

MA Commercial Music Producer Assignment

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**Tileyard Education,
University of Wales Trinity Saint David**

“Dreaming in December”

CREATION ELEMENT C2B - REFLECTIVE COMMENTARY

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WHERE DID WE LEAVE OFF?

For good measure, let us look at my criteria for success which I set in my proposal:

“creating a 3D environment with virtual musicians (animated or not) playing the movement from my suite, and creating a player character (VR, or just a regular First Person character as in a First Person Shooter game) which can move around and experience the concert as they please, with a generally pleasing sounding and satisfying experience for the user.” (Rasmussen 2021)

And as nice-to-haves I wished for the following features:

“the opportunity to move the musicians around the space and thus change the soundscape; the ability to change the volume of each musician in-game; to interact with the environment in the form of virtual paint brushes; to animate the musicians in a satisfying way; to design lighting and particle effects for visual aesthetics.” (Rasmussen 2021)

Let us take a look at what happened since.

It would be an understatement to say that the past 3 months have been a roller coaster. On the 7th of May I handed in a proposal, stating that I wanted to create a Virtual Reality concert experience, featuring a full orchestra playing an original composition and arrangement of mine called Dreaming in December, animated using motion capture, and with the ability for the spectator to walk freely between the musicians for a fully personal and unique listening experience. Having never done anything like it before, naturally the idea was met with some scrutiny from well-meaning friends and family. For example, in preparation for my proposal, I had to research how one goes about performing motion capture when you don't have a motion capture suit, but in hindsight that was actually one of the easier things to solve. Since then I have encountered a plethora of obstacles and unforeseen challenges, and even though I was at times very close to limiting my expectations in order to have a working product, I somehow managed to find solutions or work-arounds to my problems - usually in the dark corners of a forgotten internet forum post.

During these reflections I will first lay out the process up until now, detailing key learnings and surprises along the way. Due to the complexity and varied nature of the project, I will cover each section relatively briefly. I will then proceed to give a quick overview of what the ever expanding combined market for VR, music, and education looks like. All this will feed into my personal development plan, laying out a strategy for how I can use this knowledge and experience to push myself further and find paid work within the field. Finally, I will reflect on the project and my time at Tileyard Education as a whole in the context of the larger scope of my life.

THE JOURNEY

1) Recording

The first stage of the journey was relatively slow, seeing as most of what I could achieve in those weeks depended on the musicians I had engaged. But slow does not mean not stressful. I had set aside roughly 4 weeks to get all the recording sorted, and some of the musicians recorded at home, and some recorded at my place. Both kinds came with their merits and challenges.

To make everything as smooth as possible, I invited everyone to a pre-production meeting via Zoom, where I specified in a presentation what the project was about, and exactly how the recording process would look like, down to which backing tracks to use when. To the people who couldn't make it, I made the recording of the meeting available. The sheet music was beautifully engraved by my pianist Tom Knowles, and the division of the parts, backing tracks in all conceivable combinations, recording specifications, plus a "Read Me"-PDF was sent to all musicians - to practice to and use for recording if recording at home. One of the first challenges I encountered was that people still asked me questions which were answered in the material I sent, or simply ignored it, and sent me recordings which were unusable due to too much room in the recording, clipping, or other issues. Naturally, all the people recording from home also postponed their task till the last minute, with a handful waiting till the deadline I set, 1st of June, to ask me whether they could in fact come in to my studio to record after all, which set me back almost 2 weeks from my plan (see Appendix A).

As annoying as this is, it's important to remember that they were doing it for just a bottle of wine, so it was limited how much commitment I could expect from them. A key learning here is that communication is key, including conveying the message in different ways, repetition, and following up. Another learning is that deadlines should be set before you actually need the material.

In the end, however, most musicians actually recorded at my place, where there were other issues at hand. First of all, several of the instruments I had never recorded before, like the tuba, double bass, oboe and trombone. For this I consulted *The Recording Engineer's Handbook* (Owsinski 2017) and a series of sources on the web (Audio-Technica 2015, Summer 2004), as well as asking the musicians themselves what kind of mic placement etc. they usually record with. After some experimentation in my humble-sized studio, I managed to get a decent sound out of even the tuba. I used a Neumann U87 for the quieter instruments like strings and oboe, and a Beyerdynamic M-160 ribbon mic for the louder brass instruments (I prefer the colour of the ribbon, but due to inherent noise levels it didn't work for quieter instruments, especially pizzicato strings).

But as with many things in this first stage of my journey, the hurdle was more with people management than with the harder skills like recording techniques. Several musicians had volunteered their services while quite severely underestimating or under preparing for the changing time signatures and complexity of the score. This meant that in order for me to get what I needed, I sometimes had to sit 3, 6, or even 8 hours with a musician to get the part down, all the while doing my best to keep spirits high, and blame my "annoying music" rather than their abilities. It took a lot of focus for me to achieve this while conducting the music in an engaged way, but sometimes there was just nothing to do. A few of the musicians got tired and frustrated, and called the recording session early - officially with the intent of coming back to finish at a later date, but with some of them I knew that I wouldn't be able to use the material anyway. In order for me to get the required parts down, especially for the strings, I managed to convince the more skilful and experienced players to lay down more layers of their part in return for multiple bottles of "appreciation".

I said yes to every musician who showed interest in the project - due to the size of the orchestra needed, I figured I couldn't afford to be too critical - but in hindsight I think I could have saved a lot of time by making sure to have some kind of audition for the parts: either in the form of witnessing their performing elsewhere/on video, or by having a phone call with them to talk about their sight-reading

skills. Then again, I also engaged three flautists, even though there are only two flute parts: one of them had a hospital situation last minute, and had to leave the project, and another one sent me subpar stems and didn't have time to redo it. So the last one remaining recorded both parts plus the piccolo. Lucky I said yes to them all, because I couldn't possibly predict that.¹

2) Editing

Question: How do you get an orchestra's worth of musicians to sound "together" when they recorded in different rooms and at different times? Answer: Editing. A lot of editing.

