

MESTRADO INTEGRADO
ARQUITETURA

Metaverse Architecture

Simão Reis Coelho

M
2022



Metaverse Architecture

A Study on the Metaverse from an Architectural Perspective

Student: Simão Reis Coelho

Student #: 201504081

Publishing Date: September 30th 2022

Tutor: Carlos Nuno Lacerda Lopes

Institution: Faculdade de Arquitetura da Universidade do Porto

7	An Introduction to the Metaverse
9	The Metaverse
25	The Technology
33	Living in the Metaverse
35	Digital Experiences
42	Articulating Worlds
45	Metaverse Urbanism
49	Working in the Metaverse
51	Work Life in the Metaverse
56	Metaverse Architect
63	Creating for the Metaverse
70	Glossary
72	References

Abstract

The upcoming metaverse is a massive market with a lot of creative opportunities about to surge for artists. The three dimensional virtual world will require development of the environments which populate it and architects should be the main force behind it. With technologies such as virtual and augmented reality, immersion in those spaces will feel almost as real as the physical world. Although the technological development of the field is massively important for its success, it's worth highlighting the importance architectural work will have as well for the human feel of experiencing virtual spaces. The gaming industry has explored similar fields for years, but lacks the sense of casual interactions or shared experiences in the same way the metaverse does. This one resembles more of social media than video games. In this space, architects are the web designers of the metaverse.

As a completely new field, researching the metaverse and how it can be beneficial to architects requires a certain amount of critical thinking and abstract views on what is architecture traditionally. This new artist branch diverges from what we currently define architecture, both in the artist sense, but also in the social impact it has in society. Architecting the metaverse tackles both sides in a different manner, virtually, but which ramifications also impact human lives, albeit in a modern global network.

As it stands, the metaverse doesn't have a concrete definition. It's still a concept being built and there's various opinions on its current development stage and what it'll look like as a complete product. To integrate an art like architecture, with such a rich history and involving experiences traditionally so grounded on physical sensations, focusing on the key components of the metaverse and working with the most credible speculations of the finished product is key. The digital revolution that started in the 1990's with the World Wide Web and gained traction in the transition into the 2010's with the portability possible with smartphones and wearables, has impacted multiple industries, including architects. The profession has changed drastically throughout time, but the metaverse might become the biggest catalyst in the next few years, possibly branching formed architects into another profession of its own dedicated to the metaverse. Though those share similar knowledge in skills such as spatial design and 3D modelling, they differ in knowledge key to each's product. Metaverse architects don't require knowledge in areas such as engineering, but do need to understand the technology that supports their work.

All considerations going on right might change as the project develops, but it's important that architects integrate in the process of building the metaverse. Understanding human anthropology in a digital space will be one of the challenges to overcome in creating a virtual universe where, though it's not the physical reality we were born into and live in, is still a real place, where we can socialise and live experiences not possible without it, that's still designed by and for humans.

In this dissertation, we gather information about what the metaverse is and possible ways architects can integrate its development, reflecting on its current stage and future integrations it can have by society.

An Introduction to the Metaverse

The Metaverse

Defining the Metaverse

In the year of 1992, technology was yet to reach the boom that it had starting in the 2000's, leading up until today. As depicted in sci-fi movies, the world was imagining a future of flying cars and teleportation, arguably living our technological dreams through fantasy stories. At that time, we barely knew the true power of arguably the greatest invention of the last few decades, the internet, a technology that has changed the world drastically in many aspects. In fact, not only hadn't the adoption of the web been just a minority of the world population, passing through the niche phase of what we call "the enthusiasts", but also a large portion of the world hadn't even heard of it yet.

Information travelled very slow across the world, not everyone could access it at whatever time and wherever as they pleased. Traditional methods, like newspapers and television, with a very limited selection of channels available, were the popular way that information was passed through around the population. The portable phone wasn't very common, the only 2 models released that year amounted for a total of 13 million units in sales^[1], and scaling of adoption didn't happen roughly until the turning of the century. Personal computers were still big and slow^[2], Microsoft had yet to reach the success it had with Windows XP and Apple was approaching filling for bankruptcy^[3], with business decisions made while Steve Jobs was away from the company leading to the decline in the company's revenue.

The context in which we lived back then is important, the world has developed and progressed massively in just 3 decades, more than it ever has technology wise. With analog being the standard in most aspects through which media was consumed, the digital space was but an imaginary dream in human's minds, a goal through engineers mindsets working for big corporations, and expressed by creative minds through Hollywood and other sources of media, which weren't as many as we currently have.

Yet, even before global adoption of the internet and the digital connections it made possible, the term metaverse was first brought up and it's actually surprising how close it resembles the current state of the project in the year 2022. It was in this year of 1992 that the book *Snow Crash* by Neal Stephenson^[4] was released. In this sci-fi story, the world has a parallel virtual universe where society, through virtual reality headsets, can visit. Here, they can spend time and perform certain activities, away from the reality of a damaged physical world they live in. In the metaverse, there are no boundaries restricting humans in ways that physical reality does. Aspects such as gravity, distance and physical matter can be manipulated in ways that shape the virtual world according to its creators. At the end of this introduction, there will be a transcript of a portion of chapter 5 from *Snow Crash*. The proximity that a book written 30 years ago has with the current state of the metaverse deserves a place in this dissertation and is probably the best way to present the upcoming virtual world, straight from the words of the first to visionary to talk about this concept.

With the passing of the years and technological advancements, analog methods of

sending and receiving information, like text, audio or video, are now a thing of the past. Most of the world's information is stored digitally in small drives. Amounts of data that previously would require massive libraries containing thousands of books can now be stored in a drive that fits in our hands. This information can be copied an infinite amount of times and shared with anyone anywhere in the world in a matter of seconds. Connections have become instant through modern devices, with messaging and video calling services making it possible to communicate with anyone in the world, at any time, instantly. We share moments and thoughts on social media, creating, in the process, our own profile, which represents ourselves in the digital space, manipulating the image of what our real physical lives actually are. Through this, we have created an alternate parallel life and, even though it is still ourselves in these platforms, there's still a disconnect between who we are and the lives we experience digitally.

The screens that link us to our digital selves, though simple, is a huge barrier in what biologically separates the digital space from us. It's a barrier that changes the way we perceive the digital space into being something that we are using instead of something we could be experiencing and living. Our senses have the capacity to link us to the environments we're in. If we are in the living room playing a game or having a video call on the TV, this experience is strictly that, we are in that physical space while staring at a fixed tool that portrays a digital experience. We see that space as a bidimensional representation of what it actually is, but we're not involved in it, we're still in our living room, changing games and apps on the TV, but not changing where we are. We need to remove the barrier between us and the digital world and allow our senses to experience the space as if it was real.

Vision and audio are intrinsically linked in how our brains interpret space^[5]. When we hear something, we are able to spatially locate it around us. To immerse ourselves in a digital world, we need to remove the physical space around us and replace it with the digital spaces we want to immerse ourselves in. As hypothesised way back when Neal Stephenson wrote *Snow Crash*, virtual reality is a way of achieving this goal. By covering our vision with a headset that blocks exterior environments and replaces them with a tridimensional digital one, in addition with other features such as head tracking, that allows what we see to match where we look at, and good spatial audio with good noise isolation from external sources, in few moments we can transport ourselves into an environment completely different from where we physically are. Despite how much evolved our brains are, we still are biologically very primitive, with senses and emotions easily taking over rational thoughts we may think we have. Using VR to explore a digital experience has an effect in our brain that we can forget what we're seeing is not actually real.

Connecting with the digital space without the barrier of a physical screen gives us a whole another dimension to interact with one another, as well as with the information and content we produce. As Mark Zuckerberg says when talking about virtual and augmented reality, this new dimension will give back to humans something that was lost when interacting digitally which is the feeling of presence.

The metaverse will create a parallel digital universe where humans can socialise and experience new activities that are not possible without it. The development of this platform will give a lot of new job opportunities to countless people, including architects. Creating and designing the digital environments in the metaverse links to how architects have developed the physical world through generations and, as we step into another world, virtual this time, the metaverse should be something that architects are aware of as the market will be massive in the future as adoption increases.

Throughout this dissertation, we will explore the metaverse, what it is and how it works, with the nuances that make it exist that are essential to those looking into it from a creators' perspective, more than as a consumer. Then we will look at how using the metaverse will feel like, the experiences that we will have from it and how it will shape the physical world with it. Finally we'll take a look at the profession of a metaverse architect, how it will develop with new technologies facilitated by the metaverse and how actively working on it will be.

To conclude this introduction to the metaverse, nothing is better than the promised words from Neal Stephenson, the first to write and describe the metaverse. This text comes from chapter 5 of his 1992 book *Snow Crash*, where the main character, Hiro Protagonist, enters the metaverse for the first time in the book. The writer explains what the virtual world is and how it looks like. Although some things in this book are likely not to be a part of the real metaverse we will have in the future, it's interesting how so many of these are present in already existing metaverse platforms, which will be talked about in later chapters.

"As Hiro approaches the street, he sees two young couples, probably using their parents computers for a double date in the metaverse. (...) He is not seeing real people, of course. This is all part of the moving illustration drawn by his computer, according to specifications coming down the fibre-optic cable. The people are pieces of software called avatars. They are the audio-visual bodies that people use to communicate with each other in the metaverse. Hiro's avatar is now on the street and the couples coming off the monorail look over in his direction. They can see him just as he's seeing them. They could strike up a conversation, Hiro in LA and the 4 teenagers probably on a couch in the suburb of Chicago, each with her own laptop, but they probably won't talk to each other any more than they would in reality. (...) Your avatar can look anyway you wanted it to up to the limitations of your equipment. If you're ugly, you can make your avatar beautiful. If you've just gotten out of bed, your avatar can still be wearing beautiful clothes and professionally applied make up. You can look like a gorilla or a dragon or a giant talking penis in the metaverse. Spend five minutes walking down the street and you will see all of these. Hiro's avatar just looks like Hiro, with the difference that, no matter what Hiro is wearing in reality, his avatar always wears a black leather kimono. Most hacker types don't go in for these garish avatars because they know that it takes a lot more sophistication to render a realistic human face than a talking penis. (...) You can't just materialise anywhere in the metaverse (...) This would be confusing and irritating to the people around you, it would break the metaphor. Materialising out of nowhere or vanishing back into reality is considered to be a private function best done in the confines of your own house. Most avatars nowadays are

anatomically correct and naked as a babe when they're first created. So in any case, you have to make yourself decent before you emerge into the street, unless you're something intrinsically indecent, then you don't care. (...) a person who is coming in from a public terminal, then you materialise in a port. (...) The ports serve a function analogous to airports. This is where you drop into the metaverse from somewhere else. Once you have materialised in the port, you can walk down the street or hop on the monorail or whatever. The couples coming off the monorail can't afford to have custom avatars made and don't know how to write their own. They have to buy off the shelf avatars. (...) Looks like she has bought the Avatar Construction Set™ and put together her own customised model out of miscellaneous parts. It might even look something like its owner. Her date doesn't look half bad himself. The other girl is a Brandi, her date is a Clint. Brandi and Clint are both popular off-the-shelf models. (...) but then they come down the escalator and disappear into the crowd and become part of the street, where there are enough Clints and Brandies to found a new ethnic group. The street is fairly busy. Most of the people here are Americans and Asians, it's early morning in Europe right now. (...) The moment Hiro steps across the line separating his neighbourhood from the street, coloured shapes begin to swoop down on him from all directions. (...) Animericals are not allowed in Hiro's neighbourhood, but almost anything is allowed in the street. (...) Amusement parks in the metaverse can be fantastic, offering a wide selections of interactive 3 dimensional movies, but in the end, they're still nothing more than video games. (...) He cuts straight across the street and under the monorail line, headed for a large low slung black building. It is extraordinarily somber for the street, like a parcel that someone forgot to develop. It's a squat black pyramid with the top cut off. It has 1 single door. Since this is all imaginary, there are no regulations dictating the number of emergency exits. There are no guards, no signs, nothing to bark people from going in, yet thousands of avatars mill around, peering inside, looking for a glimpse of something. These people can't pass through the door because they haven't been invited. (...) Underneath it, in letters carved into the walls black substance, is the name of the place: The Black Sun. So it's not an architectural masterpiece. When David and Hiro and the other hackers wrote The Black Sun, they didn't have enough money to hire architects or designers, so they just went in for simple geometric shapes. (...) the computer system that operates the street has better things to do than to monitor every single one of the millions of people there, trying to prevent them from running into each other. It doesn't bother trying to solve this incredibly difficult problem. On the street, avatars just walk right through each other. (...) When things get this jammed together, the computer simplifies things by drawing all of the avatars ghostly and translucent so you can see where you're going. (...)”

