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Virtually Together: on creating learning spaces for VR production using free and open-source software tools and open standards platforms

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Introduction

This paper reflects on the development and delivery of a visual art elective titled Mixed Reality Production. This unit introduced students to the theory and practice of building virtual and augmented reality projects for application in creative and industry contexts, including the visual arts, digital storytelling, documentary, and journalism. It is structured around the use of free and open-source software tools, and open standards platforms as well as the use of web-based technologies for the authoring and distribution of creative virtual reality (VR) projects. While this studio-based unit was first proposed in 2019, it wasn't taught until 2022 because of the COVID19 pandemic. It ran with both face-to-face and remote classes. The decision to use free and accessible technologies worked well with the remote cohort. This paper draws from the author's first-hand experience of designing and teaching this elective, and reflects on some of the technological, cultural, and pedagogical issues that were considered. It considers how the use of networked virtual technologies and accessible tools can create diverse experiential learning spaces and communities.

As an artist who has been working with virtual three-dimensional spaces since the mid-1980s and with VR for the last four years, it was exciting to develop and teach a research-led unit that focuses on mixed reality. I am fascinated by both the possibilities and problematics of these technologies. For media artists, it is constructive to reflect on the broader social, political, and economic contexts of the tools and platforms that they use for the production and distribution of their creative works. As educators, these issues should be considered in the design of a curriculum, especially decisions around the choice of production tools and distribution platforms. The 'circuit of culture' (Du Gay et al. 1997) is a framework in which a cultural object is viewed from five interlinked positions – production, consumption,

regulation, representation, and identity. This framework is useful in reminding us to consider the complexities around how creative works are produced, distributed, regulated, and consumed. This has been complicated by the emergence of 'software culture' (Manovich 2013, p. 6) and 'platform capitalism' (Srnicek 2017). Manovich suggests that 'software culture' is a new mode of cultural production and consumption that is shaped by digital technologies and software and is distinct from earlier forms of culture. For Srnicek, digital platforms such as social media sites, app stores and ride-sharing apps play an increasingly dominant role in the economy. In introducing the concept of the 'circuit of culture', the canonical example used was the Sony Walkman, but perhaps the Sony Playstation videogame console would have been a more insightful case study for our contemporary software culture – as it was a media ecology where the tools of production, distribution and consumption were all tightly controlled by Sony. Indeed, the games industry has historically been at the forefront of developing techniques for this 'platformatization of cultural production' (Nieborg & Poell 2018). Techniques developed in the 1980s and 1990s include 'the razor and blades approach – selling hardware at a loss and recouping revenue through software sales – and the notion of a walled garden platform ecosystem' (Chia et al. 2020, p. 2), where bought content is tied to a specific platform.

~~Facebook~~ Meta and consumer VR

Consumer VR headsets have utilised many techniques borrowed from videogame consoles to gain market dominance, including subsidised hardware and the use of a 'walled garden' app store. This paper will focus on Meta's Quest headsets (formerly the Oculus Quest) as the computer lab that Mixed Reality Production was taught in contained 20 Oculus Quest VR headsets. Meta is currently the dominant player in this market; the Meta Quest 2 is by far the most successful VR headset released to date. In 2021, Facebook changed its name to Meta to signify a shift in focus to the 'metaverse'. The metaverse can be thought of as a digital version of the real world, where people can interact with each other and with digital objects and environments in a way that is similar to the way they interact in the physical world. Users will be able to access the metaverse through VR and AR devices, such as headsets and smartphones. Egliston and Carter suggest that Meta's actions over the last few years 'reveal a vision for a spatial computing future where its technologies are integrated widely across economy and society … such that society becomes dependent on them to function' (2022, p. 3). To advance this goal, Meta is reported to have invested more than US $10 billion in these technologies in 2021 and 2022. As an artist working with VR this makes the author feel quite ambivalent – on the one hand

Meta is doing a huge amount of research to advance these technologies and is subsidising the cost of consumer hardware; on the other hand Meta (and previously Facebook) has a poor history with regards to data privacy and surveillance capitalism practices (Carter & Egliston 2020) and the diffusion of misinformation (Allcott, Gentzkow & Yu 2019). While Meta has 'first-mover' market advantage and is trying to lock users into its ecosystem, there are other players in the consumer VR industry that might help to diversify the market or at least create a duopoly similar to what currently exists with desktop computers (Apple versus Microsoft) and mobile phones (Apple versus Google). Chinese company ByteDance (parent company of TikTok) bought Chinese VR company PICO in 2021 and released the PICO4 headset in 2022. Apple is also rumoured to be working on some sort of mixed reality headset (MacRumours 2023).