While I did my best to instruct the musicians on the specificity of the score, and to conduct the musicians at my studio exactly as I wanted the phrasings to be, there was always going to be a lot of editing required.

First of all, timing. Using the assortment of time-correction algorithms supplied by Ableton Live 11, I had to meticulously go through each phrase of each instrument and tweak it to sound coherent with the rest. In a big orchestra, especially for the strings, subtle variations in timing between musicians are normal because the transients are pretty soft. In a smaller orchestra size, and when the audience can walk up close to each musician, this kind of discrepancy would be much more obvious, however, so I needed to adjust it carefully.

The same can naturally be said for pitch. When playing with other people, most musicians adjust their tuning to the people around them and then blend in, but this was not possible here - only with a not-so-inspiring MIDI backing track. Using Melodyne and manual tuning of tiny clip sections, I got there after several hours.

The variety of different recording circumstances for the various instruments meant that I had to use the RX 8 audio repair suite to fix crackling, reverb, spectral noise, and even clipping noises to get coherent and professional sounding stems.

"Get it right at the source" is a phrase often used in the field, and it was at the back of my mind all the time. However, due to circumstances and amount of material I needed, there often simply wasn't time to be as thorough as I'd like to be during the recording sessions: musicians get tired after a while, and I wasn't paying them to be there. So it was more important to get the raw material, and then I took it upon myself to spend the many days it took to edit it all together.

In an ideal world, I would have a budget to pay for seasoned session musicians who just "get it right at the source". Or maybe the preparation of the musicians I engaged would have come with a fee. I'm not sure, but it is something I need to make sure doesn't happen again in the future, so we do not waste each other's time.

3) Mixing

It was fascinating from the beginning how I was going to approach the task of mixing. Seeing as the sound would be 3D in the experience, meaning that the panning and volume of each part would change depending on where you are in relation to the source, the mix would essentially change in real-time as the spectator moved. Therefore I couldn't make too drastic, say, EQ or gain-staging

¹ There were also a lot of positive experiences in this phase, like the recording of the piano, but I chose here to focus on the parts where there was most room for growth.

decisions. I also needed to figure out how I could make all these instruments, which were recorded in different spaces and on different mics, sound like they were in the same room.

For the volume, I balanced them in instrument groups first, making each choir, as they are also called, sound cohesive within itself, and then balancing the groups afterwards. In essence, they all needed to be more or less equally loud, however with the brass and some of the percussion being louder than the rest, as they would be in real life.

For EQ, I performed a low-cut around the instrument's lowest fundamental frequency, and applied a plugin called Gullfoss on each instrument. Gullfoss uses artificial intelligence to "recover" or "tame" frequencies which it deems to be out of balance in real-time, with the user adjusting exactly how much "recovering" or "taming" it should apply to which frequency spectrum. The result was surprisingly good, and it was a very time-effective way of processing all the different instruments, which in a dynamic orchestral piece like this would obviously have varying EQ needs throughout the piece, what with the change of timbre that orchestral instruments undergo with fluctuating dynamics and pitch. This also somehow got the instruments to sit well with each other, seeing as the same AI algorithm was applied throughout, making discrepancies in recording circumstances dissipate.

For compression, I used Fabfilter's Pro-C on the Classic setting to tame each part around 2-4dB, with around 6ms attack to again even out the dynamics and transients of the parts a little bit. Nothing drastic, but it made a huge difference in getting the sections to blend.

The stems got exported from Pro Tools (where I performed the mixing after editing in Live) and put into my audio middleware program FMOD². From here, each part had a spatialiser plugin applied called Oculus Spatialiser, which is responsible for creating the binaural effect of the sound moving realistically through space, always in accordance with the position of the listener's virtual ears. Each section has its own bus, which in turn sends to the relevant reverb. For reverb I used a mix of the native reverb plugin inside FMOD, and the Oculus Spatial Reverb plugin, which applies realistic reflections to every sound according to room parameters you feed it - like room dimensions, and how reflexive each surface is.

Furthermore, I utilised what's called Snapshots. A Snapshot is a temporary gain-staging and effect setting which can be triggered by events inside the experience. For example, when the player solos the strings, a Snapshot is applied which lowers the volume of all the other buses. The same applies for when the reverb changes with the player changing the venue inside the experience, or drinking a special potion, which adds special effects to the sound for a psychedelic effect.

In this way, most of the mixing is actually done in real-time, by the player themselves: I'm merely facilitating it.

There are more elements which I applied - like audio occlusion (having the volume and EQ change as you go behind, say, a wall) (Scott Game Sounds 2020), and early reflections (having the audio reflect off the virtual surfaces, so it sounds different if it's right next to a wall compared to in the middle of the room) (Oculus 2018) - but because they were too processor intensive for the HMD in question, I had to remove them again. It is unheard of in the field to have so many continuous

² Software used to control the parameters and audio sources of sounds and music playing in Unity. Almost like a kind of DAW specifically for real-time engines.

3D sound sources playing for such a long time (maybe there is one “music” track, as opposed to my 50), so I was really pushing the hardware to its absolute limit. I even had to remove a couple of the string doublings because it simply was too much to handle.

4) Motion Capture

Among the many things I had to learn for this project was animating using Motion Capture technology [or mocap for short]. As explained in my proposal (Rasmussen 2021), I found out that I could use my Oculus Quest 2 device [a Virtual Reality Head-Mounted Display, or HMD for short] to capture the movements of the arms, head, and torso, using an independently developed software called LUXOR.³ There were a few bumps in the road in this part as well. First of all, it seemed like the program would crash if I performed mocap recordings that were the required 10 minutes of the piece. After asking in the software’s Discord⁴ channel, I found out that I could adjust two settings when exporting the file which prevented the issue. Second, the fingers of the 3D models that came out of it were all jagged and misplaced. Again after consulting the same Discord channel, I found out that it was a bug, and that I could manually place the bones of what’s called the Animation Rig in the right place, and all looked fine again. It took hours, but it worked.

