

**IMPLEMENTING VIRTUAL REALITY INTO THE CREATIVE SET DESIGN  
PROCESS**

by

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## **Abstract**

This thesis explores how the theatre industry could adopt virtual reality into the creative set design process to provide a director with a walkthrough of a set before it is built. The aim is to create a better visual platform for communication between a director and a scenic designer, as well as enhance collaboration with the entire production team. I investigate different software to achieve a successful workflow that is used in a case study that involves creating a set design from start to finish with a director and other industry professionals. The results and responses are evaluated to establish if virtual reality will benefit the creative set design process and how it can be used in other creative streams in the industry.

## **Lay Summary**

Virtual reality is a fast-growing industry. It is used in many fields of work to provide research, education, visual communication and entertainment. In this thesis, I investigate the usage of virtual reality in the theatre industry and how it can be used as a visual tool to facilitate communication between a scenic designer and a director. I develop a successful workflow that I implement into a case study that evaluates the visual communication between a director and a scenic designer. I compare traditional ways of presenting a set design to the ways in which a set design can be presented using virtual reality. At the end of my research I take the feedback provided and determine if using virtual reality in the creative set design process is beneficial or not.

## **Preface**

This thesis is an original, unpublished, independent work by the author Kimira Bhikum. This document consists of the written portion of a project that includes the breakdown of a workflow that is used in an unproduced set design process in collaboration with director Lauren Taylor.

Student versions of the software programs such as Iris VR Prospect, Unreal Engine 4, Google Blocks, Google Sketch-Up, Google Tilt Brush, Autodesk Revit, Autodesk AutoCAD, Kubity and Vector Works are used as part of research.

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## List of Abbreviations

AR	Augmented Reality
ASM	Assistant Stage Manager
BP	Blueprints
CVR	Consumer Virtual Reality
PTSD	Post Traumatic Stress Disorder
SL	Stage Left
SM	Stage Manager
SR	Stage Right
UE4	Unreal Engine 4
VR	Virtual Reality

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Mum and dad, wish you were here

&

Sashen, for helping me through it all; not just this thesis

## Introduction

In 2017, I attended the Consumer Virtual Reality conference in Vancouver, where I had the opportunity to test out an architectural walkthrough demo. This was my first experience with virtual reality. When I placed the HTC Vive headset on, I was completely blown away, as I was placed in a new immersive environment. I was impressed with the high level of detail and believability. The demo proved the concept of giving a client an idea of what an apartment would look like before it is built and decorated. The highlight of the demo was that the environment created, was in a 1:1 3D scale, meaning everything was in scale in relation to me. I was able to move around the space and interact with the environment. Intrigued by this method of presentation, I had the idea to apply the same principle to set design, which would allow directors to do a walkthrough of a virtual representation of a set.

In 2018, I was the set designer for *Arthur Miller's, The Crucible* directed by Jessica Nelson. With the knowledge and experience gained from this production, I apply the same traditional process into my workflow for this research. One of the biggest challenges I experienced for *The Crucible* was explaining to the director what I visualized for the set design and how it would look on the stage. Taking the above into account I will endeavour to determine if virtual reality could be the solution to overcoming this challenge. This thesis is broken into three parts:

The VR journey,

The design process and

The evaluation.



The first part of this thesis involves a prototyping phase where I test different tools and applications to create a smooth workflow. Success would be defined by the development of a workflow that offers a designer the freedom to explore their designs in a VR space and, allows for the output of a complete drafting packing. The second part of the thesis involves using the successful workflow in a case study to create an unrealized set design with director and UBC alumni, Lauren Taylor. In addition, I test the walkthrough of the set design with other directors and designers from the industry. The feedback and responses are recorded and evaluated. The final chapter of this thesis is a conclusion to evaluate the process and determine if VR would be a beneficial tool for the collaboration and communication between a director and a set designer.

## Chapter 1: Virtual Reality journey

### 1.1 Virtual Reality application in theatre and other industries

Currently, the biggest use of virtual reality is in the gaming industry. Apart from gaming, VR is used to train soldiers in the military, help people cope with PTSD, and even assist medical students to practice surgeries. (Eisenberg) These are just a few examples of the usage of VR. Apart from the industries mentioned above, architects are slowly moving away from building maquette's, and are rather presenting their designs to clients by make use of VR. Set design and architecture have similar design processes which is my motive to apply VR to set design.

In theatre, VR and AR are now becoming popular among artists, designers and directors. *Cirque du Soleil* is a well-known Montreal based entertainment company that is using AR in their creative process to collaborate with directors and designers. By partnering with Microsoft, they have used the HoloLens, which is an AR headset to collaborate with the team. With this technology they have the capacity to allow performers to test the space while they modify the design to produce a perfect stage. With the use of AR, they can communicate with designers and directors no matter where they are in the world by bringing everyone into one space virtually, using avatars. This is extremely beneficial for the company as they are known for their elaborate, expensive stage design. With the help of AR, they have saved time and money and reduced the risk of errors in design. (Russo)

Theatre companies around the world are using VR in their performances to give the audiences a better experience. One example is *The Royal Shakespeare Company's* partnership with *Intel* to

create a visual experience of *The Tempest*. The project took two years to create a virtual character for the performance. With the success of *The Tempest*, they continue to use VR in performance in other shows. (Royal Shakespeare Company)

Oculus VR has plans to develop an immersive theatre experience. The project aims to feature real –world actors that will perform in VR simply by using motion capture. Viewers are given the opportunity to interact with the actors from home and experience a shared world. (Statt)

In Vancouver of 2019, *The Electric Company Theatre* produced an immersive theatre experience of *The Full Light of Day*. VR Film Writer/Editor, Kevin Kerr created a few short films in VR that is used in the performance to enhance the production. Viewers are placed inside the created environment to get a full experience of the characters. (Electric Company Theatre)

As mentioned, there are many ways to use VR and AR in performance and creation. With this research, I narrow the focus to compare how different ways of presenting a virtual scenic model might affect a final design.

### **1.1.1 2D vs. 3D vs. VR**

Communicating your ideas to a production team is one of the most important parts of the design process. Not everyone has a visual mind and presenting directors with spatial information can be challenging. For smaller shows with a low budget, set designers present their ideas on paper or on a computer. Drawings and sketches work well but they are not in scale and they do offer the same dimensional view of the space.

A digital 3D model done on a computer is another way to present designs. Screenshots can be taken, or the designer can view and move around the model on screen. A commonly used technique for designers to present their scenic designs to the entire team is by moving around in a 3D model to demonstrate the different elements and space. However, even though it's a 3D model, it is still being presented on a flat screen and thus, much of the dimensionality of the physical space is lost. This method is perhaps better used to give a general idea of what the set could look like.

A maquette is the most common way to present a design to a team. In theatre, it's a good way to show the position, size and details of a set on stage in relation to the theatre. White models or maquette's are usually done in 1/4" scale. The ideal way to view these models is to look at it at eye level. The production team can easily make changes to the maquette by physically adding or removing elements. The problem with maquette's is that it is in a smaller scale and is not always to detail. Materials and tools used to create these maquette's are expensive and it takes designers a very long time to build these little models. It still doesn't give the team an accurate realistic view of what the design would be, because you are not in scale in relation to the model. However, some might disagree with this statement as maquette's have been useful to directors for viewing textures, colours and blocking.

I consider that a model viewed in virtual reality enhances the presentation of a design. It works because you can be fully immersed into a model to view a realistic design. It is as if you are seeing a completed set before it is even built. With this method of presentation, I anticipate that directors can walk around on the set to see how actors could interact with the space. Apart from

directors and set designers; other designers can easily look up and around to see what's the best way to work with the set. If an entire theatre model is viewable in VR, this would give the director an opportunity to sit in the auditorium and check sightlines. If architects are using VR to save time, money and risk then I am certain that the theatre industry could achieve similar results.

## **1.2 Getting started with VR**

With the aim of to creating an immersive experience by placing a director in a theatre, with a set on stage, I begin by researching the different VR and AR headsets available. AR generates a digital element or a layer to a live view, which can either be seen using a headset, a tablet or a mobile device. Snap chat and Pokémon Go are perfect examples of Augmented Reality.

Currently, AR headsets are more expensive than the VR headsets. An inexpensive way to use AR is by using a tablet or a mobile device but I wouldn't achieve the believable immersive experience. It would still be viewing a 3D model on a flat surface such as a tablet or mobile device.

VR completely shuts out the physical world and creates a new immersive environment. In addition, there is more software available to do VR than AR. Companies are making it easier to create VR experiences with little or no knowledge. I decided to use VR however, in the future I believe that AR will be a better option for designing and collaborating.

From the reviews I read and the headsets I tested, I chose to work with the HTC Vive. This headset was reasonably priced, had good picture quality, great software/setup support and comes

with controllers to allow the viewer to move and interact in a 3D space. In addition, the HTC Vive requires a VR ready/compatible desktop. Refer to table 1 below comparing the desktop specifications to run the HTC Vive:

<b>Key information</b>	<b>Minimum specs</b>	<b>Recommended specs</b>
<b>Graphics card</b>	NVidia GeForce GTX 970, AMD Radeon R9 290 equivalent or better	NVIDIA GeForce™ GTX 1060 or AMD Radeon™ RX 480, equivalent or better
<b>CPU</b>	Intel i5-4590, AMD FX 8350 equivalent or better	Intel™ Core™ i5-4590 or AMD FX™ 8350, equivalent or better
<b>Ram</b>	4 GB or more	4 GB RAM or more
<b>Video output</b>	HDMI 1.4, DisplayPort 1.2 or newer	1x HDMI 1.4 port, or DisplayPort 1.2 or newer
<b>USB port</b>	1x USB 2.0 or better port	1x USB 2.0 port or newer
<b>Operating system</b>	Windows 7 SP1, Windows 8.1 or later, Windows 10	Windows™ 7 SP1, Windows™ 8.1 or later or Windows™ 10

**Table 1. VR ready specifications**

The biggest expense for this research was the computer as it was required to be a VR ready (fast enough processor and graphics card) computer to run the HTC Vive. The department of Theatre and Film purchased the Asus ROG GR8II-TO45Z for me to use for this research. Refer to table 2 for the specifications of the computer.

<b>Processor</b>	NVIDIA® GeForce GTX 1060
<b>Graphics</b>	Intel® Core™ i7 7700
<b>Memory</b>	16 GB
<b>Video output</b>	2 x HDMI, 1 x DisplayPort
<b>Operating system</b>	Windows 10
<b>USB</b>	2 USB 3.1 Gen 1, 1 USB 3.1, Type A, 1 USB 3.1, Type C

**Table 2. Asus ROG GR8II-TO45Z desktop specifications**

Other equipment required is a dual monitor, mouse, keyboard, monitor stand, cables and adaptor. In addition, the HTC Vive requires a minimum room scale of 6'-6"x 5'to allow the user to move around and interact in a space. (Vive)

After setting up the Vive, I downloaded the following programs:

- Google Tilt Brush,
- Google Blocks,
- Steam VR,
- Unreal Engine 4,
- AutoCAD,

- Revit,
- Sketch Up,
- IrisVR-Prospect.



### 1.2.2 Headsets, software and their costs

The HTC Vive is currently \$799. I was able to purchase the HTC Vive for \$699 with the student discount through Microsoft.

When I explained the purpose of the project to directors, designers and students, the most common question asked was, “*many theatre productions have a low budget; is there a way to experience a set model in VR without the high cost?*” After researching, I found applications that make use of mobile devices and low-cost headsets such as the Google Cardboard to view designs. The Google Cardboard is inexpensive, but it doesn’t display the best picture quality, and the viewer is not in scale to the model. However, it gives you a basic idea of a design.

Apart from the cost of equipment, software costs are high too. Refer to table 3 for the cost breakdown of equipment and software I used.

Device/software	Cost
HTC Vive	\$799
Google Cardboard	\$25
IrisVR prospect	\$50 a month Basic Plan \$150 a month Pro Plan 1 year free for students
ASUS ROG GR8 II-T045Z desktop	\$1,534,94
Kubity	\$0
Sketch Up Pro	\$695 USD for student
AutoCAD	\$2,055/year Free for students
Revit	\$2,935/year Free for students
Tilt Brush	\$21,99

**Table 3. Cost breakdown for software and gear**

### **1.3 Workflow and software testing**

To generate a successful workflow, I will incorporate VR into the traditional set design process.

Ideally, I want other designers to be able to use the same workflow in their process.

