An Inquiry into Designing Metaverses

Daniel Murray BSc

Submitted in partial fulfilment for the degree MSc Serious Games and Virtual Reality

School of Simulation and Visualisation
The Glasgow School of Art

May 2021

Abstract

In its simplest form, a metaverse is a set of interconnected virtual worlds that have some shared properties. Metaverses have the potential to change game design and the way we interact with the internet; however, they also pose significant challenges.

This dissertation is an attempt to define metaverses and to describe the possible virtual worlds from which they are made. We will then discuss the main considerations that go into designing a metaverse. These include the way in which virtual worlds are structured within the metaverse, the communities they will create, the issues around moderating them, their economies, and some of the reasons why metaverses should be made.

Finally, this study looks at potential projects that could evolve into the first stages of a metaverse. The aim is to provide an introduction and inquiry for anyone interested in the creation of virtual worlds and metaverses.

Table of Contents

List of Figures

Glossary

Term	Definition
3D model	Three-dimensional representation of an object as a digital file.
3DSMax	A 3D modelling program by Autodesk Inc
Client	A programme used by a person to access a digital service.
Game engine	An underlying block of code used as a foundation when creating a game or virtual world.
Game Jam	A type of game design competition where participants will attempt to make a complete game in short time frame.
glTF	A file format standard for 3D models.
HTTP	A standard used to send data over the internet.
JavaScript	A programming language used on the web.
Library	A collection of code fragments
Photon	A common multiplayer package available for Unity.
Server	A programme used to provide a service on the internet.
UI / UX	Acronym for computer-user interfaces.
Unity	A popular game engine developed by Unity Technologies.
Virtual reality	A means of accessing a virtual world using a stereoscopic headset and other motion controls.
VRML / X3D	An XML-based 3D model standard.
WASD	A common game control scheme where the W, A, S, and D keys are used to move the player's avatar.
Web 1.0 / 2.0 / 3.0	Recognised technical and cultural eras in the development of the World Wide Web.
Web3D Consortium	A non-profit standards group for 3D web content.
WebGL	A technical standard allowing websites to utilise the graphics hardware of a computer.
Webmaster	A person who maintains a website.
XML & HTML	Markup languages used to define structured data, often for internet transmission.
Zine	A short informal magazine.

Acknowledgements

Special thanks to Dr. Daniel Livingstone for supervising this project.

Special thanks to Penny Iremonger for her work copy editing this text.

Thanks to Michelle Selwa and InvisibleUp for discussing their projects and virtual worlds in general with me. Additionally, thanks to members of Neocities.org,[1] and the wider web revival community[2] for their inspiration and encouragement.

Thanks to the Glasgow School of Art staff and student halls staff for their work both before and during the covid pandemic. I would also like to thank the other students of the Simulation and Visualisation School for their good conversations and thoughts.

Finally, thanks to family and friends who put up with me over the months this dissertation was written and provided feedback and support along the way.

[1] https://neocities.org/browse

[2] https://melonking.net/thoughts/webrevival.html

Declaration of Originality

Name: Daniel Murray

Course/Programme: Serious Games and Virtual Reality

Title of Work: An Inquiry into Designing Metaverses

I confirm that all this work is my own except where indicated, and that I have:

- Clearly referenced/listed all sources as appropriate
- Referenced and added inverted commas to all quoted text (from books, journals, web, etc.)
- Given the sources of all pictures, sound, data, etc. that are not my own
- Not made any use of the report(s) or essay(s) of any other student(s) either past or present, or lifted extracts from web pages without appropriate referencing
- Not sought or used the help of any external professional agencies for the work
- Acknowledged in appropriate places any help that I have received from others (e.g., fellow students, technicians, statisticians, external sources)
- Complied with any other plagiarism criteria specified in the Course Handbook
- I understand that any false claim for this work will be penalised in accordance with the GSA regulations

Signature:

Date: 6th May 2021

1 Introduction

When I first heard the word ‘metaverse’ in May 2020, the term had a Google Trends index of 7; in April 2021 its index was 100, when compared to the previous seventeen years of search history.[3] This spike in popularity highlights the need for further study on this subject.

The aim of this dissertation is to question some of the assumptions made about metaverses and offer guidance to those interested in creating them.

In its simplest form, a metaverse is a set of interconnected virtual worlds that have some shared properties. This interconnection changes the way these worlds are designed. Virtual worlds within the metaverse become components of a greater experience, which offers players and developers the potential to achieve things that would not be possible in isolated projects.

The tools for creating 3D virtual worlds and spaces are more available than ever before. 3D modelling programmes, such as Blender, and professional grade game engines, like Unity, are freely available to everyone. Tutorials and documentation to learn how to use these tools are also freely accessible. Support communities and chats can be easily found to help any new world builder get started.

It is reasonable to assume that with these new forms of accessibility we will see new kinds of people developing virtual worlds, with new ideas and expectations concerning how their worlds will evolve. Metaverses may not only be designed by traditional game developers but also by interested individuals.

Over the course of this dissertation, we will look at these aspects in greater detail; by understanding the elements that make up a metaverse we can begin to comprehend how such elements can be designed and how they can successfully fit together. Moreover, virtual worlds can have unique personal meanings for their players. We will explore what these meanings could be and how they influence the creation and culture of a metaverse.

---

[3] https://trends.google.co.uk/trends/explore?date=2004-05-04%202021-05-05&q=%2Fm%2F054_cb

1.1 Audience

This dissertation should be of interest to developers of large-scale metaverses, individuals interested in metaverses, and those who are drawn towards virtual worlds. This is not a technical discussion although some technologies will be mentioned. Some familiarity with virtual worlds, the internet, and the World Wide Web is assumed.

1.2 Reason for this Dissertation

Work on this dissertation was inspired by a number of questions posed while I was working on a web-based game for a college game jam. The game implemented its own multiplayer system, and after seeing this system in operation I found myself asking:

- If you can sync players between one world, why not multiple worlds?
- If you can sync players between multiple worlds, why not multiple games?
- If you can sync players between multiple games, why not games using multiple game engines?
- If you can sync players, why not sync everything?

This dissertation is an attempt to answer these questions; if the answers to all of them is ‘yes’, then a metaverse is the type of system that might exist. The web-based game that led to these questions will also be discussed in greater detail in chapter 5.

2 Literature Review

This literature review will explore the basic definitions of Virtual Worlds and Metaverses. It will then discuss the ideas supporting these definitions, asking questions such as what is player-generated content and what is the player? The purpose of this is to establish a clear understanding of the definitions and ideas surrounding metaverses. Once these definitions are clear we can start to construct the framework around which this dissertation will unfold.

2.1 What are Virtual Worlds?

Virtual worlds include both game worlds and digital social worlds. They are online and connected multiplayer spaces. Richard Bartle is regarded as having co-created the first virtual world with the Multi-User-Dungeon (MUD) programme in 1978 (Bartle, 2009). It is worth noting that both the definition and example of the first virtual world were created by Bartle himself.

Figure 1 shows yay.tim.org:5440 as seen in 2021, a MUD-type world that has been operating since 1990.[4] The room being explored is an example of player-generated content.

[4] TinyTIM, website and history, http://www.tim.org/

MUD-type programmes, as seen in figure 1, are entirely text based and have little or no visual element. The mid-1990s saw the arrival of 3D virtual worlds, such as *Worlds Chat* (1995) by Worlds Inc. These were primarily social worlds, where players would meet and chat. Figure 2 shows *Sony SAPIRi*, an early 3D virtual world; note that it still has a heavy dependency on 2D and text-based UI elements. Other more gaming-focused virtual worlds, such as *Ultima Online*, arrived in 1997. Gaming-focused worlds offer more clearly defined objectives for players.

Figure 2 shows Sony SAPARi, an early 3D virtual world.[5]

Text-based worlds could be modified by players quite easily, however most early 3D worlds had limited capacity for players to modify them. This started to change with games like *Minecraft* in 2009, where it is possible for the player to modify every aspect of the world. This was made feasible by the game's use of a voxel-based world structure, although Minecraft does not use voxels to render the world to the player.[6] The simplicity of *Minecraft*'s world may also have contributed to its success, creating a distinct divide between its world and the real world, affording players a degree of self-reinvention. Since the arrival of modern Virtual Reality (VR) headsets, there have been several virtual worlds aimed at VR users. These worlds include *VRChat* released in 2014 and *JanusVR*, also released in 2014, which we will explore later in a case study.

[5] For further reading see Sony SAPARi, https://kokoscript.com/sapari.html

[6] Voxel Wikipedia entry, https://en.wikipedia.org/wiki/Voxel#Computer_games

A virtual world is a simulated world. It is different from an imaginary world because it must have some sort of clear definition. This differentiation is described by Bartle in the following way: the real world, “that which is”; an imaginary world, “that which isn’t”; and a virtual world, “that which isn’t, having the form or effect of that which is” (Bartle, 2020).

Bartle also describes a set of requirements for what he calls a true virtual world. First, the world must have defined physics. Physics refer to the way the world functions and the way the player can interact with the world. They should not be confused with the physics of matter. Second, the player must be represented by an individual character in the world. This character does not need to be humanoid, however, it does need to be unique to the player. Third, the world must be live action, in other words, it cannot be turn based. Fourth, the world must be multiplayer; multiple players must be able to inhabit the world. Fifth, the world must be persistent. This means that changes made by a player must remain after the player has left the world. There is some implication here that the world allows the player to modify it. Finally, the world must not be reality; if it is reality then it is not virtual (Bartle, 2004).

An alternative, although related, delimitation is that a world is a perspective. Two possible definitions for world are “someone’s individual way of life or range of experience” and “a particular area of activity” (Chambers, 1999). A person’s world is viewed from within the bounds of their human life. That person might have a pet bird; the bird’s world shares a similar location to the person, however the world it views is quite different. This is relevant because it is helpful to understand that a virtual world is not a virtual location. As we will see later in the section on connecting worlds, a virtual world can take the form of a simulated perspective. A virtual world can be the sum of the locations, objects, interactions, and experiences that a particular player has.

2.1.1 Player-hosted Worlds versus Developer-hosted Worlds

There is a difference between player-hosted virtual worlds, or small servers, and developer-hosted virtual worlds, or big servers. *Minecraft* is a multitude of many small player-hosted servers, some interconnected, some not. A large game like *World of Warcraft* is developer-hosted. These two kinds of worlds can have very different traits. *Minecraft* servers can be player modified, in other words, the players can edit the game’s code to add their own new features. This is called ‘modding’ and may have contributed to *Minecraft*’s success. Figure 3 shows a *Minecraft* world which, at first sight, appears

standard but which in reality contains modded elements that have been blended seamlessly into the world. In contrast to this, according to the *World of Warcraft* terms of service, players attempting this form of modding could be banned from the game and face further legal action (Blizzard, 2020).