Distribution and gatekeeping of VR content

The primary means of distributing content for the Meta Quest headset is through the Meta Quest Store. As with all online app stores, content is regulated according to a set of content guidelines (for example, https://developer.oculus.com/policy/content-guidelines/) as well as technical guidelines. Many of the technical guidelines are designed to ensure that the experience doesn't make the user feel unwell, which is reasonable given that VR has the capacity to make users feel quite nauseous. Initially the store was highly curated; Meta wanted what they perceived as high-quality experiences on the store. On the page documenting the review process it states, 'we review the content for production value, polish, and general utility or appeal' (Iguchi & Shum 2018). The store was mostly dominated by mainstream commercial game genres – it is likely that Meta needed to sell blades to pay for the razors; Meta takes a 30% cut of apps sold through the Meta Quest Store. For content creators the review process can seem opaque and arbitrary (Skarredghost 2019). For artists making more experimental or non-mainstream content and for those who are not so technically orientated, the review process can be intimidating.

Oculus introduced the App Lab in 2021 as a second tier store with a less stringent review process that allowed developers to 'get an app directly to your community, even if it is early in development, experimental, or aimed at a unique audience' (Oculus Blog 2021). These apps are not listed in the main store and contain a warning that they have not gone through the full review process. Meta takes a 15% cut of App Lab apps. Over the last year, there have been several artworks (for example, *This is Not a Ceremony* (2022) and *On the Morning You Wake* (2022)) that

were first released on the App Lab as part of restricted access programs for major festivals (for these two examples it was the Sundance Film Festival 2022) that have later gone on to be listed in the Meta Quest Store and receive broader distribution.

In the 2000s, there was a sense that emerging Web 2.0 platforms such as YouTube and Soundcloud would facilitate a shift towards a 'participatory culture' (Jenkins 2006) that bypassed traditional cultural gatekeepers and allowed content creators to freely self-publish. More recently, these ideas have been criticised by media scholars who have noted 'the profound unevenness of the relationship between platforms and cultural producers' (Poell, Nieborg & Duffy 2022). Meta controls both the means of consumption (the VR headset) and the means of distribution (the Meta Quest Store). As an example of how this can play out for artists trying to distribute their work via an app store platform, in 2011 Italian artist Paolo Pedercini's game Phone Story (2011) was banned from the iTunes App Store. The work explored the iPhone lifecycle, from the mining of conflict minerals in the Congo, to the treatment of workers at the Foxconn factories that build the iPhone and the planned obsolescence of phones that end up as toxic e-waste that is then recycled in developing nations.

When the author started working with VR in 2019 for their own creative practice, they decided to circumvent the app stores on various VR platforms by working with WebXR to author artworks. WebXR is an API (Application Programming Interface) that enables the creation of immersive, interactive VR and AR experiences using web-based technologies such as JavaScript, HTML and CSS. WebXR based projects do not need to be installed and can be self-hosted – for example, on an artist's own web server. WebXR applications can run on a wide range of devices, including smartphones and VR and AR headsets. If a device has a WebXR capable web browser, then it is capable of viewing WebXR applications. As of late 2022, the Meta Quest platform has two WebXR capable browsers – the Meta Quest Browser developed by Meta and the Wolvic Browser. While WebXR is more constrained in what it is possible to create compared to other 'industry-standard' tools such as Unity, the idea of working within the scope of technical constraints is a recurring one within creative arts pedagogy. This is something that will be expanded upon in the next section.

Thinking about production tools

The unit Mixed Reality Production is designed to work for a diverse cohort of students including visual arts, film production, media production and design

computing students. These students have a broad range of existing technical skills, levels of technical competence and experience in making creative works. There is a huge amount of technical material and skills that could potentially be covered within the context of this unit, but instead it was decided to use a constrained set of relatively simple tools and processes and to instead focus on helping students to make artworks that were more conceptually sophisticated.

