challenge was met.

All the software used for 3D animation and rendering require high configuration computers. In this case the higher the configuration the better the quality. But for our average quality computers we faced a lot of challenges to work with. The software kept crashing or getting stuck. Sometimes they became slow and could not read the commands and execute them properly. Sometimes files would take several minutes to even open up. These kinds of problems wasted a lot of time which would not have been an issue if there were better quality computers available.

Computers with higher configuration can decrease render time exponentially. Render time a big factor when it comes to producing any computer graphics. Keeping computer limitation on mind sufficient time slot needed to be allocated for the rendering segment.

In order to create the desired outputs a few new software and commands from known software were needed to be learnt in a very short time. As the knowledge of these software were limited so problem solving became a big issue.

CHAPTER 5

Some Problems and Solutions

UV Unfolding: The default unfold option sometimes does not work properly while unfolding the shells. For eliminating this problem sometimes the default unfold method needed to set to legacy in the options box beside unfold in the UV toolkit.

Rigging: as the project was done mainly in Maya 2018.6, the plug in we were using for rigging did not work properly. The skeleton build process could not be completed. To solve this problem the rigging was done Maya 2017[14].

Maya Mash: The threes in this film were made with Maya Mash. While doing this sometimes the leaves were not attached to the surface of the mesh they were input on. They would scatter by offsetting around the mesh. It was then figured out that if the main leaf was freeze transformed at 0, 0, 0 point of the gridline then it would work properly.

Leaf Texturing: The leaves were made with a PNG file on a plane to make the trees low poly. But the leaves were not rendering transparent. By assigning maps in the parameters of the plane this problem was fixed.

Arnold Stand Ins: some heavy objects were made proxy by the Arnold Stand In options to the scenes would be less heavy. But these Stand Ins did not receive texture files when transferred to a different computer. Several methods were tried but the result was the same. We couldn't solve this problem entirely but it was decided the scene with Stand Ins will only be rendered with computer they were made in.

Source Image: while rendering the files were distributed to a number of computers. But some of the models did not receive textures directly from source image. So they rendered without texture. This caused us system loss and a lot of rendered files were discarded. So every file needed to be checked thoroughly before rendering in every single computer. This added to the total time allotted for rendering and created a time crunch.

Texture loading failed: as there were a lot of heavy models in most of the scenes and all of them had high resolution textures, the GPUs in our computer failed to load them eventually

causing software crash sometimes. So texture mode was turned off while working on heavy scenes.

Viewport loading failed: Some of the scenes were so heavy that the computers with lower amount of RAM failed to load them on the viewport. To temporarily fix this problem extra RAM was borrowed and added to the computers.

Storage problem: the entire project was approximately 1.5 TB in size. Some of the files also needed back up. To meet this challenge portable hard drives were managed.

Render time optimization: Each frame required 20 minutes to render on average. In this rate the total rendering time would exceed 2 months. We could not afford this much time so rendering was distributed to 29 Computers in total. This reduced render time exponentially leading us to finishing our project in time. Some of the scenes were also rendered in alpha channel where background could be a still image. This also reduce render time.

Manual Subdivision causes PC freeze: for giving a high poly look to the character hairs more subdivision were needed to be added. But by adding more subdivision the file size increasing a lot causing software crash. So instead of increasing subdivisions physically on the model, the iterations were increased in rendering within the Arnold tab which gave the model the desired high poly look without actually adding more subdivisions.

CHAPTER 6

Conclusion

Due to the weakness of the law and mass poverty, the number of child laborers are increasing day by day in our society. These children are subjected to harsh and dangerous working conditions, even in some cases physical abuse and sexual harassment.

This animated short film is a small attempt to expose all these inconsistencies of society with child labor.

While doing this project we had some unique experiences. We learned a lot of in depth knowledge about 3D animation pipeline. This project gave us the opportunity to learn a few new software's and more about the software's we were already familiar with.

We faced various issues while working on this project but solved most of them by consulting and researching together. Although there are some problems we were unable to solve but we are keen to learn about them in the future.

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