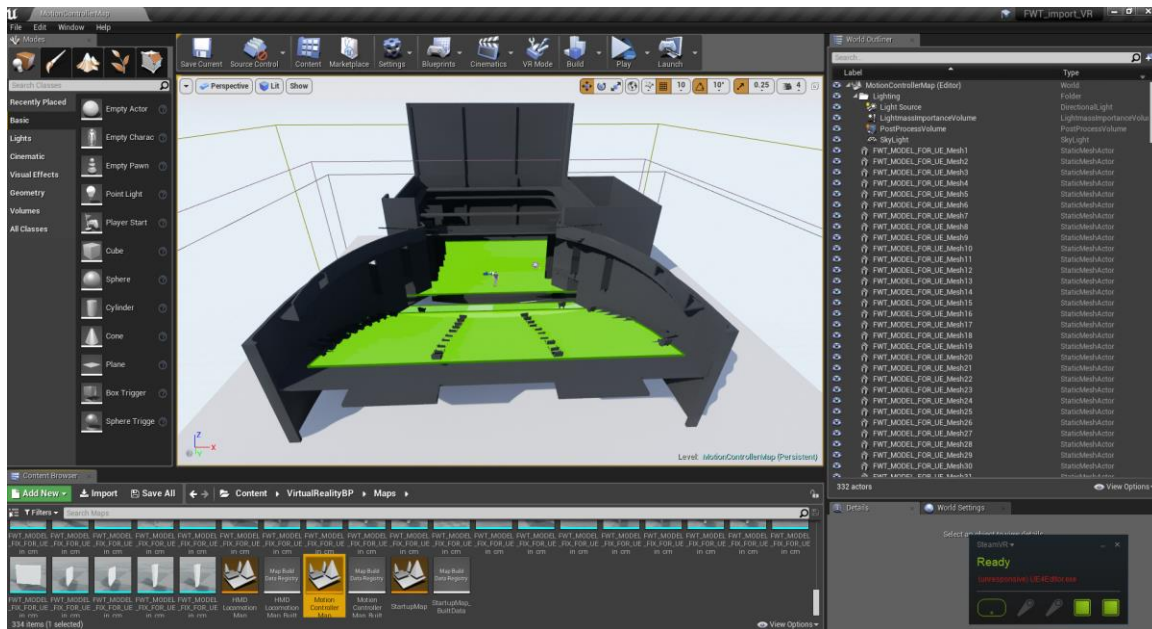
- Tilt Brush is a program made for artists and designers. It allows the user to draw/paint in a 3D space using Virtual reality.
- Google Blocks is like Google Tilt Brush; however, this program lets the user 3D model in a 3D space.
- Steam VR is the program that runs the HTC Vive.
- Unreal Engine 4 is a game engine used by game developers and designers to create games and other applications.
- AutoCAD is a 2D drafting program and a 3D design program.
- Revit is a 3D building information software program used by architects, designers, and engineers.
- Sketch Up is a 3D modelling computer program used by designers, filmmakers, engineers, and architects.
- IrisVR- Prospect is an immersive VR program that is compatible with Sketch Up and Revit.

After having downloaded all the software programs mentioned above, I test each one as part of my workflow. Because I was testing some of these software programs for the first time, I made use of YouTube tutorials and software forums/blogs as a guide.

### **1.3.1 Unreal Engine 4**

After figuring out how to use and navigate my way in Unreal Engine and understanding what the program was capable of. I placed a 3D model of the Frederic Wood Theatre stage into the program and tried viewing it in VR.

1. I imported an fbx. file into the program and create a navigation pane to allow teleportation in the model. To give my director the the best view of my set, I needed the navigation bounds volume to cover the stage area and the complete seating area.
2. I programmed the controllers, to let unreal engine know that I am using them to teleport.
3. After testing, I tested the model in VR.



**Figure 1. Screenshot of UE test**

Using Unreal Engine was fairly time consuming. By the end of the process, there were still a couple of unresolved issues with navigating around the model and a few of the pieces of the model were missing. Unreal Engine gives you the potential to add lighting, create effects and interact with objects. These three elements would be perfect for viewing a set design in VR. But due to the steep learning curve and lack of programming skills, I was unable to do a successful walkthrough of the theatre in VR.

### 1.3.2 Google Tilt Brush & the ability to generate design ideas

Google Tilt Brush is a popular tool used by artists. You can physically walk around your artwork, viewing it from any angle. Your designs can be uploaded to the Google Poly library, which can be shared with others, even if they don't have a VR headset. Below is an image of the first doodle I created in Google Tilt Brush. At this early point in the stage I wanted to experiment with the brushes and get used to the program.

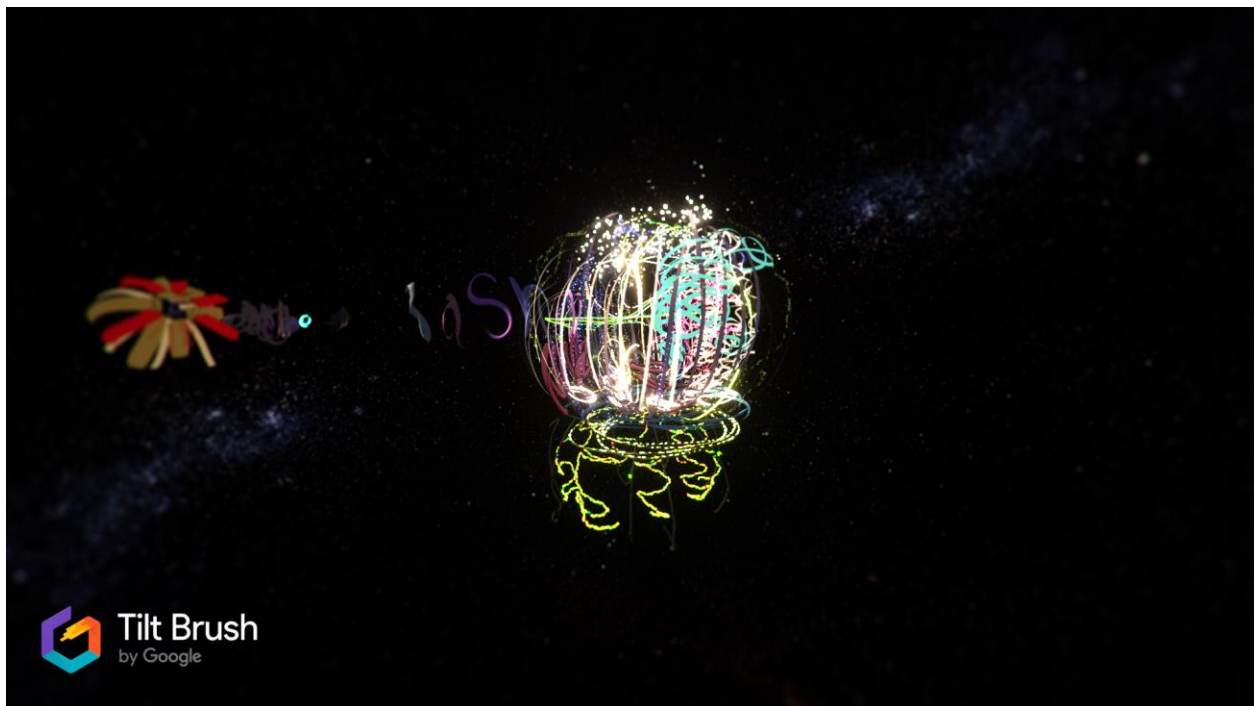
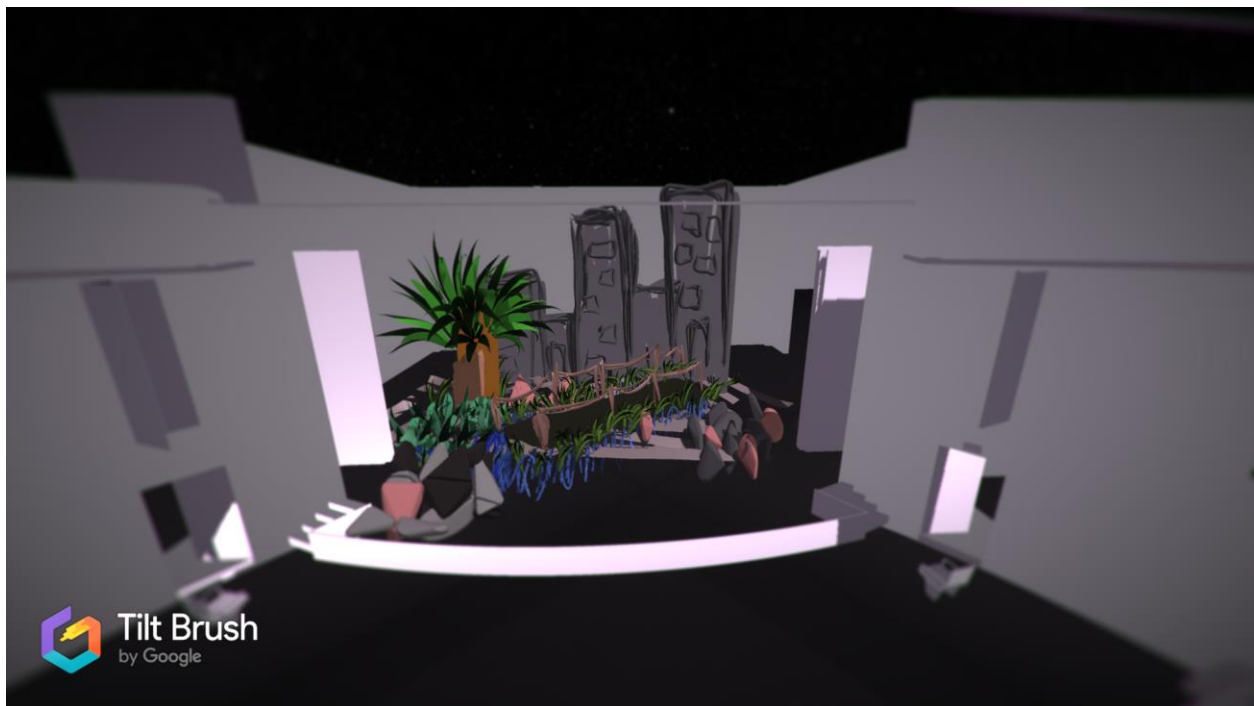


Figure 2. My first Google Tilt Brush doodle

I discovered that this is an ideal way to start a creative process and present the director with rough 3D drawings of the proposed set design.

The goal is to import the Frederic Wood Theatre model into Google Tilt Brush so that I can draw my design ideas directly onto the stage.

1. Using Google poly, I import the Frederic Wood Theatre model into Tilt Brush.
2. I can scale myself up and down and move around in the model using the scale bar provided.
3. I can easily draw anything directly onto the stage and view it from anywhere.



**Figure 3. Close-up of design on stage using Tilt Brush**

With the wide spectrum of brush options, sizes, tools and colours, I can create exactly what I imagine. By drawing directly onto the theatre stage, I can easily communicate my ideas and walk around my design. I found this method of designing easier than drawing on flat piece of paper. It helped me to quickly get my ideas out and see it directly in the theatre space. The only problem I

discovered with Google Tilt Brush was that I was not in the correct scale in relation to the theatre. This program is great for coming up with ideas and doing rough sketches, but it can't be used to do a 1:1 scaled walkthrough with a director.

### 1.3.3 Google Blocks

Google Blocks is a good tool for creating 3D models. Unfortunately, I am unable to import the theatre model into Google Blocks thus making it difficult for me to create a design or use it elsewhere.

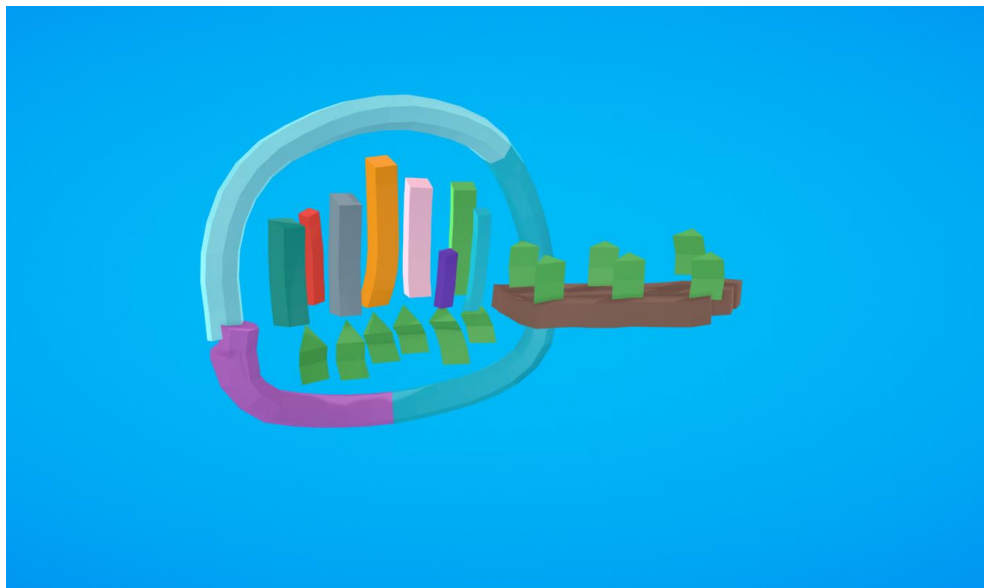


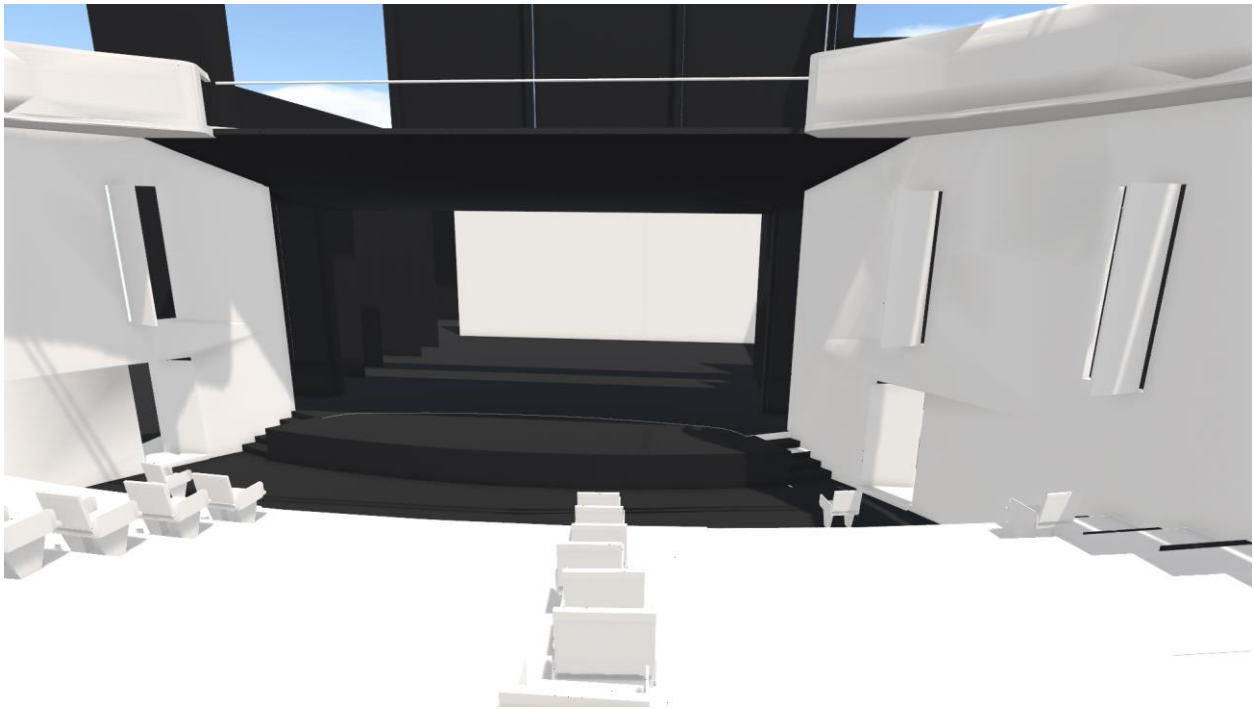
Figure 4. Google Blocks modelling doodle

### 1.3.4 IrisVR Prospect

IrisVR is a software tool recommended by architects. The software completes all the programming for you on their side, allowing you to create without trying to figure out the technical aspects. I import the Frederic Wood theatre model from Sketch Up into Prospect

1. After a few seconds of uploading the model, the model is ready to be viewed in VR.

2. I place the headset on, and I am immediately immersed into the model and I could easily navigate in the space using the controllers
3. There is a tutorial available demonstrating the navigation and other tools. I am able to view the model on a table as a ‘digital maquette’ or in a 1:1 ratio.