A game engine is a software development environment designed for the creation of video games. It provides a framework of tools and technologies that developers can use to create a variety of different types of games that run on different platforms. Most VR experiences such as games or artworks are authored using one of the 'industry-standard' game engines Unity and Unreal Engine. These tools are complex and assume at least some programming literacy. If the class had used one of these game engines, then the teaching of the tool would have dominated the curriculum and not allowed much time for the conceptual development of projects. Instead, students were taught to use the much simpler web-based tools Mozilla Hubs and Mozilla Spoke as the authoring tools for creating VR artworks.

In developing this paper, the author found very little existing research into the teaching of VR production, especially from a creative arts context. Instead, this paper will draw from research in the field of game studies that has been useful in thinking about the choice of production tools. Brendan Keogh has interviewed game developers about their tools and processes. One developer described commercial game engines like Unity as offering too many possibilities that were 'overwhelming' like 'a blank sheet of paper' (Keogh 2022, p. 380). Another developer found 'a sense of empowerment through the explicit limitation of tools, rather than a promise of endless freedom' (Keogh 2022, p. 382). This idea of working within the constraints of tools and materials is very familiar in the visual arts and visual arts education. Keogh writes 'videogame makers do not just work within the realm of what is possible with a tool, or what they are able to do with that tool, but also what is expected for them to do with that tool' (2022, p. 382). Drawing from interviews with VR developers who used Unity, Foxman found that for those who wanted to make non-gaming content that the conventions that Unity used to structure its authoring environment pushed them 'to create content which conformed to popular gaming genres and standards' (2019, p. 1).

Game scholars Chia et al. have compared the game development tools Unity and Twine (2020). While Unity is the dominant ‘industry-standard’ platform, Twine is a free, open-source web-based interactive fiction editor that is similar in complexity to Mozilla Spoke. In the 2010s, Twine was enthusiastically taken up by game-makers who had traditionally sat at the margins of videogame culture, including women, people of colour and queer communities. In contrast to Unity, Twine games are constrained technically, which makes them relatively easy to make. As Chia et al point out, the Twine developer community produced a broad range of games that contested mainstream ‘videogame conventions such as challenge, choice, and graphical fidelity. This includes narratives that deal with disempowerment rather than conquest, and mechanics favouring introspection over agency’ (2020).

The technological scope of the unit

Mozilla Hubs (https://hubs.mozilla.com/) is a free open-source 3D web-based social platform that is built using WebXR. This means that Hubs experiences can be viewed using a mobile or desktop browser, or in a VR headset. Students were able to view their work as they developed it, regardless of whether they had access to a VR headset. Students who were studying remotely were still able to develop and view their projects. On-campus students could view their work in the VR Lab or borrow a VR headset to take home and test their work. When they didn’t have access to a headset, they could still view the work in a mobile or desktop web browser.

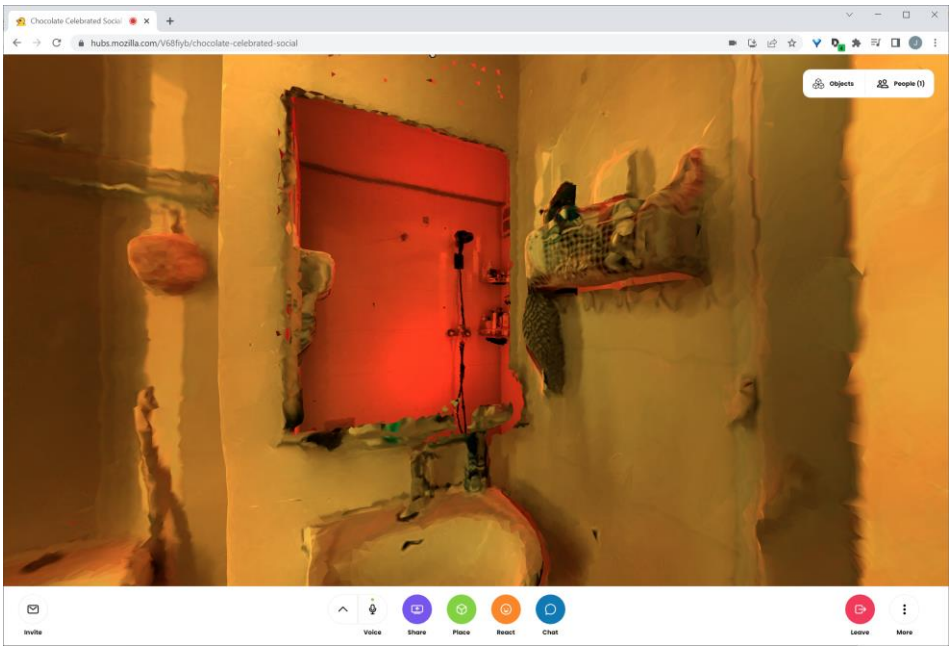

Figure 1: A Hubs scene

Mozilla Spoke (https://hubs.mozilla.com/spoke) is a free open-source web-based tool for authoring 3D scenes that can then be loaded into and viewed in Mozilla Hubs. Using Mozilla Spoke, students were able to assemble 3D models, images, and audio into a Hubs scene. Spoke is an easy-to-use tool that students were able to learn quickly.