Some large virtual worlds, such as *Roblox*, simulate the ability to modify the underlying game code by providing a modifiable or scriptable layer to the world. This layer is typically bound by rules defined by the developer, unlike a truly modifiable game which in theory has no limits. *OpenSim* is an example of a platform which attempts to remove these limits. Players can modify the underlying code as much as they wish; the risk they face is modifying the code to a point where it's no longer compatible with other parts of *OpenSim*.

Figure 3 shows players in the game Minecraft, which uses a player-modified server. The statue in the right background is not native to the game; these players have all cooperated to modify their games in a compatible way to allow this extra content to exist.

2.1.2 Worlds with Purpose

In many cases a virtual world will have a single purpose, such as to race cars in a racing game or explore dungeons in an adventure game. *Minecraft* offers potential for more open-ended experiences; however, these experiences still lean towards having a purpose. One example of this is the *Minecraft* server *Magister Craft.*[7] This server provides a virtual world that is a simulation of ancient Rome. Interactions with the world are conducted

[7] https://www.magistercraft.com/

through classical Latin. The world's purpose is to teach the language and history of Roman civilisation, a purpose that is quite different to the original design of *Minecraft*.
The idea of purpose could be considered a contrast between a virtual world and a metaverse. A virtual world has a purpose, a metaverse has many purposes.

2.2 What is a Metaverse?

"The metaverse is a synchronously shared and persistent three dimensional context where players, embodied as characters, navigate immersivity and interact through direct presence." (Shah, 2021) This is a definition provided by Duality Robotics, a small studio which receives funding from Epic Games. While concise, this definition does not appear to differ much from the definition of a virtual world. This suggests that there is some confusion as to what exactly a metaverse is.

The original term 'metaverse' was coined in Neal Stephenson's 1992 science-fiction novel, *Snow Crash*. In the book he describes a virtual world that resembles a complete analogy of reality. His metaverse is a vast city street that spans a planet. On this street players can do anything that they can also perform in reality. Stephenson's metaverse is accessed using a virtual reality headset and is owned by a single corporation. Land within the metaverse is finite and although it's a virtual world it enforces the same scarcity-based economy we experience in the real world (Stephenson, 1992).

Another definition of a metaverse is a network comprising many interconnected virtual worlds (Dionisio, Burns & Gilbert, 2013). This could also be called a virtual multiverse. The nature of the connection could vary greatly. In most examples of this type of metaverse, the player remains the most consistent element. The player will usually be able to travel between these worlds while retaining their physical appearance and many of their abilities to interact with the world.

Second Life, an actively developed virtual world, could be considered a proto-metaverse or a 'MetaWorld' a term defined by the *IEEE Metaverse Standards*, although the website listing those standards is no longer active. This can be taken in contrast to a platform like *OpenSim*, which is described as a 'MetaGalaxy' due to the fact it is a set of virtual worlds or MetaWorlds following a standard set by a single authority (IEEE Metaverse Standards, 2011).

Second Life operates on a similar model to what is described in *Snow Crash.* Linden Research, its primary developer, sells virtual land. Ownership of land is required in order to modify the landscape and build structures. Players can also create and trade virtual objects, potentially making a profit in the process. They do this using Linden Dollars, a virtual currency that can be purchased from Linden Labs at a market exchange rate (Castronova, 2001).

Figure 4 shows a view of Second Life in 2021. In the centre is the player avatar looking out over a communal plaza. The conversation window open on the right is a multiplayer chat.

Second Life's structure follows the traditional approach taken by proto-metaverse platforms. It has a single game engine with fixed standards. Worlds made on this platform must be constructed within the bounds of this engine's standards, which enforces some consistency between them. Figure 4 shows a view of *Second Life;* while the fidelity and complexity of the world has advanced, its interface and design does not differ greatly from the early 3D world shown in figure 2.

Tim Sweeney, the CEO of Epic Games, recently raised one billion US dollars to fund their vision of a metaverse. In an interview for *GamesBeat,* Sweeney describes a metaverse as "a place where you can actually drive the cars around and feel the experience of it. You can use a Corvette in the game." (Takahashi, 2021) Although he does not clarify what driving a Corvette has to do with connected virtual worlds, or how a metaverse would

change the experience of driving a car in a virtual world, it's possible he is referring to a metaverse as an advanced virtual reality interface. This highlights a potential confusion between a metaverse and the means of accessing a metaverse. While *Snow Crash* described a metaverse that was accessed via a virtual reality headset, the metaverse itself existed separately from its means of access.

We are left with the question, how does a metaverse differ from a virtual world? A loose analogy may be the difference between a city and a town. There is a myth that traditionally a city has a cathedral and a town does not; however, most modern city definitions are based on population count (Rosenberg, 2020). This is a difference between provision of services and size. Is a virtual world with many players but no services a metaverse? Is a virtual world with many services but few players a metaverse? As mentioned in the virtual worlds section, the answer may come from the diversity of both. A metaverse should offer many different services or purposes, and a wide range of communities.

There may be some confusion between a combination of many worlds defining a metaverse versus many purposes defining a metaverse. If each world provides a different purpose, then, by proxy, the collection of worlds definition is the same as the *Snow Crash* definition. The key difference is that defining a metaverse as a set of connected worlds is a technical perspective, while a metaverse defined by many services is an experiential perspective.

With this in mind, a purpose is a world, a perspective, a service, and a community all in one. I will conclude this section by stipulating that a metaverse should at least meet the following requirements:

- There must be multiple purposes.
- Players must be able to create their own purposes.
- Some or all content must be accessible for all purposes.
- There must be multiple overlapping standards for purposes to follow.

2.3 What are Players?

Players are the real people inhabiting and interacting with a virtual world. There are a number of steps that make up the connection between a player's human self and their presence in the virtual world: the human, the computer, the programme, their avatar, and the world.

There is no guarantee that a player is a single person. A player account accessing a virtual world could be accessed and operated by many people. A player and an individual may be quite different things (Dibbell, 1994).

All these steps play a role in the player's sense of 'embodiment' within the virtual world. Embodiment is their sense of presence, their physicality within the virtual world. That sense is the product of the player physically interacting with their computer, the physics that define the virtual world, the visual appearance of their avatar, and the player's own personality creating a story for their avatar.
There is a feedback loop between the player and their avatar – the player defines the avatar but the avatar also defines the player. This is discussed in *The Social Life of Avatars* where Frank Biocca describes a physical body, a virtual body, and a phenomenal body, the phenomenal body being the individual's mental representation of their body (T.L. Taylor, 2002). In their argument, the phenomenal body is warped away from the physical by the existence of the virtual.

This description could be considered a little biased towards physical representation. A person's identity can exist quite separately from any physical form. Biocca's phenomenal body could be regarded instead as inner identity. This identity is formed from all personal experiences in reality, from media and dreams to virtual worlds. A person is both actively constructing their identity as well as being constructed unwillingly by events in their life.

This raises interesting philosophical debates. If a person's identity is formed by the sum of their life experiences, including virtual experiences, is it right for the developer of a virtual world to dictate what those experiences should be? In the physical world most societies have laws, but those laws can be broken. Virtual worlds have laws too, however, unlike reality, the virtual laws are built into the structure of the world. Laws can become physics. Should players have the right to break laws in a virtual world? (Dibbell, 1994)

There is also a distinction between players and developers. Traditionally, a developer is a person who makes the game or virtual world, and a player is a person who accesses that game. Increasingly the line between these two has become blurred. A player may become a partial developer by creating player-generated content. Equally, many developers play the games they are developing, which poses the question, is all content player-generated? The

simplest definition is that a developer is the person who defines the structure of the world, while a player is operating within the bounds of that structure.

2.4 What is Player-generated Content?

One feature of both virtual worlds and metaverses is player-generated content. This refers to the player's ability to create content within a virtual world. This content can be anything including, but not limited to, text, 3D models, sounds, images, or gameplay. Player-generated content is not supplied by the developer of the virtual world; however, the developer may provide tools to help the player create this content.

To understand player-generated content, let's look at the World Wide Web, the most ubiquitous space of player-generated content available. In the context of the web the term 'user' is more common in place of player. However, player will be used here for the sake of consistency with virtual worlds. Primarily, the web is an interconnected platform for sharing information and for many people it has become a platform of self-definition. Tim Berners-Lee, the creator of the Hypertext Transfer Protocol (HTTP) on which the web operates, defined it as "a collaborative medium, a place where we all meet and read and write" (Berners-Lee, 2005).

Silver's article for *Forbes Magazine*, "What is Web 3.0?" is a discussion about the future development of the web. It describes a common narrative: the early web was difficult to use and only a small number of developers could create content on it; the web today offers more freedom, as players can upload content and become creators; the web tomorrow will be nothing but player-created content (Silver, 2020). Figure 5 illustrates Silver's vision of the web today, with freely uploaded content; however, this content must conform to a predefined structure which the player does not have the freedom to modify.

Olia Lialina presents an alternative and inverse history in her article "From My to Me". She talks about freeform early web development, where players created their own websites from scratch. She goes on to describe a partial loss of freedom as player uploads became standardised by structures in the social media age. Finally, she theorises that the Web 3.0 era could be characterised by a total loss of player freedom, being populated only by content provided within developer-made structures (Lialina, 2021). Figure 6 shows a modern interpretation of Lialina's freeform early web, which is in direct contrast to figure 5. There is a distinct conceptual and asthetic diffrence between these two web spaces.