Metaverse Timeline

Currently, not many know what the about the metaverse and what it is. From those that do, many think that it's a scam, a bubble or a concept that has no future^[6]. While we can't put aside the hypothesis of the project to fail, it's unlikely considering those involved in its development^[7].

With every technological step, there's always been critics and skeptics, from both common consumers and competitors. The announcement of the iPhone in 2007 was one of the most important pieces that shaped how the world is today, leading mobile connectivity to become an essential part of our lives. Though it seems silly now, back in 2007, a completely different landscape, the iPhone was criticised, that it didn't make sense. A vast amount of articles were written before and after the announcement 'predicting' that the iPhone would fail^[8]. Even the competition's then-CEO, Steve Ballmer of Microsoft, made fun of the product^[9] and claimed that it wouldn't sell well^[10].

This comparison highlights we need to keep an abstract vision of the metaverse and do our own proper research. Humans get complacent in how they live and don't like change. Another great example is the article "Why the Web Won't Be Nirvana"^[11] by the professor and astronomer Clifford Still or even Robert Metcalfe, internet pioneer and co-inventor of the ethernet, who predicted the collapse of the internet in 1996^[12].

We'll analyse the timeline for the metaverse, the steps already taken, at what stage we are currently and what the upcoming years will bring. For context, the timeline of the internet^[13] will be referenced as a guide since it's the most related advancement we've previously made.

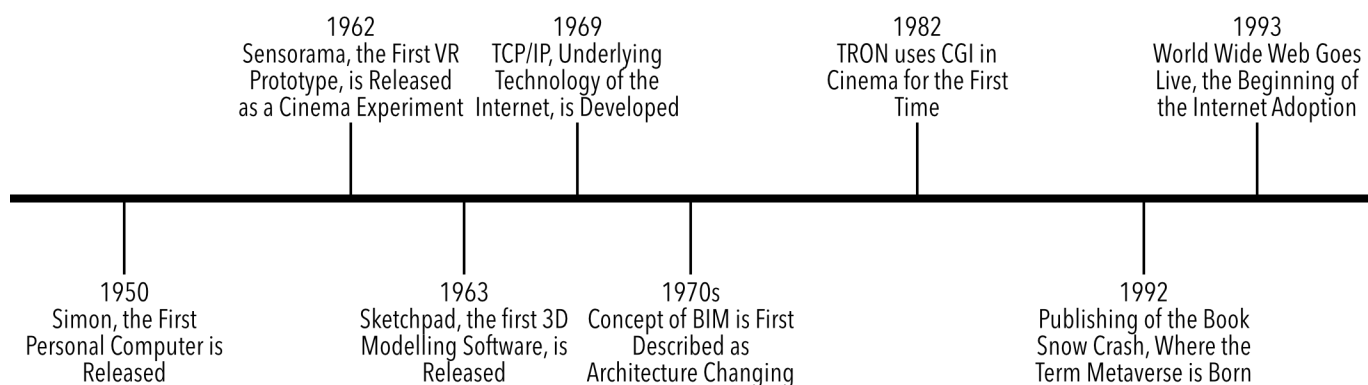
The history of the metaverse^[14] starts in 1992, when the term was first mentioned on the sci-fi book *Snow Crash* by Neal Stephenson. Back then, it was a very different world, with less than 16 million people, under 0,4% of the world's population, using the internet^[15]. Despite this, the book describes the metaverse very similarly to current platforms. In 1992, this was just a fantasy story, but it represents the vision that humans already had of an alternate digital universe, accessible from our own, long before the days where we spend more and more time in digital environments. Between 1997 and 2000, the franchise Digimon was created. The main characters are sent from the real world into a digital one, although not through virtual reality. Among other examples, we see that the concept of humans living experiences through a digital world has origins from long before the digital space was so accessible to everyone.

In 2003, about a decade after *Snow Crash*, the metaverse concept is first experimented with the release of Second Life. The creators defended that this wasn't a game^[16], but instead a multiplayer virtual world. It introduced many of the concepts we expect from the metaverse, like digital environments users can socialise in, an open economy, a market, services and property ownership. The platform never became too popular due to technological limitations at that time.

It resembles the first steps of the internet, like the World Wide Web being released in 1993 and making the internet more accessible to users, even though it still wasn't the product it was meant to be. Second Life launching over 20 years before the metaverse starting to become reality isn't an exception. Social Media is a part of everyone's daily lives now, and though it gained popularity with the creation of MySpace in 2003 and Facebook in 2004, communication platforms have existed since Usenet was created in 1979^[17].

Newer digital platforms have become much more popular than Second Life since younger generations have grown up with computers. *Minecraft*® and *Fortnite*® have revolutionised the market with 175 million^[18] and 255 million^[19] monthly users respectively. Although these are considered games, younger generations use them for much more, like socialising or even attending shows. Travis Scott and Ariana Grande's music performances in *Fortnite*® were reported to have earned about 20 million dollars each^[20].

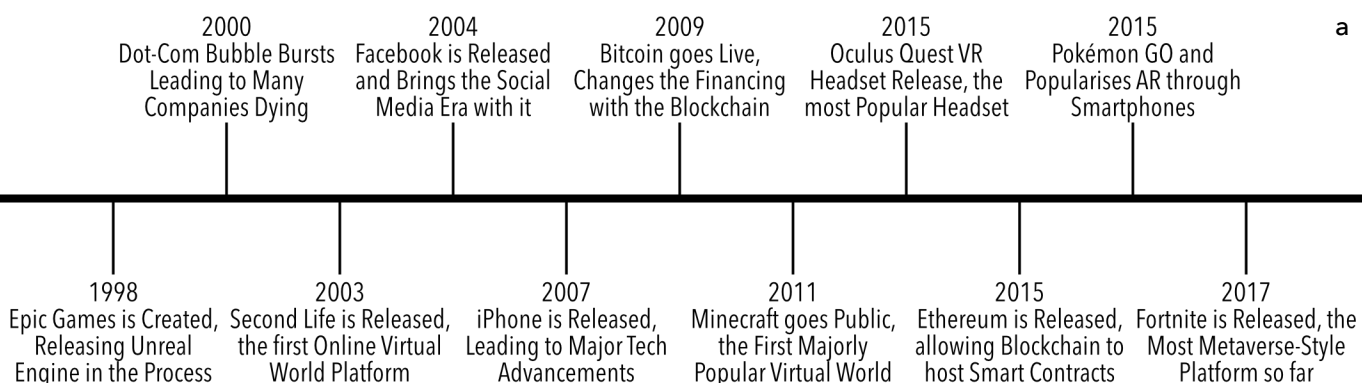
Although Second Life was a great prototype, it lacked essential technologies for the metaverse. The technologies that support our current web have existed for decades, for example, TCP/IP were created in the early 70s^[21]. Important technologies were developed in the years after Second Life's release. An important piece was Bitcoin, released in 2009 off the backend of the Great Recession, that brought key technologies like a decentralised blockchain. It is one of the biggest leaps made by humanity and it's still being improved with new generations, yet to reach its full potential. The release of the Ethereum blockchain in 2015 brought smart contracts into existence, a concept that dates 1998^[22]. This technology allows a virtual machine to run decentralised, where users can run applications. With this, the amount of functionality in a blockchain grew exponentially compared to Bitcoin's. The apps that run on phones and computers are now possible to run without a central server with Ethereum. Platforms similar to *Fortnite*® and *Minecraft*® have been created on the blockchain, like Decentraland and The Sandbox. Though their user count is smaller^[23], as the technologies improve, get more efficient and cheaper, it's only a matter of time until blockchain metaverse platforms take off.



This is a market that not everyone is aware of, but tech enthusiasts, investors and big companies are showing clear interest. Until the metaverse truly comes into existence, like the internet and social media, there might still be some turns. Technology was in a very big bubble in the late 90s, everyone was creating companies but not bringing anything of useful. The dot-com bubble popped in 2000, the stock market crashed, and many filed for bankruptcy. Without this crash, we might've not developed the way we did since this allowed companies like Amazon, Apple and Google to rise among others^[24]. The current cryptocurrencies market, decentralised web's counterpart of the stock market, resembles the dot-com bubble of 2000^[25]. An upcoming crash of the market would allow valuable projects to gain popularity, like tech companies have, and remove worthless projects as to increase trust in this market. As of writing, the macro economy is taking a massive hit, so it may already be in that phase.

Adoption of web 3, the decentralisation of the web by moving hosted content from companies servers into nodes on a blockchain, will lead to faster development and adoption. It's common that the more users, the faster a products can improve. Gaming and software companies use this technique by creating beta programs, allowing users try and use the product in order to detect flaws. With the number of usage of cryptocurrencies^[26] and dApps^[27] rising, it's clear that these technologies are being adopted, however, it's possible that mainstream adoption will occur only when tech companies like Epic Games, Meta or Google enter the market in scale.

Adoption of the metaverse will be gradual like the internet and social media, society might not even notice until it's implemented. It took years to go from mobile phones exclusively making and receiving calls to being portable computers for daily activities like work, leisure and education. We won't wake up and have VR or AR glasses in our faces 6 to 8 hours per day, maybe they won't even be required, and the early adopters will likely be seen as misfits, but as per past developments, these become the norm and socially accepted^[28].



Digital Social Platforms

The development of metaverse concepts isn't new. One of the original projects in this space was the game *Second Life*, released in 2003, where players from all around the world could gather in a tridimensional space and do activities within.

The technological field got more advanced and interesting with the turning of the decade when computers got more powerful and smaller. By bringing more computing power to the masses, adoption of these technologies lead to more investment to develop them faster. Open world games like *Fortnite*® became digital spaces where millions of users worldwide joined to interact with one another.

The next step towards the metaverse looks to be reaching the decentralisation of these platforms. Due to *Fortnite*® being inside Epic Game's servers, it can't reach the interoperability that a digital space should have. Allowing users to buy and sell items through various platforms should be a requirement, only possible with digital ownership.

Since the introduction of the first fully functional blockchain in 2009, developments have made it so applications can be run in a decentralised way, no single entity can control it. We're currently entering the stage where social platforms can be implemented on a blockchain instead of a private server, as is the case with Sandbox and Decentraland.

Although we can enter these spaces through a Web 3 wallet, making us own all out information, assets and others, and connect that into every of these platforms, there's still a difference in each of them. They communicate with many assets which can be shared across them, but don't communicate between platforms, which should be resolved in a way to turn the digital space into one, composed of all these individual parts.

Centralised Platforms

A centralised metaverse is a platform through which users interact through a company's servers. Some examples that we'll be taking a look at are *Second Life*, *Minecraft*®, *Fortnite*® and *Spatial*. These platforms are hosted by a single company that takes the decisions on what the direction is. These companies are organised by a small team of decision makers, the board of directors, that are above every member of the community that makes up the platform. Although it might not always be the case, these examples can focus on paths that not always is what the majority of users of the platform prefer. This can happen with any kind of digital platform.

A platform ran this way is not interoperable. *Fortnite*®, for example, has its own little economy ran by the V-Bucks currency, but its market value is what the company, Epic Games, decides and not the open market. A user can only exchange V-Bucks for another currency through Epic Games' exchange. Everything that a user owns in *Fortnite*® is locked in there and, if the company shuts down the platform, all value the users have accumulated is lost forever.

Throughout the years, games, social media and other applications have come and gone, occasionally due to new competitors capturing the market. With the rise of TikTok and its short form content gaining popularity, specially with younger users, Instagram and Youtube have altered their platforms^[29], trying to recover the market share lost to the new competitor, but, for users that stuck with them, now they see their platform changing into something they don't enjoy anymore. It begs the questions that if the users of Instagram had left for TikTok, or if this is just a new market that wasn't using Instagram anyways, if by try to cater to it, they won't just push long term users of the platform away.

This traditional hierarchic business model model of a centralised system has slowly started to change. With the push towards the digital space, the population is slowly adopting digital nomadism^[30], due to factors like easier marketing of portfolios, communication with clients and flexibility with work place. This system is allowing workers to be the creators of their own art and communicating with clients directly other than represented through a company.

Communities developing the decentralised web and the metaverse tend to prefer this business model for a fairer value for everyone, as well as allowing the users of the platforms to actively develop them.