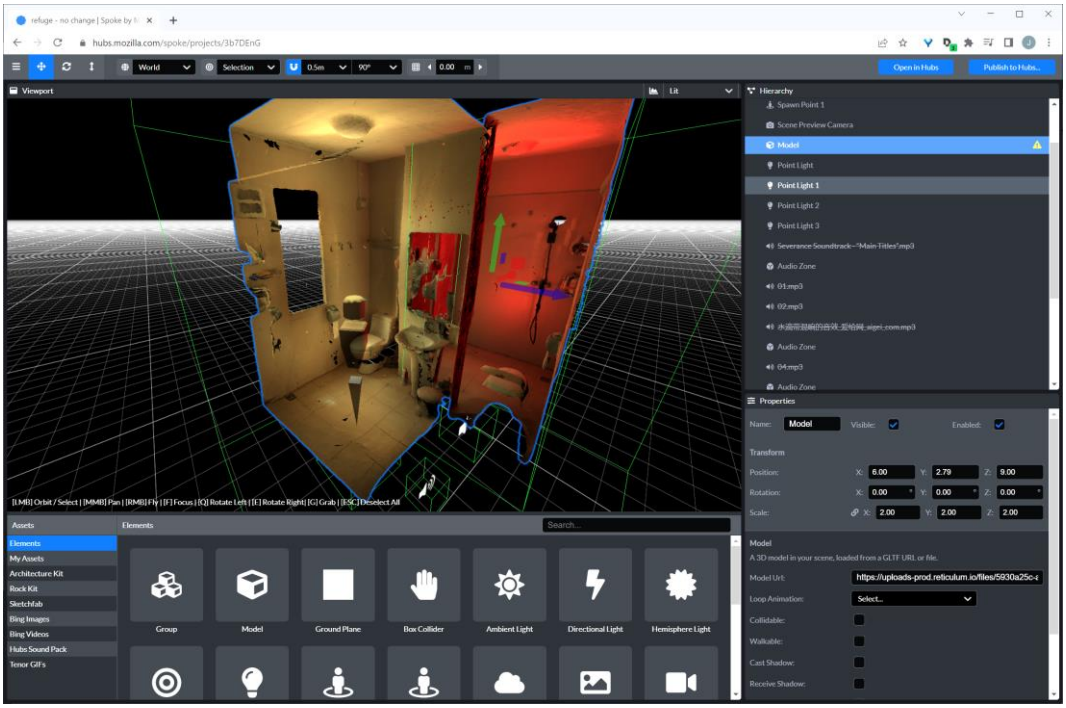

Figure 2: Mozilla Spoke

For the 3D models that were imported into Spoke to generate virtual scenes, students were encouraged to use 3D scanning software, as this is considerably easier than creating 3D models from scratch in 3D modelling software. Phone-based apps like Polycam (https://poly.cam/) and Metascan (https://metascan.ai/) allowed students to create 3D scans of rooms and objects. Some students used the open-source desktop photogrammetry software Meshroom (https://alicevision.org/#meshroom) to create 3D scans from collections of photographs that they took.

Blender (https://www.blender.org/) is a free and open-source 3D modelling and animation software that is complex and can be intimidating. Tutorials deliberately focused on just a small part of its functionality: using Blender to clean up and optimise the 3D models that students scanned. Some students taught themselves more advanced functionality in order to create 3D models from scratch and to assemble more complex 3D content together. Students were also introduced to the

Hubs Blender add-on (https://hubs.mozilla.com/labs/what-is-the-blender-add-on/). This allowed more technically competent students to create Hubs scenes directly in Blender and gave them access to more advanced functionality, for example lightmaps and custom navigation maps. Because Hubs is not designed to make complex interactivity, students were encouraged to create rich soundscapes where multiple sounds were positioned in 3D space. Many of the case studies that were looked at in class used voice-over and this is something that was also encouraged as a way of adding depth to the students' own projects.