Originally, it was the plan to have the musicians come in and perform the movements themselves. I tried that with the bass clarinetist, but it was clumsy to both be holding the instrument and the VR controllers necessary to capture the movement. It also took a while to explain how it all worked, and how to move to get the best possible result. Moreover, editing separate animation clips together at a later stage would be very complicated if I wanted to get the timing right, so we had to do it in one take. All this combined with the fact that I was already delayed due to the musicians not sending their material on time meant that I decided to do it myself.

First, to make the process more efficient after my previous delays, I did two 20 second animation clips for each part: a “playing”, and an “idle” animation. These would be triggered by the volume of the part inside my real-time engine Unity⁵, and it actually worked. The problem was that the movements didn’t match the sound - it was merely a generic “playing” animation, and when my wife tried an early demo, she said it was lacking excitement. So, I went back and did full 10-minute takes of all the “moving” instruments (strings, piano and percussion have more obvious musical movements than, say, a flute, so for the woodwinds and brass I kept the “playing/idle” system), and even added a conductor to boot. Seeing as I didn’t have a mocap tracker on any instruments (I was merely doing the air-guitar version of each due to lack of resources), it was tricky to attach the instrument models to the musicians and make the movements look realistic. In the end I managed to make it look passable, and I am very happy I did the full takes in the end. In order to learn how to edit the timings of the animations, I took an online course called Real-Time Animated Storytelling on Unity Learn (Unity Technologies 2020) and watched a few relevant YouTube tutorials (Brackeys 2017, Unity 2017). With an actual budget it would of course have been ideal to put the musicians in a mocap suit and have trackers on the instruments. The HMD was also

³ It was an involved and very time-consuming process creating a usable file format from LUXOR which I could use in my project, but I won’t go into details here. For more information check Animation Prep Studios (2020).

⁴ A social media communications platform, often used by gamers.

⁵ The main piece of software used to design and build the 3D experience.

impractical as you had to have it in front of your eyes during mocap recording, making reading sheet music complicated. But by moving the HMD up to my forehead rather than eyes, we got there in the end, albeit a bit uncomfortably so.

5) Coding and Visual Aesthetics

The amount of obstacles I encountered and eventually overcame in this section could easily fill up a few essays in itself. But I will share a few highlights.

One key thing to decide on was the look and feel of the musicians. For a few reasons, I had a feeling early on that I couldn't go for a too realistic look: First, I didn't want to end up in the "uncanny valley" - having musicians who look fairly close to people, but not quite, yielding an uneasy feeling in the viewer (think creepy mannequin); second, due to before-mentioned issue with the movement of the musicians and the instruments easily leading to "penetration"⁶, the more realistic the models would look, the more obvious this penetration would be; third, the Oculus Quest 2 is essentially a mobile device, and as such doesn't have a lot of processing power in the GPU - therefore I had to go with models that were so-called "low-poly", meaning low polygon count, lending itself better to a stylised visual expression. With all this in mind, I managed to find low-poly models to apply the animations to, and then have these models use a "ghost shader" - a way of rendering their skin which makes them look ethereal (Easy Game Studio 2021). This way I could also easily give the different instrument sections varying colours without it looking jarring.

To guide the viewer's attention, I wanted to have the musicians only appear when they were playing music, and disappear when they were silent. Although I did manage to create a code that did exactly that, it turned out to be unreliable once I unplugged my HMD from my computer, thus making it rely solely on its own processing power. Therefore I ended up having the musicians stay where they are once they appear for a more stable experience⁷.

6) Virtual Reality

There was a lot of work to be done first, but eventually it became time to actually apply the Virtual Reality element of the whole thing. I took a course called Create With VR (Unity Technologies 2021) from Unity Learn's site to learn the ropes, and rather quickly felt comfortable applying my knowledge in the experience. Getting the functionalities to work were actually surprisingly easy, so teleporting the player around and grabbing objects were features swiftly added.

The challenge was more in UX design. For example, how high should a table be so that it is comfortable to do the experience both standing and sitting? What degrees of movement freedom should be available? Which buttons on the controller should do what? And what's the most satisfying way to interact with the environment? Rather than simply choosing a venue from a dropdown menu, which was the original idea, my wife suggested having potions to drink which would do exactly that (a feature praised by the testers, see Appendix C). So you grab a potion, and something

⁶ A phenomenon where a 3D model jarringly passes through another as if it didn't exist or have any physical properties, like a violin bow going straight through the head.

⁷ Even though that means - for complicated reasons - that during a solo a whole section will look like it's playing even though the sound is actually only coming from one player. This is due to the amount of individual motion capture takes I performed. Compromises!

called a collider, which is attached to the camera (the “eyes” of the player, if you will), registers when a potion gets close enough: the potion vanishes, a gulp sound is played, and the venue changes.

But the biggest challenge was not ideas or implementing them. The biggest challenge by far was performance. Having a game run smoothly on a mobile device is a bigger challenge than on a computer or console with more powerful hardware, so it took a lot of research to get a respectable frame rate. I had to learn about baking lights (Unity 2020, Unity Technologies 2020), reducing triangle count (The Game Guy 2020, JunLaJubalaM m 2020), reducing draw calls (Lofi Dev 2020), texture compression (Unity Technologies 2021), and much more. It was so hard, in fact, that at one point I was considering whether I needed to completely rethink my whole project to make it work, and Ciaran Robinson suggested on the 16th of July (exactly one week before my deadline) that I could send a screen captured recording of the experience from my computer for the assessment (Robinson 2021). But I wanted to share it with people easily aside from the assessment, so I had to find a solution. After a lot of perseverance, google searching, and trial and error, I managed to get there in the end: apart from the above mentioned steps, reducing the amount of virtual musicians slightly did the trick.