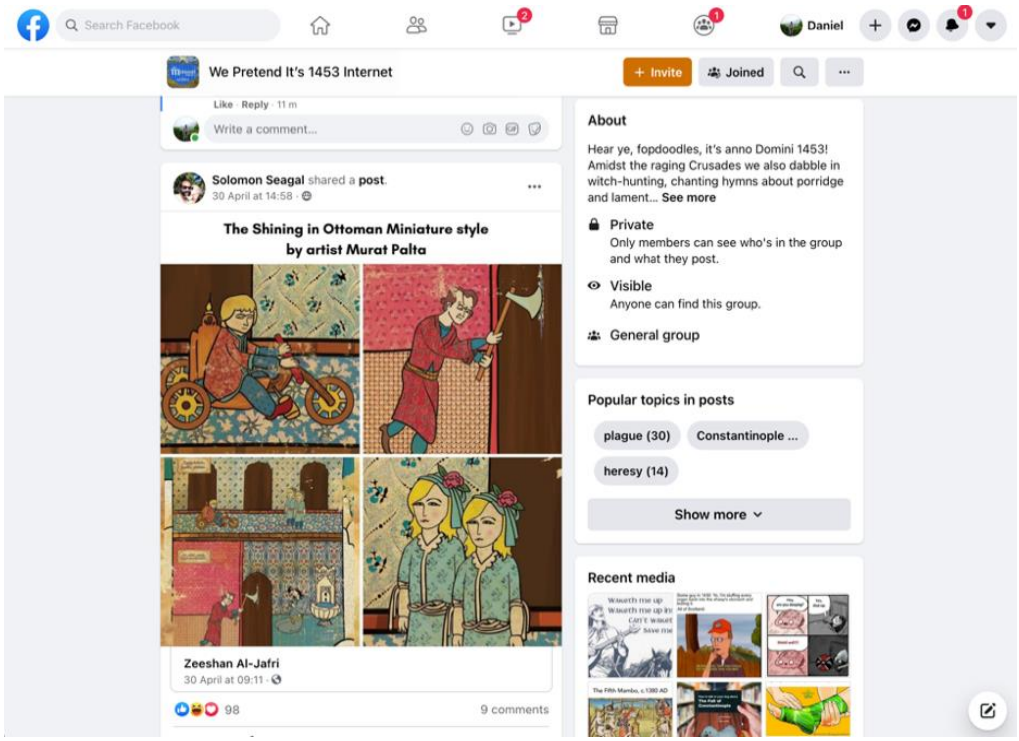

Figure 5 shows the Facebook group "We Pretend It's 1453 Internet". There is a focus on content provided by many people, while the structure is provided by Facebook. The culture of this group can only be expressed through members' content, which contrasts with the structure.

Figure 6 shows dokodemo.neocities.org in April 2021, a modern website made in the fashion of an old site. This site is a combination of its content and its structure, both working together to create its aesthetic. This is the work of one individual without formal web development training.

The truth between these two histories may be somewhere in the middle; however, the comparison raises key questions about player-generated content. How ‘player-generated’ is that content? How regulated is it? How regulated are the tools used to make it? What does creating, uploading, and sharing of player content mean to the players and the platform? How do the players associate themselves with this content in this scenario? How does the website or structure that holds this content also define the content and the player?

In the case of the web today, there is significant backlash against platform-regulated player content. This can be because of privacy, or for political or other reasons. Perhaps more interesting to our discussion is the backlash against platform-provided structures. A structure, in this case, is the way the content is held and displayed for the player. Facebook is an example of a rigid structure where the player has little ability to modify the appearance or interaction of the Facebook site. The player can only control what content is on display, within Facebook’s rigid structure.

2.5 What is Structure?

In the previous section, Facebook was described as a structure. When discussing virtual worlds, we are primarily discussing the structure of the virtual world. If a virtual world had no structure, it would be an imaginary world. There is a distinction between content and structure.

Structure goes beyond the visible parts of a virtual world; it refers to the world’s interface but also the underlying technology that supports it. Structure allows the virtual world to exist. Structure also defines the final experience that world will provide and the kind of communities that will form within it. For example, if the underlying technology of a social network does not allow you to upload images, that changes the nature of the experience.

Rather than focus on technical structures alone, let’s take a moment to consider a real-world physical structure. An art gallery is analogous to a virtual world — it’s a definable structure that primarily exists to be populated with player-generated content, the artworks. In his collection of essays *Inside the white cube*, published in 1976, Brian O’Doherty questioned the idea of the ‘white cube’ art gallery. This is the concept that an art gallery should be a neutral and somewhat standardised space. This is beneficial to the gallery as it means artworks can be moved between different rooms and displayed in a standard way.

O’Doherty’s argument was that this process is not neutral; isolating the artworks from the gallery’s structure influences and defines what kind of art will be created and promoted (O’Doherty, 1999). O’Doherty attempted to challenge this idea by creating works that included their structure. Figure 7 is an example of this, showing an artwork that is within the room, but which is also the room. The artwork can only fully function when viewed within this structure.

Figure 7 shows Borromini's Corridor, Rope Drawing # 103 from 1995 by Brian O’Doherty, at the Crawford Art Gallery, Cork.

In computer interface design we see a similar philosophy. Modern websites tend to be white cubes. The prevailing view is that the interface should be invisible, leaving only the content. Even the word ‘interface’ is often replaced with ‘experience’; UI is changed to UX (Lialina, 2012). However, like O’Doherty’s white cube gallery, such invisibility influences the content — it is not invisible. This is illustrated in figure 8 where both structures shown have an implied consumer focus. The structure has been made invisible to showcase the content: without structure the content becomes a defined product.

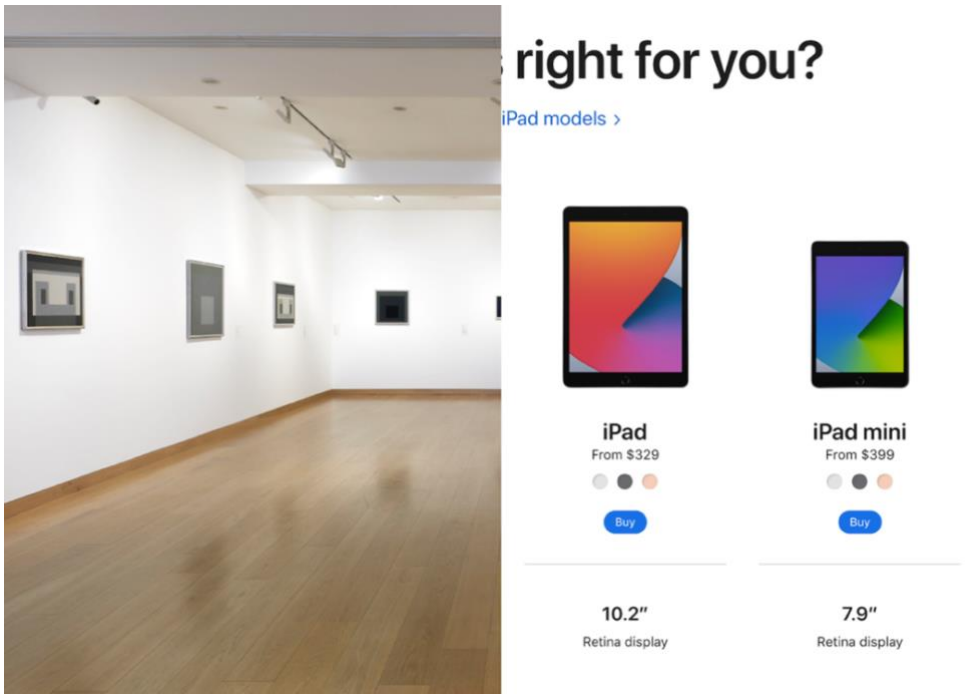

Figure 8 shows a white cube gallery on the left and a white cube UI on the right from apple.ie.

The article “Beyond the White Cube”, by Oliver Jameson, brings O’Doherty’s ideas up to date and applies them to virtual worlds. Jameson talks about virtual worlds as artworks, and as tools for the artist to gain control of the structure within which their art exists (Jameson, 2020). An important conclusion is that the virtual world becomes the artwork, the structure becomes the content. The two cannot be separately defined. We will see later that this has implications for any economy in a virtual world. This also suggests that for a virtual world to be fully realised the player must feel they have as much ownership over the structure of the world as the content within it.

2.6 Case Study – The Web as a Virtual World, JanusVR

3D worlds on the web are not a new idea. VRML, an XML markup language like HTML, was launched in 1995. It evolved into the modern format X3D in 2004 and is still being developed and maintained by the Web3D Consortium (Web3D Consortium, 2020).

There is a leap that must be taken from a 3D world to a virtual world. As defined above, a virtual world must be a persistent multiplayer space. *Second Life* and other proto-metaverse platforms were discussed as examples of these kinds of spaces.

An alternative approach was taken in 2014 by a company called JanusVR. Their approach was to generate 3D spaces out of existing websites. An attempt to convert the Reddit

homepage into a 3D space is shown in figure 9; although the space is 3D, the content shown on the walls is still 2D. JanusVR created their own markup language similar to X3D, called Janus Markup Language (JML), for describing these spaces. The company would then convert existing websites into JML using their own behind-the-scenes process. Webmasters could also perform this process themselves, creating custom 3D versions of their website that could be supplied to JanusVR.

Figure 9 shows a view of JanusVR. The room represents the Reddit website. © JanusVR

JanusVR also provided multiplayer services. Players exploring the platform could see and interact with other players. Modifications those players made to the world would remain in place after they had disconnected. In this sense it was a true virtual world and a form of proto-metaverse.

In late 2019 JanusVR was dissolved. James Mccrae, the CEO, wrote in an open letter on Reddit (later deleted) to the community about the dissolvement. He described high operating costs maintaining its servers as the primary reason, despite the service having “hundreds of thousands of players” (Mccrae, 2019).
The project was open sourced and is currently being operated as a community project called JanusXR. The ongoing fate of this project is unclear.

Taken at face value, the issue here was that a single company could not afford to maintain the technology needed to support a metaverse on its own. The source of their content was third party or player generated. However, the structure connecting that content was a centralised financial business. It was that business which failed.

3 Considerations for Metaverses

This chapter will highlight some of the key points and issues related to metaverses and metaverse creation. It will conclude with some thoughts about the reasons and justifications for creating or using a metaverse.

3.1 Cultures in Cyberspace

The culture of a community exists in a feedback loop with the structure that supports it. Here we will briefly discuss the relevance of culture within a virtual world. The goals, interests, and commonalities that communities share will come from how they can interact with the platform on which their community exists. The study of online communities is well established in both virtual worlds and social media (T.L. Taylor, 2002) (Tierney, 2013).

When considering the kind of culture that is being formed by a virtual world or metaverse, the key question is, what does this platform mean to the people who comprise this culture? “The Third Place” is a term coined in 1982 by Raymon Oldenburg. He defined the home as the first place and an office or worksite as the second place. The third place is a social space, a place where work is not performed and there is general equality between the people who use the space (Oldenburg & Brissett, 1982). A third place encourages individual self-expression, but there is no focus on any one individual. Some examples of third places in society are pubs, churches, and parks, however, many virtual worlds, social networks, and online chat rooms also act as third places for people.

When considering the culture that will evolve within a space, it is necessary to take into account how that space will be used. The structure needed to support a virtual third place will be different to the structure required for a virtual workplace and, likewise, the culture that structure produces will be different.