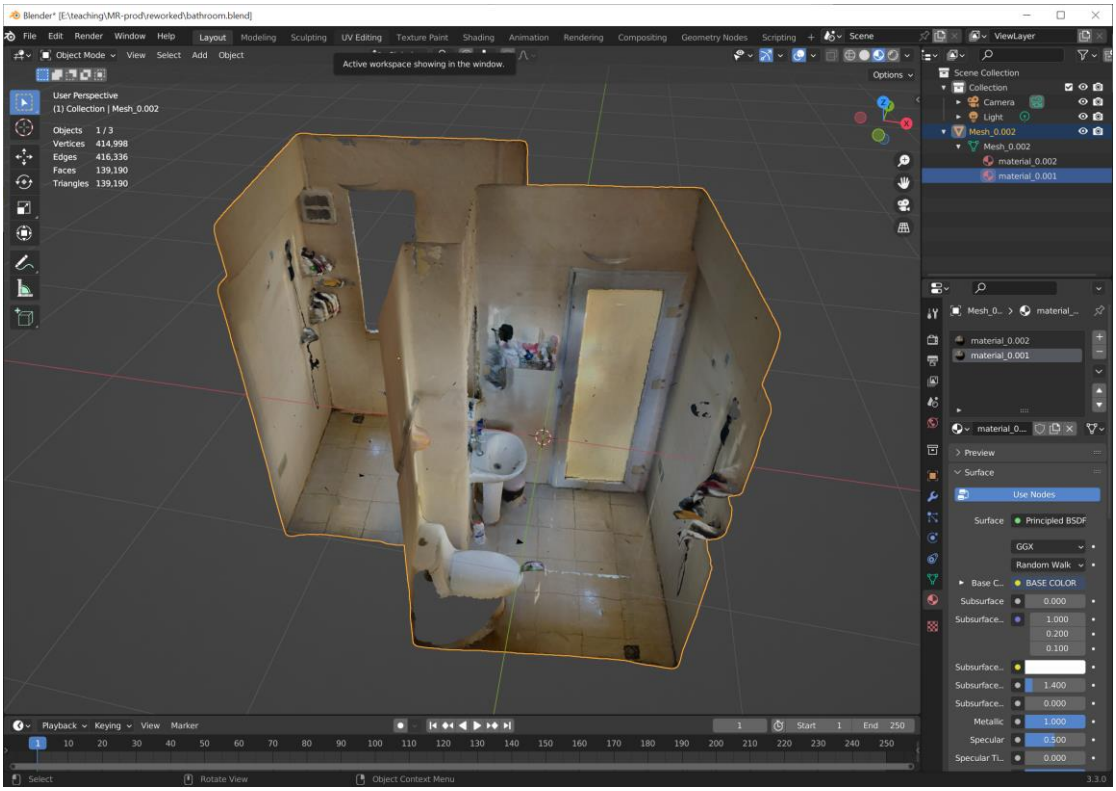

Figure 3: Editing a scanned room in Blender

The tools and workflows around creating real-time virtual spaces in Hubs that have been described above made up one of the two main approaches to content production that were offered to students for Mixed Reality Production. Students were also introduced to shooting and editing 360 video and stereo 180 video. These are more established processes that build on techniques and processes that are familiar to a screen arts student and are not the focus of this paper; however, there are a couple of points that connect to ideas already discussed. In relation to distribution, edited 360/180 video files are standard video files that are rendered in a specific format to work in VR. All VR headsets can access software that will play these video files once they are copied to the headset. This means that it is relatively easy for

students to view these projects in a VR headset. It is also possible to upload the video files to services such as YouTube, where they can be played in the headset using the YouTube app on most VR platforms. In relation to production tools, students used 'industry-standard' editing software Adobe Premiere to edit the video files together. Adobe moved to a subscription-based model in 2013. While students can access this for a cheap annual subscription, it is useful – as an academic who has had ongoing free access to Adobe Creative Cloud for many years – to remember that the standard subscription cost is quite onerous for artists who are not creating commercial work.