**Figure 5. Viewing and navigating the theatre in VR**

By the end of this rapid process, I was in scale in relation to the theatre and there were no errors with the program.

A key feature of IrisVR Prospect is the Multiuser Meetings tool. This feature gives me to the opportunity to have meetings with my director in which we are both viewing the same model regardless of our location. In addition, I can share my model with the director and up to 10 other users. The program comes with many tools allowing everyone to collaborate by experiencing the



same environment and make design decisions together regardless if you have a VR headset or not.

Due to the program's clarity and ease of use, I decided that IrisVR would be the best program for viewing my final VR set design to a director.

### **1.3.5 Kubity**

Kubity is an application designed to show VR models on a headset or mobile device. With Kubity, I can upload a Sketch Up model of the theatre stage. Once it's uploaded, a link is sent to my phone that allows me to open the model and view it using the Google Cardboard.

I am able to view the model and move around the space with Google Cardboards pre-programmed raycast teleportation. Using the Google Cardboard is quick and easy but because you are using a mobile device, the graphics quality is not high enough. When viewing the model in the Google Cardboard, my movements are not tracked. Although, the Google Cardboard is an alternative inexpensive solution when presenting a simple idea of a set design.

## **1.4 Pipeline test**

After discussing the possibilities of each program with my advisors; Professor Brad Powers suggested that I design the basic model of a set in Revit and export it into the other programs to generate a drafting package and a textured model ready to view in VR. Since I have previous experience using AutoCAD, I chose to import my Revit model into AutoCAD to produce a drafting package.

Below is the pipeline I developed to test out on *The Glass Menagerie*:

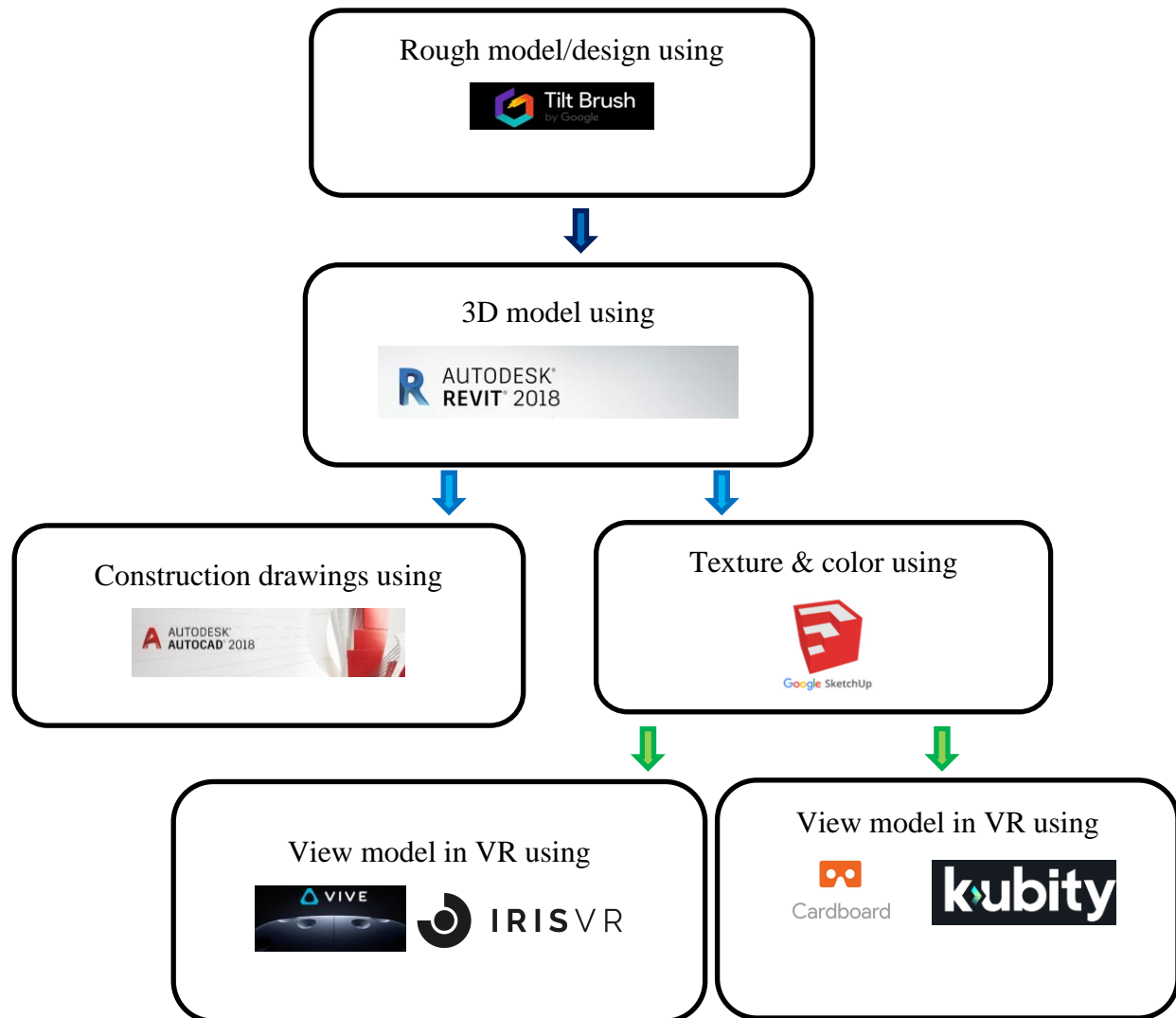


Figure 6: Pipeline test

### 1.5 The Glass Menagerie box set

This phase of the research is centred around producing a quick and simple box set of *The Glass Menagerie* by *Tennessee Williams* to test and evaluate my workflow. The aim is to determine how 3D models, textures and lines translate in all the programs.

The play is a ‘memory play’ narrated by character Tom, based on his memories of his mother Amanda and mentally fragile sister Laura. It is set in their old St. Louis apartment. The story is about how Amanda desperately wants to find a husband for her daughter Laura, as she is worried about her future. Tom finds a man for Laura but later in the play we discover that this man is engaged. The play ends with guilt-stricken Tom saying that he left home and never went back.

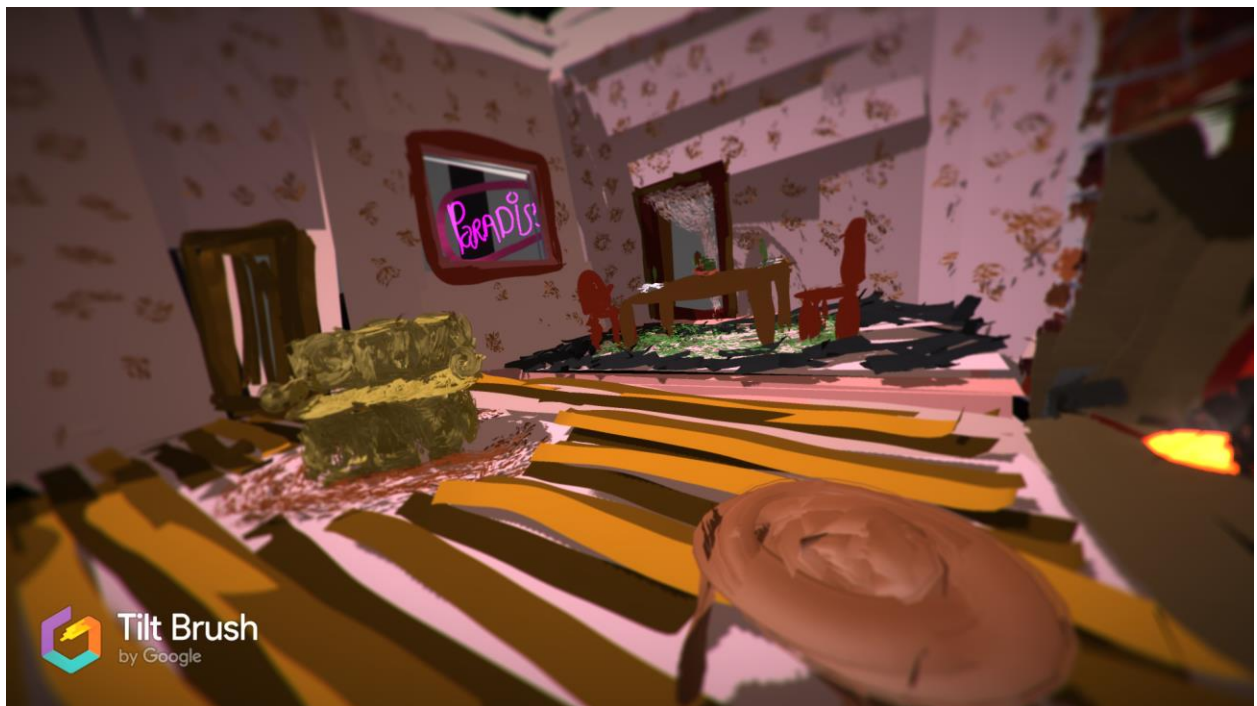
For the design I decided to:

- Keep the location and time period of the play as written; St Louis, USA, 1937.
- Design a simple naturalistic interior that had a realistic floor plan
- Use characteristic old faded pink striped wallpaper with checkerboard floors and dark wood furniture. The apartment belongs to the mother Amanda, so I came up with the colours and designs based on her personality.
- Add character to the house by having a table with Laura’s typewriter, a large couch for Tom to sleep on and a window with the glowing “Paradise” sign. Juxtaposing the miserable life of living in a small box (apartment) as opposed to paradise and a better life outside.

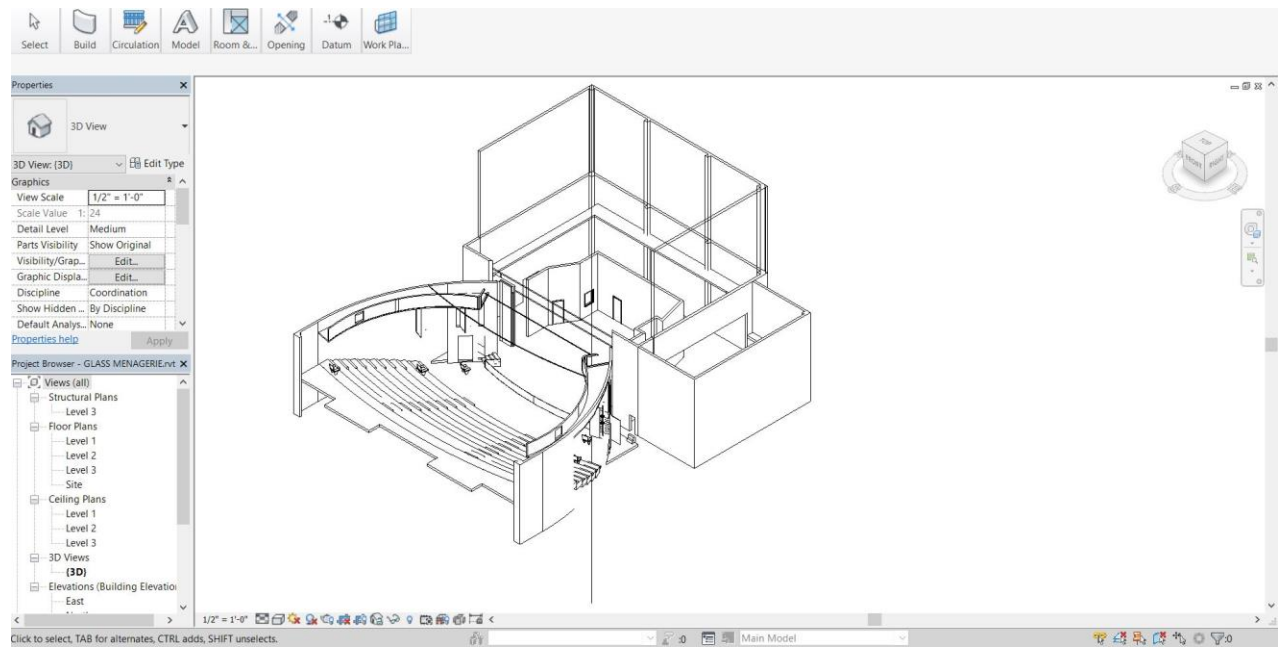
The images below are screenshots of the creative process, starting with rough designs in Google Tilt Brush and concluding with VR models viewed in Iris VR prospect and Kubity.



