

Executive Report of ROBUST

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Executive Report on ROBUST

Executive Summary

This project was a massive undertaking right from the start: from the photorealistic visuals that were being aimed for; to the emotionally engaging story, that is more prominent in the real world now than times before.

The main principle that was carried out over the following work was that if nobody was distracted by the visuals, they would get lost in the story. This meant the visuals had to be of a consistent, well produced quality, to ensure that people were not focusing on single visual elements, but a whole, broader picture. This is an important aspect to ensure normally, but with the added element being an emotionally enveloped story, it's more vital than ever.

If all went to plan, the audience would be rooting for the robot the whole way through the short.

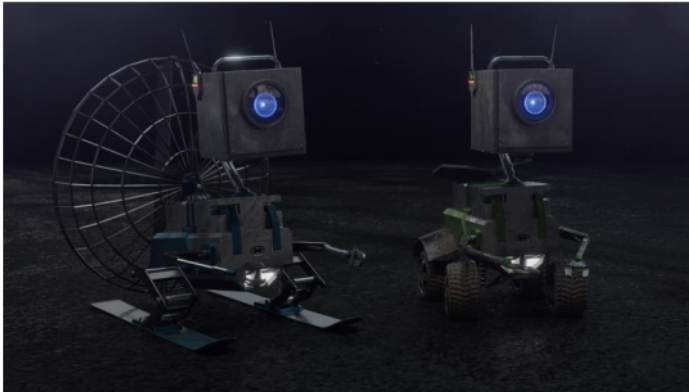
Robot Design

The first thing that was worked on this semester's project was texturing the robots. When doing this it was important to make each of them a little different to make it easier to differentiate between them without looking at the wheels or skis. This was accomplished by giving each of the robots a different main colour. This means that an audience should instantly understand which robot they are looking at. The colour of each robot matches the type of environment they are suited for. This makes sense from a real life practical point of view, but the main goal of this was to hopefully further engrain the idea that each robot is built for a specific task, and will most likely fail doing anything else. Another factor considered here was that Broadbent (2012) found people prefer a robot to look suitable for its role. For example, a robot that lifted things need not look human, but one that gives personal care e.g. telemedicine should. The robots in this short were not giving personal care and so it was more important they looked like they could fulfil their role rather than look human. This unhuman like design also reduced the risk of 'uncanny valley' where a robot looks almost human but not quite (Mori et al. 2012)



During this stage some adjustments were made to the headlights and the eyes of the robots. They started off as flat emission planes, but after showing this to a test group it became clear that as the aim was for a realistic visual style, this wouldn't work, as flat emission planes don't exist in real life. To remedy this inspiration was taken from Disney's "WALL-E" and the eyes were redesigned to more resemble real life lenses and then remodelled them to create a more realistic appearance.

Adding realism and the 'less flat' eye allows for a cuter look (while still looking non human), captivating the audience more than before.



Environment Mockups

At the beginning of this project, although a decision had been made on the type of environments (Ocean, beach and wheat field) there was no real consensus about the final appearance of them. Therefore, It was decided it would be beneficial to do some mock up images of each environment with the robot model placed in them, giving a better understanding of how the full animation would look. It also helped the development of some techniques that would be needed to create each environment for the final short.

Desert mockup

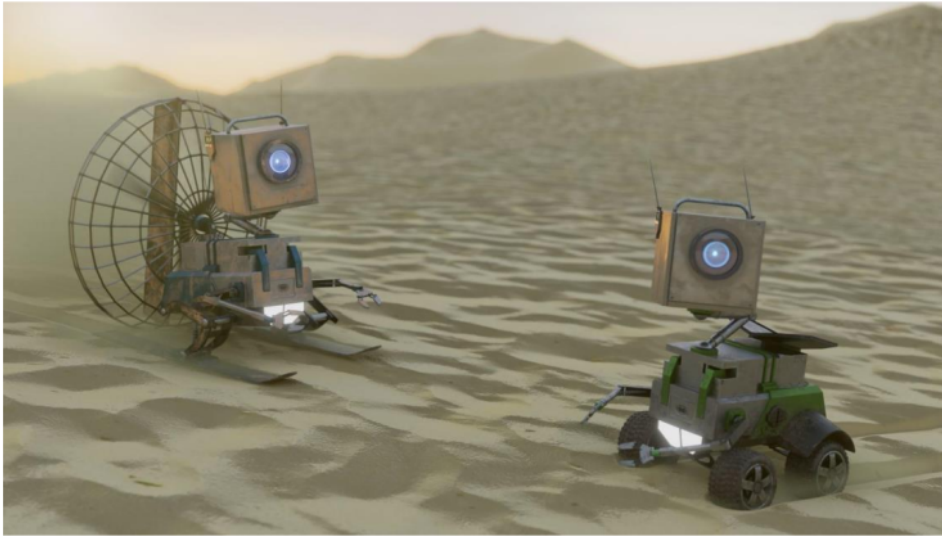
The first mockup created was the desert. Firstly a dust layer was added onto the water robot's texture. This worked well, making it seem as though the robot belonged in the image.