An important question this raises is how does a virtual world define the players within it? How is a person influenced by that world? The answer is different for every virtual world. In a metaverse, a player has the potential to become anything offered by each of its worlds, as well as by any number of subsets or remixes of those worlds. However, in many cases a player will also want to define what others become by making their own worlds and having other players visit them.

3.1.1 Moderation

Moderation is the art of guiding a community culture to grow in such a way that is healthy and beneficial to all its members. The job of a moderator is the same as the host of a party; the moderator ensures maximum enjoyment with minimal visible effort. One simple example of moderation in *Snow Crash* is avatar size. Who or what stops a player from making their avatar ridiculously large? Is that something that should or could be regulated? An obvious answer might be that it should; however, suggesting such a thing assumes a great deal about the design of the worlds and the communities within them. A metaverse is not bound by real world physics, so what right does anyone have to say you can't be a giant?

There are two kinds of moderation that take place in any online community: hard moderation and soft moderation. Hard moderation is the formal rule structure and management of the community. An example of this is when a person does something that is explicitly forbidden within the community and is punished for it by a moderator. Soft moderation is enforced by subtle community cues; for example, in a community dedicated to gardening, a person would be unlikely to suddenly start talking about airplane engine design. Soft moderation is enforced by the assumed norms and expectations of the community as a whole.

Hard moderation is expensive in time and effort and can also be inaccurate. If it's badly enforced, hard moderation could punish those who do not deserve it and miss those who do. In any community, it's preferable to favour soft moderation over hard moderation. However, soft moderation can be elusive; it relies on trust within the community. Often the harder the moderation, the less trust will be present, and the weaker the impact of soft moderation.

Cultures have expectations around behaviour in certain spaces. These expectations are formed as the culture evolves and discovers its own values and faults. In a new metaverse this culture has not yet formed. How can the expectations of a culture be moderated if they don't yet exist? It's very possible that for the culture of a metaverse to grow it must be allowed to make mistakes. In this case, the purpose of moderation is to watch and learn from those mistakes, then decide how to moderate in the future.

3.1.2 Accessibility

If a metaverse becomes a ubiquitous utility, what rights do the population have to gain access? Typically, these kinds of rights are enforced by city or government regulations on public spaces and businesses.

Imagine a metaverse has become very popular, with many businesses and services available. A local government deems that disabled people, such as the blind, must be able to access the metaverse. If the metaverse is totally decentralised, would individuals with limited technical world-creation experience be responsible for making their spaces meet regulations?

Additionally, what computing resources would be required to access the metaverse? Would a person have the right to access a computer in order to access the metaverse? Who would be responsible for supplying that computer? The metaverse designers would be responsible for creating the metaverse's structure. Such a structure may heavily impact on the kind of computing resources needed to run it and, therefore, its accessibility.

If a metaverse does become a ubiquitous public utility this topic will rapidly become an issue for everyone involved. It's possible these questions cannot be answered until the problem itself is present; nevertheless, this whole area warrants further study.

3.1.3 Populations Lost in Space

It is worth mentioning that while virtual worlds can be big, metaverses can be exponentially bigger if they combine many large virtual worlds. The size of the metaverse can grow, however, the number of players within it will always be limited by the number of humans willing to use the metaverse. This poses a significant design issue.

The larger the metaverse grows, in terms of physical space, the more dispersed players will become. This tends to result in large numbers of players gathering in particular areas, leaving the rest of the metaverse abandoned. Maintaining abandoned spaces can be costly for developers, but it also damages the community. This happens because a player exploring a world that they perceive as empty may conclude that the world is unpopular because it is flawed or unappealing.

This same issue occurs when developers attempt to release new platforms or versions of their products. Imagine a popular virtual world that is running on older technology. A developer might wish to release a new virtual world to replace it. In most cases, this will result in a split, with some players staying on the old world, while others leave for the new world. This split reduces the population count and leaves both the old and new worlds feeling more abandoned.

3.2 Structure and Size

This section explores some of the issues related to how technology or structure needs to be considered when designing a metaverse.

In the JanusVR case study we saw that while a metaverse platform can be popular and technically possible, operating costs can be prohibitive. Creating a platform that's easy and cheap enough to develop and operate is vital to a metaverse's success.

When approaching size, we have to assume that the metaverse can and will grow indefinitely, in terms of the player-content generated within the metaverse, as well as the complexity of that content.

Growth occurs in two forms: as a volume of content and as a temporal evolution. This temporal evolution takes the form of player technical and cultural expectations. Put in more practical words, in year one a player might be very happy with certain technical or graphical limitations. However, ten years later those same limitations may have become totally unacceptable.

When designing the structure of a metaverse, it must not only be able to handle an infinite amount of content expansion at the time of its creation, but also an infinite expansion of player expectations over time.

In practice, infinite expansion is not possible. There will always be technical limits to what a system can handle. Managing the balance between those limits and the player's expectations is one of the key factors in creating a metaverse.

The web is a good example of a relatively infinitely expandable system. It is not known if the World Wide Web will ever become obsolete. As new technologies and expectations

appear they can be added to the web. This addition is possible because the web is highly modular and decentralised. However, this decentralisation also leaves the web at risk of being inconsistent in its design.

This consistency takes the form of visual styles, player interactions, technology standards, and physics. It is typically the case that the more consistency is enforced by the metaverse designer, the more rigid and less modular the metaverses structure will become. This leads to a possible dissonance between the designer's vision of the metaverse and the infinitely scalable structure required to make a metaverse.

There are some key takeaways from this speculation, the main one being a metaverse cannot depend on any single service or server and will need to be made up of a large number of independent services, with redundancy and overlap between them.

3.3 Worlds within the Metaverse

How do worlds within a metaverse interconnect? Are they physically co-related or is the metaverse a sequence of disassociated worlds? There are several approaches and combinations possible.

3.3.1 Mono World

This is mentioned briefly to acknowledge its possibility. A mono-world metaverse has a single unbroken world. It is similar to our experience of reality. All players and content exist within this single world, which has consistent physics and interaction rules. The mono-world metaverse is indistinguishable from a very large virtual world.

Sections of the mono world may function like puddle worlds, where an area or district may have distinct owners and physics. The structure of a mono-world metaverse makes modular design difficult, although such a metaverse is the closest to what is described in *Snow Crash*.

In practice this approach is unlikely to be successful as it does not scale well, and all player interaction is heavily dependent on the developer. That dependency forces up costs for the developer and also limits a player's sense of ownership of the space. This limitation also hurts the developer as they are forced to regulate and moderate all content because they are responsible for it.

3.3.2 Puddle Worlds

My definition of a puddle world is based on C.S. Lewis's book *The Magician's Nephew* (Lewis, 1955). This describes a world where many disconnected worlds can be accessed by jumping into puddles or portals. These worlds appear to share many similarities, and beings and objects can travel between them; however, they are quite separate. The space that connects these worlds is depicted in figure 10; in the case of Lewis's book there is only one connecting world, however in a metaverse there may be many.

Figure 10 shows the illustration section from the cover of The Magician's Nephew. It features the world that connects all worlds, depicted as puddles in a forest. The characters are being pulled out of one of these worlds. © 1970 Macmillan Publishing Company

This is the most common form of a linked virtual world. It can be equated to the idea of levels in traditional video games. *Metaplace*, a virtual world's platform, implemented this approach as an early metaverse design (Koster, 2013) and, today, *Roblox* and others use it.

Each puddle may have somewhat different physics. One might be dedicated to racing and contain a racetrack with cars. Another puddle may be more socially focused and offer many mini-games or other social entertainment.

Puddles, in these cases, are connected by a number of potentially shared properties. They are typically accessed through the same client so movement between them has low friction. The player tends to keep the same avatar in each puddle although the abilities of that avatar may change. Other services, like friend lists or chat, may be consistent across all puddles. In a metaverse that has an economy, money or items may be transferred or used in different puddles.

In player-generated worlds, the player is often only able to modify and create inside puddles they own or where they have received special permission to work. Players visiting puddles which they do not own may have limited interactions. This creates a separation between the creator and the viewer of a puddle.

In some situations, puddles may be non-persistent or single player, while still being a part of the metaverse structure. In this case, when a player enters the puddle they will be in their own personal copy of that puddle and will not perceive the actions of other players.

3.3.3 Leaf Worlds

Leaf worlds are puddle worlds with the capacity to inherit properties from a root or upper-puddle world. This could be considered a treelike-metaverse structure where the core of the metaverse branches out into puddle worlds, and those puddle worlds branch out into smaller worlds.

An example of this would be a world dedicated to racing. A player may wish to make a leaf world that would inherit all the cars and racing physics from a root world, but provide its own racetrack. Players visiting the leaf world might share their racing stats with the root world while racing in the leaf world.

In order to maintain compatibility with their root world, leaf worlds must conform to a set of rules defined by the root world. Such conformity, and the additional content provided by the root world, are the main differences between leaf worlds and puddle worlds.

A leaf world can be considered a first step towards a glass world. The base world and the leaf world both act as glass layers.

3.3.4 Glass Worlds

Glass worlds are a single world made up of many transparent ‘layers’ or sets of content. The glass world only exists within the player’s client. The player displays the layers they wish to see, one on top of another, similar to the way in which augmented reality displays virtual content over the real world. The virtual world, in this case, exists only in the player’s client and is made up of people and objects pulled out of many worlds, all existing simultaneously.

An analogy of this can be seen in animation slides. In traditional animation you have many parts of a character drawn on transparent film, and each glass sheet of film can be stacked and moved to form a whole character. I am unaware of any active or past implementations of this type of world connecting in a virtual world; however, it is quite developed in the field of augmented reality.

The player uses a client which can subscribe to or download layers of content provided by developers. These layers can be moved around and organised by the player into a cohesive world. The player may then send these layers back to the metaverse for others to access and modify. In this sense, the player’s client can be regarded as a puddle world itself. The player can freely modify the world within their client in any way they wish and have full ownership of their experience.

Maintaining compatibility between the layers is the primary challenge to this approach. For example, a developer may wish to provide a glass world with a building for the player. The player may want to fit that building into a city supplied by another developer. To accomplish this, it would be helpful if both developers used a standard size and coordinate system within their layers. This agreed system might suggest that players are a particular size, so buildings should be proportional to that size. Developers might also wish to agree to standardised city layouts, fitting their buildings into an agreed grid or street plan.

As with puddle worlds, we would see some shared properties. All clients may access the same chat systems or economies, regardless of the layers they are accessing. Alternatively, properties could be bound to layers. A glass world may contain its own economy and the player could access multiple economies within their client by accessing multiple layers. Likewise, multiple chat systems, multiplayer systems, and world physics may co-exist, depending on the player’s glass world selection.