**Figure 7. Rough drawing of box set using Google Tilt Brush**



**Figure 8. Rough designs for box set**



**Figure 9.** Revit model of *The Glass Menagerie*



**Figure 10.** Sketch up model of *The Glass Menagerie*

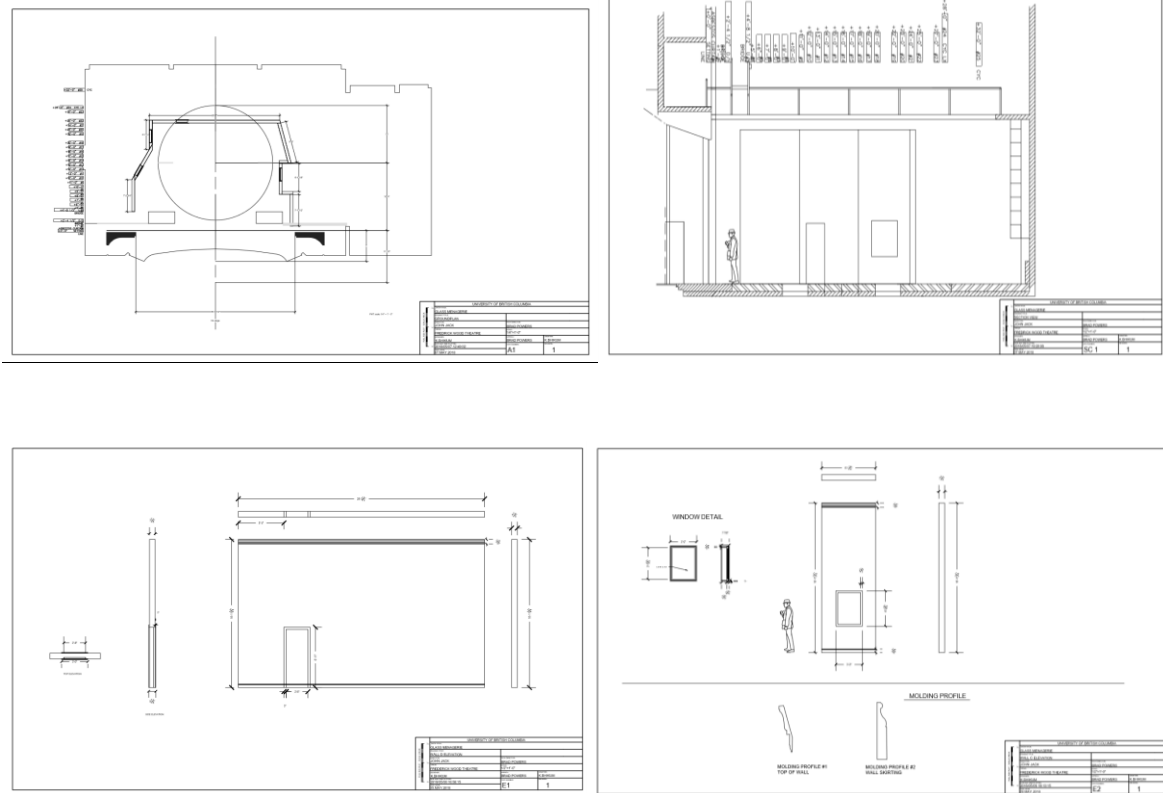


Figure 11. First draft of construction drawings



Figure 12. VR model using Kubity



**Figure 13. Final model viewed in VR using IrisVR Prospect**

This process proved a successful workflow. By the end, I had rough designs, a model that can be viewed in VR and a drawing package printed on ANSI-D size paper. While viewing the model in VR, I am completely immersed in the design. I discovered that I can easily find design errors I made in the model. Some errors were` the height of the picture frame, the placement of furniture, the poor level of detail in the doorknob and colour errors. I am in scale in relation to the theatre and it feels as if I am physically standing on the Frederic Wood Theatre stage. In addition, I can easily check my sightlines by viewing the model from the seats in the theatre.





**Figure 14. View of the dining area**

Set dressing provides personality and subtle details to tell the audience more about the story.

Sketch Up has a 3D warehouse that offers furniture and other props or decor that can be used in a set. When an object is placed on the set, each piece acts as a mesh, which allows the viewer to walk around the model. For viewing purposes, it's ideal to get a feel for the space and how performers can move and interact with the furniture and the props. The director and set designer can view the set dressing from the auditorium and check for sightline issues. Furniture can easily be adjusted, sized, textured and coloured to see if it fits the scene or not.





Figure 15. Laura's typewriting station



Figure 16. Digital maquette of the *Glass Menagerie*

In conclusion, by the end of this process I developed a successful pipeline that generates a rough model, a drafting package and a VR model. It is easy to export the model from Revit into AutoCAD and to Sketch up. In addition, because of Sketch Up's 3D warehouse, I can easily add furniture, molding and set dressing to the model. By using existing 3D models, I saved a lot of time and was able to focus on designing the world as opposed to building a model of each prop. Texturing in Sketch Up is very simple and really enhances the design by giving it a more realistic appeal.

In total, the process took about 4 weeks, from research to producing a design and drawing package. The next phase of this research will focus on design, as now I have solved the technical aspect of the project.

## Chapter 2: Design process

In this section, to determine if the pipeline will work in the traditional set design process, I test out the workflow with director Lauren Taylor. We choose *Caryl Churchill's, Far Away*. Lauren Taylor, UBC alumna is the director for the play who advises me on how she pictures the set to be. I record her input and feedback to analyse if this process works for her or not and if there are any ways that I can improve it.

### 2.1 Far Away by Caryl Churchill

*Far Away* is a play written by British Playwright *Caryl Churchill*. Lauren and I picked this specific play because it lends itself to an imaginative scenic design and we wanted to have the freedom to explore without any specific boundaries of a naturalistic interior. The play is separated into three acts. In act one we are introduced to two characters, Joan and Harper. Joan is Harper's niece. The two characters are having a conversation in a kitchen. Joan has witnessed her uncle loading bloody people and children into a lorry. Her aunt tries to reassure her that he is only trying to help these people. Act two takes place fifteen years later in a hat factory. Joan, who is now an adult works as a milliner with an experienced hat maker named Tom. They both make hats for prisoners who are sent to their deaths. In this act, there is a scene with a hat parade performed by one hundred prisoners. Act three takes place back in Harper's kitchen. Todd and Harper wait for Joan to return from the war. Joan arrives stating the fears she encountered on her journey and that she doesn't know what side of the war they are on.

After analysing the short script, my ideas are as follows:

- Each act needs to be different
- I want to show the effects of the war over time
- Lauren also gave me her vision to get my design started. She wants three different looks to match the three different acts.
- There are no boundaries, allowing me to design a set that was naturalistic, symbolic or fantastical.
- She wants to see the effects of the war on the house from act one to act three.
- The only requirement for scene changes is that they need to be less than two minutes.

Lauren provides me with keywords describing the aspects of design that she has in mind for each act.

Act 1: Home, safety

Act 2: Factory, work

Act 3: Home, unsafe, war

Lastly, she wants a 'fourth look' being the hat parade done by the prisoners. It needs to have a procession of one hundred shackled hat wearers marching across the stage.

The questions Lauren has for the hat parade scene are:

- What state are we in when this happens?
- What does the stage look like for this?
- How is it different to the other locations?

After having the director's vision in mind, I begin to think about the design which lead me to draw my ideas in Google Tilt Brush.

### 2.1.1 Rough Model

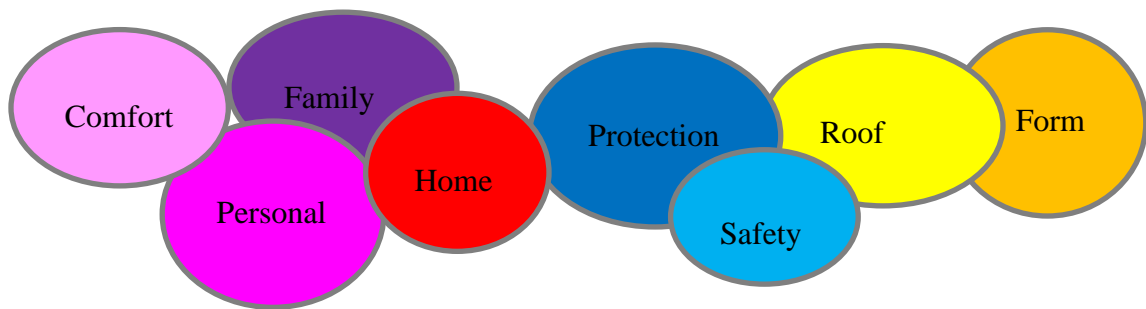
For the rough design, the main element of the set is a structure representing a house. Over time, the structure of the house changes, showing the effects of the war. Before I delve into the details about set dressing, I use Google Tilt Brush to create the bones of the set. The playwright doesn't tell us what war we are dealing with, so I choose World War II. Below is the first idea for my design.



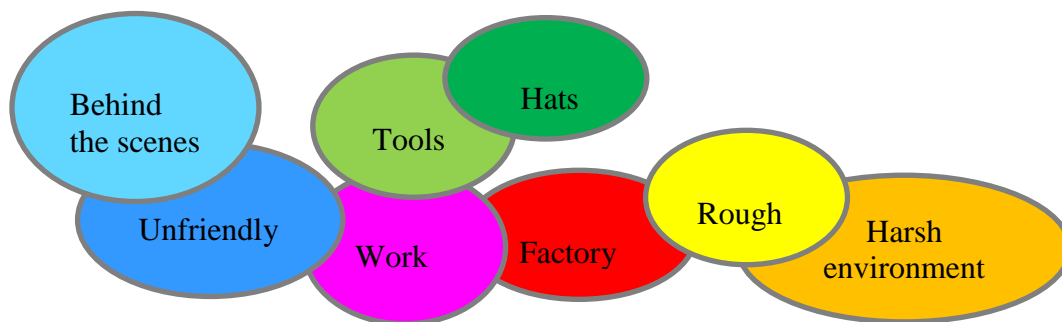
Figure 17. First rough model of Far Away

I research the structure of homes during World War II. Wood was not used as often. Concrete was popular or commonly used on houses. The texture of the walls is changed to concrete with a roof with black shingles. The contrast between the two materials are an ideal look for this design. It was strong, bold and characteristic.

Apart from the textures used, I focused on the keywords Lauren provided me.



**Figure 18: Keywords provided by Lauren Taylor**



**Figure 19: Brainstorming ideas for set**

While analysing act one, I thought about what was occurring in Harper's life and how that might affect her home. Questions and thoughts that arose were:

- Is this a happy home?
- Why doesn't Harper have kids?
- Why did the Playwright name this play, *Far Away*?
- Why are these events taking place in a desolate space?
- What is Harper's husband doing to these families?
- How do these events change an individual's personality?

To begin, this home is a broken home. Harper and her husband are protecting themselves from outside danger. Their home is not perfect, and neither are they. Harper's husband is committing a serious crime, and harming families in the process. The set needs to show this pain and corruption. To elaborate this, the layout of the home is iterated by turning it on its' side. The idea is to keep it looking like a home but with a twist. The angle of the roof is adjusted too, and the windows are added to the sidewall.

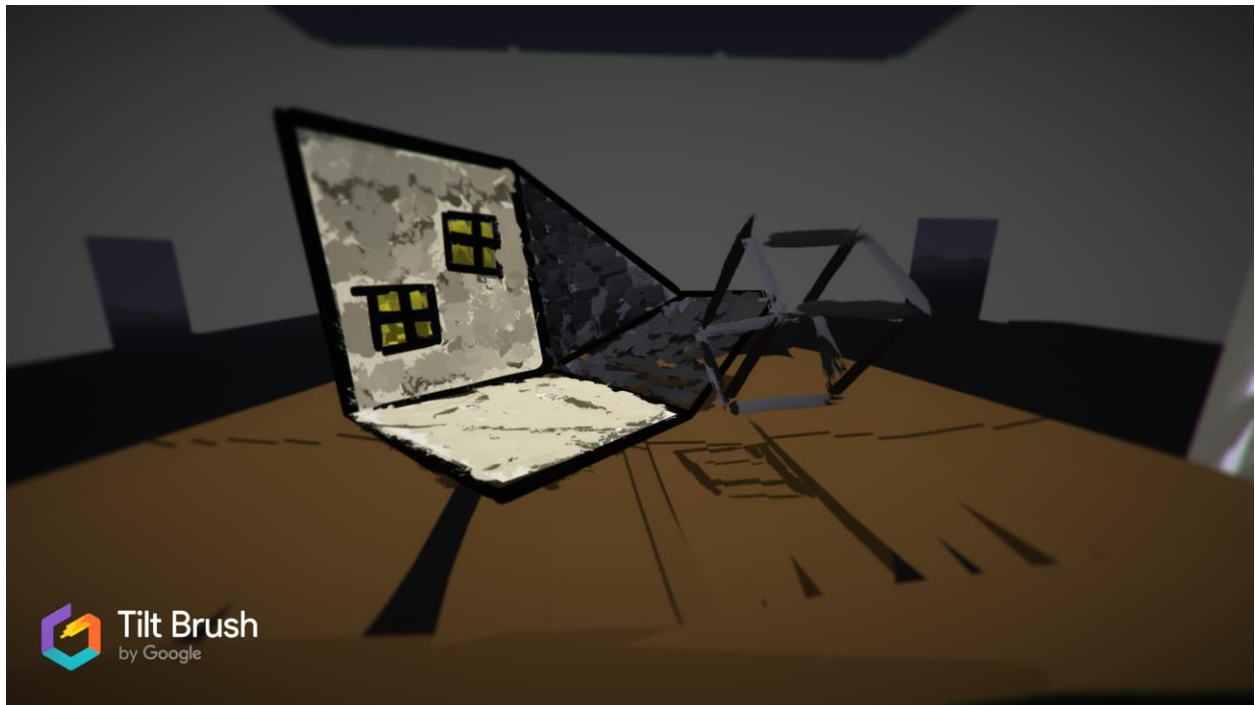


Figure 20. Second rough model of Far Away



Figure 21. Roof angle



Keeping the colours of the home strictly to two colours, black and white is fitting for the morbid story. The contrast between the black and white is a good symbol of the dark lies being covered up by made up positive stories.