Second Life



Second Life^[31] is the oldest game, released June 2003^[32], that resembles what the immersive virtual world concept of the metaverse is. In fact, calling it a game it's not entirely correct in itself. The creator and first CEO of Linden Labs, the company behind it, has said: "So, we don't see this as a game. We see it as a platform."^[33] Inside this 3D virtual world, there are no objectives or pre-defined actions like a game. The users, represented by their avatars, are invited to explore the places which in there exist but also to help collaborate in developing them by designing and creating their own spaces and experiences. This concept of user-generated content has become increasingly popular in the era of Web2 with social media, representing the majority of the internet, but, in 2003, it was still a niche. Second Life is developed around this core concept of social interaction and user-generated content^[34]. Throughout the grid, the platform's map, there are many kinds of experiences to take part in like art exhibits, live music, cinema, etc. Users can voice or text chat with others nearby or have direct messaging or calls to others anywhere far on the virtual world, similar to a phone call.

Inside of this virtual world, the company has created a real economy ran by the Linden Dollar. Residents of Second Life, a term used for users of the platform, can buy and sell items between each other through the digital currency as well as parcels of land. Land development is facilitated by the integration of a 3D modelling and scripting tool on

the platform. It allows artists to design spaces on the grid and sell them to costumers looking for their own virtual home. Ailin Graef became a millionaire in 2006 thanks to Second Life's real estate market. Although the process of inputting money into the platform's economy through its own exchange was automatic, withdrawals are not, centralising the system. Second Life's popularity peaked at around 1 million regular users in 2013, far behind the next 2 examples, but there's a lot they did right long before the metaverse became a term mentioned around the world^[35].

Minecraft®



Minecraft®^[36], officially released to the public in 2011, is one of the most popular video games of all time, reaching 140 million monthly active users in 2021^[37]. It's very different from Second Life, most importantly being, in fact, a game. Even though it doesn't have a very specific objective and leaves a lot of freedom for its players to decide what to do, the mechanics are more objective than those of Second Life.

It's a sandbox game, this basic concept involves users destroying, building and placing blocks of the cubic world, effectively being able to create anything^[38]. The worlds in *Minecraft*® can be very creative throughout the infinite horizontal plane with the input from different users collaborating. The players can create houses, cities and other art pieces in the different biomes, designed to replicate different ambients of the world. Although *Minecraft*® explores a cubic blocky design style instead of a realistic 3 dimensional world, the creativity it allows is very interesting and forces players to think outside the box.

Due to its popularity, it's an important example of a digital world gaining utility and influence in our world. Institutions have used the game to interact while working on their projects. Communities have been allowed to propose changes to their neighbourhoods through a digital twin created on *Minecraft*®^[39]. In the same vein, The British Museum announced plans to create virtual experiences in *Minecraft*®^[40], although the project was never officially launched. Cody Sumter, research assistant at the MIT in 2012 and currently working as product manager at Meta, has even compared the game to a CAD software^[41]. Multiple institutes and schools have used the game for education purposes throughout the last decade on a variety of subjects, from science to history.

Minecraft® does not have its own currency or a marketplace. Even though it facilitates the creation of economies within each server, the game itself does not have any real economy like other platforms and doesn't allow users to exchange their physical money for a digital counterpart. Microsoft, the owner of *Minecraft*®^[42], believes introducing monetary concepts to the game would destroy the entertainment purpose of a game^[43].

Fortnite®



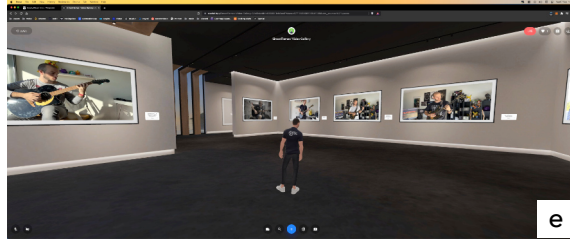
Released in 2017, *Fortnite*®^[44] is the closest prototype of the metaverse. Even though some of the features present in Second Life over a decade earlier aren't present, they are vastly overshadowed by how modern Fortnite is and the large scale of users. The CEO of Epic Games, the company behind it, Tim Sweeney is very vocal about his interest in developing the metaverse, which shows in Fortnite's development. While, at its core, it's a game, it has slowly been shifting into a social platform where users can interact and experience different kinds of cultural activities^[45], one of them being gaming. The platform has hosted a plethora of music concerts from large names such as Ariana Grande and Travis Scott, acted as a hosting spot for franchises to promote upcoming movies and providing digital art galleries^[46] users can visit.

The company is partnering with different IPs like the Marvel Cinematic Universe, Jordan and the NFL^[47]. With this strategy, the company is gathering a collection of different cultural brands and integrating them into their platform. This approach is referenced in the 2011 book and sequential movie Ready Player One, where the characters spend large amounts of time in a metaverse. Inside, a lot of cultural characters like the Iron Giant, Jurassic Park and Godzilla are present and users can utilise them as their avatars. It's very similar to what *Fortnite*® is trying to accomplish with their partnerships and, even though it is not an hyper realistic virtual reality world like the one on Ready Player One, the concept of a virtual world where multiple IPs exist and interact with one another is becoming a reality.

The virtual world runs on the V-Bucks currency, convertible from any local currency through the Epic Games' store^[48]. Users utilise it to purchase assets in the platform, as well trading with other users. In total, Fortnite generated \$9 billion up until the end of 2019, although, since then, the platform has more than doubled the user base into 350 million, becoming even more valuable.

Fortnite is the leading platform developing the metaverse right now in a centralised manner. Although it's still early in development to know how decentralised counterparts to Fortnite will evolve to compete in the market, bringing newer technologies like blockchain and smart contracts, it will be important that they partner with big brands in order to attract users, as is the case with Fortnite having the Marvel Cinematic Universe, probably the biggest franchise in the world.

Spatial



Spatial^[49] differs a lot from the previous platforms. While they are either a game or game-like, Spatial is not and it's clear from the moment we login. It's not an open metaverse, there are specific purposes the platform is built for. Spatial was launched in 2018 with the purpose behind to explore augmented reality by expanding the canvas of our computers, while also being able to connect users from around the world by bringing them into our rooms. It allowed remote collaboration without being physically together with tools such as brainstorming and sharing of 3D AR models^[50].

Recently, the company has started to shift their roadmap into leaning towards the concept of the metaverse^[51], it is promoted as a metaverse for culture, exhibitions, events and experiences. VR compatibility gives the platform a new dimension of immersion by allowing users to get inside the spaces and interact directly with the activities in them, which, in turn, brings out a more realistic experience to others as the movement of the body is portrayed as it is in reality.

The design choice leans towards a realistic approach and the avatars, although not as realistic as Metahumans by Unreal Engine^[52], are a step above all platforms mentioned here. Spatial integrates with the platform Ready Player Me^[53], a name inspired by the book and movie Ready Player One, that allows users to create their avatar and use it in any metaverse platform compatible with their API.

The platform allows users to utilise spaces to create virtual hosts for cultural events. There's a variety of default designs, from galleries to offices, but it's also possible to upload your own 3D model^[54] from standard formats such as FBX. After the design is scaled and placed in the world, we can use the built-in tools from Spatial to bring it to life to allow visitors to interact with it. It's possible to upload any kind of file to the platform, including photos and videos, and put them on the walls like a virtual painting or monitor, along with sticky notes and even a browser. Although Spatial doesn't run on a blockchain, unlike future examples, it's possible to integrate a web 3 cryptographic wallet to allow the platform to read blockchain content, through which users can exhibit their NFTs.

Despite still being in an early development stage, the diversity of experiences possible with Spatial is exciting. We can create virtual museums 3D modelled to blend with the storytelling of the exposition, which is not possible with physical museums. Though we can redecorate a museum, we cannot change the building itself. An art exposition about sea life can be exhibited in an unreal building, where the walls and the ceiling are made of water and the floor is made out of sand from the bottom of the ocean. Maybe we don't need a building at all. With the rise of digital art, maybe a new form of hosting expositions should be created for this new genre, one that lives in the same realm as the art itself. Instead of having our photo libraries on an infinite

bidimensional list in our phones, we can have customised 3D spaces where each room resembles the memory portrayed from the photos.

Inside a space, we can locate portals to another and link different experiences. If you're creating a digital representation of your creative mind or a portfolio of your work, you can link between each category so that each has its own design. This level of interaction between art and space brings another layer for architects designing spaces for culture. While physically we need to be worried about designing a space that is neutral enough to host any art piece, this allows us to design specific spaces for each exhibition, with the freedom of design that the digital environment allows us. These possibilities are currently available with Spatial and we can live them on our computer and phone screens, but also in virtual reality.

From the original release roadmap, Spatial has always been a great platform for work related digital experiences. Just like zoom, we can use our webcams, with the video showcasing on top of our avatar^[55], but also share screen and have it become a small or giant projection in the digital space. Instead of the screen forcefully the centre focus of our work, it's just another piece of the work canvas, along with 3D models, sticky notes and various elements that surround us. With virtual reality, we can all use Spatial to share the same space and work together with tools that immerse us in what we're doing and not with the tools themselves.

Decentralised Platforms

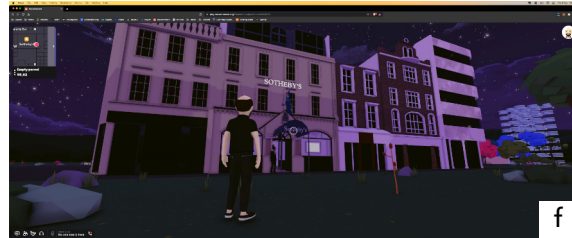
With decentralisation, the hosting of the network connecting users is distributed amongst several computers around the world through a blockchain. The most popular examples are Decentraland, The Sandbox and Voxels. While running on smart contract enabled blockchains, they have input from a larger amount of users than their centralised counterparts. The code is open source and upgrades to the platforms can be proposed by anyone and voted by holders of the native cryptocurrency of the platform through a governance protocol^[56].

The assets are interoperable and exchangeable and platforms' currencies can be exchanged, therefore users aren't blocked from removing their money from a platform they're no longer interested in. The currencies' worth becomes more volatile since it's not managed by a company, instead it comes from the value the platform has, along with some speculation, and how many people are actually using it. A platform running on an Ethereum or similar blockchain, cannot be shut down, which protects users from losing their assets.

Unlike centralised platforms, users decide on importing or changing features from new platforms on the market. Although this might be good, it might instead make users move from platform to platform, keeping their existing assets through their web 3 wallets, and leaving behind dead platforms on the blockchain.

Although it's still uncertain how effective this model will be in the longer term, it can allow creators and developers to work for a multitude of platforms and make a living through usage of their creations. As the interactions and end product are all digital, workers can achieve a complete independence on managing their work. As the quality of the product is what matters for monetary value, creators will always be incentivised to make high quality work, instead of relying on releasing a lot of bland content that blends with everyone else's.

Decentraland



Founded in 2015 and released in 2020^[57], Decentraland quickly became one of the most popular decentralised platforms for the metaverse. The cartoon style visuals explores a very colourful art style commonly used in the gaming world. The user base so far has peaked at 300K monthly users^[58], way behind centralised platforms.

It operates on the Ethereum blockchain, which removes a single entity from owning and deciding changes to the digital world and moves the power to the users. The Decentraland DAO^[59], Decentralised Autonomous Organisation, allows users with governing rights to vote on changes to the platform via smart contracts. To participate, it's required to hold Decentraland's token on the Ethereum blockchain called MANA^[60].

The virtual world is composed by a pre set number of 90 601 land parcels^[61] organised in a grid layout on a flat terrain. The number of parcels can't be changed to keep their value through scarcity. Owning property in Decentraland would keep losing value if the number of properties available kept increasing, as well as too many parcels could lead to many ending up empty as demand wouldn't be enough, leading to a worse experience^[62]. A parcel's value moves accordingly to levels of interest in the platform. For users investing their money by acquiring land, it's important to do so with the goal of developing the property to have return over investment. One of the biggest successes in Decentraland is ICE Poker^[63], an estate where users gather daily to complete challenges by playing poker against each other, where, not only does the owner make money in commissions from the games, but also raises the value of the land itself and the ones around it by turning it into a desirable and prestigious spot inside the world.