For the ground a sand texture with a displacement map was used. Because the displacement map needed geometry to displace the render times were far too long. To allow for a faster render the ground was split into 3 segments, each segment further away from the camera. Each segment was subdivided less and less, as the displacement wouldn't need to be 100% accurate miles away from the camera.

Blender's Dynamic Paint feature was used to allow the wheels and skis of the robot to draw onto the sand displacement texture. This meant that the wheels and skis actually draw a path in the sand where the robot travels.

To finish off this image volumetrics were added behind the water robot to look like the propeller was spraying sand out behind it.

The results of all of these techniques, combined into an engaging image that gave high hopes for the future animation.



Wheat Mockup

The wheat field was the most challenging environment. The first step was finding a wheat strand texture, which was textured onto a clump of planes, which were then scattered around a plane. However, this caused the render times to skyrocket! In order to correct/reduce this, instead of having small bunches of wheat strands everywhere, wheat was placed in a row and rendered out, resulting in an image with a strip of wheat, this meant that high detail groups of wheat could be used for the close ups with just a few of the strips of wheat in the background. This worked really well on the first attempt and was pleasing as it meant the render times were a fraction of the time, with almost no visible difference.

This scene was also used to further check how the wheat would look after being mowed down using the 'Lattice' method "I essentially faked all the physics of the grass. There is a lattice parented to the robot in the shape that I want to make the grass move. This meant that when I moved the robot over the grass the grass folds down and replicates the shape of the lattice." (Smith, 2021). Again, this worked well.





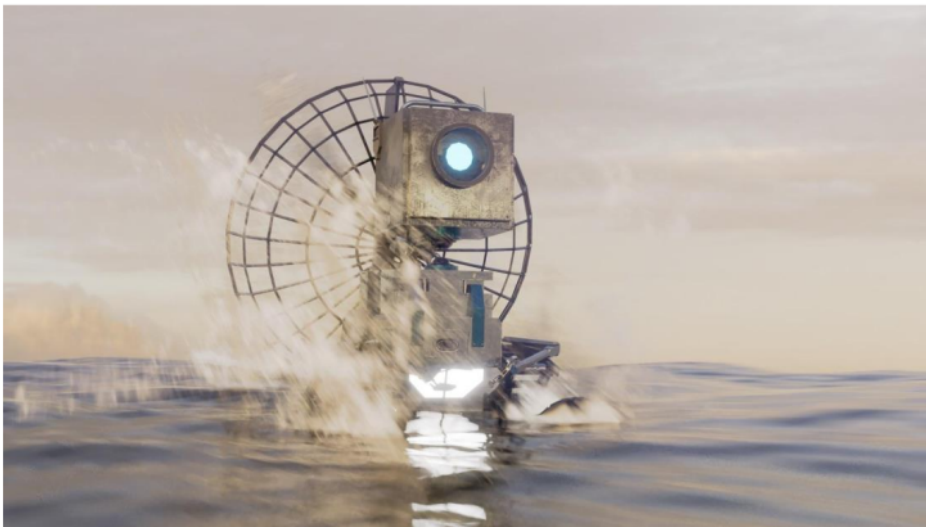
Ocean Mockup

The final mock up was the ocean. An ocean displacement shader, previously made in the previous semester, was applied to a disc. A disc was used instead of a plane as it allows a more natural horizon due to the lack of corners.

For the splashes I originally tried emitting white/see-through balls from the robot's skis, but this method didn't provide the hoped for quality so other methods were tried.

After considering various video sequences of some splashes, and as this was just a mock up, the next stage was to experiment with the splash videos on various planes and placement around the robot.