The set can easily be dressed to represent the different acts. To distinguish between the kitchen and the factory, a shelf with hats and tools are added in act two. In act three, the house pulls apart showing the breaking down of not only of the family's situation but the effects of the war on the home.

Overall, I am happy with the outcome, and any changes needed could easily be done without wasting a lot of time.

### **2.1.2 Preparing for the first presentation of the model in VR**

After creating the rough model, I use it as reference to model the set in Revit and texture it in Sketch Up. To add scene changes that could be viewed in VR, each act is set on its own layer. Iris VR prospect lets you view different layers. This was my way of showing the different acts. A chimney is added to the upstage left roof, to symbolize a chimney for a home/shed or an incinerator in a prison. Each act has different set dressing although; Lauren doesn't want the scene changes to be very long. It is kept simple by adding a few set dressing pieces to the set. For act one, a simple wooden table with chairs is added.



**Figure 22. Changes to textures and stage**

In act two, the table from act one is used but the chairs are changed to high stools. The high stools help portray the factory station. In addition, the roof structure is removed and replaced with a large metal shelf with hats and tools. Finally, to add to the factory look an industrial looking light is hung just above the table/work space.



**Figure 23. Act two preliminary model**

Act three takes place back in the kitchen, fifteen years later. The effects of the war have taken place on the house and the lives of Harper, Joan and Todd. To show this drastic change, the structure of the house breaks or pulls apart. It is not whole anymore and everyone inside is exposed by the gaps. This is the basic idea that is will be shown to Lauren.



**Figure 24. Act 3 preliminary model**

Once the model is textured in Sketch Up, it is uploaded to Prospect to be viewed in VR. I was in and out of the VR headset to make iterations to the design. Some of the details were left out and a few of the colours did not look good on stage. One of the layers were not viewable, but it was fixed by insuring each object was its own component and then set to a layer.

## **2.2 Response and feedback from the director**

Lauren is ready to view the model and I explained to her how the navigation and the mechanics of the headset and the program function. On my monitor, I can see exactly what she is seeing or talking about in the model. Lauren had never experienced virtual reality before this, but she had no issues using the controllers and navigating in the space. After a short adjustment period, Lauren was able to view the model and move around in it easily. She was fascinated by the fact

that you can be in two places at once. The realistic appeal gave a good impression of being in a theatre while standing in an office space.

To further her experience, Lauren physically sat in a chair and looked at the stage. This is advantageous for her because this is something, she as a director would do when viewing a set in a theatre. She was able view the set from any seat in the auditorium.

Lauren did a walkthrough of the stage and could easily get an idea of the space. She liked the 3-dimensional roof, and the chimney, especially in a domestic home that suggests a shed.

She appreciated the windows, their positions on the wall were perfect. She had ideas for light to be used on the windows. After she sat in the back row, she suggested bringing the set closer to the audience. Sightline checks are important, and this method of checking sightlines is hugely informative for her.

By using the callout button in IrisVR Prospect, she could indicate elements that required attention. While looking at the house, she loved the idea of having the house in the odd orientation. It made it look as if the world is turned sideways. This way of viewing a set helped her to be able to see the different acts and view props. It was beneficial to talk about how set pieces were brought on and off, and how scenery could be flown in and out.

The concrete texture fits all the scenes. The corrugated iron shelves support the rough factory look. Wood is too soft and the hardness of the concrete suits the industrial feel. Another element Lauren pointed out was that she was fascinated with the ability to move in the space especially

on stage. This would help the ASM's with seeing where actors can stand and assist with entrances and exists. After thirty minutes, Lauren felt slightly dizzy, but she opted to continue as we had one last act to view.

In act three, the house pulls apart. Lauren loved this idea as it reminded her of a jigsaw puzzle breaking apart. This concept was striking. However, she encouraged me to push it further and change the angles. She didn't want straight lines as she preferred to see skewed lines. By tilting the entire house slightly, it would break conformity and symmetry. The breaking apart and losing symmetry between the spaces show interruption. The set already suggests this, but it needed to be pushed even more. Lauren favoured act three as it was a strong concept with a strong design.

We talked a bit about the theatre space and how it affects the design. The replica of the theatre was good enough to show you that you are standing in a theatre.

Lauren mentioned that from a director's point of view, it is amazing that you can place yourself exactly where you need to be. She really wanted to walk around but due to space limitations, she could not move around as much.

She pointed out that she was a 'blue-sky thinker' and that I should get other directors and designers with technical or production backgrounds to try it out. She was intrigued to see how this would work for lighting as the biggest problem director's face is not being able to visualize lighting before tech week. This method of presenting also benefits actors. Actors have a better sense of the space and the set. It won't be a complete shock for them during tech week. This

exceeds all expectations especially the fact that you are physically standing in a set. It replicates the idea of a director standing in a space when the set is built.

Lauren was curious about the time it took to make this possible, and how much time it would take to make changes. I assured her that it quick and easy to make changes. However, she said that directors sometimes get carried away with making changes and forget that designers need time to make the changes. Some director might take advantage of this.

Lauren expressed that she was more creative in the model. The ideas were flowing, and she could think instantly than when she took the headset off. If she saw a 2D model, she wouldn't be able to come up with the same thoughts and ideas she had. There was something about being in the space and seeing the final product.

Using VR maximizes the tech time giving you more time to create and finalize a design. Overall, Lauren was impressed with the potential of VR and happy with the concept of the design. We could easily communicate, and I could understand exactly what she wanted and didn't want.

### **2.2.1 Improvements and iterations to the design**

Lauren was happy with the concept of the design. She liked the different angles especially how the house pulled apart in act three. She had a few iterations in mind that she wanted to make to the overall set.

### 2.2.1.1 Act one

To bring the audience closer to the intimate space, Lauren wanted the set to be brought downstage.



Figure 25. Iterations for Act 1

Once the set is brought downstage, the sightlines change due to the angle of the walls. They are too narrow causing the audience seated on the side's very limited visibility. To fix this, the walls are widened slightly, and the entire set is rotated just enough so that it would not affect the sightlines. Lauren mentioned that the angles of a set play an important role in audience's perception. A 90° angled wall or a line might be too harsh. To avoid that, the angles are changed to soften the set because it was a "home" after all.



### 2.2.1.2 Act two

Lauren loved the props in the factory. The changes she wanted in act two was to have the scene begin with minimum props that gradually increase as the scene goes on. She liked the juxtaposition between the soft hats and the hard-concrete walls. Because this act takes place in a factory, she wanted me to add more to the industrial look by bringing in a factory hook. This act is not a happy act as the prisoners walk to their deaths, so the hook is a metaphor for the rawness of reality behind the scenes.



Figure 26. Iterations for act 2

The prisoners are fine as is. The hook stood out like a sore thumb with its bright yellow colour. It is placed in the space above the factory so that it is separated from the prisoners.



**Figure 27. Iterations for act 2-prisoner scene**

The texture of the concrete is adjusted to look rougher and darker to avoid light reflecting off the lighter grey colour. The wood on the window frames are darkened to brown so that it fits the colours of the walls. The original yellow colour stood out and seemed too joyful for this set.

### **2.2.1.3 Act three**

Finally, for the last act, Lauren liked the idea of the house splitting. She wanted me to push this concept even further and change the angles so that everything is skewed. The effects of the war needed to be present. The house is breaking, and it is no longer a home. While Lauren was in the VR model, she was able to tilt her head to show me how she would want to see the house. This helped me understand her vision of the angles. The angles of the whole set are changed by raising the platform from the SL side. This may be a huge technical challenge but for the purpose

of this project the boundaries were pushed. Once the platform was raised slightly, the whole house tilted, altering all the straight lines. In addition to the skewed house, Lauren wanted a broken window to be added. A darkened broken window replaced the previous window to represent a blackout of the house. Towards the end of this act, Joan returns to the house and she describes her journey through the war. Lauren asked me to add barbed wire or some element from the war to show the audience the route she took or that she has come from the war. Sandbags and war spikes are placed in the act to represent the warzone or war field.



**Figure 28. Iterations for act 3**

It took me roughly two working days to do research and make the changes on the entire model.

A few issues occurred with the textures and layering but it was resolved quickly. It was ready for viewing in VR.

### 2.3 Final design

After having Lauren view the final model, a few modifications are made to the set. The only changes she wanted was to have the yellow hook in act two be able to move during a point in the act. The furniture in act three needed to be old and broken to fit the rest of the scene as everything is breaking down and is no longer homely or comfortable anymore. She said I should add the barbed wire to act three to make the war zone more apparent. Once these changes were made, I began drafting the drawings for the design package. Below are screenshots of the final model in VR and drawings from the design package.