Land parcels can be merged into estates to become more valuable. At present time, individual parcels on sale start at 4 200 MANA, over \$3000, and can go all the way up to a million MANA^[64]. The most expensive land sale to date occurred on the 23rd of November 2021, when the company Tokens.com Corp bought Decentraland's Fashion District for 618 000 MANA^[65], equivalent to 2.4 Million dollars at the time. Brands like Samsung^[66], Nike^[67], Domino's^[68] and Sotheby's^[69] have also made their presence in the platform, presenting new ways of offering their services.

The Sandbox



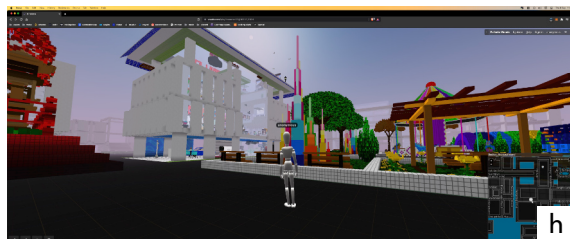
The Sandbox^[70] approaches the metaverse like Decentraland, although their development process is different. It's launching the platform slowly through alpha seasons to allow users to try it and give feedback. As of the end of 2022, there have been 3 seasons launched to the public. The company behind it is keeping development closed before launching the DAO, opting to create the technology, the tools and mechanics before giving power to the artists^[71]. Even though it's a platform that allows users to create games on it, it blurs the lines between a game and a social platform, like *Fortnite*®. The visual style resembles a mixture of *Minecraft*® and *Fortnite*®, something easy on the eye but also on processing power.

There's a lot of hype behind The Sandbox, it succeeds games with the same name released on iOS and Android years prior that got over 40 million downloads^[72]. The platform has acquired big partnerships through 2021 and 2022, which include popular artists like Snoop Dogg^[73], Avenged Sevenfold, Tony Hawk^[74] and Shaun the Sheep, as well as game publishers like Square Enix^[75] and ATARI^[76]. Big names helping the development and participating in the virtual world will attract users to the platform like it did for *Fortnite*®.

Users can play experiences created by brands and artists, but it's also possible to create them yourself if you own land in the virtual world of The Sandbox. The game creation tool developed by the company behind the platform, Pixowl, is very easy to use and anyone without coding skills can create a game. The diversification possible is something only a platform based on user-generated content would allow for.

As it runs on the Ethereum blockchain, everything within the game is owned by users as NFT's and the currency of the platform is \$SAND. Just like Decentraland,\$SAND is used to buy and sell assets and land and to participate in the project's governance and security within the blockchain.

Voxels



This platform, previously known as Cryptovoxels, can be described as the decentralised *Minecraft*®. The cubic design looks very similar to Microsoft's game, which The Sandbox also approached, but with their own little twist. Users create their buildings by placing blocks in the world.

Voxels^[77] is also built on the Ethereum blockchain and uses its native token, \$ETH^[78], for all the transactions of assets inside the virtual world. It runs on any common browser to be more accessible to anyone. Users' accounts are registered through their web 3 cryptographic wallet that allows them to receive and use the digital currency, as well as verify the ownership of assets. Unlike Decentraland and The Sandbox, at least for now, Voxels is compatible with virtual reality^[79] which brings another dimension of immersion.

The virtual world has a similar infrastructure to our physical world. It organises itself through roads and individual property, the latter where users can develop and design their own creations. The platform, like the others mentioned, uses a model of scarcity towards its land management. The availability of land to purchase is limited to a predefined number. This topic can have some benefits and downsides, as mentioned on the Decentraland topic, but will be developed later on. Depending on what's created inside the lands, different types of events can be had. Due to the flexibility of the platform, not just by the abstract design but also the built-in scripting, users can create many different types of interactions from parties to educational activities. With the deep integration of NFTs on Voxels, users can use assets they own on their wallets that are also used in other metaverse platforms like Decentraland. The platform is currently developing the technology to allow users to use augmented reality to insert objects from the physical world into Voxels. Although designing these properties is easy enough for anyone to do it, architects have the skills to do something better and interoperable, able to be used in all of these platforms, and more relevant locations will be centred where unique buildings are located.

The Technology

Casual interactions with the metaverse won't require high levels of knowledge on how the underlying components that make up the metaverse function. Just like how we interact with our gadgets and apps currently, Web 3, the foundation where the metaverse will build upon, will become just as easy as the technology matures and fades into the background, allowing the applications that interact with the software underneath to be intuitive so that anyone can enjoy the new internet update.

To be a part of improving the metaverse, basic knowledge of the core technologies behind the decentralisation of the web is required, in the same way that, to design a building, it's required to understand concepts of construction and structure. Therefore, an architect wanting to explore the potential of 3D spatial design in the metaverse needs to comprehend how it works, even if not to the level of what the developers working on the space do. Understanding between both design and programming sides of the team is key.

Here, we will describe the very basic of the following technologies: blockchain, cryptography, cryptocurrencies, smart contracts, decentralised applications, non-fungible tokens, how they all blend to create the web 3 and the ways to interact with it, virtual and augmented reality.

Blockchain

The major technological advancement allowing the concept of a metaverse to move closer to reality was the blockchain. As the population moved more of their daily activities into digital environments, the amount of data being produced has increased. Up until 2005, around 5 exabytes (50^{18} bytes) of data had been produced by humans^[1], as estimated by, then CEO of Google, Erich Schmidt. In 2020, 59 zettabytes (590^{21} bytes) were produced in total^[2], according to Statista, a massive 59 000x increase in just 15 years. With such large amounts of data produced, the easiest way to store it with available resources has been by creating massive buildings designed to hold this information. Currently, Google owns 23 data centres all around the world^[3] while Microsoft has 200 of these large buildings^[4]. Storing data this way has led to problems with the ownership of our online presence and, as we keep moving towards more digital interactions, more of our lives will be owned by companies, who are able to change the way we think and act in society^[5].

Although the original technology sources from 1991^[6], designed to time-stamp documents by taking the fingerprint of digital files to prevent others from tampering them, it wasn't ready for the vital role it will have in our digital future. Blockchain technology got upgraded in 2008 when someone under the pseudonym Satoshi Nakamoto published the Bitcoin whitepaper^[7], with sub sequential release in 2009. It innovated by combining different existing technologies into one single blockchain. The bitcoin blockchain created by Nakamoto has the goal of creating hard money and decentralising its users from a central monetary entity, allowing peer 2 peer transactions between anyone anywhere in the world, changing the ledger, previously owned by central banks, to public.

A blockchain consists of blocks in linear chronological order. Every block contains a certain amount of encrypted data that's added to the chain when it hits the size limit. Each has its own ID and the ID of the previous block. Blockchains can store different kinds of data. Bitcoin only holds a list of transactions by registering the account that's paying, the one that's being paid and the amount of the transaction. Ethereum, the second most popular blockchain currently, functions as a decentralised computer running applications, possible by smart contracts. Instead of data centres, property of one single entity, storing all information, blockchain allows everyone to own their data as part of a shared and transparent database.

The first generation of blockchains, like bitcoin, relied on proof of work technology, in which computers are presented with demanding tasks to complete. Users taking part in running the networks with their own computers, known as miners, spend a lot of energy and money. To compensate the expense, incentivise the continuation of the nodes running and promote security, these users are rewarded with a monetary token. This is a reason why many blockchains have a financial aspect to it, leading to the existence of cryptocurrencies and their value. The security and well functioning of the network is important and keeping it running will help their investment long term. New blockchains have used a proof of stake system, where users lock up assets to keep the network running, which requires less computational work and is more scalable^[8].

Anyone can participate in the network with their own computer^[9], therefore, a globalised system can work without a single entity's control. Blockchain improves transparency by allowing direct communication between 2 parties and moving trust from a third party to an open source code that works, is immutable and which data is incorruptible. As a decentralised platform to which every can contribute, it promotes collaboration between different parties as the institutional gains are shared across everyone, while databases and services owned by various central entities can promote certain levels of competitiveness.

As the digital space transforms and evolves into a global distributed cloud computer infrastructure, more of what we interact with will be hosted on blockchains. It's important to consider the fact that, even though the metaverse can run on the current landscape of centralised servers, its foundation may require the mass adoption of blockchain technology in the digital space. To own a digital asset, one needs to own the digital fingerprint of the asset and have it registered in a blockchain, a public database where transactions and ownerships are stored.

Cryptography

For a public database accessible by anyone around the world, it's required for security measures to exist and allow data inside the blockchain only be controlled by their rightful owners. For Bitcoin to work, a public ledger where every transaction and balance are visible to everyone, only the user that owns their account should be able to make the transactions or access the funds. With Ethereum, a blockchain we can own and exercise more activities like voting, owning assets and using applications, the same applies where the account representing the user should only be controlled by the user themselves, certifying that every transaction of data is valid.

Cryptography is a method for protecting information through code, allowing only the receiving end of the message to read the information, and works at the core of blockchain technology^[10], ensuring that every transacting between the user and the public database is secure and not tampered.

It works through the process of encrypting a message, into a cryptogram, by altering the way it is perceived using the cipher, a set of encoding rules, like replacing the letters in a message with ones a specific number ahead^[11]. The receiving end of the message will receive the key to decrypt the code. It's impossible for any cryptogram to be unbreakable as they always follow rules, however, the combinations tend to infinity, which in the case of Bitcoin's encryption, would take more time to decipher 1 code than there has passed from the beginning of the universe^[12]. To access a blockchain, the user needs access to the private key, which is a cryptographic key that decodes access to the public key on the chain.

Cryptocurrencies

The bitcoin blockchain works by having digital assets registered on a public ledger, whose ownership belong to each user represented by a cryptographic wallet. Bitcoin was the first fully functioning of this kind and, so far, the safest, named cryptocurrency. These will be a key part of the metaverse, which will be detailed later.

Although, since Bitcoin's release in 2009, many different cryptocurrencies have been released, each with their unique use case, the core concept remains the same. They are used as means to interact with a blockchain and represent monetary value in the digital space. Each blockchain has its use. In Ethereum's blockchain, the Ether token is used as a gas fee to interact with the virtual machine^[13], while other cryptocurrencies are used as governance tokens^[14], amongst others. Bitcoin is known for being a store of value in the cryptographic space.

The value of a cryptocurrency can depend on various factors, generally from how much they're used to just hype on its future. A coin like Ethereum is valued by how much people use the virtual machine as well as all the apps that run on it, like Decentraland or The Sandbox. Those have their own tokens inside the network through the protocol ERC-20 (Ethereum Request for Comment)^[15] and work like an app inside a computer. Polkadot, a layer 0 blockchain, is like a network where you can build multiple Ethereum-like computers on top^[16], each with its own apps.

Due to these tokens living natively inside blockchains, the metaverse can have the process of buying, selling and owning assets in this digital space more efficiently, automatically and without third parties.

Smart Contracts

This technology is becoming one of the most important in the space and have a promising future^[17]. An agreement between 2 sides has needed to be verified by a 3rd party, but smart contracts allow to replace the human verifier by trusted code in the blockchain, removing reliance on centralised systems and makes these contracts immutable, impossible for a malicious party to tamper it to their benefit.

The open source code is law and will act exactly according to the inputs of the users. It acts on a set of if/then rules, meaning that if certain conditions are met, a pre defined outcome happens automatically after the deployment of the smart contract.

As blockchain technology becomes better, faster and scalable, we maybe see smart contracts being used everywhere, allowing for true internet of things to exist^[18]. Oracles, which are verified entities, can input real world data into the blockchain to automate services like weather analysis or traffic management^[19].

Vending machines operate similarly to a smart contract. A user inputs the money and the number of the row the item is located at, and the machine outputs the action of pushing the item to the user. It can't decide not to operate as it's not part of the code.

dApps

dApps, short for decentralised applications^[20], are the interface through which we interact with the metaverse as part of Web 3. To understand a decentralised application, we need to compare it to the apps we currently use on our phones, tablets and computers. dApps have the same goal as those with a similar user friendly interface, what changes are the technologies which they run on.

They can be a social media like Twitter, a finance app like any banking one, a search engine like Google, a marketplace like Amazon or a game like *Fortnite*®. These genres of dApps already exist, like Minds^[21], Uniswap^[22], Presearch^[23], OpenSea^[24] and Decentraland^[25], respectively. These run on a smart contract compatible decentralised network, like the Ethereum blockchain, and work peer-to-peer.

The earliest example of a dApp goes back to 2001 with the release of BitTorrent^[26]. It allowed file sharing between users around the world with no centralised servers. With advancements in regards to blockchain, applications currently allow for more complex tasks like graphic interfaces for games or explore 3D virtual worlds.