3.4 Content of the Metaverse

In this section we will look in more depth at the idea of content within the metaverse, which can be developer or player generated. It represents everything that exists within the structure of the metaverse and, in some cases, parts of the structure itself.

3.4.1 Scarcity

Virtual worlds do not have the same form of limited matter as we experience in reality. An object in a virtual world can be duplicated infinitely, with very little cost. This is in direct contrast to reality. For example, if you want to duplicate a car in reality, think of the cost and expense of that process.

There is, of course, some cost involved in the virtual world; for example, that duplicated car takes up a small amount of memory, which must be stored on a computer somewhere. However, the difference is size. There is no fair comparison between the physical production of a car and the data storage used to describe a virtual car. Equally, there is no fair comparison between the design labour of a real car and the design of a virtual one.

Objects that exist within a virtual world or metaverse are quite independent from our concept of a real object. In many cases, the situation is even more extreme, for example, an object in a virtual world may not be a copy, but a partial copy. That object might share assets or components with many other objects, just as a plane and a car might share the same metal textures. This is a further departure from the idea of a distinct physical object.

Even when that object is entirely made up of unique components not shared with any other object, it still relies on the world's underlying structure. It cannot exist alone and still be a usable dynamic object with all the interactions it has in the virtual world.

3.4.2 Production

As mentioned earlier, there is a design labour that goes into creating the first instance of a virtual object. Modelling work, texturing, scripting, and audio all take a significant amount of labour. Labour is a quantifiable real-world asset that has a value.

The key question is how does that value relate to the object's presence within the virtual world? In economics this is a question concerning the exchange between real value and nominal value. There is a tendency in virtual-world design to consider virtual objects as

financial resources. An object is made; therefore, it has value and, as such, it should cost something to acquire. However, as discussed in the section on scarcity above, this is not necessarily the most natural approach for a virtual world.

If scarcity is not an issue then nominal value becomes very hard to calculate. If a person spends ten hours creating an object, but that object is reused a near-infinite number of times, then the ten hours of initial work are nearly irrelevant to the object's use or impact. In this case, it's impossible to quantify what that object's real value means to its original creator.

The flip side of this argument is that because every object has near-infinite potential to impact the virtual world, everyone who participates in the virtual world, including the object's creator, has near-infinite potential to benefit from the impact of that object. The value of the object, therefore, comes from the scope of its existence.

An established idea in economics is that incentives are a key factor in economic success (Smith, 1776). Thus, the question that arises is what is the incentive for a person to create an object within the metaverse? Profit, praise, status, and self-expression are all potential answers.

More practically, this is a question that can only be answered by the culture that exists within the metaverse and by the structure that defines it.

3.4.3 Real-World Economy

There are two key reasons a developer will try and tie their metaverse into real-world economies. In this section we will look at both and conclude with some questions.

Firstly, the developer can earn a profit from the virtual world by converting real-world currency into virtual assets. Those assets could be purely cosmetic, or they could be intrinsic parts of the virtual world's gameplay. In social virtual worlds this practice is generally accepted and considered a key part of the virtual world's structure. As mentioned in an earlier chapter, *Second Life*, allows players to purchase Linden Dollars, which can be used to buy virtual land or assets from other players. Conversely, in competitive multiplayer games this practice is nicknamed pay-to-win and is deeply frowned upon by

the gaming community. In 2017, Electronic Arts had to issue a statement claiming their game *UFC 3* was not pay-to-win after a public outcry (Ruppert, 2017).

Secondly, the developer might use real-world currency to regulate virtual assets. Charging a real-world currency for a virtual asset potentially gives that asset a nominal value related to the currency. This means the developer of the virtual world is not fully tasked with maintaining their own economy. They can piggyback on the stability of a real economy to manage their own virtual economy. The developer can charge a large amount for a rare virtual item, thus ensuring that the item remains rare even though, technically, it can be infinitely replicated. This does not just apply to developer-made content but also to player-generated content. If the virtual world supports player to player trading of assets, you will very likely see players buying and selling these assets in the real world.

How necessary is this process? A virtual world does not need an internal economy to fit the definition of a virtual world. A developer does, however, need income to support a large service like a metaverse, but only if the structure of that metaverse is designed in such a way that it requires a large developer. In economics this could be referred to as the rent cost. The developer can decide the rent of a virtual world by designing it in a way that reduces or raises the cost of its operation.

Knowing that a virtual world does not need an economy, by definition, and that the cost of maintaining the virtual world could be very low if the structure allowed, it is valid to ask the question: does a metaverse need an economy?

Such a question may be beyond the scope of this dissertation. From a game-design perspective, it is widely considered that players benefit from being able to trade and work for objects within a virtual world (Ruggles, Wadley & Gibbs, 2005).

However, it could also be argued that while an economy may be necessary, a financial economy may not. An economy of creativity, where players trade ideas and compete to produce more elaborate or popular spaces within the metaverse, may be quite successful. There is a cultural debate here. Typically, financially successful cultural artefacts are considered more legitimate or mainstream than non-financial ones (Fiske, 1992).

3.4.4 Crypto-technologies and NTFs

When this dissertation was in its early stages, I did not believe there would be a viable way to enforce scarcity-based object ownership in decentralised virtual worlds. Since then, NFTs (Non-Fungible Tokens) have become hugely popular and may offer one path to decentralised virtual ownership.

Crypto technologies are a decentralised form of data storage and transmission. They use the near-unlimited nature of digital space to simulate scarcity. They do this by filling up that space with many copies of the data they wish to reference. This takes a large amount of processing, allowing the data to become scarce based on the physical cost of computing power. This process means that no central authority is needed to regulate the data, yet it is very reliable because so many copies of it can be cross-referenced (Zheng *et al.*, 2018).

There are numerous issues related to crypto technologies and many solutions proposed to those issues, one of the most pertinent being scalability. As more data is stored within the crypto system, that data must be copied and cross-referenced each time it is accessed or modified. The computing power required to maintain the crypto data expands indefinitely (Zheng *et al.*, 2018).

When discussing metaverses it's easy to suggest that crypto technologies are the solution to scarcity of objects, and it is possible that such a suggestion is correct. Currently, there are a number of virtual worlds offering crypto-based land ownership, including *Decentraland* and *Cryptovoxels*, with an estimated market value of millions of US dollars (Howcroft, 2021).

However, it is worth repeating, as discussed earlier, that financial value does not define a metaverse. Enforcement of scarcity is not a metaverse requirement. Crypto technologies offer a solution to something that does not need to be solved, and so an overfocus on these technologies can be misleading when designing a metaverse.

3.4.5 Concept – Living Content

Living content is a concept about how data within a metaverse could be shared and replicated. This is intended to complement the glass-world approach to connecting worlds, although it could be used with any other.

There are many established asset stores, such as the Unity Marketplace. These stores allow people to create and share models, scripts, textures, and sounds between different projects. It could be argued that a group of virtual worlds created in Unity, all using the same set of shared assets from the Unity Marketplace, is a kind of very loose metaverse due to the worlds' common components. Within a true metaverse there would almost certainly be some analogy of the Unity Marketplace, a system of sharing assets between connected virtual worlds. However, in a metaverse, assets do not need to be static.

A metaverse is a living space and, as such, shared content within it can also be living. In most cases, a virtual object has a number of components: its model, its textures, its scripts, and the data that describes what its state is in the world. That data may be its location or its size. It could also be more specific information, for example, regarding a virtual person, their health or their mood. Most asset stores work by copying the models, the textures, and the scripts into a programme's structure, then creating data within the programme. In a metaverse there is no need to copy this information. Each virtual world is already connected to the metaverse, so it can access all these things from the network. This means that the data describing a virtual object's state is also accessible.

This suggests a potential shift in the approach to world design within metaverses. Rather than developing a world out of static objects, worlds could be constructed out of dynamic living objects that change, based on what is happening to them in other worlds. For example, one world could get the live location data of virtual characters from another world and render those characters into its own streets, instantly populating them. A proxy effect of this would be encouraging compatibility of street layouts and object sizes. Having common standards would make integrating live data much easier.

There is also the potential here for collective processing. In this situation, complex calculations could be distributed across many virtual worlds. For example, if there are a hundred virtual worlds, and each generates the data for one simulated citizen living their life, that data can be combined and each of those hundred worlds can benefit from one hundred complexly simulated citizens.

What this potentially does is provide an artistic and economic incentive to make your virtual world a part of a metaverse. The metaverse can provide a structure which allows vast and complex worlds to be created from the combination of many other worlds. An

individual with very little skill could use this data to create spaces which they could never have made outside the metaverse. Additionally, access to this data could save developers huge amounts of production time. In this situation, the metaverse would be defined by an economy of abundance rather than an economy of scarcity.

3.5 Reasons for a Metaverse

Something that has not been previously discussed in much detail is the purpose of a metaverse. What can a player do in a metaverse? Why would a person interact with a metaverse rather than with another digital platform, like a video game or social media site?

In section 3.4.3, it was suggested that the economy of a metaverse was its own content. Freely shared content in the metaverse would allow participants to create things which they would never have been able to create on their own. For example, an individual working alone can build a house, but a community of individuals can build a city. This feedback loop of creation may be the most unique and powerful feature of a metaverse. All content could be freely available to be remixed and reused, including objects, music, scripts, and animations.

There is also a social aspect to a metaverse. Tim Sweeney believes that hanging out with friends may be the single most important feature of a metaverse (Takahashi, 2021). While socialising will be a large part of the metaverse experience, it is competing with both social media and real life, which puts it at a disadvantage due to the added friction of accessing a complex simulated 3D world. Perhaps a stronger community aspect is the exposure a metaverse can offer. An individual can create a small virtual world, which on its own would not afford much appeal; however, within the context of a metaverse and all the features a metaverse can offer, this small virtual world could become a far more popular world.

A metaverse can also leverage the unique aspects of being a digital world; such worlds can simulate complex theories that are outside our normal experience. A metaverse could possess multiple realities. A situation that occurs in the metaverse could be simulated with many possible outcomes, with the player moving between those outcomes. Additionally, a metaverse could implement a form of time travel, where the player could move backwards through past events. Both scenarios could be made possible through structural choices, such as logging data that flows through the metaverse, although the volume of that data

could be very large. It is possible that the more a metaverse embraces its abilities in the realm of fantasy, rather than limiting itself to resembleing our reality, the more interesting it could become for players.