This method worked well for the mockup, however, as the planes were just static this would not work for the final animation.



The ocean and the beach

After completing these three mock-ups work was began on the final animation. The beach scene was the most technically challenging scene in the animation. Fortunately, primary research photographs taken at the local beach were useful as a frame of reference.



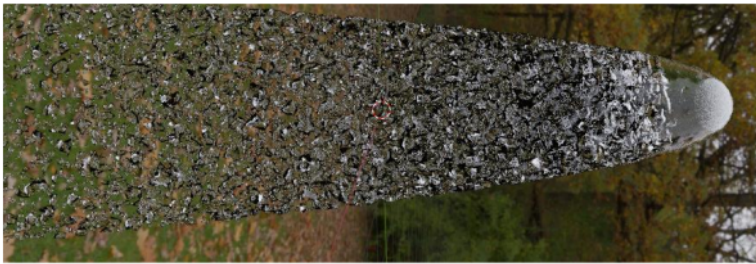
Unfortunately during this stage there were a few unanticipated challenges. The first problem was that the add-on used did not support any kind of buoyancy simulation. This meant there was no way to simulate the robot floating towards the beach and being affected by the waves. It took a while to think of a solution but in the end a workable method was devised. The method involved baking the beach simulation at a low resolution, then hand animating the robot to be floating and being pushed by the waves. Then finally re-baking the water simulation at a higher resolution. This meant that the waves appeared to be affecting the robot, but the robot also affected the water and left ripples behind it.

Next was the ocean shot. Although a previously made shader (from first semester) was used for creating the ocean there was still one more challenge to tackle for this shot, and that was making it so the robot created ripples in the water. There were two possible methods of making this work, both of which included blenders "Dynamic Paint" feature. The first of the two methods was using a method used in a previous year in university, which was using dynamic paint to have the ocean as a "wave canvas" and the robot as a dynamic paint "brush"; this simple method would have allowed the creation of ripples exactly how they were needed. However it came with one problem. Dynamic paint needs lots of vertices to calculate and move the ripples, which meant the mesh had to be very high resolution, which normally works on a small scale. However on a large surface like the ocean the resolution would have had to have been so high that it would take far too long to calculate each ripple for every frame. Knowing that ripples were essential for a realistic result the second method was used, which was to allow the dynamic paint "brush" (the robot), "paint" onto the texture of the ocean. This would have the ripples output as a texture and allow the ripples texture to mix with the main ocean displacement

texture. However, that would require a single patch of ocean dedicated to where the robot would be skiing, which would have a combined ocean displacement, and ripples caused by the robot.

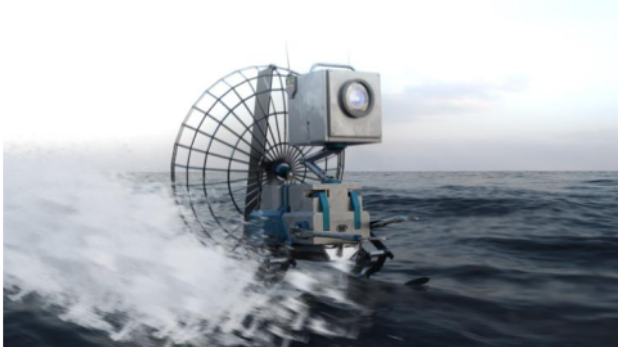
With the water displacement texture done it was time to work on the splashes that the robot would cause. After experimenting with MetaBalls, which connect together when placed close to each other It was considered a valid method as it's essentially the same as how water droplets form and connect to each other, but after trying a quick test it became apparent that another method might be preferable as it didn't give a polished, realistic finish.

At this point adding some seafoam into the shader underneath the splashes was tried, as an attempt to make it look more natural. This addition did help, a little, but the MetaBall splashes just weren't working.