While on a centralised app users interact with it by sending and receiving data from the company's servers, a decentralised version of the same app interacts directly with the code, paying very small transactions in the blockchain's native cryptocurrency to those running the network anonymously and automatically. Their code is open source to keep transparency and anyone can contribute, as long as the majority of users approve the changes.

Non-Fungible Tokens

NFTs, short for Non-Fungible Tokens, are a big part of what makes the metaverse so appealing to architects and other artists. NFTs are a contract on a blockchain that certificate that an asset is owned by someone^[27], similar to what a deed signifies to property owning. Represented on the blockchain as a token, these assets can be bought and sold like any property in the physical world, except they don't require any 3rd party to validate the transaction. Unlike a cryptocurrency, where every token can be exchanged by another, as any of them represent the same and have the same value, an NFT is scarce, each of them is unique^[28]. Even though, in the digital space, it's

possible to make numerous copies of the same file, a file on a blockchain has a unique ID that cannot be tampered with, therefore, an NFT contract will always give ownership value to a certain file or asset, something that has never been possible before in the digital realm.

When utilising NFTs on Web 3 platforms, like the metaverse, they will read blockchain data to verify users' NFTs to allow them access to content or other utilities, like using digital assets as clothing or art in the metaverse. Without this technology, features and automation like this would not be possible.

Web 3

The interaction between these technologies approaches us to the concept of web 3, expected to become the future of the internet. To understand the concept, it's recommended to understand how the internet has developed since its inception and the problems it has that the next generation seeks to solve.

The first generation of the internet ran from 1991, when the first webpage went online^[29], to around 2004. It was a very simple system in which the websites acted like virtual public documents visitors could read. The focus was on delivering information faster than other services available at the time. Websites were static, the same for every user, and had no interactivity, only the owners of the website could input content. There weren't large amounts of data without interactivity and advertising wasn't profitable.

The transformation into web 2, first highlighted in 1999^[30], gained traction around 2004, the year when the first Web 2.0 Conference took place^[31]. This event highlighted the benefits of web 2 as "customers are building your business for you"^[32], shifting from a 'read only' model to one more interactive through which users could input content. Websites like Amazon began allowing users to review products and Youtube was launched^[33], letting users upload their own videos as content, later reviewed and commented by other users.

Eventually, users became the content creators^[34], delegating the companies to hosting the websites they interact on, now known by social media. By interacting and spending more time with these platforms, user data increased exponentially. Companies like Facebook and Google gathered more information that allowed websites to become more dynamic and personalised to each user.

Data the platforms gathered became a commodity companies sold to 3rd parties^[35] as a way to be profitable without costs to users. This model highlights how users' don't own their digital presence, the platform hosts do and can do with it as they want^[36].

By combining the previously mentioned technologies, it's possible to build a web that tackles these problems. Web 3 seeks to decentralise the internet by removing power and control from large enterprises using blockchain technology^[37]. It allows content hosting platforms to be moved away from centralised servers as the data can now be running on a blockchain.

Virtual Reality

Although there will be many ways to interact with the metaverse, it seems like the main one will be through virtual reality. VR allows us to fully immerse in computer-generated environments, making virtual scenes feel as if they were real. It was first experimented in the 1950's^[38] and is now growing in popularity in multiple industries like medicine^[39], education^[40], entertainment^[41], tourism^[42], architecture^[43] and manufacturing^[44].

It works via cooperation between hardware and software that absorb users into the experience, making them a part of it and not just a viewer from the exterior, like other non immersive virtual experiences, like playing a video game on a regular monitor.

The hardware component is what most associate with VR as it's easily recognisable. Our bridge of interaction with the digital realm through VR is an headset composed by a group of sensors, to track the users' movement, headphones, to sonically immerse in the digital space, and the screens. There's a screen for each eye that, together, allow users to see one single image as if no screen was there. It's designed to block our view of the physical surroundings through peripheral vision to fully immerse in the digital world.

VR headsets commonly are paired with hand controllers that better analyse the movement of the body, as well as allowing users to control their avatars to interact with the digital world. It's also possible to use external sensors, like cameras or infrared sensors, around the room to analyse the users' movements. There's companies working on suits that will better track every movement from the user and reproduce them on the avatar, but also use electric signals to allow users to physically feel the same as their avatar, like touch or the wind.

The software component transmits the data from the digital world while analysing the one from the headset and other equipment to adapt the user's avatar to what the user is physically doing, the direction they're looking at or the movement of their body.

Augmented Reality

Although virtual reality is an exciting part of how we might interact with the metaverse, not everyone's excited in the concept of removing ourselves from physical reality and immersing into a virtual digital one. One of the prime examples pushing towards a future where the metaverse develops via augmented reality is John Hanke, the CEO and founder of Niantic^[45], the company that brought AR to mainstream attention with the release of Pokemon Go in 2016.

The video game industry have been leading ones developing and adopting emerging technologies. Unlike VR, augmented reality uses the real world as a foundation and overlays digital content over it, amplifying physical reality instead of abstaining from it^[46]. It's already more accessible than VR as it doesn't require any additional equipment than what the user already has. It can be used with any smartphone by simply pointing the camera at a scene and it will display the virtual world on top through the screen.

Hardware wise, the goal is to move the sensors and screens into glasses. Instead of looking through a small screen to watch a portion of our environment be augmented, the glasses will allow all our surroundings to be overlayed and become more natural and real. The challenge with those glasses as gadgets we wear lies on making them look like a normal pair of glasses and being light.

As the technology evolves and data servers with information grows, it'll become possible to create experiences in real time according to where and what the user is staring into. These can be historic reenactments in locations where they happened, information on products when shopping, visiting a museum^[47] or a monument walked by, control information and data on manufacturing machines^[48], and others.

For architects, AR is extremely useful by allowing to preview in real time 3D models of the design and its details before moving into the construction phase, saving time and money in the process.

Decentralised Economy

In a future chapter, we'll be researching and understanding some of the main experiences possible with the metaverse, but first we need to understand how the economic side relates to our current economic system and how it can benefit architects and other creators involved. As the internet developed, content shifted into being generated by those using the platforms^[49]. Social media's entire concept revolves around users posting content so others can interact with it. However, as it stands, no user owns their content. When a video is uploaded and shared on YouTube, the creator is giving the rights to the host of the platform, who can then censor or change it. Web 3 will give birth to a creator economy by allowing content creators to own the rights to their content and share it via decentralised platforms. This economic system needs to be safe and fair to all parties involved as well as improve upon the current one existent on Web 2.

Automatisation

Smart contracts play a huge part in this economy, they show blockchain projects can benefit architects and other artists in a way that has never been possible before in traditional markets. When a metaverse architect sells a design to a client, it's minted into an NFT through the smart contract. Like any traditional contract made between a buyer and a seller, the sale price, outright or through instalments, is written down as well as what the item/design being sold is.

This technology allows artists to predefine an amount of royalties that trigger on every further sale of the NFT^[50]. Not only does the architect profit off the direct sale of their design, but if the owner eventually decides to sell the building to another person, the architect will profit again a percentage, according to what was set on the contract, and so on with future sales. Since this process is written on the blockchain, it can't be changed or tampered, the entire process is automatic.

This business model favours creators^[51] compared to traditional ones since they still get monetary value off their designs when they're used in the metaverse for different

occasions and get a reputation of their own. The smart contract can create royalties over NFTs that are associated with the design. What this means, for example in a situation where the design in case is for a metaverse museum or concert stage, for every ticket sold for a performance on that design, its creator can earn an automatic small commission. To put matters into perspective, imagine NBBJ, the architects behind the Crypto.com Arena, the former Staples Centre, earning a small commission on every ticket sold for every LA Lakers NBA game. The owners of architectural pieces in the metaverse are incentivised to raise the value with positive experiences in order to make return over their investment.

Decentralisation

Bitcoin has revolutionised the financing world by introducing a trust-less system, entirely digital, in which users can exchange without requiring a middleman. In the digital realm of the metaverse, where information travels quick between users, decentralisation becomes a necessity.

Unlike the Web 2, which was built by big centralised corporations, this new platform is being built by the community. The code for each component is open source, published on a developer platform like GitHub^[52], and anyone can make contributions, as long as the majority of users agree with the proposed changes. The direction will be decided by the parties involved in creating the metaverse and those participating should be recompensed by their work.

This automatic system is written on the blockchain code and therefore peer to peer. Unlike the world's economic system, where central banks control the flow of money and the population's wealth, in the metaverse, everyone owns and controls their own money through their private wallets and transactions are made directly between users on the blockchain's public ledger. The traditional economic system, as it stands, doesn't work in a digital world as it's not built for a high speed information platform built by a community of users whose work improving it should be priority in economic benefits.

Adoption

This system needs to be considered viable for making a living for any creator working in the metaverse. Money on the blockchain needs to be legal tender and exchangeable into any other currency. Nations like the United States^[53], United Kingdom^[54] and European Union^[55] have announced that they have been researching Central Bank Digital Currencies^[56], a government owned cryptocurrency which might go after the stablecoins^[57] market, a cryptocurrency backed by physical money that is pegged to FIAT money, usually the US dollar. The country of El Salvador took a different approach and adopted Bitcoin as legal tender^[58], also funding some of its national reserves with the cryptocurrency.

This digital economy has peaked \$3T on November of 2021 and adoption is coming with businesses starting to accept digital currencies. In the metaverse, where creators use and receive such currencies, allowing them to be used or converted into other types of money is a positive into adopting the metaverse and trusting its economy.

Living in the Metaverse

Digital Experiences

The hype and investment happening in the metaverse from companies and investors comes from more than just the technologies being developed, but from what the end goal experience of using it is expected to be. As the project matures, we'll see more users adopting the space in their daily lives, which will bring even more use cases and experiences to develop.

In this chapter, we'll be looking at some use cases of the metaverse providing a space for experiences. Some are only considered a possibility in the future due to current limitations of the technology, many already exist with varying levels of success in different platforms. The metaverse can provide an alternative to activities we live in our physical world, with its own pros and cons, but can also provide unique experiences that aren't possible without immersing ourselves in another reality.

Recreating Experiences

By recreating experiences in the metaverse, we can change them to benefit the users. In the physical world, there's limitations we can't overcome, like physics, financial issues or even a matter of logistics. A modified digital version can overcome these and bring new levels of interactivity to people enjoying them.

By bringing them into the metaverse, it's possible to get more exposure and accessibility, similarly to how Youtube has brought the ability to view videos or documentaries to the masses and even the ability to create and showcase your own content. While location is key in physical experiences, their metaverse counterpart can be accessible by anyone with a way of entering the digital world. As it develops and adoption increases, the number might rival what the internet's currently is and digital experiences in the metaverse can have a large audience that, otherwise, wouldn't be able to enjoy the physical version of these experiences.

Although none of these will fully replace what we already have and will become more like an alternative, let's research some of the experiences the metaverse can recreate from the physical world, starting by my first experience using the metaverse.

My First Metaverse Experience

On February 9th, Samsung held their annual Unpacked event⁽¹⁾, where they present their new yearly flagship products. These presentations are held live in theatre rooms to an audience, but during the COVID pandemic, they shifted to pre-recorded videos hosted on YouTube and other social media platforms.



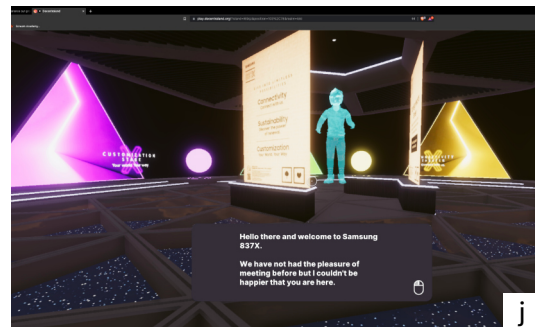
In 2022, the event was also present in the metaverse and it's possible that, in the next few years, not only will more brands start doing the same as it has success, but maybe they will be the exclusive hosting place of the event, as metaverse adoption picks up.

The event happened at Decentraland^[2], a metaverse hosting platform, in their digital venue 837x^[3], with coordinates 101,76. Samsung has a parcel of land isolated from others. When you travel to their location, everything is designed by them, according to Decentraland's visual language, which is a cartoon game looking 3D engine, almost like The Sims. There's a twin building of Samsung's 837, located in New York, with the immediate physical world's neighbourhood modelled for context, giving the feel that we are getting into a venue for a show.