This departure from reality also gives a metaverse the potential to act as a bridge between real-world cultures. The TV show *Star Trek*, originally conceived by Gene Roddenberry, depicts a vast and diverse universe. The Federation within this universe is an organisation of many worlds who have overcome the limits of material need and instead focus their energies on discovery and creation. *Star Trek* can also be seen as an analogy for our own world, where we explore the interactions and challenges our societies face. A metaverse provides a platform where groups of people can work together to build new worlds, learn about existing worlds, and discover the diverse cultures that create those worlds. Like *Star Trek*, a metaverse can provide a means to explore ourselves and what we, as a species, hope to become.

4 Indie Worlds on the Web

This chapter will look briefly at several projects under development on the web today. The purpose of this is not to focus on projects aiming to become metaverses but, instead, to focus on worlds which have the potential to become parts of a freeform web-based metaverse. These projects are all from independent developers in order to make the point that a metaverse may arise from many such independent works rather than any one large organisation.

4.1 Exploration Interfaces

Some projects are interested in creating worlds, while others are interested in connecting those worlds. This section briefly considers an alternative form of connecting worlds that might prove more immersive for a player.

4.1.1 Netgardens Online

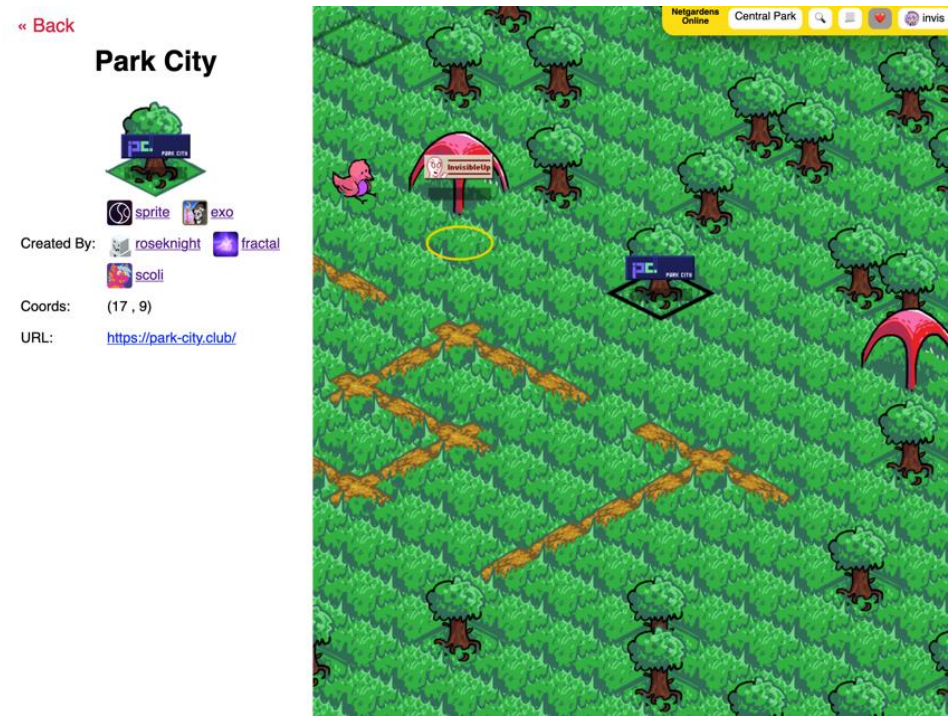

Figure 11 shows Netgardens Online, an interface where websites are represented by tiles.

Netgardens Online is a project currently being developed to create a visual landscape of websites.[8] In *Netgardens*, each site can claim a tile and decorate it as they wish (see figure 11). The tiles use an isometric perspective and can be combined to produce larger designs.

[8] *Netgradens Online*, https://netgardens.online/

Clicking a tile can provide information about who worked on the site and how to access it (see figure 12), along with additional controls allowing a visitor to claim new tiles or explore existing ones. Visitors to the *Netgardens* can explore sites as if they were physical locations. They can also search by 'creator', which links together and encourages site-design collaboration.

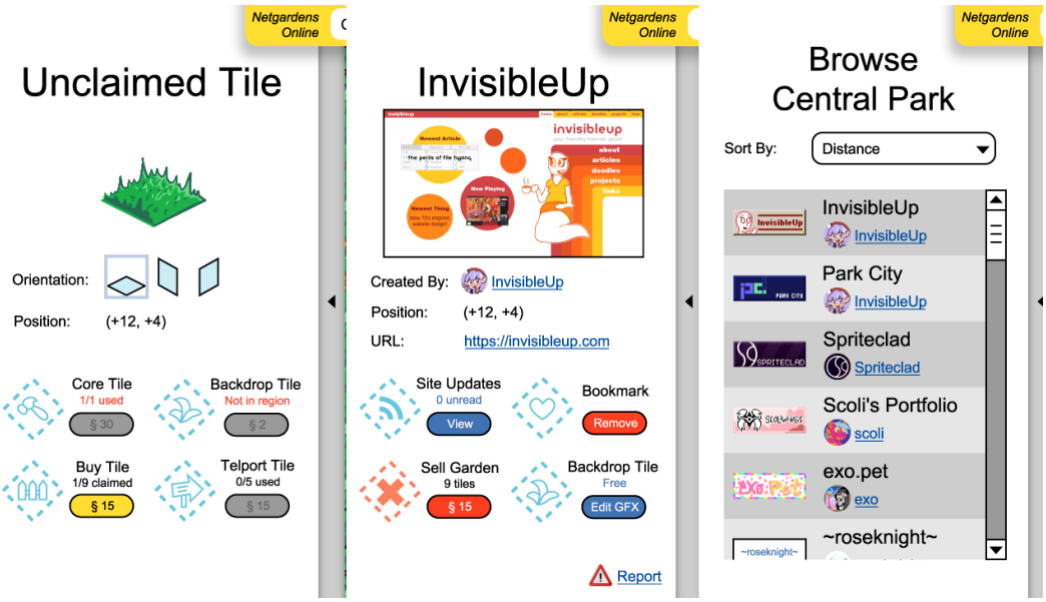

Figure 12 shows a selection of Netgardens Online's different user interfaces.

Different areas of the *Netgardens* may have different atmospheres, climates, and associations. In practice, this means a website dedicated to spooky things might be placed in a dark gothic part of the *Netgardens*. Visitors exploring this area of the garden will already have some idea of the kind of sites they will find there.

In a brief interview with the project's lead, InvisibleUp, they expressed a desire to "Recreate that experience of walking down the street, but on the internet". They see the *Netgardens* as a kind of third place of web exploration. However, when asked about their views on 3D worlds versus 2D websites they expressed concerns about accessibility, stating "[3D worlds are] a lot harder to navigate and properly present information in".

4.2 Virtual Galleries

There are a number of artists and arts groups creating virtual gallery spaces. These spaces tend to focus on the player's experience rather than any set goals, like a traditional game does. The art world has a culture of collaboration which makes these projects well suited to exist in some form of metaverse-like system.

4.2.1 Entrance or Exit

Entrance or Exit is a project to create a series of 2D and 3D art exhibitions on the web.[9] The project's creator, Michelle Selwa, hopes the spaces will encourage new kinds of art making, and help foster and build a community around the gallery spaces. Each gallery can be accessed as a multiplayer world, simulating the experience of viewing art in a public space with others around you. Figure 13 offers a view of one of these spaces; note the total departure from the traditional 'white cube' approach to gallery design.

Figure 13 shows an empty virtual gallery space prior to an imminent exhibition.

In a web conversation Michelle describes her gallery as an extension of exploring the web: "... maybe my virtual gallery would be just another rest stop where you can discover other artists!" This could be seen as directly opposing the idea of a virtual world as an all-encompassing programme.

---

[9] *Entrance or Exit*, https://entranceorexit.net/

4.2.2 VideoGame Reader: The Game – TXTreader #3

Figure 14 shows a view of the TXTreader #3 virtual exhibition exploring video games. Accessible for free on the web.

Created to complement the third instalment of the *TXTreader*, a group zine project by TXTbooks (an independent publishing group), this virtual exhibition celebrates video games and what they mean to players, which is the subject of the zine collection.[10] The project was initially conceived as a real-life exhibition but was pushed into being a virtual show by the coronavirus pandemic. The project was created as part of the 2021 *Printed Matter's Virtual Art Book Fair*.

Figure 14 shows the player's view when they arrive in the virtual world. There is a building on the right which contains the zines that the player can read. Surrounding the building is a dense collection of video-game, pop-culture icons. The structure of this world is intended to invoke an idea, and to propel the player's thoughts towards the content the world is promoting, and the discussion that content wishes to have. By doing this the world becomes a new expression of the subject it is attempting to discuss.

[10] *TXTreader*, https://www.txtbooks.us/special-projects/

4.3 Further Notes on Indie Worlds

Projects like this are partly made possible by the ubiquity of free 3D modelling tools and game engines. *Entrance or Exit* and *TXTreader* are made in Unity and can be accessed on the web due to Unity's ability to export WebGL projects.

It's also worth noting that many other non-Unity engines exporting to the web all use the same underlying WebGL technology, they all exist on webpages, and they all share some way of accessing JavaScript functions. It's possible they could all access the same standard syncing library made in JavaScript, allowing some standard form of connection between them.

Most devices with web access today are also capable of displaying 3D content with ease. This combination of accessible production tools and a large market makes 3D worlds an appealing area for artists and other creatives to move into.

5 Creating a Web-based Virtual World

This chapter discusses my own work on web-based virtual worlds. We will look at *Ozway*, a simple multiplayer world that is integrated into a website, and conclude by considering what steps are necessary for this world to become a component of a Metaverse.

5.1 Pre-dissertation Work

This project was started prior to the start of this dissertation and was an attempt to create a template for 3D websites that would allow web developers to easily create 3D rooms and spaces. These spaces could then be uploaded to a website and navigated by site visitors.

There were several basic requirements needed for this idea to be practical:

- Interaction with the world should not block the user's interaction with the site
- The world had to load extremely fast
- Creating content for the world had to be easy for a single developer

Two of these requirements are depicted in figure 15: a world with simple low poly models could be made rapidly by a developer and load extremely fast for a player.