7) Testing

As already mentioned, the project was so massive that I cannot possibly share all the struggles and learnings that went into each phase. But suffice it to say it was a lot, and it was finally time to book the main studio at Tileyard for testing. Seven members of the Tileyard Education staff and two of my fellow students came to experience it. After the session I sent them all a questionnaire to document their experience. Naturally, there were a few things I would have liked to have done differently after seeing people try it (like making it easier to start the concert when they wave the conductor’s baton, and a few mentioned in the questionnaire (Appendix C) that making the instructions for the controls clearer would have been nice), but I was quite taken by the overwhelmingly positive feedback. Martyn Ware - Principal of Tileyard Education and famously anti-VR, making a living out of real-life immersive experiences himself - found it fantastic, and lightheartedly said I should just go out and make a lot of money (Ware 2021). Joking aside, Ware along with Director of Tileyard Education Harry Leckstein and producer Sean Hargreaves, all have since offered their help and experience in connecting me with relevant industry people, creating a business plan, and meeting potential investors (Ware 2021, Leckstein 2021, Hargreaves 2021). To say that I am thrilled would be an understatement, and I am thoroughly proud of what I have achieved so far. After being stuck in my studio alone for so long, it is truly heartwarming to be reminded why we do what we do, and the literal goosebumps, tears, laughter, and outbursts of “wow” that I saw on the testing day were both relieving and fulfilling.

CRITERIA FOR SUCCESS

When looking back at the criteria for success I cited earlier, I am pleased to say that I achieved all that and more. I was able to design and implement not one, but three different venue environments with different acoustic qualities, and the responses to my tests and questionnaires (Appendix C) showed that the experience was pleasant both aurally, visually, and as a whole. I even implemented a

paint brush feature as well, but removed it again from the final build because it seemed to be too many things for the player to get familiar with over 10 minutes. The rest of the features were also audio focused, and I wanted to focus on the sound. I might add it back in a future iteration, we'll see.

THE MARKET

Since doing my proposal, I haven't been able to find more examples of the use of VR and music that come close to what I have done. Overall, the XR market is estimated to be a \$6.7 billion industry, with VR game revenue rising 25% from \$471M to \$589M from 2019 to 2020 (Graham 2021). Specifically, virtual concerts have seen an incredible boom in 2020. With COVID-19 keeping many people indoors, people have sought immersion elsewhere, and the scalability of virtual concerts is immensely greater than that of real life concerts: Tomorrowland festival sold 1 million tickets in 2020 for the virtual edition of their annual events (Rickard 2021)! With this kind of growth, and with the omnipresence of COVID-19 forcing many people indoors (either by choice or by law), it is reasonable to expect the field to continue to grow for the foreseeable future.

In the educational field, there are companies like ClassVR and Eon-XR who champion the use of VR. ClassVR, which targets school children, have music lessons available, but they only amount to showing 360-videos of a few live performances of music from different cultures - no interaction, no exploration, little to choose from. Eon-XR, which is aimed at delivering training for professionals like engineers or doctors, has a great platform for creating and customising your own lessons, but nothing about the arts. I mention them because they worked with the Sydney Opera House to create a virtual tour of the building (Looker 2020), but to my knowledge it did not feature any 3D music.

There is clearly a thirst for using Virtual Reality in education (Masie 2017), and there are also hints of use of VR in music and the arts, but it is still at a relatively primitive stage compared to what's clearly possible. I imagine what I have made could be of great use to both children and adults alike in for example exploring the auditory elements of music - in any genre. Of course, seeing as nobody seems to have done it before, it is hard to tell with certainty.

In the art sector, I witnessed *Current, Rising* at the Royal Opera House. It was a Hyper Reality⁸ opera, and it was visually striking, but although the sound was panned 360 degrees and the sound sources were fixed in place regardless of where you looked (or, in other words, spatialised), the experience itself was very static. You had a fixed little platform to stand on 90% of the time, and therefore could not walk around and explore the music or indeed the environments. The actual moving was only used in the first minute to find your platform. I secured an interview the director, Netia Jones, about the process on May 25th (Jones 2021). Apparently, it was a process that lasted for a few years, with a team so big that Jones did not have an overview of what every department was actually doing, and they had funding from the ROH, Audience Labs, and beyond. The experience lasted 15 minutes, roughly the same as *Dreaming* in December.

⁸ Hyper Reality is when moving through a physical space is integrated seamlessly with the virtual world. If there is a wall in the experience, you can feel the wall with hands. If there is a doorway in the experience, you can physically walk through it. It also lends itself to other special effects, like blowing actual wind at the audience when outside in the experience, or the use of smells.

I wasn't sure at the time, because it was early stages of my project then, but having had the experience of developing *Dreaming in December* *on my own* within 3 months and no financial funding, I am very excited for the possibilities that having a whole team commissioned for a long period of time can unlock for the purpose of creating a truly groundbreaking VR experience.

MOVING FORWARD

While I'm proud to say that I have learned and achieved more than I expected in the past three months, there is still plenty to work on. There is a big difference between creating an isolated experience, and penetrating the market, let alone simply profiting from it. How do you get affiliated with an institution like the The Royal Opera House?⁹ What are the profit margins for different kinds of VR experiences? How do you reach people with no HMD? How do you secure Arts Council grants to get the project off the ground? What are the opportunities for securing investing? How do you create a solid business proposal to share with key stakeholders? With relatively little experience in the field, how would I go about hiring a team for these projects? How would I know exactly what qualities I would need in, for example, a programmer, an animator or a 3D designer, when they would all know much more about their field than I do?