There's an initial incentive for brands to replicate their physical buildings and offer users experiences similar to those offered in existing buildings the brands own. The entrance is signalled by a purple light, where you need to go through to access Samsung's world in Decentraland. Though from the outside it looks like we're in a real public place, the interior is completely different and spacial design here separates itself further from architecture of our world. After we're teleported inside, immediately we're presented with a tunnel entrance, created by a tubular pattern of lights circling around us, identifying where we're entering: Samsung 837X.

It leads us to a reception that looks from a sci-fi movie. Enclosed by light abstaining black circular walls, as if they weren't there, it feels like we're standing on a platform in the middle of space, the only piece that extends beyond this platform is the entrance portal. The surrounding void highlights what's located on the platform. Samsung placed big flyers highlighting the key topics of the day's keynote right at the centre. A voice is revealed explaining what's happening, the keynote, and the activities to partake in. Unlike in a physical event, where many hosts are needed to talk to each person individually, here there's only a pre recorded voice that only the user can hear while entering the space for the first time.

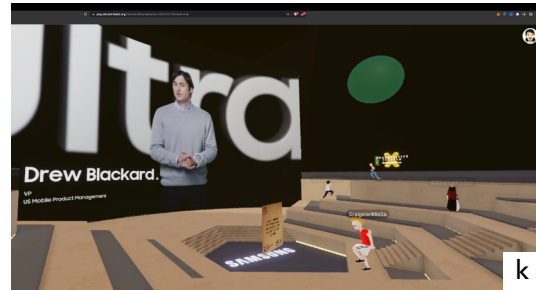
There's 3 coloured triangular portals spread through the platform that teleport us to different "worlds" inside the land. They are like doors to move between divisions, but, by removing the needs to be connected with each other that physical spaces require, why just design digital movement between different spaces like their real counterparts?



From here, we can teleport to as many different digital worlds as Samsung wants to. In this case, it's the 3 related to the keynote about to start. The purple portal leads to the Customisation Stage, where events like live music performances in mixed reality can be held. It's a big space with a performance stage at the centre, surrounded on top by big screens, simulating the experience of a real club concert in a digital scenario.

The green portal leads to the Sustainability Forest, recreating a forest digitally to showcase Samsung's goal to plant 2 million trees during the first quarter of 2022 with Veritree^[4]. In here, we can read about the cause and explore the lake and digital trees.

The main focus is inside the gold portal, the keynote theatre. It's designed similar to a physical event, we sit in the audience while a monitor the size of the room plays the transmission feed of the event. It feels almost like being in a digital cinema, we can interact and comment on what's happening with other people in the room.



There needs to be a reflection on why this needs to exist and why it's advantageous, as well as consider why architects should be involved since it's entirely digital and doesn't require parts of knowledge architecture has been using for years, like construction and urban integration. The key linking the metaverse with architecture is spacial design, shaping the future of the metaverse by the minds of architects like the physical world was. Considering the progress in the history of architecture, we can define a line of causation leading here, from ornamentation to minimalism, the world shares a trait line integrated with human history. Unfortunately for the creative minds, there's many curves this line needs to overcome that may detour the creative view. The metaverse allows artists to express however they want and it can be a beautiful thing. Virtual reality has shown us that these fictitious spaces can become real.

Watching Samsung's presentation in their virtual auditorium feels just like being in a physical cinema though virtual reality and adds many features, only possible with the digital realm. The volumes can be adjusted to our taste specifically, we can be share the auditorium with strangers or with just friends, we can hear everyone talk or mute people, blocking the "annoying person talking loud at the cinema".

This technology is aiming to change the digital interactions we already have on the current stage of the internet, possibly changing video and voice calls, message chats and the way creators share videos and live streams to something more interactive, almost like we're together.

This experience at Decentraland felt different than any keynote I've watched in the past on Youtube or any other website. The level of immersion by integrating 3D spaces is something that will shape the future of the internet and its design.

Concerts

As a music enthusiast, it's very exciting to see how the industry is adapting into creating musical experiences in the metaverse. One the ways we enjoy music's by going to live shows and the package that comes with it. Attending a concert is much more than music, we forms connections with other's that share the same interests. By going to an artist's show, we have conversations with people who also enjoy the same artist and have their own history and thoughts related to them.

Musicians often play shows in tours, promoting their latest album, which may have a certain artwork style or concept behind it. With live shows on these tours, the set is played around by designing it accordingly to the concept of their songs, with lighting, imagery projected on the background, costumes, objects on stage and others.

This iteration of shows requires budget to be a big factor to take into consideration, as well as the logistics of shipping equipment between cities for each show. Creativity mostly is restricted to bigger artists who can net the most amount of money out of their shows with bigger tours. Rammstein are known to have expensive concerts, carrying dozens of trucks between shows^[5]. As expected, medium and small sized artists can't afford the freedom some of this creativity costs.

Having concerts in the metaverse can be confusing at first, sounds just like watching a performance on Youtube or Spotify. This is a completely new experience, different to any other way to enjoy music and it's not a replacement for live shows. There's something special artists can create while fans experience and connect with their idols in a new way.

The biggest events in a metaverse platform made about \$20M^[6], performed in *Fortnite*® by Travis Scott and Ariana Grande, more than what their regular shows make. Snoop Dogg also announced he'll perform a concert in The Sandbox^[7], with which he has a partnership with.



The Sandbox is a decentralised platform while *Fortnite*® isn't. While the first 2 concerts were done in collaboration with the platform owners, Snoop Dogg's doesn't require that since The Sandbox is built for users to contribute and develop their own experiences. Decentraland had its first festival in 2021^[8], headlined by Deadmau5, an artist with 5,4M monthly listeners on Spotify. It's clear that there's a market for these types of experiences and a lot of creativity to explore with them.

Compared to physical performances, the metaverse allows for a broader degree of creativity, with collaboration between artists of different areas. Architects integrate in designing these experiences due to their skills in spatial design and 3D modelling.

We don't just design a basic stage, but the entire area where the performance occurs. When a festival sets up preparations, they work within the confinements of a specific location, like a stadium. In the metaverse, we design, not the stage, but the stadium, already in a way meant for that performance. We don't need to be confined to predetermined concepts of what a space for an activity should be. The way the metaverse can distinguish itself to attract the population is to take advantage of the infinite canvas it provides and bring out as much creativity as we can come up with.

In 2018, Swedish metal band Avatar released a concept album about a fantasy kingdom and performed live with a throne, props and every band member acted as a character from the kingdom. Representing this concept in the metaverse, we can go well beyond. Teaming up with a group of architects, designers and coders, it's possible to create a virtual experience through their fantasy kingdom while they perform in various areas, like a plaza or the castle. Architects have the work of bringing the concept to life by designing the city, the castle, organising public space, while the rest of the team works on the performance and the technical part of the project.

The metaverse music scene has the potential to transform music from a listening experience into a revolutionary new visual and interactive experience, similar to what video games have done for years, like in movie adaptations.

Cinema

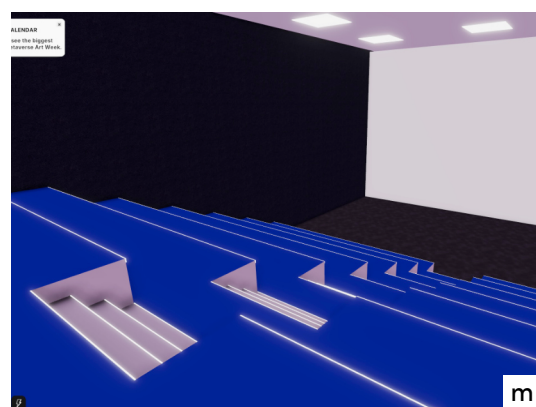
The film industry has been adapting to the digital space for years with the use of digital effects becoming more common by the year. When watching recent Marvel movies, it's hard to distinguish what's real and what's not. Though these movies are recorded with human actors, production is able to create an environment to place them on, either tweaking real locations or a green screen. Cities getting destroyed or imaginary planets are constructed on a computer so characters portrayed by humans can interact with them for the film.

It has been a pioneer in implementing many technological leaps throughout history^[9], since most companies have large budgets allowing them to resource from the highest quality technology available, artists and professionals. Higher quality media has become more accessible recently, causing the popularity rise of independent movie making. The metaverse opportunities for film makers will still favour studios with high budgets, but, with standardisation of tools, everyone will have access to them.

Metaverse film will develop along with the platform itself and the experiences coming out might vary. Like the decentralised nature of the technologies, these experiences remove third parties between the artist and consumer, generally the movie distributor. Though some experiences will likely fail to catch on, current developments can guide us into what the future might be.

The focus with metaverse film should be on how technology allows new experiences impossible without it. Architects integration with this art form depends on what development the industry takes. We'll analyse some possible options possible for metaverse film to explore and how architects can integrate their skills on them.

The blandest route is creating digital cinemas in the metaverse, inspired by the ones we've know for over a century^[10]. Groups of people sitting in a theatre room watching a movie projected into the walls can be easily replicated. This model has been done and is growing in platforms like Decentraland^[11] and CGV^[12], one of the largest cinema companies in the world, where users can enter buildings designed like a traditional cinema and watch movies.



As platforms incorporate VR technology, this experience will become more immersive. With eventual rise in popularity and bigger studios selling tickets to exhibit their own movies in the metaverse, smart contracts will play an big role in finance management.

The architect role here is easily comprehended due to the similar nature of the task. The process resembles the creative part of designing a traditional cinema, removing some necessary elements for designing physical buildings, like infrastructure and structural engineering. Architects need to make sure that the layout is intuitive, which should be simplified with the removal of components like sanitary or staff rooms, while also exploring creative design with form and material composition in ways not possible with traditional methods.

We Met In Virtual Reality^[13], released on HBO Max July 27th of 2022, is a documentary entirely filmed in VR where the character's are the users' avatars. This isn't likely to become the norm, specially in big budget film making, but it's an experience worth being aware of as there might be a market for them in the metaverse.

The key for success in metaverse film at the start is in bringing celebrity actors into the metaverse. The scenes where the action happens can be either a set or popular public places inside metaverse platforms, which should be designed by architects and landscape designers. It can be recorded as a movie or performed live like traditional acting. Designing a digital set will require skills in 3D modelling while collaborating with the creators of the film/play.

The finish line, however, surpassing all the previous experiences, would integrate viewers in the story being told by the filmmakers. Without the screen, users' can watch films as if they're part of it, an extra walking through Manhattan in a Spiderman movie. This concept to merge blockbuster film and best selling video games by creating the ultimate immersive storytelling, placing the viewer in the scene with the characters without requiring traditional filmmaking equipment, is enormous and would require large teams composed of actors, writers, producers, 3D modellers, architects, costume designers, and plenty of others.

Due to the amount of scenes present in movies, architects can design large digital worlds that match the story told by the writers, the same way composers enhance it with sound. Video games have recently explored more open worlds, incentivising exploration and storytelling, and the lines between film and games started to blur. The metaverse might be an experimentation canvas where they start to merge.

Education

The ways metaverse interacts with the education system leaves a lot of opportunities and work available. Education in the metaverse is a collective of experiences^[14] by itself and metaverse architects can take part in the majority of them. Though education has functioned for years with physical presence in schools, the 2020 pandemic shifted the paradigm and classes became digital. Results were mixed and, although some aspects were detrimental for students' results, others benefitted from the online behaviour. With the upcoming virtual world, immersive interactions between students and teachers are improved, which has the potential of mitigating or even solving the problems we had during the pandemic years.

Studying in the metaverse integrates both current education aspects, school and the internet. Approaching education through this method requires planning and research. Just like with cinema, the metaverse can replicate how schools currently work^[15]. We'd have digital versions of schools which students would attend through virtual reality. Classrooms and auditoriums designed similar to traditional physical ones would add flexibility for both students and teachers, like reducing commute times or even moving home due to school placement. Though this might be a start to experimenting with metaverse education, it's just a foundation for future developments.

Each subject can have its own different experience in the metaverse. Biology students can visit environments they're studying, with theory and examples taught by the professor. Medicine classes can be taught inside the human body or surgery rooms^[16], while pre-recorded operations in 360° play, which allows students to learn by practical real life examples. Astrology students can visit the stars like they're in space^[17]. There's no limit to the creativity and, by showing students real time 3D representations of theory's what's and how's, the platform might benefit students by becoming more active in learning^[18], in conjunction with the possible gamification of school^[19].