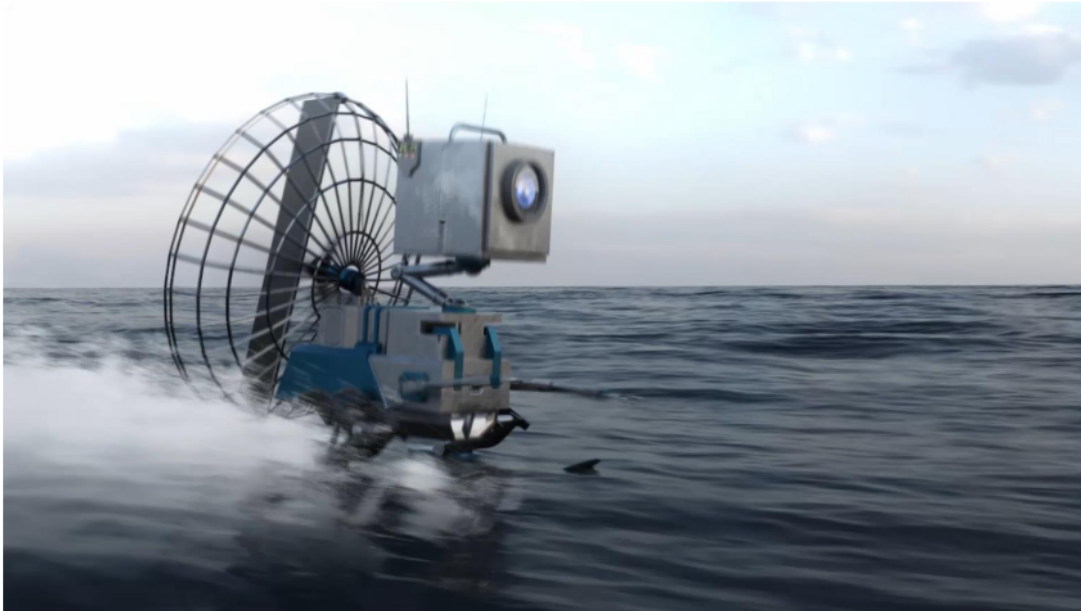


Returning to the water splash image sequence from before, the robot was used as a particle emitter and emitted hundreds of the splash videos on planes. A simple node setup removed the background from the videos and adjusted the settings of the particles to look good. Simple changes such as making the particles grow overtime had a huge impact on the final look and a lot of time was spent here perfecting it.

There was still one problem with this however, which was that the planes with the splashes were clipping/cutting into the ocean, leaving a harsh edge where the splashes touch the water. Initially this didn't seem an issue, however after repeated watching it became quite distracting from the main story. To correct this problem the scene was re-rendered without the splashes, and then the splashes were rendered out by themselves, this led to a weird situation where the splashes that would have been underwater were now showing above water.



To solve this "Davinci Resolve" was used to rotoscope the splashes to only show the parts that would be above the water. A soft feathering effect was added to the edges in order to give a nice gradient from splashes into the sea foam texture on the surface of the water. This definitely worked better on some shots compared to others, but overall gave a pleasing result.



The next phase of the project was to find a solution to the biggest problem. The main shoreline of the beach and the ocean in the background were two different objects. This meant that it was necessary to find a way to merge the two parts seamlessly to have one shoreline that goes all the way out to the ocean behind it. After spending a few weeks trying to resolve this problem a method was found that involved vector displacement again.

A simple node setup using the dot product was used to get a mask of only the top part of the simulated water. Then the mask was used to completely flatten and move that part of the simulated water to the same height as the ocean plane behind it. This gave a completely seamless beach.

Unfortunately, when it came to the final render, one of the settings was set wrong unnoticed. This was not helped by time restraints as I didn't have time to re-render it. Therefore in the final animation, the appearance of the water is not as desired. However, hopefully most of the viewer's attention will be on the robot. (This will be re-rendered at a later date after submission)