These are some of the many questions I will have to answer going forward, and my Personal Development Plan [PDP] (Appendix B) is therefore centred around commercial applications for my project and my skills and knowledge, seeing as that is the area that currently needs most development. In the past months I have studied and learned extensively about the creative process and execution of the experience. But now it is time to literally get down to business. With the support I am currently receiving from the leaders and mentors at TYE, I have to leverage the momentum, meet the right people, and truly get the most out of my time here. Maybe that means being hired by a VR company (Hargreaves will introduce me to people at Breaking Fourth (Hargreaves 2021), starting working with a venue (again, Hargreaves will introduce me to the commercial director of Kings Place in London (Ibid.), or securing funding to develop the experience further.

With the help of Harry Leckstein and my other tutors and mentors at Tileyard Education, I will create as strong a business case for the project and myself as possible, and see where it takes me - because there are so many places it *could* go, it might not be wise to fix my gaze on one single idea in the next couple of months. Leckstein has proposed we do several testing sessions at Tileyard, inviting the community and relevant industry professionals to come and experience it. Overall, I think this is an exciting way to finish my post-graduate degree, and begin the next journeys ahead.

⁹ Netia Jones said that she was simply asked if she wanted to do a VR project at the ROH (Jones 2021). But how do you get to a place where you get asked?

References

Articles

ClassVR (2019) *Top 10 ways to use ClassVR* [online] ClassVR. Available at:
<https://www.classvr.com/download/5722/>
[Accessed July 21st 2021]

ClassVR (2019) *WHITE PAPER: A Guide To AR & VR In Education* [online] ClassVR. Available at:
<https://www.classvr.com/download/whitepaper-a-guide-to-ar-vr-in-education/>
[Accessed July 21st 2021]

Graham, P. (2021) *Vr Game Revenue In 2020 Increases 25% To \$589M Superdata Reports* [online] VRFocus. Available at:
<https://www.vrfocus.com/2021/01/vr-game-revenue-in-2020-increases-25-to-589m-superdata-reports/>
[Accessed July 21st 2021]

Looker, P. (2020) *Experience the Sydney Opera House in 360° Immersion* [online] Eon Reality. Available at:
<https://eonreality.com/experience-the-sydney-opera-house-in-360o-immersion/>
[Accessed July 21st 2021]

Masie, E. (2017) *VRLearn: Virtual Reality and Learning* [online] Masie. Available at:
http://ivrtrain.com/ivrtrain/VR_Learn_Report-2017.pdf
[Accessed July 21st 2021]

Rasmussen, M. (2021) *Written Proposal*, University of Wales Trinity Saint David, London.

Rickard, M. (2021) *The Next Normal for Immersive Concert Experiences* [online] VRFocus. Available at:
<https://www.vrfocus.com/2021/02/defining-the-next-normal-for-immersive-concert-experiences/>
[Accessed July 21st 2021]

Summer, D. (2004) *The Brass Ring – Recording and Mixing Brass in a Home Studio* [online] David Summer Music Studio. Available at:
<https://www.summersong.net/recording/brass-instruments/>
[Accessed July 21st 2021]

Unity (2020) *Light baked prefabs and other tips to get 60 fps on low-end phones* [online] Unity. Available at:
<https://unity.com/how-to/advanced/optimize-lighting-mobile-games>
[Accessed July 21st 2021]

Books

Adler, S. (2002) *The Study of Orchestration*, 3rd edn, W. W. Norton & Company, New York.

Owsinski, B. (2017) *The Recording Engineer's Handbook*, 4th edn, BOMG Publishing, Burbank.

Courses

Unity Technologies (2021) *Create With VR* [online] Unity Learn. Available at: learn.unity.com/course/create-with-vr [Accessed 6th of May 2021]

Unity Technologies (2020) *Introduction to Lighting and Rendering* [online] Available at: learn.unity.com/tutorial/introduction-to-lighting-and-rendering [Accessed 21st July 2021]

Unity Technologies (2020) *Real-Time Animated Storytelling* [online] Unity Learn. Available at: learn.unity.com/course/real-time-animated-storytelling [Accessed May 6th 2021]

Personal Communications

Hargreaves, S. (2021) Zoom conversation with Michael Rasmussen, 4th May.

Hargreaves, S. (2021) Zoom conversation with Michael Rasmussen, 1st July.

Hargreaves, S. (2021) Email to Michael Rasmussen, 19th July.

Jones, N. (2021) Zoom conversation with Michael Rasmussen, May 25th.

Leckstein, H. (2021) Email to Michael Rasmussen, 19th July.

Robinson, C. (2021) WhatsApp message to Michael Rasmussen, 16th July.

Robinson, C. (2021) Email to Michael Rasmussen, 19th July.

Ware, M. (2021) Email to Michael Rasmussen, 19th July.

Ware, M. (2021) Zoom conversation with Michael Rasmussen, 30th April.

Videos

Animation Prep Studios (2020) *APS to FBX tutorial (Blender, Unity)* [online video]. Available from: [youtube.com/watch?v=SyFvBqTX6RA&ab_channel=AnimationPrepStudios](https://www.youtube.com/watch?v=SyFvBqTX6RA&ab_channel=AnimationPrepStudios) [Accessed May 6th 2021]

Audio-Technica USA (2015) *Basic Recording Techniques: Brass* [online video]. Available from: www.youtube.com/watch?v=4xt1SJ0U6Us&t=89s&ab_channel=Audio-TechnicaUSA [Accessed 21st July 2021]

Brackeys (2017) *Intro to Unity Timeline* [online video]. Available from: www.youtube.com/watch?v=G_uBFM3YUF4&ab_channel=Brackeys [Accessed 21st July 2021]

Brackeys (2019) *Fun with MOTION CAPTURE in Unity!* [online video]. Available from: www.youtube.com/watch?v=4v4SsYoZjYY&ab_channel=Brackeys [Accessed 21st July 2021]

Brackeys (2020) *HDRP vs. URP - Which Unity Template should you choose?* [online video]. Available from: www.youtube.com/watch?v=5MuA92xUJCA&t=173s&ab_channel=Brackeys [Accessed 21st July 2021]