Architectural work is implemented very well in metaverse education with history class. With the amount of research done, architects can take part in recreating historical buildings and cities, allowing students to visit the past and learn from first experience. With architectural school, students can view the buildings professors mention and visit them to take look at the details and design. Construction models and structure can be showcased in realtime, allowing future architects to easily understand how things work. These educational platforms, located on the open metaverse, are always open and students can visit them anytime they need. Information can be overlayed on top of materials and art pieces to complement the study. Classic projects by famous architects can be 3D modelled and accessible, providing descriptions and the thought process behind the architect while designing it.

Articulating Worlds

Housing Designed by Function

The way we design architecture has constantly adapted to the way we live, as well as to the technologies available. The house taken many steps throughout history^[1], from very elementary organisational concepts of space into what it is in the 21st century. As more of our daily activities are performed in a digital space^[2], we'll tend to organise our houses to accommodate for it.

As experienced in the peak of the 2020 pandemic, with everyone quarantined at home having to perform tasks normally done elsewhere, like work and physical exercise, we saw stories of the population move furniture around to find solutions to allow home spaces to accommodate these activities. Desks with computers for work and large spaces in front of the television to exercise became a scene that happened in many homes, as well as the noise and interruptions while on video calls.

As the pandemic fades away, some of the changes are likely to stay^[3]. Work from home or hybrid schedules are looking to stay, some people have performed better from home and their location are irrelevant to the tasks performed, like call support, web designers, programmers, music producers and, in some cases, even architects. Working from home can help reduce commuting time, cost and carbon emissions^[4], giving more freedom to workers. This time was a hidden add-on to jobs and not paid. With digitalisation of tasks, society moves towards remote activities. The metaverse is gaining traction on the backend of this movement, aligned with a younger generation that's more connected with friends via online platforms^[5].

Conceptually, the house is the place where we're protected from the environment that surrounds us. Though, throughout history, developments on top of this core concept emerged with evolution of civilisation, with the house changing along with humans, the foundations remained. With nomadic humans, housing was simple, consisting of a single space where all activities were performed, there were no divisions and few pieces of furniture or decoration.

New daily tasks emerged as humans developed that required changing the house. Food and hygiene activities were separated from the sleeping area, giving birth to kitchens and bathrooms. Home divisions became more abundant through time, but the trend reversed leading into the 21st century's house^[6]. Different spaces created through centuries were merged. The modern kitchen, specifically, is a merge of separate divisions from the medieval times.

The open space concept became popular since late 20th century, allowing homes to feel more spacious and improve lighting. Higher quality of life has lead to a convergence in the distinction between houses of different social classes. Higher classes have become less distinct by removing rooms obsolete in more modern times, while lower social class housing has improved due accessibility of quality construction and appliances. Different social classes still have housing differences between them, but these focus more on size, quality of construction, equipment and design.

With the recent developments in digital transition and surge of popularity of digital nomadism, how this affects housing moving forwards needs to be considered, assuming the integration of virtual reality to replace activities previously performed in a different manner.

The combination of different divisions to create the kitchen, consequence of phasing out maids and slaves and delegating activities to housewives, assumes a different way of efficiently using space. When tasks are performed by one individual, it becomes more efficient simplify work positions.

Efficiency has been key in how we change the house. By removing walls between rooms, we simplify design and construction while amplifying the spaces and laundry is integrating itself inside home with the creation of machines. Technology changed how we performed tasks and lead to house intervention.

The way we interact with VR and AR technologies is not the same as a washing machine. While we can incorporate laundry in the kitchen or design a tiny compartment enough to house a few machines, the metaverse requires a decent amount of space^[7]. Recent VR models have incorporated cameras and sensors to analyse the surroundings to detect how far users are from walls and objects. Simple VR activities can be integrated in our living rooms, bedrooms and offices, but as they keep evolving, so will the rooms hosting VR.

Some experiences the metaverse might provide could required additional equipment from what's currently available. We have consider if a metaverse dedicated room^[8] should be added to future houses or if existing rooms need to be redesigned. Integrating this room in houses would need a big upside to justify its cost in an already expensive housing market. It would be a very simple room, maybe almost empty. Our surrounding's not important when interacting with the metaverse in VR. A computer station isn't a necessity^[9] computation can be sent wirelessly to the headset. The less clutter in the room, the safest, most pleasant experience is possible.

It's likely that higher classes, with more financial capacities, are gonna integrate rooms like this due to their bigger houses with less budget limits, similarly to how it's common for them to have more rooms like cinema, arcade, gym, pool, sauna, etc. Lower classes tend to merge and perform niche activities in common rooms. In most scenarios, it would be expected that most metaverse would happen in bedrooms, living rooms or offices.

With this method, home organisation might not change much. It's likely that design path towards minimalistic interiors and simplification of construction will become a preferred route as we welcome the metaverse into our homes. Decoration becomes a lesser necessity when time is spent more in virtual spaces than physical ones. The chairs used to compose space become an object we won't be using or observing most of the time and the paintings to illustrate walls become hidden art. Bedrooms reduce to a modest bed and little decoration to allow as much space as possible for us to move around in the metaverse.

If extra large accessories come to market, more passionate users may incorporate them into their room where they can explore all corners of the cyber world. With the reduced impact home might have on us, the biggest change might be the reduction in area from divisions becoming less important. Common rooms might start conceding area to private ones like the bedroom or offices. It will be important to analyse the patterns of housing designed for Gen Z's, a generation grown up on video games in their bedrooms to understand how housing design might change with the development and adoption of the metaverse.

Digital Twins

Digital twins are a representation of the physical world in a virtual environment^[10]. By using sensors, we can input data from our world into the virtual one to create a hybrid between both, where both are equal to one another. They are commonly used for infrastructure, allowing engineers to understand the current state of machinery without having to manually check, reducing costs on unnecessary maintenance. In architecture, research is being done to allow digital twins of buildings to identify their conditions throughout their lifespan, better identifying what maintenance is needed but also further research on construction techniques and material properties.

They're becoming a tool that's integrating their way into urban planning^[11]. By gathering data produced by smart cities, it's possible to create a virtual version of cities. In those, it's possible to use artificial intelligence to analyse new interventions to cities' urbanism before implementing them in the physical city. Cities Skylines, a game about urban planning, became very popular for its high level of detail and has been used by urban planners to test out projects^[12], effectively an early prototype of digital twins' implementation on city planning.

The metaverse will also be a part of implementing digital twins for its own development, virtual cities can be used for more than just improving the physical ones. Exclusive experiences provided by city leaders to citizens or virtual tourists can be implemented on digital twin cities hosted on the metaverse along with those described on the previous chapter, instead of platforms currently in development such as Decentraland.

They're another tool helping to merge both physical and virtual worlds, breaking down a barrier that would make them completely separate from each other. Experiences in the metaverse to be experienced in AR, placed on top of our physical world, will benefit from digital twin cities. Development of virtual experiences requires an environment to locate assets on. To place them on the physical world, hardware needs to analyse the location and compute how to integrate digital experiences on top of it. By implementing digital cities, computing requirements are lower as parts of it can be delegated to the hosting computer. By having assets placed in a digital twin of the physical world, AR glasses only require to see the physical representation of what's created digitally to represent the added content in the user's vision.

Metaverse Urbanism

While the metaverse isn't one singular digital universe, the way experiences are organised is important to allow users to feel comfortable exploring them in a natural way. Current metaverse platforms are divided between 2 methods: open world or private world metaverse, each has its own advantages and disadvantages.

These methods relate to what urbanism is to cities, a way of organising private space and design public space around to accommodate while benefiting social interactions. Architects can take advantage of both in different ways, so it's important to understand how each works. Accessing the metaverse is slightly different in each of them and the way we currently do might change as AR and VR is integrated.

Open World

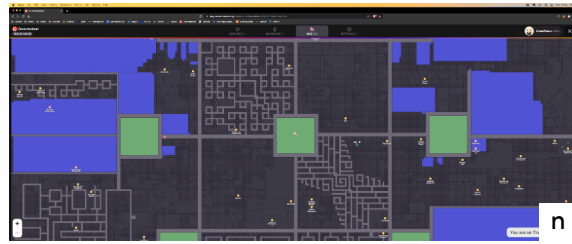
Open world metaverses are very popular, likely due to its relationship to the gaming industry. In video games, open worlds became more common in the 2010s in games like Grand Theft Auto V and The Witcher 3, with large virtual worlds brought to life by various characters. The metaverse is an evolution of GTA V, but each character's a different user accessing the world, instead of computer controlled character. Organising the metaverse this way resembles more of our physical world: a mapping of public infrastructure, that anyone can have access to, surrounding private parcels of land, which the population can occupy and repurpose it for their needs.

With the diverse number of metaverse platforms to exist, just like there's billions of websites on the internet, each can distinguish itself through various characteristics. Visual characteristics can be explored to create unique worlds, like underwater, anime, upside down, no gravity, but they can also focus on providing services. The metaverse described in *Snow Crash* inserts in this genre and suggests users entering the virtual world through their private spaces to not break the illusion to others, as the public space's population being hidden to those inside their private parcels.

Designing a virtual world this way is very interesting. Unlike its physical counterpart, the process is much faster by removing slow processes like legislation, construction and infrastructure. It's also worth noting the higher level of complexity physical urbanism has over the metaverse's. Digital cities can be updated in a matter of seconds and mistakes can be reverted.

Human input in their design process will change from how urbanism is traditionally planned thanks to AI and parameterisation. Houdini^[1], a 3D procedural software, was used to parameterise and create a large American city for the "The Matrix Awakens: An Unreal Engine 5 Experience"^[2], which worked better and faster than any human could.

Although this demo is too complex for what the metaverse could currently host, platforms like Decentraland host 16x16m parcels organised in a regular grid, detailed parametric complex urban designs might become a reality in the future.



Collaboration between designs in multiple parcels will allow the digital world to have a character of its own. Public space will be shaped by how parcels are designed, the same way facades of buildings create city street's image. This urban style of the metaverse is more familiar to architects and the design process more closely resembles traditional housing. Architects can integrate their designs with their surroundings just like any physical lot to construct on. Space is limited to the predefined size of the parcel, a limiting factor to design around, which in turn can lead to a rule to help lay the foundations of the creation.

An open virtual world where private parcels are visible to public space allows users to discover and enjoy designs and services by chance. Socialisation can be improved since users are able to see and access public space straight from own their parcels instead of being isolated in a private world.

Private World

A private world metaverse gives each user a virtual world not directly connected to others, like Spatial, Somnium Space^[3]. In theory, users get an empty virtual world or land and are able to design it with built-in tools or upload from 3rd party software like Unreal Engine or Blender, with much higher quality and realism.

This method allows for more privacy while giving the users a virtual representation of their own imagination. These virtual words allow for moments of self reflection, like being alone with our thoughts in a walk.

Krista Kim, artist behind Mars House, which was sold for 288 \$ETH, becoming the first digital building to be sold as an NFT^[4], mentions this as part of the inspiration behind the project.



Even though they're isolated from one another, it doesn't mean socialisation between users is not possible. In the mentioned examples, people can be invited and visit their friends' worlds, quickly moving between different worlds and experience a variety of creations. Big fans of anime will likely have worlds inspired by it and have it possible to watch episodes, while metal heads can have worlds based on their favourite bands with songs creating the world's sound. While they can be private and restricted with a key or portal, like a link to a website, users can also make their worlds public to allow more people to find it and interact with it.

The goal isn't just to create introspection moments for their owners but also to create public virtual experiences in the metaverse. Musical artists looking to perform in the metaverse may lean to these kinds of worlds for their performances. Previous performances, on *Fortnite*®, have been free and profits came from the sales of digital merchandise. As these experiences become more popular, it's expected they'll start selling tickets eventually. With this platform, users who buy tickets as NFTs can enter the hosting virtual world automatically, preventing others who didn't buy from accessing.

Creativity has different boundaries than an open world metaverse, mostly technical limitations such as polygon count or concurrent users, which will improve as technology evolves. Designers and architects can work with popular bands and artists to create worlds that visually illustrate the musical performances, changing with each song to fit the theme.

The downside of public spacing through this method is the need of portals to connect to it from each world individually or through a virtual map or common hub. Public spaces can resemble beaches, parks, bars, or anything really. The amount of design work coming from all these platforms and worlds about to surge is immense and, for any 3D artist wanting to explore the metaverse, these platforms are a decent way to start, get creative, learn and promote your own style in the freedom of isolated worlds.