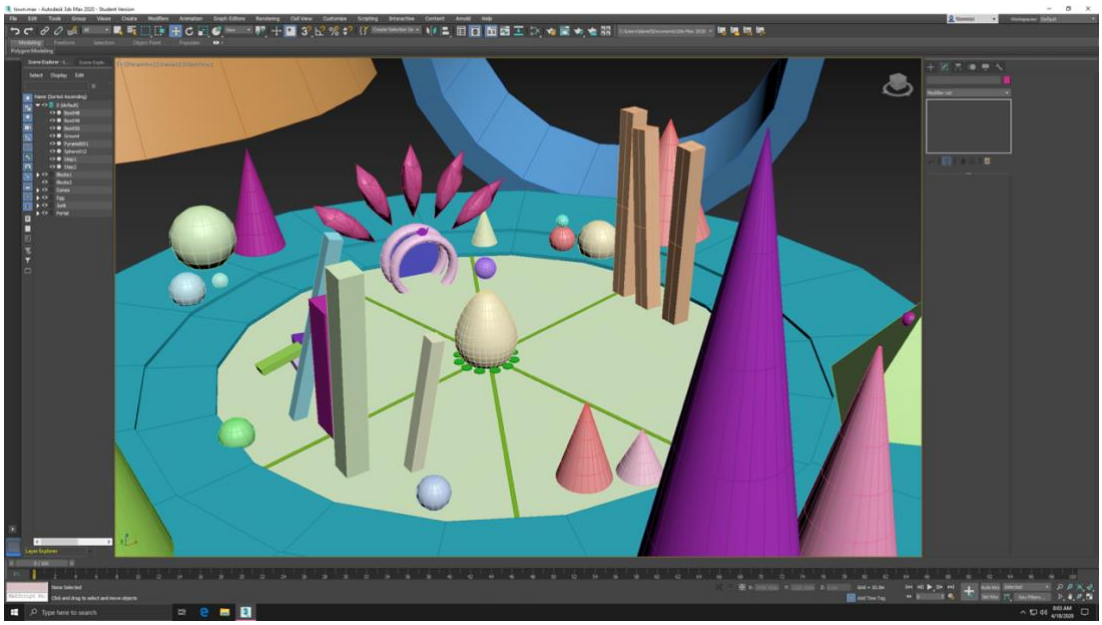

Figure 15 shows the creation of a world model for MelonEngine in 3DSMax 2020. Most objects have a low poly-count or low complexity to assist them loading quickly on the web.

The early development of the project centred around creating a simple game engine using the Three.js JavaScript library. This engine was intended to act as a drop-in foundation for any future world building.
MelonEngine initially provided a number of features including:

- A preconfigured game loop and start-up functions
- A preconfigured character controller and camera
- Functions to simplify loading 3D models and sounds
- The ability to assign scripted interactions to world objects

The engine allowed a world to be deployed on a website with minimal scripting compared to a typical Three.js scene. Additionally, the separation between the world, the engine, and Three.js also meant that code changes in Three.js could be compensated for in the engine without the need to update each world.

When dealing with player controls on web-based 3D worlds, the traditional approach is to lock the mouse into controlling the view or head of the player's character, then use keys such as WASD to control movement. The problem with this approach is that it interrupts the player's ability to continue using the site. They must first disconnect their controls from the world to regain their mouse's ability to click on other things. This project provided an alternative set of controls that avoid locking the mouse, instead relying on the player to hold down the mouse buttons in order to interact with the world.

The workflow involved in getting 3D models into the world proved to be a weak point of the design. The project used glTF models that were created in the programme 3DSMax, which required a custom exporter (Babylon.js) to support glTF files. There are several versions of the glTF format, each with different features and capabilities. At the time of development, exporting lighting using Babylon appeared to have some compatibility issues with the Three.js importer. This may have also been a result of scale differences between the models from 3DSMax and the expected lighting scale in Three.js.

This highlights the challenge of workflow in world design. If the workflow involved in creating a world causes more friction than the perceived value of the world, the project fails. In this case, the concept was successful, but the process required to create it was arduous.

After a three-month hiatus MelonEngine was repurposed as a game jam engine in late April 2020.[11] This was viable because the expected workflow of a game is more forgiving than a website. Typically, a game will often have a final world design, whereas a website requires constant small updates. This comes from the difference between the kind of information presented by a website and a game world.

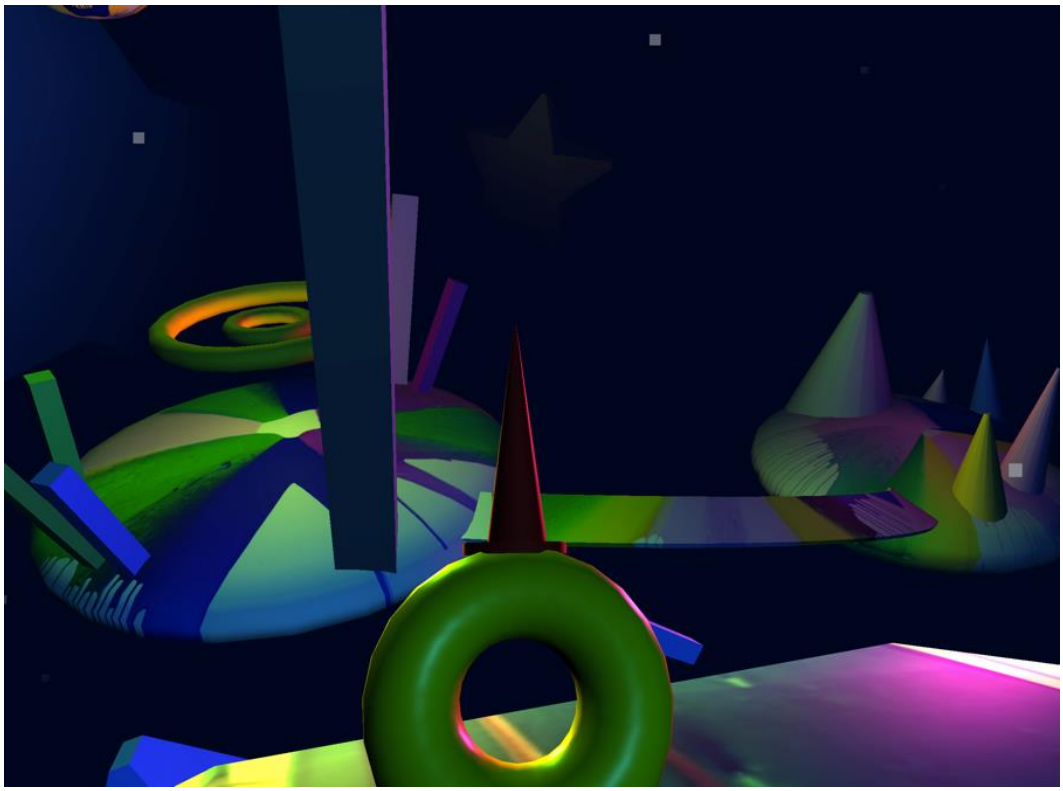

Figure 16 shows Ozway. The scene shows the player's avatar in the lower centre overlooking a meeting area where players can gather.

Gravity and complex player controls were added, demonstrating that a Three.js-based world had the potential to be expanded as a richer game world. This is illustrated in figure 16: the player is standing on a world with a range of surfaces they can walk on; between those surfaces is empty space that the player must fly between. Additionally, a basic multiplayer implementation was added. This worked by sending HTTP requests from the player clients to a server programme, with each request updating an index of all player locations. My past experiences working with multiplayer systems in games involved proprietary systems, such as Photon. In Photon it is unclear how the multiplayer code works as it's hidden from the developer's view.

---

[11] "Ozwomp is Arriving", submitted for Ludum Dare 46, https://ldjam.com/events/ludum-dare/46/ozwomp-is-arriving

The idea of a simple web-based world, running on an open-game engine, and synchronising its data to a simple non-proprietary server, provided the inspiration for this dissertation. If a single virtual world can be created in this way, imagine the potential for a larger metaverse of such worlds also created in this way!

5.2 Extended Dissertation Work

My previous work prompted the questions that led to this dissertation; however, answering those questions proved to be far more complicated than first anticipated. When I began this project, the plan was to expand the services offered by the MelonEngine server and explore the idea of micro-services and web technologies as a basis for a metaverse.

However, it became clear that regardless of my technical approach to creating a metaverse, my project was going to suffer from the same issues that affect all metaverse projects – a lack of definition about what a metaverse is, and a lack of understanding about the components that go into a metaverse. For example, when I initially approached the idea of creating a micro-service to provide an economy between multiple virtual worlds, I had no obvious distinction about why a virtual world should have an economy, and what resources would be traded within that economy. The qualities that appeared to make up a metaverse were primarily based on assumptions made by many people creating metaverse-like platforms, each with their own separate definition of a metaverse.

This dissertation became a project of defining and discussing some of the key points of metaverses. More than any technical demonstration of a metaverse, what was needed was a grounded and broad questioning of some of the fundamental assumptions about metaverses. It was only towards the end of this dissertation that I started to acquire the necessary information allowing me to return to my original project.

For this dissertation the original MelonEngine code has been restructured, the server has received a total rewrite, and a demonstration world was created. It is now capable of syncing any information from a single world selected by the world's developer. However, this is at most a demonstration of the potential of web-based virtual worlds; it is not a demonstration of metaverse design.

Notwithstanding this, the previous chapters in this study have suggested that a metaverse of web-based virtual worlds is a possible scenario. Moreover, this project has clearly demonstrated that web-based virtual worlds themselves are also possible.

5.3 The Future of this Project – One Brick in a Metaverse

The server that syncs MelonEngine data could be expanded to include information from other worlds. During this process it would acquire the ability to move information, such as player data, between these worlds. There is no reason why the information stored on the server must come from a game running MelonEngine; it could be any engine.

This approach, however, still suffers from the size issues suffered by other metaverse models: the more data syncing across the system, the slower and bulkier it becomes. There is still just one server syncing data, but there is no reason that server could not be broken up into multiple distributed pods of servers. This project initially set out to explore the idea of micro-services as metaverse tools, and that idea is still valid. This form of syncing could be one of many micro-services within a wider group forming a loose metaverse.

Would such a metaverse conform to the *Snow Crash* metaverse definition of a single world? No, it would not. It would be a set of loosely connected virtual worlds with some common components. However, as previously discussed in this paper, there are paths to enable those worlds to begin to cooperate in ways that would more closely resemble a metaverse. Seamless movement between worlds, for example, would blur the line for players. Layering technologies turning worlds into glass worlds would blur the line further.

MelonEngine is best at providing a simple virtual-world making tool that is easy to learn and modify. Ideally, further development on this project would be to expand on those qualities. Crafting a tool that allows people to create and host their own virtual worlds, with some minimal connection between them, is the first step towards turning those worlds into something more like a metaverse.

6 Conclusions

The following conclusions are derived from all previous sections. They consider the definitions described in the literature review, the subsequent considerations on metaverses, the landscape of personal virtual-world projects in development today, and my own project which posed the initial questions that triggered this research.

6.1 Topics not Covered

Here, some significant areas related to metaverses, not covered in this dissertation, warrant some discussion. These may offer potential areas for further study.