Wheat Field

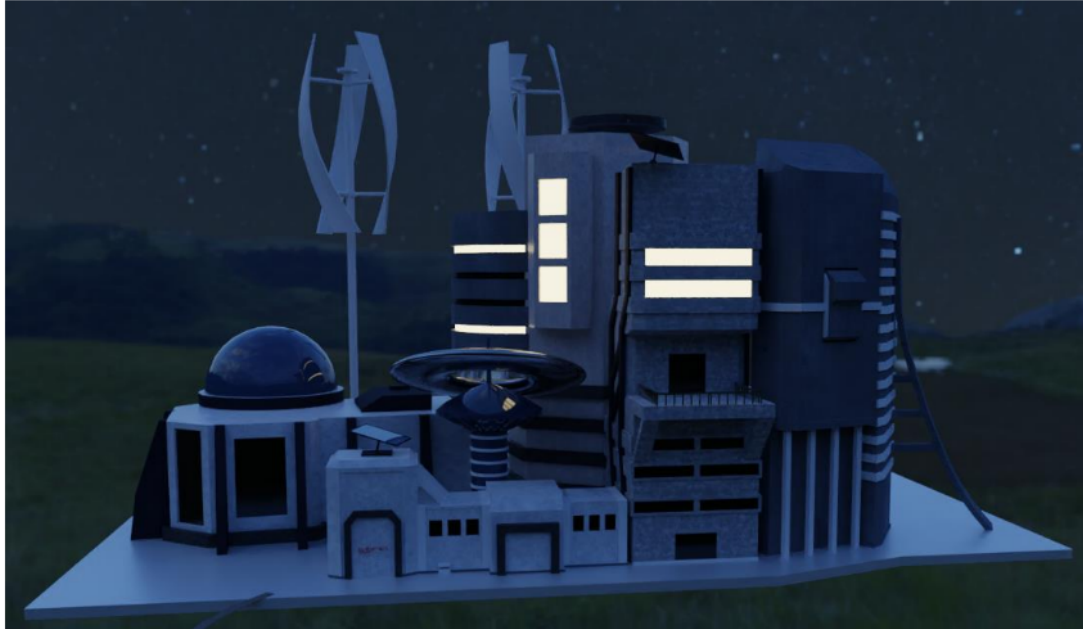
The wheat assets were available from the mockup scene created earlier. A big disc shaped plane was created and a particle simulation was used to spread the assets around the plane. A vertex group was made which allowed a choice of where the wheat was placed. This meant a path could be added through the middle of the wheat, for the robot to travel to the city on. An important aspect to keep in mind during this part was that to ensure it looked inconvenient for

the robot to have to follow the path. This was because the imagery needs to show that the robot is following his programming even when it's inconvenient for him. The reason this shot is so significant is that it needs to show the contrast between this shot and the shot of the robot tearing down the wheat field, as it is a huge moment when the robot decides to ignore his programming, in order to save the other robot.

For this reason the path was designed to run parallel to the city and slowly turn towards it. This not only worked for the story but also looked good cinematically.

Next was work on the city. This involved more work than at first anticipated. This is because the city had to be designed in such a way that it looks like a city, but not so advanced that they would have been able to make their own vaccine. If this were the case there would have been no reason for the robot to deliver the vaccine. In the first design only a few small little buildings were used and even though this worked well for the story, it didn't look add to a cinematic view, as they weren't visible from far away, and the audience wouldn't get that classic feeling from seeing a huge futuristic city. The decision was made to make tall futuristic skyscrapers, but still keeping it small. The final outcome works as, although it is small it resembles a small space outpost which is still in keeping with the futuristic look. Some animated elements were added into the city to make it more engaging and visually appealing to a viewer.

Following that began the texturing phase, in hindsight this is an area that would have benefitted from more time, particularly as when texturing it was mainly carried out with the viewpoint of looking at the city from the far away perspective of the robot. However, this didn't account for the close up shots. This led to the city textures being a little empty and visually boring compared to everything else. Fortunately it didn't really change much about the final story, but it would have been preferable to have spent a little more time on it



At this point, a quick block out animation of the wheat field scene was carried out. The animation isn't perfect but it provided a starting point for Ben to do the final animating. Doing this block out animation also helped to gain a better understanding of the camera shots that will be used in the final image, this allowed a focus of attention on the parts of the environment that are getting the most screen time.

The wheat field environment was working well at this point however there were still things to do to really fill up the scene. The first thing was adding some hills and mountains in the background. This was done by first adding some images of planes of hills and mountains in the background. Secondly, a mountainous HDRI image that wrapped around the entire scene was added. Doing this added a huge sense of depth and scale to the scene and really helped fill the space. Because the HDRI was taken in the day, and the scene needed to happen at night time the 16k HDRI was put into photoshop and a sky replacement was carried out, changing the sky from white and cloudy to nighttime with stars. All of the light in the scene was coming from the HDRI, which was a problem after the change of the sky of the hdri because all of the light had been removed. This meant that the render was incredibly dark, even though it was physically accurate, it couldn't be used as it wasn't visually appealing at all. To overcome this problem the "Light Path" node in blender world nodes setup was used. This allowed use of the old bright hdri to light the scene, but the dark night time hdri would show up in the background, allowing me to get the lighting that looked the best but also the best sky visual. This technique is a twist on the classic "Day-for-night" filming technique that allows you to film night time shots in day time.