ClassVR by Avantis (2017) *ClassVR Introduction: Virtual Reality for Schools* [online video]. Available from: www.youtube.com/watch?v=C8tuXxCAlPQ&ab_channel=ClassVRbyAvantis [Accessed 21st July 2021]

Colin V Audio (2021) *FMOD + Unity Voices & Instances* [online video]. Available from: www.youtube.com/watch?v=rkW5Fjt4y9E&ab_channel=ColinVAudio [Accessed 21st July 2021]

Dilmer Valecillos (2021) *The 5 Most Common Oculus Quest Unity Deployment Issues !* [online video]. Available from: www.youtube.com/watch?v=zuXCzHI9ox0&ab_channel=DilmerValecillos [Accessed 21st July 2021]

Ditzel Games (2018) *Fixed, Spring, Hinge, Character & Configurable Joint explained - Unity Tutorial* [online video]. Available from: www.youtube.com/watch?v=MElbAwhMvTc&ab_channel=DitzelGames [Accessed 21st July 2021]

Easy Game Studio (2021) *unity character effect - unity body effect - unity asset download* [online video]. Available from:
www.youtube.com/watch?v=N4RnZ7F6Ggs&t=24s&ab_channel=EasyGameStudio
[Accessed 22nd July 2021]

FMODTV (2015) *Introduction to the Profiler* [online video]. Available from:
www.youtube.com/watch?v=wV0kjl0U7c&t=1s&ab_channel=FMODTV
[Accessed 21st July 2021]

FMODTV (2016) *Audio for Unity 5: Survival Shooter (5/5) - Profiling and Final Touches* [online video]. Available from:
www.youtube.com/watch?v=T3SmLEiSUPM&ab_channel=FMODTV
[Accessed 21st July 2021]

FusedVR (2016) *Unity VR Tutorial: How To Build Tilt Brush From Scratch* [online video]. Available from:
www.youtube.com/watch?v=eMJATZI0A7c&t=2531s&ab_channel=FusedVR
[Accessed 21st July 2021]

The Game Guy (2020) *How to Actually optimize your game in Unity - Complete Game Optimization Guide* [online video]. Available from:
www.youtube.com/watch?v=ysk7ATmIeOs&ab_channel=TheGameGuy
[Accessed 21st July 2021]

Jayanam (2018) *Unity Inventory : Attach Weapon To Player's Hand* [online video]. Available from:
www.youtube.com/watch?v=S_USClc_r5c&t=104s&ab_channel=Jayanam
[Accessed 21st July 2021]

JunLaJubalaM m (2020) *Poly Few | Mesh Simplifier and Automatic LOD Generator* [online video]. Available from:
www.youtube.com/watch?v=3ybBou4rXCI&ab_channel=JunLaJubalaMm
[Accessed 21st July 2021]

The Leap TV (2020) *Jacob Collier at USC SCALE | Entire Performance* [online video]. Available from:
www.youtube.com/watch?v=tb5VEWnnfBY&ab_channel=TheLeapTV
[Accessed 21st July 2021]

Lofi Dev (2020) *Unity Performance Tips: Draw Calls* [online video]. Available from:
www.youtube.com/watch?v=IrYPkSIvpIw&ab_channel=LofiDev
[Accessed 21st July 2021]

Oculus (2018) *Oculus Connect 5 | Spatial Audio for Oculus Quest and Beyond* [online video]. Available from:
www.youtube.com/watch?v=sKDXksI7S6o&ab_channel=Oculus
[Accessed 21st July 2021]

Omar Santiago (2020) *Character Joint (Physics Joint)* [online video]. Available from:
www.youtube.com/watch?v=7G7SK77uFak&t=76s&ab_channel=OmarSantiago
[Accessed 21st July 2021]

OXMOND Tutorials (2019) *How To Make An Object Glow in Unity! [Beginner Tutorial - Unity 2019]* [online video]. Available from:
www.youtube.com/watch?v=87H0zmcDuUo&t=87s&ab_channel=OXMONDTutorials
[Accessed 21st July 2021]

Panedia (2017) *VRLearn* [online video]. Available from:
www.youtube.com/watch?v=vnCEUsoKv-c&ab_channel=Panedia
[Accessed 21st July 2021]

Peer Play (2017) *Audio Visualization Unity Tutorial* [online video]. Available from:
www.youtube.com/playlist?list=PL3POsQzaCw53p2tA6AWf7_AWgplskR0Vo
[Accessed 21st July 2021]

Peter Looker (2020) *Sydney Opera House - EON XR 360 Trailer* [online video]. Available from:
www.youtube.com/watch?v=BimtQLgMTq0&ab_channel=PeterLooker
[Accessed 21st July 2021]

Royal Opera House (2020) *How was the world's first hyper-reality opera created? (Royal Opera House Insights)* [online video]. Available from:
www.youtube.com/watch?v=AVXYPqdAYdY&t=1s&ab_channel=RoyalOperaHouse
[Accessed 21st July 2021]

Scott Game Sounds (2017) *FMOD & Unity | Limiting Sounds And Instances* [online video]. Available from:
www.youtube.com/watch?v=PLeRyt1v3a4&t=519s&ab_channel=ScottGameSounds
[Accessed 21st July 2021]

Scott Game Sounds (2018) *FMOD & Unity | Adding Game Sounds | Part 6 - Playback States* [online video]. Available from:
www.youtube.com/watch?v=bpxiJH2r3ME&t=779s&ab_channel=ScottGameSounds
[Accessed 21st July 2021]

Scott Game Sounds (2018) *FMOD & Unity | Creating Reverb Zones* [online video]. Available from:
www.youtube.com/watch?v=8IbWCP5FrjY&t=4s&ab_channel=ScottGameSounds
[Accessed 21st July 2021]

Scott Game Sounds (2020) *FMOD & Unity | Creating An Audio Visualizer / Getting Spectrum Data* [online video]. Available from:
www.youtube.com/watch?v=qbv891Z_3fU&ab_channel=ScottGameSounds
[Accessed 21st July 2021]