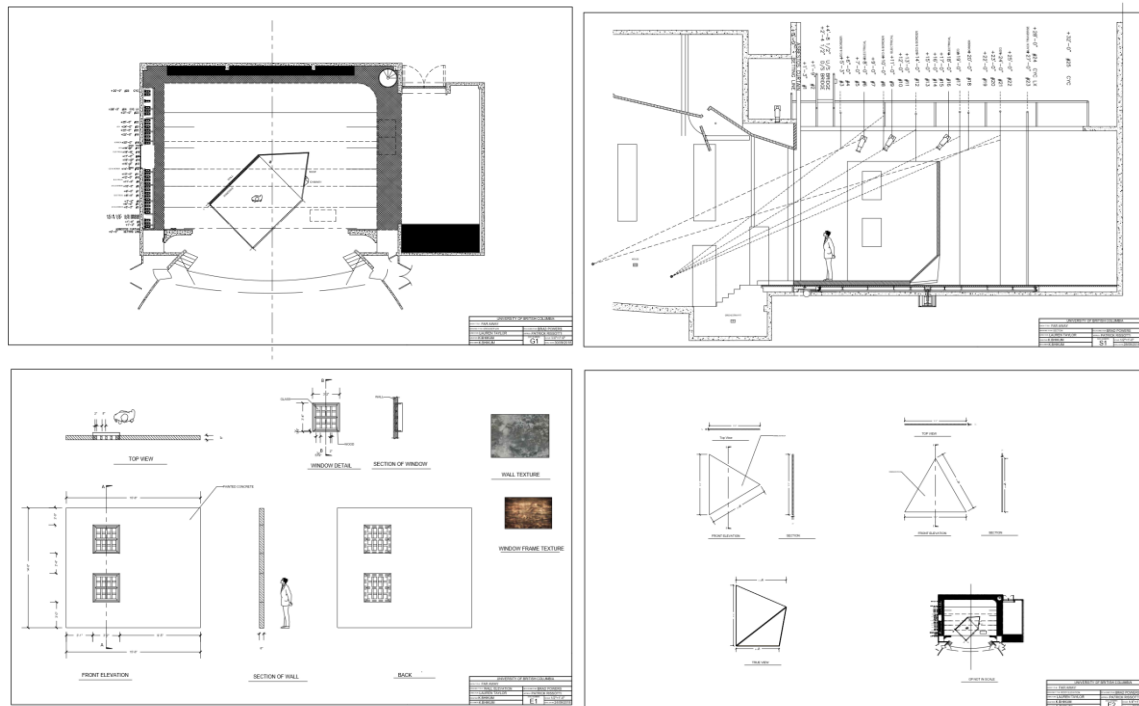


Figure 29: Drawing Package



Figure 30. Final design act 1 screenshot in VR



Figure 31. View from the stage in act 1



Figure 32. Final design act 2 screenshot in VR



Figure 33. Props in the factory in act 2





Figure 34. SR view of Act 2



Figure 35. Final design act 3 screenshot in VR

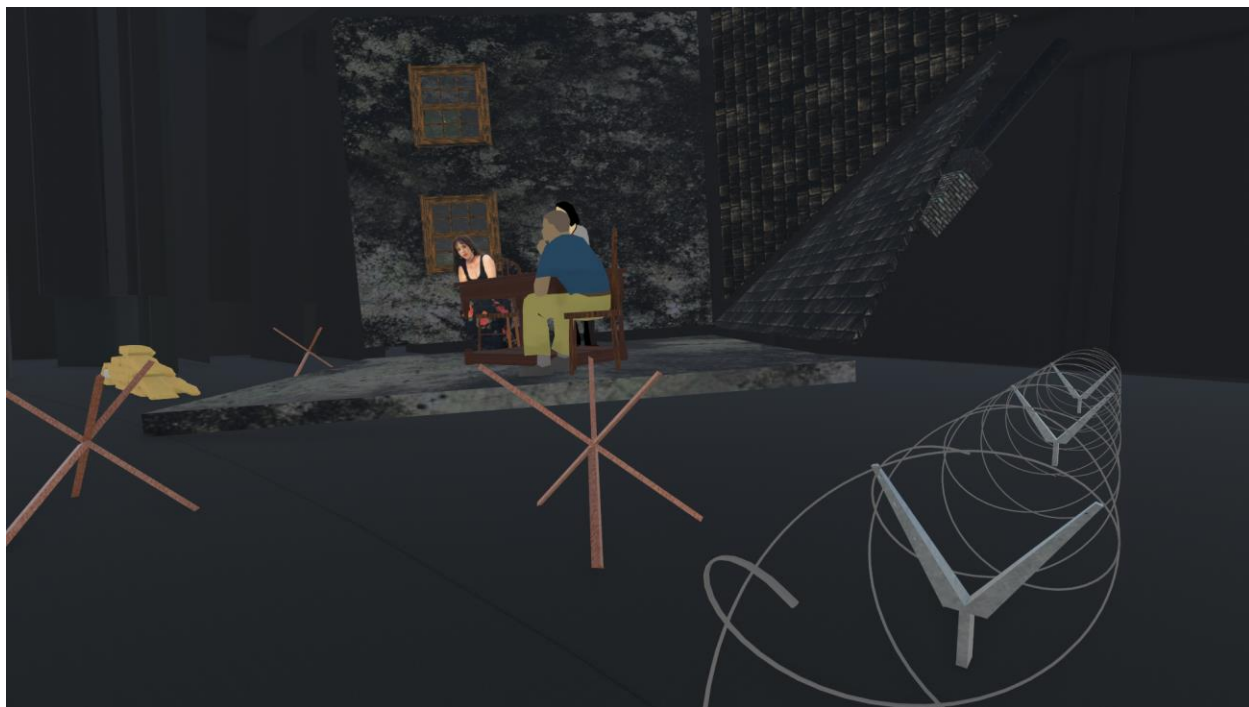


Figure 36. SL view of act 3



Figure 37. SR sightline check





Figure 38. SL sightline check



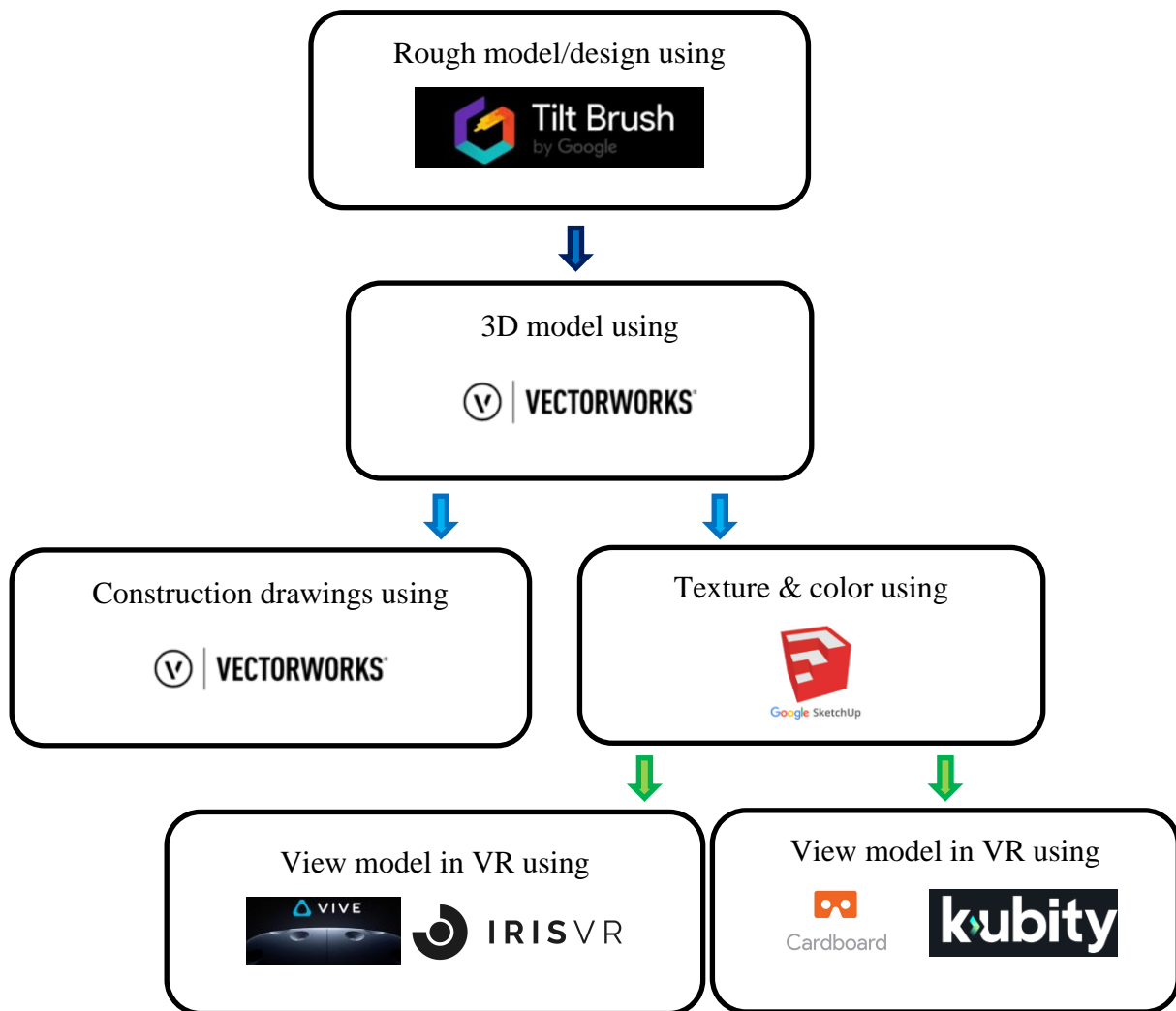
Figure 39. VR “maquette”



**Figure 40. Kubity app screenshot**

## **2.4 Issues with the drawing package done in AutoCAD**

After producing my drawing package to my supervisors, several issues were discovered. To help solve these issues, I decided to take the Vector Works class in Term 2 of 2019. This changed the pipeline I created but also proved that Vector Works improved the workflow. It was quicker to design the model in Vector Works and export it into Sketch Up and then to VR. This meant that I didn't have to model the design in Revit. Refer to figure 44 for the refined pipeline.



**Figure 41: Final Pipeline**

No other changes to the pipeline are made. Refer to figure 45 for the updated drawing package done in Vector Works. The model produced in VR remained the same.

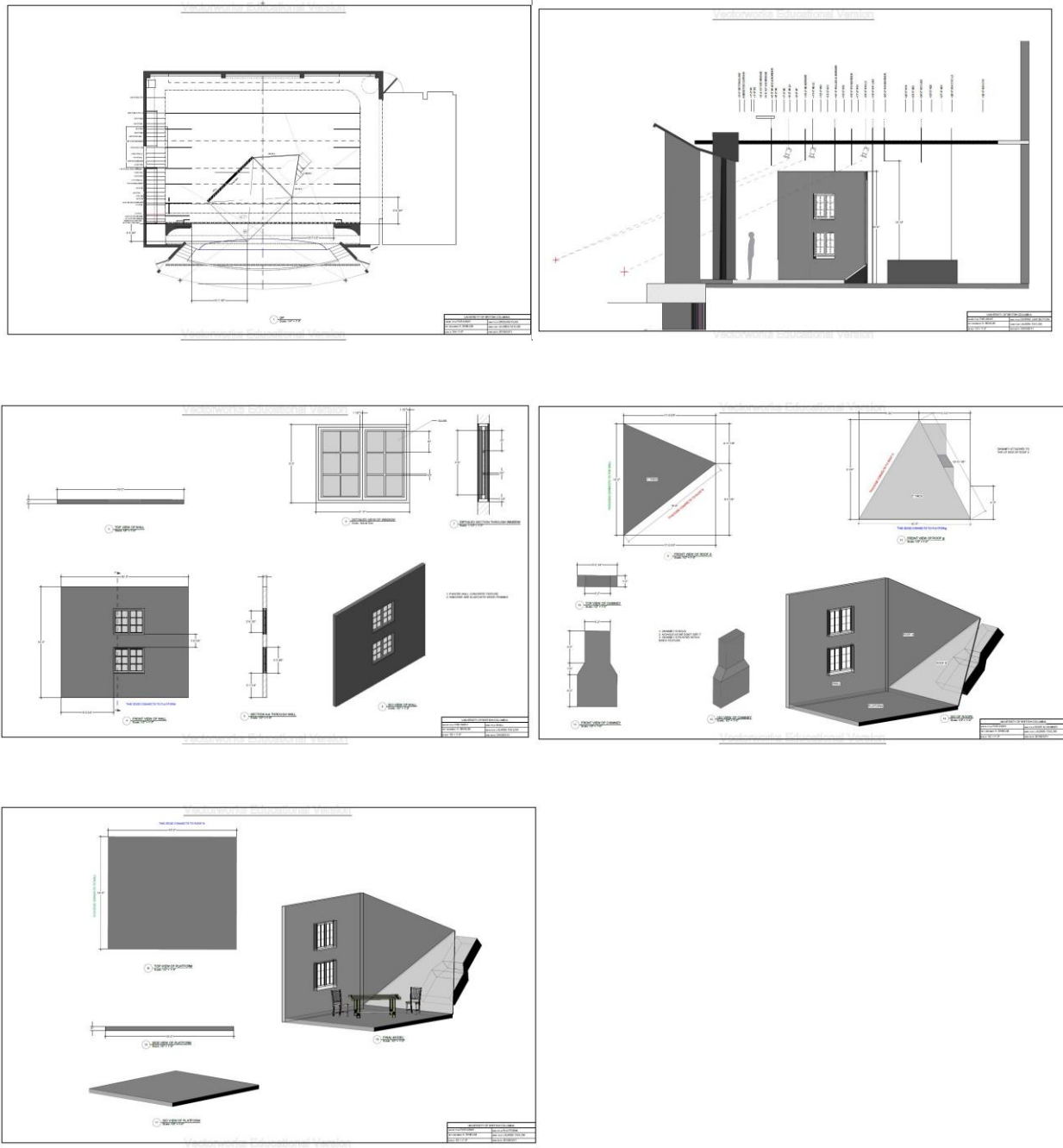


Figure 42: Final drawing package done in Vector Works

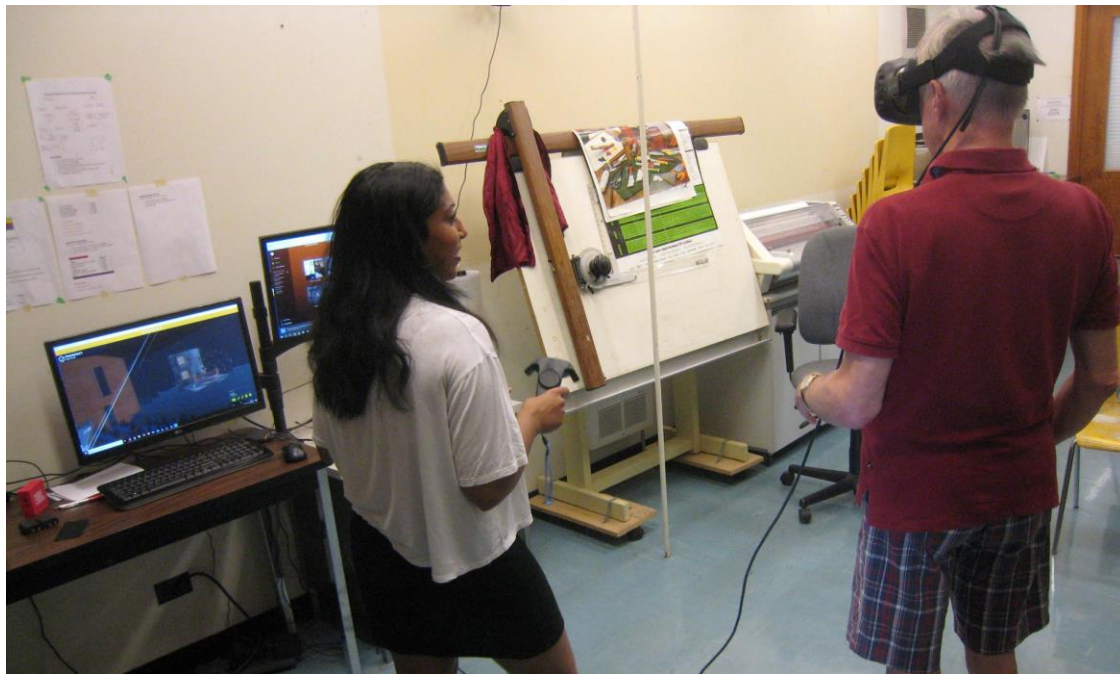
## **2.5 Overall thoughts by other artists, designers and directors**

Over the course of my design process, a few artists, directors and designers tested out the VR model. Some of which were Stephan Heatley, Alan Brodie, Stephan Malloy, Lynn Burton, Jay Hendrickson, Jason Karman, Borja Brown, Cam Cronin, Ian Patton, Keith Smith Shelby Bushell, Jessica Nelson, Ryan Yee and Erika Champion.

Below is a list of overall thoughts, feedback and views:

- VR is a great tool and it is used well for this project. Lighting would benefit from using VR. Lighting designers can view their lighting design before tech week. Lightning designers never get the opportunity to view their lights prior to tech. VR could help that process.
- Projection design could be tested in VR to see its effects on stage and on actors.
- For technical directors, it's a great way to see where a set piece could be flown out to or how it could be rigged. TD's have the option to simply look up toward the grid a see how pieces could be flown in or out.
- This works well for sightlines. It also benefits directors in seeing how the stage-revolve could be used on stage and how an actor's movement is portrayed on stage in relation to set pieces.
- It's a good way to see the expression of actor's faces and how an actor's eyes can be seen from so far, especially for intimate scenes.
- It's a wonderful tool to allow collaboration between designers and directors. The meeting tool works well if you have a team around the world. Production meetings can happen in VR instead of everyone meeting in one location.
- It's slightly scary when teleporting. A feeling of falling occurs but a great way to present a design idea to a team or a director.