6.1.1 Artificial Intelligence (AI)

AIs could play a key role in metaverse operations. One of the major challenges of designing a metaverse is maintaining some form of compatibility between disparate worlds, worlds that may be running on different engines made by different developers. It would be possible for an AI to act as a translator between these worlds, taking standards and assets and adapting them to fit into new worlds as the player moves between them, particularly within the context of glass worlds. Research in this area would potentially remove some of the restricting factors affecting metaverse design today.

6.1.2 Augmented Reality (AR)

This dissertation has not discussed the topic of metaverses and augmented reality. AR is not a part of the typical metaverse debate because reality is not considered to be a part of a virtual world. This does not mean reality cannot participate in a metaverse. It is possible that metaverse worlds and content could be overlayed with reality. If the metaverse uses glass worlds, then reality could be considered one of the glass layers of the metaverse. Alternatively, parts of reality could be augmented into the metaverse as leaf worlds. AR is, at this time, a new technology that has had limited mainstream success. As this technology improves there may be greater pressure to integrate it into existing virtual worlds.

6.1.3 Copyright in a Metaverse

If the majority of content in a metaverse is freely replicable and reusable, then existing ideas about copyright may be incapable of functioning correctly. The simplest approach might be to suggest that everything put onto the metaverse must remain in the public domain; however, as players can freely create anything in a metaverse, there is no way to stop them using copyrighted material. This suggests that at some point a full review of

copyright laws in relation to metaverses may be necessary, and a proposal for new metaverse-friendly copyright laws could be required.

One semi-solution that I would propose is a universal attribution system. Content on the metaverse could contain some information about who originally created it and who had since modified it. A player interested in a particular piece of content could then look up the original creator and see what else they had worked on. It might also be possible for the original creator to search for some of the worlds currently using their content.

6.2 Conclusion

In this dissertation we have defined a metaverse as a group of connected purposes. These purposes are the combination of worlds, perspectives, services, and communities, all rolled into one. This definition was created to separate the idea of a world as a technology from a world as a concept; in other words, to highlight that a metaverse itself is a concept rather than a technology.

The aim of this is to reduce some of the ongoing confusion in relation to the term. This confusion has been highlighted by Tim Sweeney's comments in section 2.2, and it potentially hinders the ability of further study to advance the development of metaverses. Such studies may allow those who create metaverses to explore more diverse concepts of what their creations might become. Additionally, this lack of understanding sets a dangerous precedent; metaverses could be vastly influential, while at the same time remaining deeply misunderstood.

Metaverses will form their own unique cultures, and those cultures will be defined by the players' diverse social and technical backgrounds. As such, the cultures of a metaverse will be impossible to predict in advance. Moderation and management of these cultures may become a near-impossible task for any single organisation. This suggests that the structure of a metaverse will have to allow worlds to fully moderate themselves. This could be seen as a form of self-governance, in which case a metaverse is more like a group of nations rather than a single nation.

A metaverse may be technologically very large, like the World Wide Web. The web is the sum product of the work of many smaller entities. In this case, an individual person can run a web server; however, no organisation or government could run the whole web. Likewise, it is unlikely that any organisation will be able to run a large metaverse while at the same time remaining financially stable. With this in mind, this dissertation has suggested that there should be multiple technical standards created by multiple organisations. This ensures that no single organisation is tasked with maintaining any singular irreplicable part of the metaverse.

It's possible that rather than being created by a single organisation, a metaverse could evolve naturally from the cooperation of many independent virtual worlds. This could be facilitated by making metaverses a taught subject in creative institutions, such as art

colleges, rather than existing as purely individual or corporate projects. Each world, in this case, would supply its own player-generated content to the metaverse, and benefit from the supply of content it would receive from other worlds. In this way, the metaverse would not just be populated by player-generated content, but also by player-generated structure.

An economy is not a necessary requirement to fulfil the definition of a metaverse. Additionally, the structure of virtual worlds makes them poorly suited to scarcity-based economies. This suggests that replicating a real-world economy is not the best way forwards for a metaverse.

As discussed in sections 3.3 and 3.5, the worlds that make up a metaverse and the players' perceptions of them could be heavily influenced by the way those worlds are connected. For example, a player could be following the physics of a different dimension, while still being present with other players who themselves are within other dimensions. A successful metaverse may follow a set of rules that is not based on the human perspective of the real world. With this in mind, I would suggest that the concepts behind a metaverse should not be so earth bound. Throughout this discussion there have been earthly examples made, such as driving cars or building cities. These examples are helpful when describing a metaverse; however, a metaverse should not be defined by such things.

Finally, as illustrated by the definition of the word – 'meta' meaning beyond and 'verse' taken from universe – a metaverse is beyond the universe. To return to the *Star Trek* analogy, it is an off-world realm that exists in the shadows of the undiscovered. A true metaverse presents endless opportunities to use play to explore our ideas, our identities, and the potential of our societies, while at the same time being free from the limits of daily life.

7 Bibliography

Bartle, R.A. (2020) *CE317/CE817 Lecture 1*. In: [Online]. 2020 p. Available from: https://www.youhaventlived.com/qblog/2021/QBlog270321A.html.

Bartle, R.A. (2004) *Designing virtual worlds*. New Riders.

Bartle, R.A. (2009) From MUDs to MMORPGs: The history of virtual worlds. In: *International handbook of internet research*. Springer. pp. 23–39.

Berners-Lee, T. (2005) *Weaving a Semantic Web*. [Online]. 2005. Available from: http://www.cbpp.uaa.alaska.edu/afef/weaving the web-tim_bernerslee.htm.

Blizzard (2020) *Blizzard End User License Agreement*. [Online]. Available from: https://www.blizzard.com/en-us/legal/fba4d00f-c7e4-4883-b8b9-1b4500a402ea/blizzard-end-user-license-agreement.

Castronova, E. (2001) Virtual Worlds: A First-Hand Account Of Market And Society On The Cyberian Frontier. *CESifo*.

Chambers (1999) *21st Century Dictionary*. Chambers.

Dibbell, J. (1994) A rape in cyberspace or how an evil clown, a Haitian trickster spirit, two wizards, and a cast of dozens turned a database into a society. *Ann. Surv. Am. L.* [Online] 471. Available from: http://www.juliandibbell.com/articles/a-rape-in-cyberspace/.

Dionisio, J.D.N., Burns, W.G. & Gilbert, R. (2013) 3D virtual worlds and the metaverse: Current status and future possibilities. *ACM Computing Surveys*. [Online] Available from: doi:10.1145/2480741.2480751.

Fiske, J. (1992) The Cultural Economy Of Fandom. *The adoring audience: Fan culture and popular media*. 30–49.

Howcroft, E. (2021) The ‘metaverse’ bet: crypto-rich investors snap up virtual real estate. *Reuters*. [Online] Available from: https://www.reuters.com/business/metaverse-bet-crypto-rich-investors-snap-up-virtual-real-estate-2021-04-19/.

IEEE Metaverse Standards (2011) *IEEE Metaverse Standards*. [Online]. Available from: https://web.archive.org/web/20130922014408/http://www.metaversestandards.org/index.php?title=Terminology_and_Definitions.

Jameson, O. (2020) Beyond The White Cube. *PLAYSTYLE*. [Online] Available from: https://playstyle.world/Beyond-the-White-Cube-The-Virtual-Gallery-Space.

Koster, R. (2013) *The Ready Player One MMO was Metaplace*. [Online]. 2013. Available from: https://www.raphkoster.com/2013/08/30/the-ready-player-one-mmo-was-metaplace/.

Lewis, C.S. (1955) *The Magician's Nephew*.

Lialina, O. (2021) From My to Me. In: *Turing Complete User. Resisting Alienation in Human-Computer-Interaction*. [Online]. Heidelberg University Publishing. p. Available from: https://interfacecritique.net/book/olia-lialina-from-my-to-me.

Lialina, O. (2012) Turing Complete User. *Contemporary Home Computing*. [Online] 14. Available from: http://contemporary-home-computing.org/turing-complete-user/.

Mccrae, J. (2019) *A letter to the Janus VR community*. [Online]. 2019. Available from: https://www.reddit.com/r/janusVR/comments/e7ga32/a_letter_to_the_janus_vr_community/.

O'Doherty, B. (1999) *Inside the white cube: the ideology of the gallery space*. Univ of California Press.

Oldenburg, R. & Brissett, D. (1982) The Third Place. *Qualitative sociology*. 5 (4), 265–284.

Rosenberg, M. (2020) The Difference Between a City and a Town. *ThoughtCo*. [Online]. Available from: https://www.thoughtco.com/difference-between-a-city-and-a-town-4069700#citation-2.

Ruggles, C., Wadley, G. & Gibbs, M.R. (2005) Online community building techniques used by video game developers. In: *International Conference on Entertainment Computing*. 2005 Springer. pp. 114–125.

Ruppert, L. (2017) EA Issues Statement Regarding UFC 3 Pay-To-Win Backlash. *ComicBook.com*. [Online]. Available from: https://comicbook.com/gaming/news/ea-issues-statement-regarding-ufc-3-pay-to-win-backlash-/.

Shah, A. (2021) *Defining the Metaverse*. [Online]. 2021. Duality Robotics. Available from: https://www.duality.ai/blog/defining-the-metaverse.

Silver, C. (2020) What Is Web 3.0? *Forbs*. [Online] 6 January. Available from: https://www.forbes.com/sites/forbestechcouncil/2020/01/06/what-is-web-3-0/ [Accessed: 11 April 2021].

Smith, A. (1776) *An Inquiry into the Nature and Causes of the Wealth of Nations*. London, W. Strahan and T. Cadell.

Stephenson, N. (1992) *Snow Crash*. [Online]. Available from: https://www.goodreads.com/book/show/40651883-snow-crash.

T.L. Taylor (2002) Chapter 3 Living Digitally: Embodiment in Virtual Worlds. In: *The Social Life of Avatars*. p.

Takahashi, D. (2021) Epic Games raises $1B for long-term metaverse plans, with $200M from Sony. *VentureBeat*. [Online]. Available from:

https://venturebeat.com/2021/04/13/epic-games-raises-1-billlion-to-fund-long-term-metaverse-plans/.

Tierney, T. (2013) *The public space of social media: Connected cultures of the network society*. Routledge.

Web3D Consortium (2020) *About Web3D Consortium*. [Online]. 2020. Available from: https://www.web3d.org/about.

Zheng, Z., Xie, S., Dai, H.-N., Chen, X., et al. (2018) Blockchain challenges and opportunities: A survey. *International Journal of Web and Grid Services*. [Online] 14 (4), 352–375. Available from: https://www.henrylab.net/wp-content/uploads/2017/10/blockchain.pdf.