The very last task to be done on this scene was to change the "QUARANTINE IN EFFECT" written on the door from the proxy version. Initially two variations were created on the idea, a futuristic one and a more realistic one.



Both of these designs have their pros and cons, the sci fi one fits the theme of the visuals, however the spray paint one fits the story better. If the inhabitants of the city were in a rush from a virus/disease they wouldn't have had time to set up a futuristic barrier, and so the idea of a quick spray paint fits well. The spray paint design would have worked better with a bit of tweaking, but after a group conversation it was decided to use the sci fi one, as that is the one that fit the sci fi theme better, and so would further engrain this theme into the audience. A few small aesthetic changes were made to the final design which made the gate appear more finished.



Final Sequence Editing

The final piece was edited using DaVinci Resolve. The Project file was made weeks beforehand in and before the clips were rendered. The Timeline was filled with all the playblasts that the rest of the group (Ben and Bibin) had provided as well as my own playblasts. This provided a quick timeline of all the animations, to see how well they worked together, as well as the length of the total piece. Having this early on then meant a simple update of the clips to the rendered videos as we made them. This made it very easy and is definitely a method to be used again. This method also allowed for working on the sound while the group were all still rendering. This process will be discussed in detail in a subsequent section.

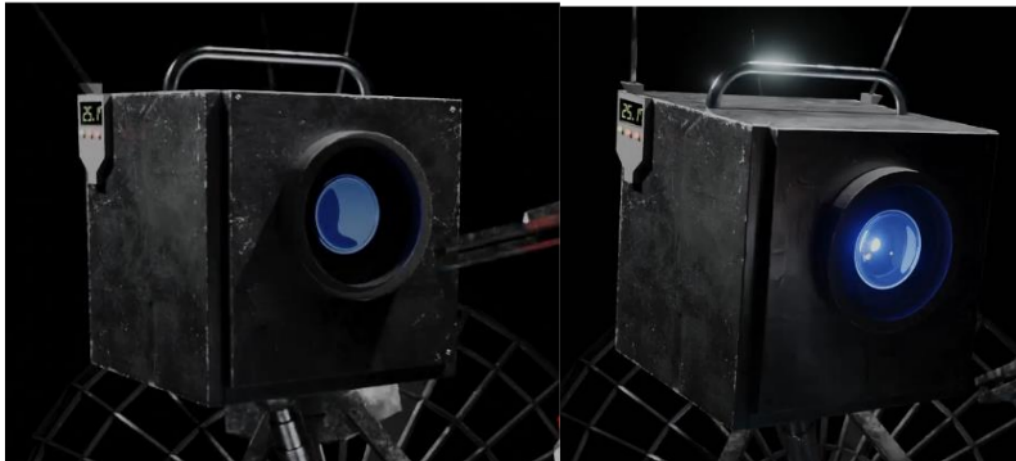
After all of the videos were received, and the clips updated on the timeline to have a fully rendered sequence, Post processing work began by balancing a lot of the colours of the videos to have a more uniform look between each of them. Some colour balancing was carried out that gave the appearance of change in the time of day, to make sure that there is a consistency between times of each of the shots. This also allowed the passage of time to be shown in a clearer way, that instinctively shows the audience how long each section is in real time.

More cinematic post processing that included things such as bloom, sun flares, camera shake, motion blur etc. was done. Doing these didn't really affect the story in many ways, but it did allow the final animation to have a more cinematic look and feel to it, which should give the audience a more engaging visual to go along with the story.

Ben had made a cloud transition from his ocean shot at the start to my ocean shot with the robot skiing across the water, although this was good it was very quick and because of that it felt a little harsh to watch, to remedy this after collaborating with Ben a Photoshop generate "Clouds" noise was added in, with the position animated to sweep across the screen. This was then blended from the hanger to that cloud noise, then to the robot skiing shot. Adding just this extra second of transition helped in making the transition not feel so jarring to a viewer.

Some rotoscoping was also done at this stage to fix some rendering problems. For example, Ben solved a problem that he had where the aperture on the robot's eye was flickering, and he solved it by rendering the glass as a separate layer.