- This idea would really work if you use different theatre spaces. For example, theatre in the round. It would be good to see how close an audience member is to a set pieces or how actors can perform in the space. The TELUS theatre is also a good space to test this out on and how audiences see set pieces.
- This pushes the boundaries to create out of this world sets that are unimaginable or difficult to describe to a director. No more need for a maquette however some directors relates more with a maquette and prefer having it.
- Another method of directors figuring out blocking. The meeting tool is a nifty tool to have to see actor's entrances and exits.
- Interesting way to see props, textures and colours and to see what works and what doesn't in the space.



**Figure 43. Walkthrough with department head Stephan Heatley (Photo credit: Andrea Rabinovitch)**





**Figure 44. Design walkthrough with lighting designers Alan Brodie and Ryan Yee (Photo credit: Andrea Rabinovitch)**

### **2.5.1 Comparing a maquette to a virtual reality model**

Every director is different, and every director and designer will have a different way of discussing a design together. Most commonly a maquette is used to show the team the complete design. While discussing the model with Lauren and other directors, I wanted to find out their thoughts on whether a VR model would replace a maquette or not.

Lauren mentioned that she wouldn't mind using a VR model although some directors would prefer to use a maquette for their blocking. She liked the idea of moving around in a model, but she wanted to know more about the textures as in the model, as they all look flat. Are these

textures rough, bumpy, hard or smooth? Are they painted or applied on a flat surface? For example, the roof is a shingled roof structure. I want this to be an actual 3D shingled roof instead of it being painted onto a flat. This could be a drawback as the roof was not designed in 3D, but it was textured with an image that looked 3D.

A maquette generally presents these textures and details. A sample board with textures accompanied with a VR model would be beneficial. It would show the director exactly what materials are being used, allowing them to touch and feel the texture. A floor made from wood or covered in carpet has a big impact on a performance. Some of the other directors stated that this could potentially replace a maquette while other said that a VR model allows them to explore further and push boundaries that cannot be done with just a maquette. A few directors prefer a maquette so that they can take home and work on away from the design team.

When it comes to VR, I noted that iterations can easily be made by the director which took less time. This didn't damage models or cost more money. Making changes digitally is faster than physically building set pieces from scratch. Being able to be in scale and see the complete product before it's built allows directors and designers to approve or disapprove a design. This reduces the risk of changes or surprises when a set is built. In addition, scene changes can be designed and viewed exactly how it would be in the actual show. Textures, sizes of objects, placement of props and set dressing is added to provide the realistic appeal. These elements can be moved or changed to the desire of the set designer or the director.



A maquette is important in any design. Although with the help of a VR model, a director can decide whether to use a maquette depending on the complexity of set design.

### **2.5.2 Effects of VR and the influence it has on presentation**

When I first started using the VR headset, I was shown a tutorial where the floor breaks and it creates an experience as if you are falling. This completely disorientated me and made me feel as if I was falling. I spent a couple of hours using Google Tilt Brush. When I was done, I experienced motion sickness. However, after a week of using VR, I was used to the technology and the motion sickness subsided.

One of the main points I noted was that a few users felt dizzy, disorientated or nauseous. As a precaution, I made sure to inform everyone that the device has different effects on different people and that if they are uncomfortable, they are welcome to remove the headset at any point during the walkthrough. This is a normal effect and it happens because there is a change between your visual, vestibular (part of the inner ear to help you control your balance) and kinesthetic (sensory system) inputs. Any change in any of these inputs could cause sickness. (Maceri)

One of the main reasons why motion sickness is caused while using VR is due to the lag time between the load times. The headset is built to track your movements and show you images as you move however it is not as fast as how your brain processes movement. A slight delay can cause motion sickness. Other reasons could be, a slightly blurry screen, eyes being too close to a screen or your brain not adjusting to what it is seeing. I noted that when a user teleported in the space while standing still, they experienced dizziness or confusion.

This has an impact on the design process because if I need to present my design to a Designer or Director and they feel ill, then they wouldn't be able to do a walkthrough and experience the full VR model. Hopefully VR technology would improve and help users experiencing VR sickness.

## **Chapter 3: Evaluation**

### **3.1 Workflow integration**

One of the main goals for this research was to find the best possible workflow, whereby VR is incorporated into the traditional creative process. Without any prior knowledge of using virtual reality, I was able to teach myself how to use software programs to find the best possible outcome that served the purpose of this thesis. At the end of the prototyping phase I managed to acquire a workflow that involved rough designs, a VR model and a drawing package. This pipeline failed when I created the drawing package for the set for *Far Away*. But after creating a model in Vector Works and exporting the design as per the original pipeline; I discovered that this workflow was better than the previous pipeline.

Figuring out what worked and what didn't work was time consuming. From the feedback received, I learned that many directors desired seeing lighting on the set. Lighting designers could have the ability to test out lights on a set and view it in VR. This is achievable in Unreal Engine and could potentially be a future project. With the final pipeline, I am certain that anyone can use it and incorporate it into their creative process to accomplish the same results.

### **3.2 Communication between designer and director**

Communication is very important in any industry. Specifically, in theatre, it can be a challenge for designers and directors to develop a design concept. With Google Tilt Brush, I was able to quickly throw my ideas out and have a general idea of what it would look in the theatre. When I had my designs ready for Lauren to view, she was happy and in complete awe of the potential.

She found it much easier to communicate with me while she was in the VR model. Other directors and designers found this helpful too. They could easily explain something to me, and I would immediately understand. A few designers mentioned that this has the potential to allow directors and designers to create complex designs and test it out in VR before it gets built. From the feedback received, I understand that everyone's personality is different and occasionally a director might be against the idea of exploring a set using VR.

With the assistance of the Multiuser meetings ability in the Prospect software, directors and designers can collaborate from anywhere in the world. This saves a lot of time and money. The team has an opportunity to go into a model space and provide their own input. I discovered that this is a valuable way to collaborate and create as a team.

### **3.3 Creative design process**

The design process for this project involved creating a set from start to finish as if it was going to be produced. Lauren was very happy with the set and preferred this way of creating. It was beneficial to get opinions from different directors. Being able to place yourself in a final model is a brilliant way to give directors the full experience. With the methods and software failures encountered, I managed to find a successful workflow that allowed more time for creativity with directors.

The design process was a success. I was able to produce a rough model, a final VR model and drawing package. After figuring out the technicalities of the software, I was able to focus on the

design. I will continue to use this creative process and offer it as a service to directors in the future.

### **3.4 Conclusion**

As designers, we look at the world in a visual way. We are right brain thinkers full of imagination and overflowing ideas. However, it may not be the same for directors who aren't accustomed to working with visuals all the time. I discovered that virtual reality is the perfect tool to bridge that gap. Overall, this saves time when it comes to explaining ideas and leaves us more time to create, explore and improve on original ideas. We always want to see a finished product before approving it and VR gives us this opportunity to see in its final stage. I strongly believe that many designers will use the method of designing in the future.

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Overall this research proved to be successful. Virtual reality is a benefit to theatre industry and most definitely enhances the communication between a director and a designer.

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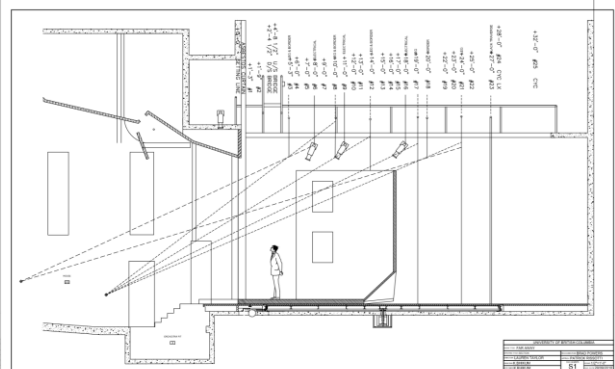
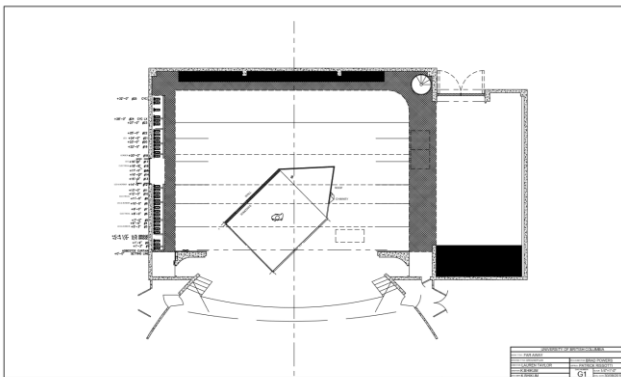
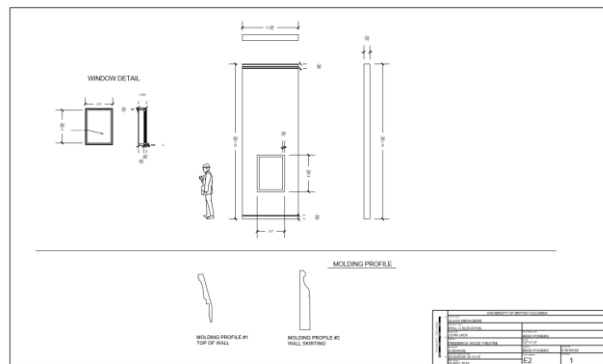
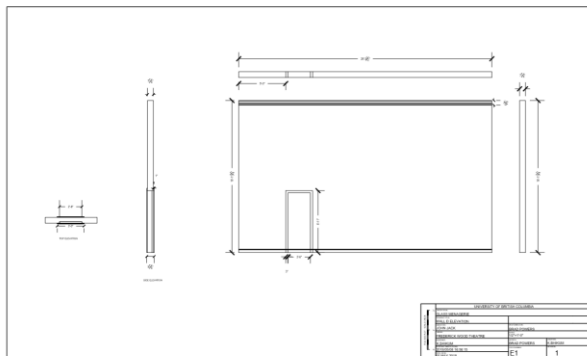
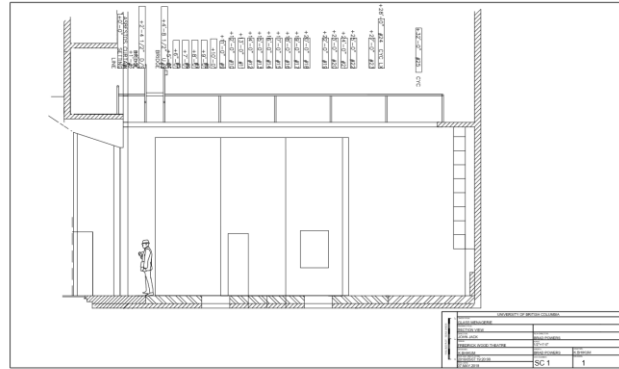
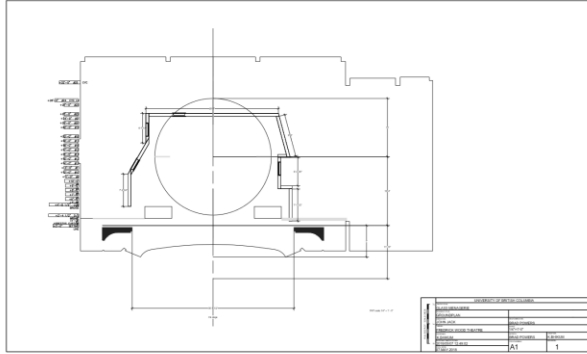
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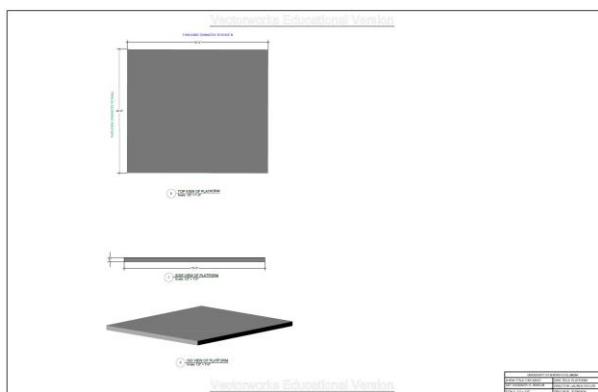
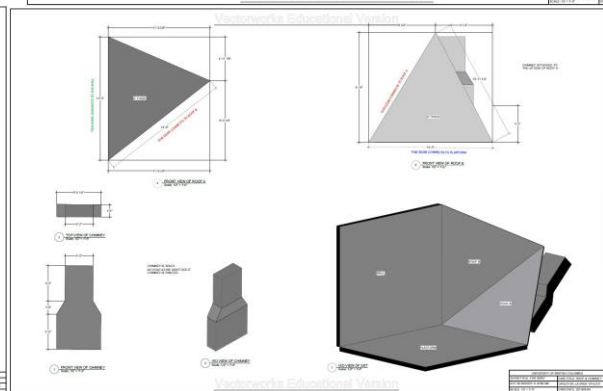
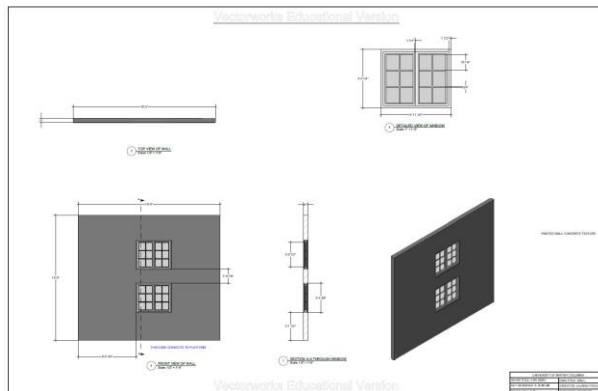
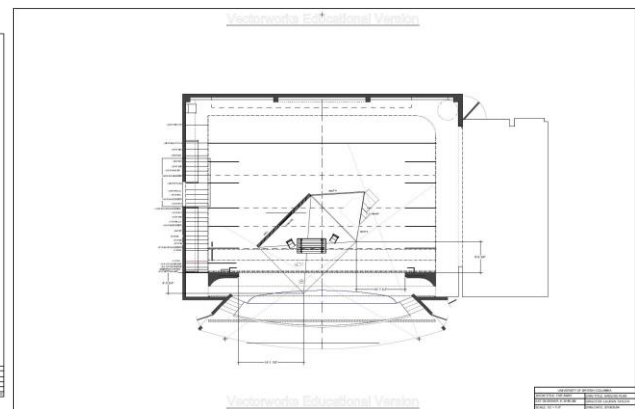
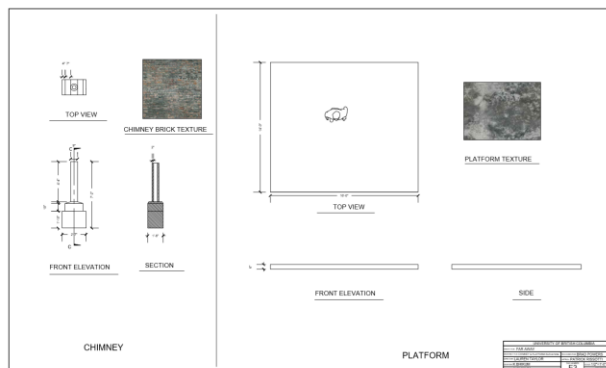
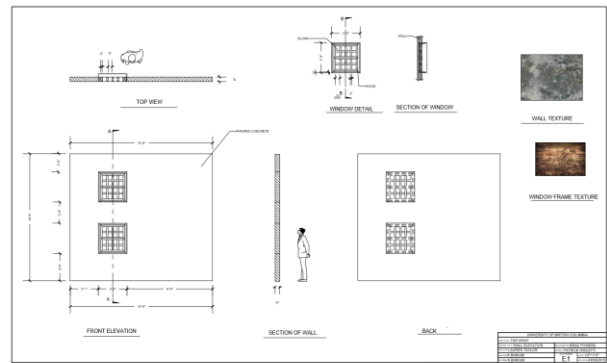
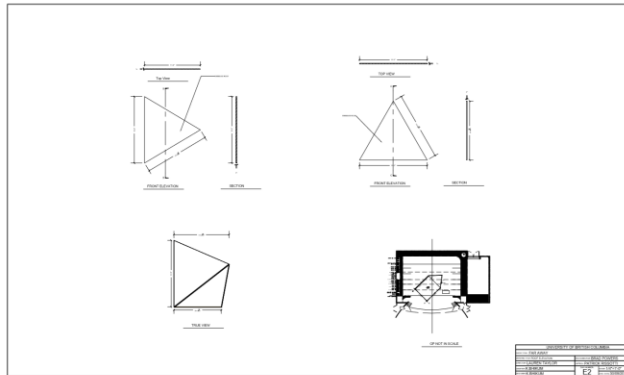
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# Appendices