Scott Game Sounds (2020) *FMOD & Unity | First Person Audio Occlusion* [online video]. Available from:
www.youtube.com/watch?v=wTOHc803_ys&t=28s&ab_channel=ScottGameSounds
[Accessed 21st July 2021]

Unity (2019) *Baking at the speed of light: Lightmapping for beginners - Unite Copenhagen* [online video]. Available from:
www.youtube.com/watch?v=pcXpY_IBSeU&t=61s&ab_channel=Unity
[Accessed 21st July 2021]

Unity (2017) *Using Timeline: Getting Started* [online video]. Available from:
www.youtube.com/watch?v=42QZ3aUDnV0&ab_channel=Unity
[Accessed 21st July 2021]

Unity (2013) *Joints - Unity Official Tutorials* [online video]. Available from:
www.youtube.com/watch?v=f4xikqJdkwM&t=145s&ab_channel=Unity
[Accessed 21st July 2021]

Valem (2019) *How to make a VR game in Unity - Part 4 - User Interface* [online video]. Available from:
www.youtube.com/watch?v=h7z4E8Qy8Ks&t=241s&ab_channel=Valem
[Accessed 21st July 2021]

APPENDIX A: TIMELINE

	Month	Apr	May					June				July			
	W/C	26	3	10	17	24	31	7	14	21	28	5	12	19	26
Activity															
Music with library															
Producing Backing Track															
Music with musicians															
Define instruments needed															
Gather participants for the music															
Sheet music															
Pre-Production meeting with musicians															
Recording Piano															
Recording sessions Wind															
Recording sessions Brass															
Recording sessions Strings															
Mixing (maybe mastering)															
Review for any extra recording															
Experience Animation															
Define experiences to animate (dance / music)															
Gather participants for the mocap															
Video recordings + mocap															
Create world in Unity															
Integrate videos / animations															
Integrate music and produce															
VR experience															
Programme for VR															
Test on other equipment															
Test for bugs															
Final Delivery															
Write Reflections															
Files ready to share															
Michael To Do															
Tom [my pianist and collaborator] To Do															
Both To Do															

APPENDIX B: PERSONAL DEVELOPMENT PLAN

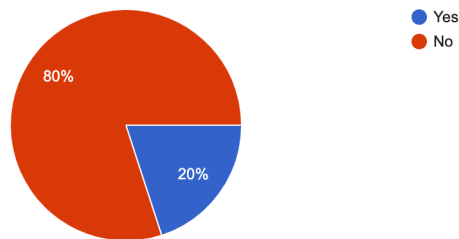
What are my goals?	What do I need to achieve first?	When do I want to achieve this?	What obstacles might I encounter?	How can I improve my chances?	What resources can help me?	Next review:
Getting a paid, professional gig as a producer of VR experiences (either employed or on a project basis)	- Polish Dreaming in December to a tight and clean standard for showcasing. - Research market thoroughly in terms of business opportunities, trends, stakeholders, and employers. - Prepare business case: hereunder create presentation in the form of both a deck and live delivery via zoom or in person. - Secure opportunities to meet the stakeholders using network. - Demonstrate proof of concept to key stakeholders.	I want to achieve my big goal by the end of the year, the smaller goals by my 31st birthday: 22nd of September.	- Lack of appetite in the industry for what I have to offer. - Not enough experience. - Gatekeepers not letting me in. - Bigger forces stealing my idea without involving me. - Loss of support from mentors. - Fear of making the wrong move leading to erratic decisions. - Presenting the idea prematurely. - Getting too attached to one avenue. - Not having the time to commit to the project due to day jobs and the coming baby.	- By using the momentum of the current excitement and support I'm receiving to keep going forward and meeting the right people. - By continuing to study and learn as much as possible about the industry, including: new horizons in VR and audio, new trending VR games, new trending VR educational tools. - By reaching out to potential collaborators. - By keeping sharing the experience in its current form with friends and colleagues in order to maintain personal motivation and engagement. - By continuing to hone my craft in VR design and coding. - By generating new ideas for potential collaborations and revenue streams. - By maintaining solid personal and professional relationships with the people who are supporting me. - By being a nice and hardworking guy.	- My wife (for personal support, and for her marketing knowledge) - Current teachers and staff. - Discord communities. - YouTube Videos. - Access to the Oculus Store. - Unity Learn courses. - Social Media. - Access to a large network of entrepreneurs.	16th of August.

APPENDIX C: TESTING DAY QUESTIONNAIRE

1/5

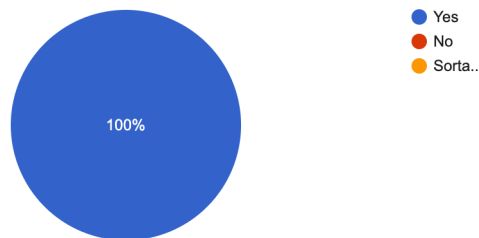
Is this your first ever VR experience?

5 responses



Was it clear what you were supposed to do?

5 responses



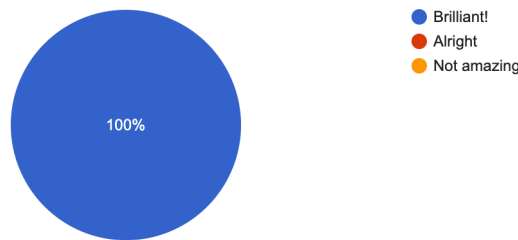
In what way could the instructions be improved?

4 responses

- Maybe idiot proof it a little more cause I need to be instructed like a toddler!
- Perhaps a visual example of what each action/controller does rather than just wording
- Instructions were clear. My ability to follow them was the issue, haha.
- no it was a wonderfully beautiful experience

How did you find the audio experience?

5 responses



Was there something that surprised you?