However, because they were rendered separately the glass no longer refracted what was inside, making the inside of the robot's head seem hollow. This was a problem because the eye is the main way the audience will become emotionally attached to the robot, which doesn't happen if the robot's head looks empty. This shot was an important shot as it is the opening shot of the entire short. I solved this by bringing back Ben's original render, where the aperture was flickering, and rotoscoping out just the inside blue "pupil" which allowed the compositing of the appealing eye back onto the hollow robot.



Even though this took a while to do, and we were running short on time, this was an essential change, and was worth doing.

Some rotoscoping was used to fix low sample renders. Due to being short of time at this stage a lot of renders were done with low samples and very high de-noising. This led to some of the shots flickering strangely and being an overall distraction from the main story. There are a few techniques that I used to conceal this. For example at the end where the robot is tearing down the wheat, the wheat was flickering a lot, to fix this one frame of the wheat with really high

samples was rendered, and composited onto the image, care was taken to rotoscope out the robot.

This was also a problem on the shot of the robot driving from the left side of the screen all the way towards the city. To solve this problem was not as simple as the camera was turning way too much. However, another solution was used. Another layer was added onto my timeline and duplicated the footage, Everything was then rotoscoped out except the flickering wheat, heavy motion blur was applied, and a slight gaussian blur. This method would not have worked on more subtle camera shots, but for this it worked well. It didn't remove all the flickering but helped decrease. This means the viewer is less likely to get distracted by the flickering wheat and keep them engaged with the story.

Sound

As this animation is all foley sounds, the background music had an important role. Working collaboratively with Pilagari Sivapathasundaram, a composer, care was taken to ensure that the music did not overpower other sounds such as the robot's fan. Its main use was to enhance the atmosphere of the film and to affect the emotions of the viewers (Bullerjahn, 2001). Cohen, (2001) found that music had as much impact on emotions as the actual storyline.

Making the sound for this animation was a long, challenging process but was definitely worth the end result.

The first two attempts at making the robot movement sounds were not very satisfactory. A friend who studied Music Production was asked and agreed to create the robot movement sounds. The sounds were made and synced up scene by scene. Starting with the water hanger scene. This was an enjoyable scene to work on, adding reverb to the sounds to make them echo, due to being in the hanger. Not only was this enjoyable to do but also added a realistic effect on the final video.

Subtle flying "whoosh" sounds were made to make the audio fit in with the visuals a little more. An example of this is the zoom out of the intro into the eye, and the whooshing sound as the camera flies out of the hanger doors.

The next stage added in the water wave sounds, the hardest part of this was trying to sync the splashes of the waves on the audio to the robot splashes on the video. This worked well, and the close side view of the robot just after the aerial shot, is a favourite shot of the entire animation, partly because of the way the sounds work.

For the beach scene the same ocean sounds were used as before and again an attempt was made to sync the audio to the crashing of the waves.

The sound of a plane propeller was added as the sound of the fan on the robot's back. The equaliser in Davinci Resolve was useful to make the sound a little bit higher pitched as the fan isn't as big as the plane propeller that the sound was from. This small adjustment meant that the sound is much more realistic.

One of the hardest sounds to get right in this entire animation was when the robot's hand touched each other. This happens twice, on the beach when the first robot holds his own hand while thinking and then at the end when the second robot comes back to the first robot. It took a while perfecting this sound and it is still not perfect. To make this sound 2 metal bars were hit together gently, and then slid one across the other. The two sounds were mixed together in Davinci Resolve. By itself this sound is far from perfect, but hopefully as long as there is a sound happening at the right time, with all the other sounds mixed in, it'll sound great to audiences.

Sounds were continued in this same fashion, recorded in various places. If an appropriate sound was not able to be made then sounds from Freesound.org or other sound websites were used. This was kept as minimal as possible.

The crashing sound of the first robot was made by mixing 5 or 6 sounds together which produced a good result, considering some were made by throwing objects down the stairs.

Conclusion

The final short is definitely something to be proud of. The visuals turned out fantastic, but better than that, all the test group understood the story and became emotionally attached to the robots. Part of what made this project so successful is that after 4 years of University all of the group have found the area that they enjoy, and what they are good at in the animation pipeline. This meant that the group could come together, putting the pieces of everybody's knowledge together, to create a wonderful, animated short.

A lot has been learnt over the last 4 years and every bit of it has come in useful this last year while working on "ROBUST", and will remain useful in the coming years.

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