## Appendix A : Designer Construction Drawings







## Appendix B Asus ROG GR8II-TO45Z desktop



Operating System: Windows 10 Home - ASUS recommends Windows 10 Pro.

Processor: Intel® Core™ i7 7700

Graphics: NVIDIA® GeForce GTX1060 6GB/3GB GDDR5

Storage: 128GB Up to 512GB M.2 SSD

Ports: 2 x USB 3.0, 1 x Headphone, 1 x Microphone, 2 x HDMI, 1 x DisplayPort, 1 x USB 3.1,

Type A, 2 x USB 3.0

Weight: 4 kg

## Appendix C : HTC Vive



### VIVE Specs:

#### Headset Specs:

Screen: Dual AMOLED 3.6'' diagonal

Resolution: 1080 x 1200 pixels per eye (2160 x 1200 pixels combined)

Refresh rate: 90 Hz

Field of view: 110 degrees

Safety features: Chaperone play area boundaries and front-facing camera

Sensors: SteamVR Tracking, G-sensor, gyroscope, proximity

Connections: HDMI, USB 2.0, stereo 3.5 mm headphone jack, Power, Bluetooth

Input: Integrated microphone

Eye Relief: Interpupillary distance and lens distance adjustment

#### Controller specs:

Sensors: SteamVR Tracking

Input: Multifunction trackpad, Grip buttons, dual-stage trigger, System button, Menu button

Connections: Micro-USB charging port

#### Tracked area requirements:

Standing / seated: No min. space requirements

Room-scale: 2 m x 1.5 m room size, 5 m max between base stations

## Appendix D : Unreal Engine 4



Unreal Engine is a complete suite of creation tools designed to meet ambitious artistic visions while being flexible enough to ensure success for teams of all sizes. As an established, industry-leading engine, Unreal delivers powerful, proven performance that you can trust.

### Requirements to run UE4:

Windows 7 64-bit or Mac OS X 10.9.2 or later. Quad-core Intel or AMD processor, 2.5 GHz or faster. NVIDIA GeForce 470 GTX or AMD Radeon 6870 HD series card or higher. 8 GB RAM.

## Appendix E : Google Tilt Brush



Tilt Brush lets you paint in 3D space with virtual reality. Unleash your creativity with three-dimensional brush strokes, stars, light, and even fire. Your room is your canvas. Your palette is your imagination. The possibilities are endless.

### System Requirements:

#### Minimum:

OS: Windows 7 SP1, Windows 8.1 or later, Windows 10

Processor: CPU: Intel i5-4590, AMD FX 8350 equivalent or better

Memory: 4 GB RAM

Graphics: NVidia GeForce GTX 970, AMD Radeon R9 290 equivalent or better

Storage: 1 GB available space

Sound Card: N/A

#### Recommended:

OS: Windows 7 SP1, Windows 8.1 or later, Windows 10

Processor: CPU: Intel i5-4590, AMD FX 8350 equivalent or better

Memory: 4 GB RAM

Graphics: NVidia GeForce GTX 970, AMD Radeon R9 290 equivalent or better

Storage: 1 GB available space

Sound Card: N/A

## Appendix F : Autodesk Revit



Built for Building Information Modelling

Revit® BIM software includes features for architectural design, MEP and structural engineering, and construction. Revit supports a multidiscipline, collaborative design process.

## Appendix G : Autodesk AutoCAD



AutoCAD is a computer-aided drafting software program used to create blueprints for buildings, bridges, and computer chips, among other things. Discover how AutoCAD is used by drafters and other professionals.

## Appendix H : Google Sketch-Up



Sketch Up, formerly Google Sketch up, is a 3D modelling computer program for a wide range of drawing applications such as architectural, interior design, landscape architecture, civil and mechanical engineering, film and video game design.

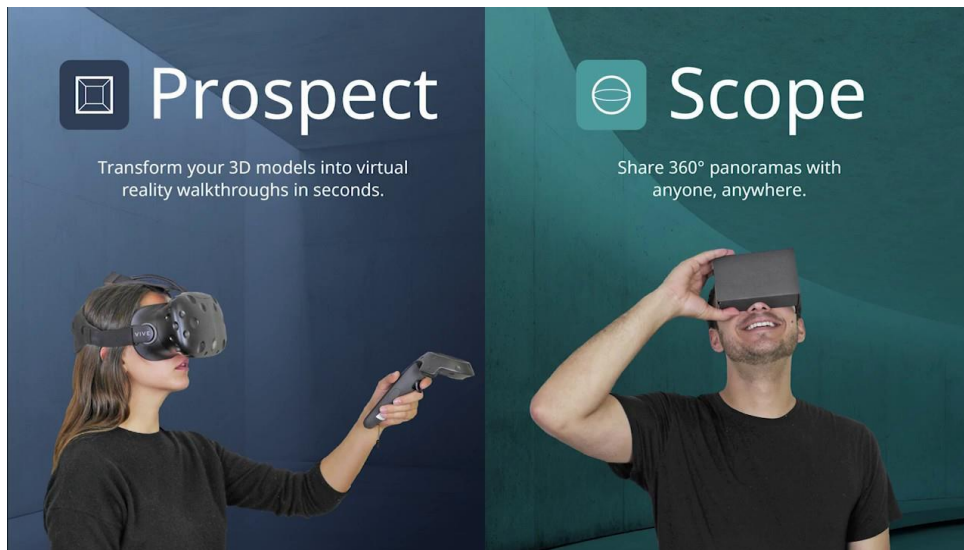


## Appendix I : Kubity



Visualize, explore and present your 3D models on desktop, web, and on-the-go with iPhone, iPad and Android devices. Instantly share with anyone over text, social media, or device-to-device by scanning the dedicated QR code with your mobile or tablet.

## Appendix J : IrisVR Prospect



Prospect will read your 3D files and send them into an immersive, navigable virtual reality e

Supports

Sketch Up | Revit | Rhino | Navisworks Grasshopper | OBJ | FBX environment in one click. No training, no coding and no waiting.

System Requirements for VR

OS: Windows 7 SP1 64 bit or newer

GPU: NVIDIA GTX 1070 equivalent or faster

CPU: Intel i5 equivalent or faster

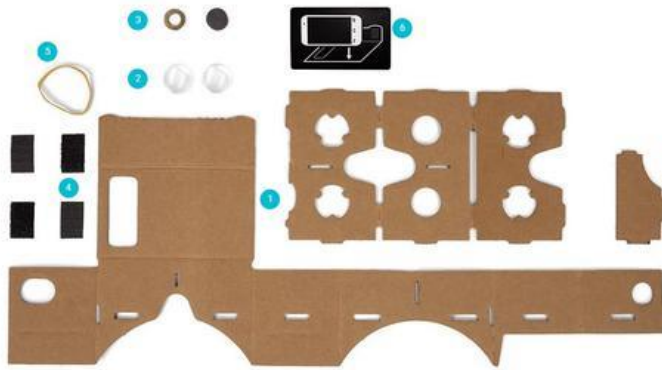
Memory: 8GB RAM

Headset: Oculus Rift or HTC Vive

## Appendix K : Google Cardboard



# Cardboard

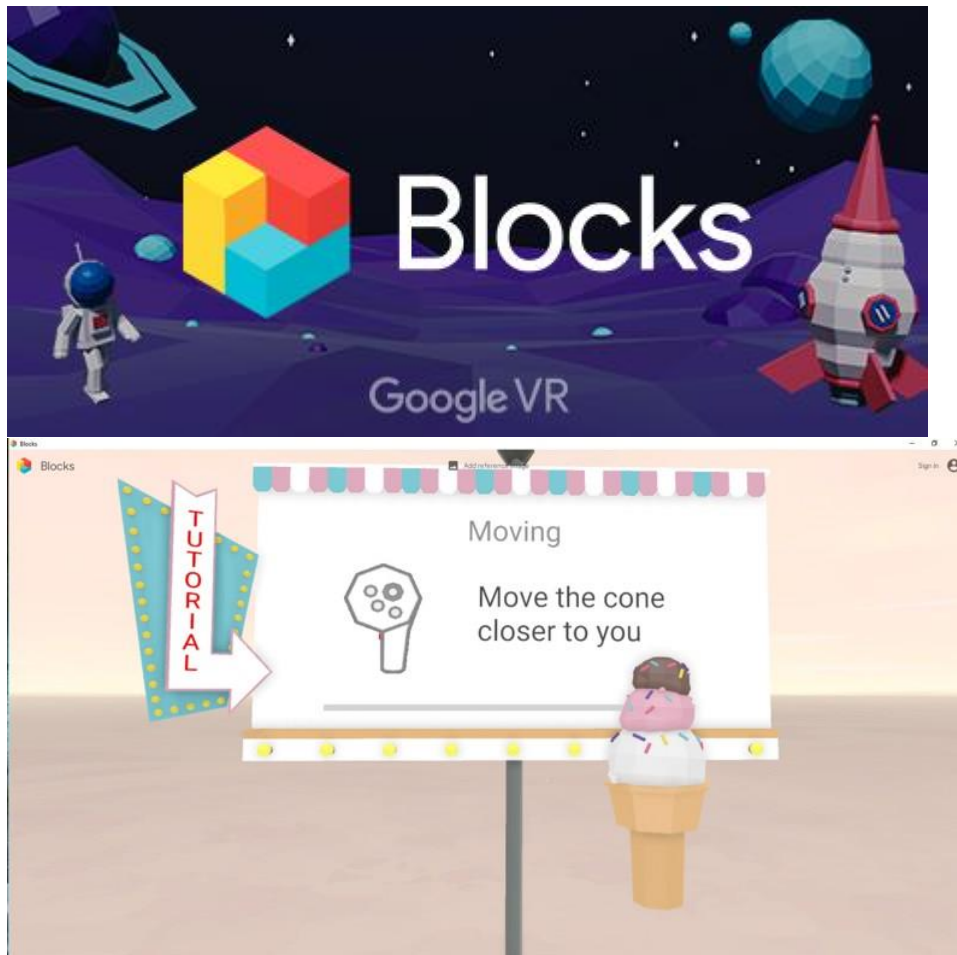


Google Cardboard brings immersive experiences to everyone in a simple and affordable way.

Whether you fold your own or buy a Works with Google Cardboard-certified viewer.

Works by placing a mobile device into the back of the cardboard and by downloading the cardboard app.

## Appendix L : Google Blocks



Blocks makes creating 3D models easy, powerful, and fun

With Blocks, you can create models in VR. That means no more mind tricks to create real, volumetric objects on a 2D surface.

Available on HTC Vive and Oculus Rift