Unit structure and assessments

The unit was structured as a weekly three-hour seminar that ran for 13 weeks. Students were introduced to a broad range of creative case studies and were asked to give a short presentation about an existing VR artwork. Students were expected to make two creative projects and to maintain a research blog. Project 1 was around the theme of capturing the essence of a place. Students were introduced to Guy Debord's concept of psychogeography (1958), and the class explored multiple ways that they might capture a space. For Project 2, which was more self-directed, students were introduced to a range of possible themes such as VR as empathy machine, embodiment and the body in VR, audio spaces in VR, and perspective and other ways of seeing. Students were also expected to keep a research blog about their conceptual and project development.

There were some impressive artworks that were created by the students for this unit. All the students had been affected by the pandemic in various ways. Many of the Australian based students were back on campus for the first time in two years, as other international based students, especially those in China, were still experiencing strict lockdowns. As many of us have become more comfortable with sharing incidental elements of the personal in the background of our webcams, it felt that students were more open to sharing quite personal and domestic aspects of their lives. Many of the works created intimate and sometimes quite claustrophobic spaces: from sharing the inside of the bathroom where a student sought refuge from the rest of her family during lockdown (with voice-over fragments describing the positive and negative ways that this affected her state of mind) to a meditation on feeling trapped in a house that was constructed from the student's personal items and artifacts. The strongest works used sound and voice-over in powerful and nuanced ways.