5 responses

Definitely being able to solo each orchestral section

The whole experience was very new to me

the immersive hall setting was stunning

The standard of the whole experience - visuals and sound - was very high. I went in not knowing what to expect but could see the amount of hard work involved

how wonderful the picture was

What was your favourite bit?

5 responses

The Space room!

Being in the spaces with the players

the music

I think entering that first venue was a moment. Still remembering that first bottle I virtually drank from laying knocked over on the table (how much did I drink?!) Nice little detail

the drinking of the bottles to choose a venue

What was your least favourite bit?

4 responses

It having to finish

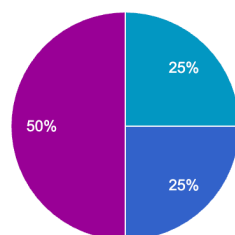
none

Not being able to follow simple instructions

the start

What potential uses do you see for experiences like this?

4 responses



- Education
- Concerts
- Outreach
- Research
- A whole new kind of art/experience
- All of the above, surely. Maybe as a therapeutic too as well.

Would you care to elaborate?

5 responses

The overall composition was incredible! And the added experience of changing the audio with the wine and beer was so cool

The score and sound was very accomplished

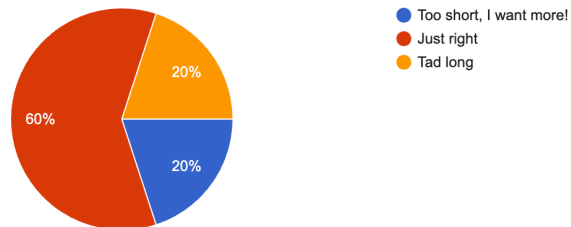
Great implementation of immersive audio techniques - ultra-realistic

Music was top drawer - dynamic, pretty and complete.

so clear and real sounding

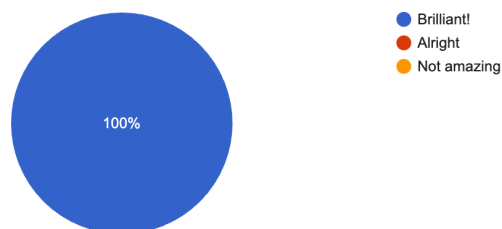
How did you find the length of the experience?

5 responses



How did you find the experience as a whole?

5 responses



Would you care to elaborate?

5 responses

Being my first VR experience I was genuinely in awe, and I came out of the experience literally wanting to cry

Switching between rooms, isolating instruments and taking the potions to get different effects was all very entertaining and informative

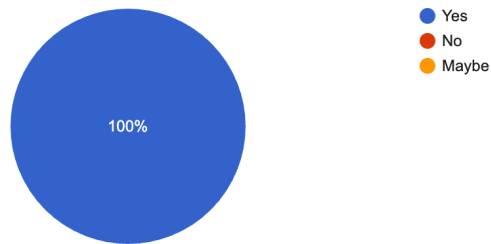
totally and disconcertingly immersive

It was very immersive, interactive, colourful and as mentioned sounded lovely. Each venue combined real and otherworldly elements, which was so nice and atmospheric. Loved the pixel esque musicians.

something everyone should try

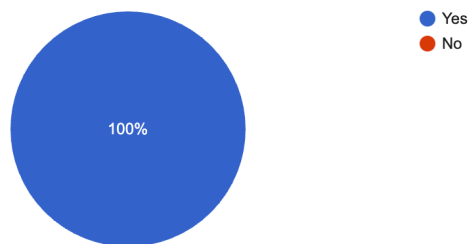
Would you do it again/recommend to a friend?

5 responses



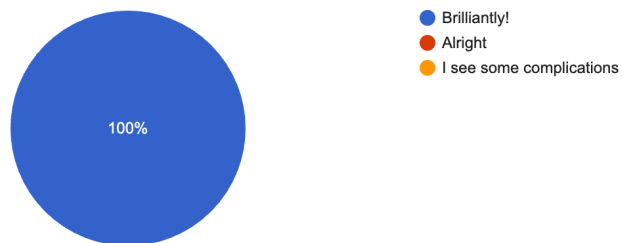
Would you be interested in similar experiences, but with different/well known music?

5 responses



This was made with orchestral music. How do you think it would work with more contemporary genres?

5 responses



Feel free to elaborate

4 responses

I would live to see a grungy band gig in a gritty venue

A very interesting concept for other genres like jazz, folk, blues, small club feel stuff

It can easily work with many genres, with appropriate venues created based on this

any concert

How much would you be willing to pay for a fully produced experience like this?

5 responses

£100

£10

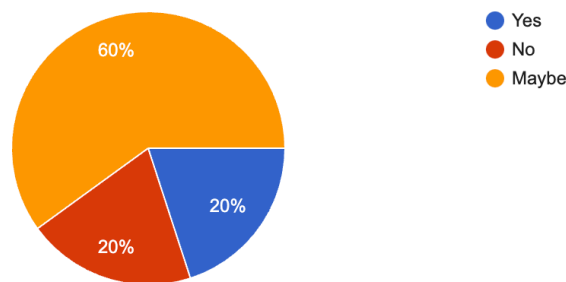
not sure

Not actually sure - i would need to know the running costs. £25 maybe

£30

The headset you wore today cost £299. Could you be tempted to invest in a VR headset after today's experience?

5 responses



Any other observations?

2 responses

Can I just do it again? 🤔

non wonderful

Analysis

The main take-away from the responses is that there seems to be quite a learning curve with the controls during the tutorial section in the beginning. Adding in-game visual demonstrations of where exactly each button is on the controller could help a lot in smoothing this process. Both from the responses and my own observations in the room it seems that once the controls are down and they have picked their first venue, they get fully immersed and have a great experience. One participant, due to time constraints, chose to skip the tutorial altogether, going straight to the concert, and having me explain the controls on the fly. He explained to me that he had a great experience like that, and that it could be worth considering removing that section (although, of course, he wouldn't know what he was missing). How that would work without me in the room to explain the controls is to be discovered, but will be considered.