Figure 4: 360 video by Selena Wu 2022

Figure 5: 360 video ‘Sinking into the Afterglow’ by Francis Cai 2022

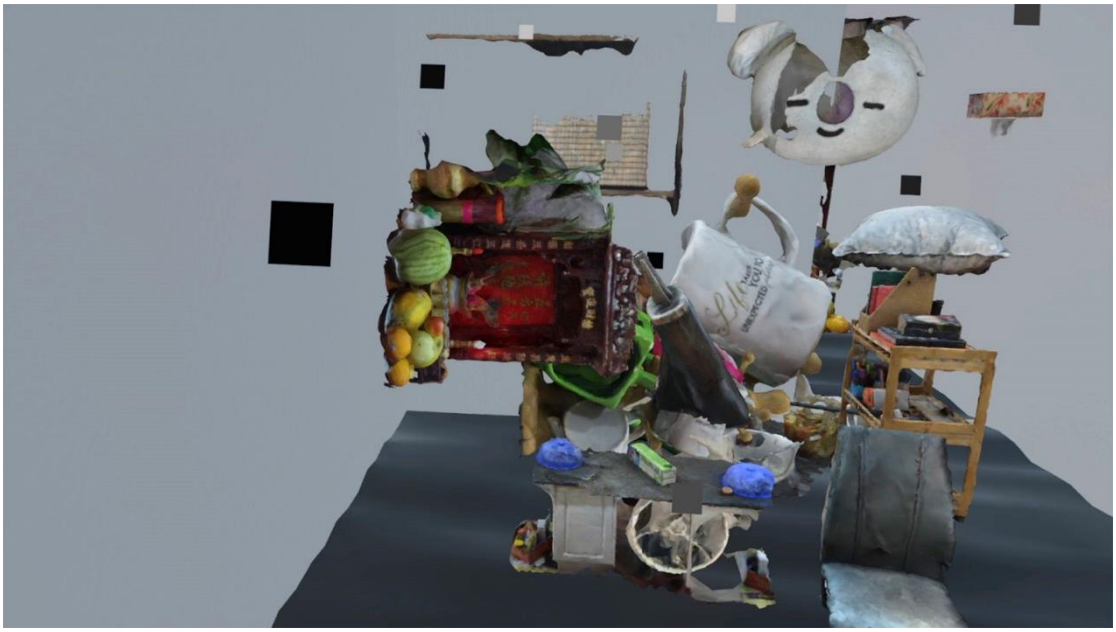

Figure 6: Mozilla Hubs work by Lillian Trieu 2022

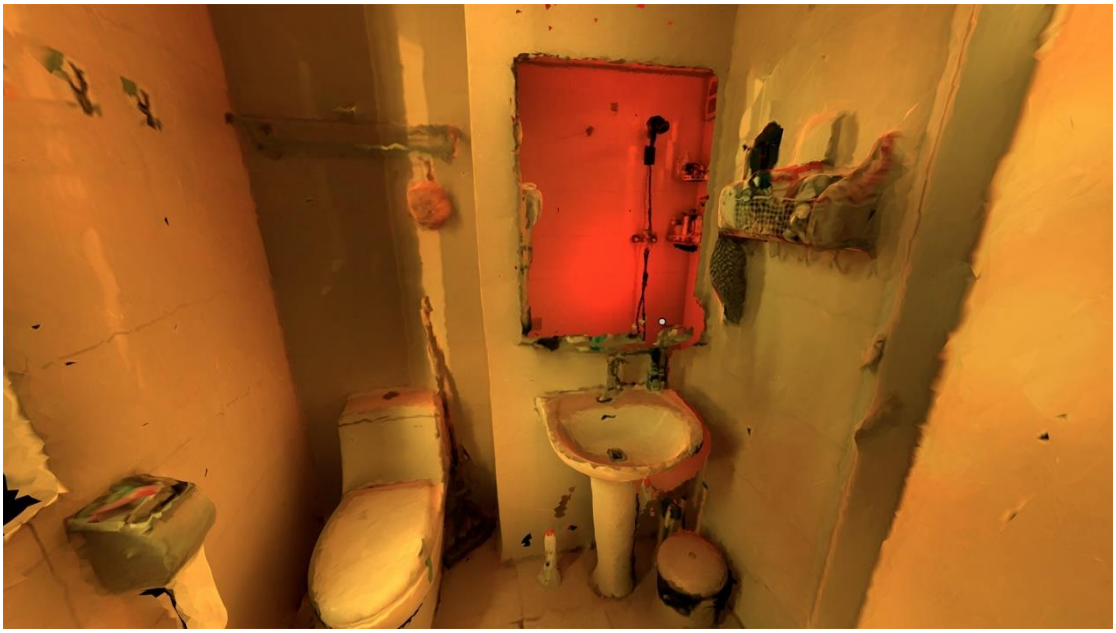

Figure 7: Mozilla Hubs work, ‘Refuge’ by Xue (Kara) Zhang 2022

Technical issues with the VR Lab

The Quest headsets in the VR Lab were set up with Oculus for Business accounts. This meant that the headsets were locked down and centrally managed. These accounts were designed to work with custom enterprise developed apps, so it was not possible to install apps from the Meta Quest Store. This demonstrated a mismatch between the enterprise needs of the university’s ICT support and the pedagogical needs of the unit. ICT had not anticipated the need to install VR

artworks and other case studies to show to students. While it was possible to work around this by running software apps on the attached computers, this added an extra layer of complexity for students to access the works and limited what they could view. The Oculus for Business program was discontinued at the end of 2021 and the headsets were effectively frozen into an older version of the system software. This caused further problems in viewing works that emerged later in the semester. Meta has announced a new Quest for Business program that will be introduced at some stage in 2023, and that might be more suitable for teaching than the Oculus for Business accounts (Oculus VR 2021).

Changes for 2023

There are several changes that the author plans to introduce when the subject is taught again in 2023. Writing this paper has been a valuable process in reflecting on how the course was run in 2022. It will be useful to better articulate the pedagogical approach of the unit to students – for example, around the choice of the production tools that they are using. It will also be useful to discuss with them in more detail some of the broader social and political issues within mixed reality production that have been considered here – for example, around the distribution of artworks via app stores versus web-based distribution.

While Mozilla Hub is a multiuser social space, the class made very little use of this feature in class. It will be useful to encourage students to invite each other into their creative works and even to give short tours of their work in VR.

There were different expectations around groupwork across different student cohorts. The visual art students tended to work on their own whereas the moving image students were much more open to working collaboratively. In the future, groupwork will be encouraged, especially for the second project. Mixed reality production is a complex technical endeavour not dissimilar to filmmaking; working in groups can allow for the realisation of more sophisticated and ambitious projects.

A lot of technical materials created for this unit, such as written tutorials and video tutorials, currently sit on a Canvas site that is only accessible to enrolled students. Classes also made much use of informal teaching materials that sit in the public domain on sites such as YouTube. In the spirit of the conference theme of public pedagogy (ACUADS 2022) some of the tutorial materials that will be generated in

2023 will be made available to a broader public on sites such as YouTube in acknowledgement that much learning happens outside institutional contexts.

Conclusion

Mixed reality is still a relatively new medium, especially within a visual arts education context. This paper has sought to map out some of the issues that were thought through when teaching a mixed reality production class for the first time. While teaching students in person was enjoyable after years of pandemic lockdown, having to also consider the needs of remote students was useful in shaping the overall pedagogical scope of the class and the overall approach towards the selection of the tools that were taught.

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