Land Scarcity

One of the biggest criticisms about metaverse land usage is the scarcity factor present in most platforms and the requirement of buying land to be able to build on it like both of the most popular platforms, Decentraland and The Sandbox. Users can visit the world and all existing creations and experiences, but are unable to create their own or hire someone to unless they invest money into buying digital property. This model has been criticised by billionaires such as Mark Cuban, calling it a stupid idea^[5].

Preventing free access to owning and creating on the metaverse will limit diversity of the space. Prices for land at popular platforms currently starts at the equivalent of over \$3000, which is a huge barrier for the majority of the population^[6] wanting to casually test them. As the metaverse gets popular, this might lead to big brands owning all the available parcels in the most popular worlds.

This barrier limits who can develop the virtual world, but also promotes those willing to invest to have good intentions by creating interactive experiences in interesting designs, as to raise the profile of the land they bought and possibly monetise it. With large amounts of money invested into a project, more care will be put into it. Brands are more likely to hire reputable architects and other artists to work on their metaverse designs than teenagers who are still learning the craft, so it's undoubtedly expected that the quality will be higher with the former than the later.

Land parcels need some restriction somehow. Just like in the physical world, land to construct on cannot be owned by 2 different entities at the same time, where each is working towards constructing their own building in the same spot. Land is scarce, it's

that exact place and not another, with its defined characteristics and can physically only host one construction. This is the model most virtual worlds are exploring, and even though land has out priced itself from the majority of the population, you can't have 2 different designs in the same space and pricing is following the market's interest in these properties.

The way to avoid this and make the metaverse always accessible to everyone is by making an ever expanding virtual world where new land is constantly created for each new user. This idea theorises that, with more land available to create on, more experiences would exist in the metaverse, opting for quantity over quality. Allowing anyone to create on an ever expanding open world metaverse would likely cause areas of uninteresting and badly programmed experiences with plain and unpleasant designs that unqualified users would create, either testing, learning or just having fun, as well as uncompleted projects. Protecting these assets by creating a monetary barrier secures those willing to afford have meaning behind their acquisition, likely to the benefit of the virtual world.

Although private worlds are also sold to users wanting to put their own creations on the blockchain, in this scenario, worlds are not infinite. While, in the open world metaverse, we can have millions or even billions of parcels all in the same plan, private worlds don't. Each world is owned by an individual or entity. Everything is controlled by the owners. They can be a great platform to allow users to own their digital space in the metaverse privately, as it's their own world and no one can access it without an invitation, creatively, with everything in there being of control by the owner, and cheap.

Working in the Metaverse

Work Life in the Metaverse

Now that we understand what the metaverse is and will provide, we'll take a look at the creators behind it. Society has had strict and routine methods of implementing work into our lives. The industrial era changed how humans work. Previously, for example, a farmer would grow their own crops and sell to locals, growing their own business independently and keep the profit to feed their family, but industrialisation has made such work obsolete due to how quick production became with industrial machinery. Workers went from independent businesses, that are able to support their families, into requiring to work in massive factories for others to be able to survive. Those who were wealthy and entrepreneurs enough to negotiate their way into creating big factories first started to outsell the individual. The more they profited, the more they were able to hire even more workers and increase revenue.

Big factories created awful work conditions and social fragmentation^[1], which we have fought to improve with time, that made the worker class poorer while getting the rich even richer. This business model has lasted until the modern days. During rough times for society, such as recessions and pandemics, the worker class struggles while big industries make record profits. The Forbes Global 2000 from the year 2022^[2] cashes in \$233,7T in assets, while, individually, the CEOs of tech's top 5 account for a total of \$442B^[3], with Elon Musk and Jeff Bezos making up for more than 80% of it.

The approach of making the brand or company above the individual creator has caused work location to become a priority. Since we have become dependent of higher ups, where we live needs to be according to it, instead of what we want it to be. Portugal is known to have large portions of its population emigrate to other countries in search of better work conditions^[4].

While the metaverse is a new development and needs large scale examples of how it can impact the lives of the world's population, many of the key characteristics it looks to achieve and problems to solve allow us to analyse how it may play out in bringing change to workers' lives. The topics presented in this chapter can be adapted to most professions that work with a computer or other internet connected devices, while a later chapter will take a deeper focus on the architecture profession and integrating a metaverse business model.

The Digital Work Environment

Saying society will change from working in physical locations, under the supervision of their employers, and move into a digital environment, with no physical interactions with their coworkers or clients, may sound lunatic, like coming out of a science fiction movie, but, with reflection on how work has progressed through time, we can see that we're reaching a threshold where the only physical barrier we haven't crossed yet is space. Though manufacturing will take the longest to reach this digitalisation, Elon Musk's goal of creating machines that creates the manufacturing machine^[5] shows the goal is being pursued. For the majority of work, specially one that involves a computer, like architects, designers, accountants, producers, editors, writers and more, the metaverse has the potential to change these professions as we currently know them.

Since the first computers were built and developed into the small powerful devices we currently have, our usage of technology has increased and we've come to depend on it more than ever. Even a small device like the Apple Watch is faster^[6] than computers we have used in the past^[7] and we carry it on our wrist, while, previously, computers this powerful were large and completely unportable, occupying entire rooms. With the surge of AR and VR, we are going one step further into pushing technology more into the background while using it. It is expected that AR glasses will replace our phones in the future^[8], which will integrate technology even more in our lives and work.

Currently, we commute to specific physical locations to sort and work through digital files on a stationary computer, communicate with clients and third parties through email or phone calls and get paid in money, generally, through a bank transfer, so we don't even see or touch the money. We text colleagues, friends and family through smartphones, share our lives on social media, entertain ourselves with television, YouTube or video games.

Although virtual reality takes us one step further away from physical reality, the activities we currently do in a digital environment questions if we are still living in it. If anything, these technologies would allow us to distinguish the virtual realm from the physical more precisely. While using VR or AR, we would be in the digital space, either working or entertaining ourselves, actively connected, but by removing them, we become offline, no longer being able to watch the digital world. With smartphone addiction, we are constantly in a balance between on and off, always a grab and swipe away from losing our focus from the world we have in front of us.

By integrating the metaverse, we can remove the necessity of workplace being a limiting factor in people's lives and give them back the independence to live wherever they feel most comfortable at. As mental health has deteriorated over the last few years^[9], home can be a foundation to improve it^[10], which might, by correlation, allow better productivity.

While each profession has different requirements and function in different manners, we can improve our interactions while not being in the same physical space through the metaverse. In the same process as we did through the 2020 pandemic, the day doesn't start with long drives through traffic to a specific work place, instead, work place is located either at home or wherever the person wants. Each job has different requirements and, therefore, would integrate accordingly in the metaverse. Let's use the architect as an example.

While buildings are currently designed on flat 2D screens, this is not a necessity in the metaverse. As we are currently watching the evolution of apps like BIMx Viewer^[11] and ARki^[12], the 3D models we design on the computer are starting to be transported from the screens into being overlayed over our world through augmented reality.



They can be seen at any scale, either a small 1:100 model, like the ones commonly used by architects in the past, before 3D visualisation became easy, quick and popular, or even in real size on site, which allows architects and clients to have a tour through the project before it has even left the concept stage. It's expected that the integration between AR and 3D design will keep improving and getting more immersive^[13]. With AR, we can move the model on the computer and have it constantly on our floor or desk. A physical monitor is not a requirement because we can view a big screen or the drawings on the wall or desk and manipulate them with our hands. Virtual reality takes the immersion inside the design into another level by removing the physical space and only the virtual exists in our vision.

For a metaverse architect, these technologies work in the same way as they do for a traditional architect, with the major change being the end goal of the project. They can focus even more on the virtual visualisation of the design because that is ultimately what the project is, while, for the traditional architect, that is a representation of what the project will become. Depending on the approach taken with home design in the future as the metaverse is accommodated in our homes, the outcomes on how the work spot will look may differ, but the most important tools will definitely be visualisation tools, AR and VR headsets, which may merge in the future, as well as computers even more powerful than what we currently, sending the image and audio signals wirelessly to the headsets. We still don't know how 3D modelling will adapt in the future on a different platform. Currently, we are working with clicks of the mouse, while AR and VR are often manipulated with pointing and clicking with the hand controller, which is considerably slower and less precise. Research is being done on voice controls with AI, which we'll analyse later.

The production part of working through the metaverse might not deviate a lot from how we have worked from home in the past, except with the integration of new technologies which allow multiple parties from different locations to be virtually in the same place. Communication between a team and work colleagues is fundamental in many situations and, with existing methods, there is a barrier between both parties. A video call through a platform like Zoom or FaceTime doesn't portray the human interaction we have in a physical location. AR prototypes have managed to allow users to "teleport" into another's room^[14] and, with VR, users are able to digitally share the same space, where they can communicate more naturally than with a video call. Audio sounds like it's coming from where the person is located around us, we can point, stare at them and even whisper one on one in a group meeting like it's possible in physical reality. Meta is working on a platform for this type of communication with Horizon Workrooms^[15] and the same experience is possible on Spatial. Architects can create exciting designs for their virtual rooms to have meetings with clients and partners or the meetings can happen inside the projects themselves.

Although we can use these tools to create the experience of having an absolute virtual work environment, in which users can do everything like if they were in the physical counterpart, using VR to have a virtual simulation of a traditional work place, this might not be a positive outcome worth replacing how we work currently for. Not to mention that, currently, VR glasses can cause fatigue for some users while used for prolonged periods of time, we should use these technologies to revolutionise the way we work

by allowing them to change it for the better. Using them to replicate a model that is limited by physics and other technologies has never been the best way to implement change.

Focus on Skill

The quality of our work is based around our knowledge and expertise on the matter we're working on. The education system provides the basic tools to later develop on and become skilled workers, but, with the rise of online education, via paid courses or free YouTube tutorials^[16], younger demographics have been able to develop skills, independently, much faster than what was previously possible. Although when building a business or a company, it is obvious that hiring skilled talent is important, sometimes hiring decisions get complicated due to a number of factors, of which we may include location, discussed on the previous topic. These workers are able to get the job by being qualified, while, by remaining in the previous situation, they would not be compensated fairly for their skill. Not everyone is able to concede on moving far for a job which longevity is uncertain.

Assuming the metaverse transforms the way we work by allowing users to have more control on where and how they work, job distribution will change accordingly. A big company hiring for a determined task will increase the range from which they can accept employees and, by exchange, it also allows the worker to have a broader selection of companies to apply to. Although it is completely untested on current circumstances, the shift already has started with remote work and freelancing becoming popular, facilitated by the internet. While this can become a very powerful flexibility tool and promote improvements to worker's both personal and professional lives, it can also bring positive change to companies by being allowing them to select available workers that match the companies' profile and requirements without having to shape anyone from the smaller selection of nearby or move in workers.

By correlation, the development of Web 3 allows for some additional interesting changes that aren't possible at the moment. The automatisation of processes happening in the blockchain allows job hiring to be done through dApps that, with the assistance of AI, analyses the selection of candidates and determines which match the company's profile. Though it can still be filtered and confirmed by a human, this would save time on countless interviews where workers don't meet the expectation, specially considering that the amount of candidates would significantly rise with the rupture of borders with the metaverse. Continuous use of the this method increases the data that dApps have to work with and leads to more precise analysis, in the same way that Google has been able to improve accuracy while targeting users' searches.

The other alternative to consider is that the metaverse could allow freelancing to be taken to another level, according to the industry. As smart contracts and the projects details are programmed on the blockchain, workers can instead be selected for tasks by the blockchain, according to their skill. An application can distribute jobs accordingly to the workers available and qualified for them, which would be certified either by past performance or an oracle. Tasks would be selected by a larger pool of candidates instead of a small selection locked into a single company. This mechanism

would work natively for projects built in and for the metaverse, as is the case for metaverse architecture, and wouldn't require as many nuances or inputs as traditional work that involves the physical world, like construction. The platform behind this needs to be secure and efficient for it to work. Later on this chapter, this model will be proposed under a DAO, Decentralised Autonomous Organisation.

Redistribution of Profits

Digitalisation of society through the metaverse and concurrent technologies will eventually lead to the current financial system being left behind. With central banks researching into CBDCs, it is a matter of time before the world's finances live in the blockchain. Platforms that automatically distribute tasks through work need to also be the ones to automatically pay them to work. The lesser the human input, the more the machine will act according to the instructions.

By removing the middlemen in all transactions, we can guarantee that those who are putting the time and work into a project will be fairly compensated. By traditional methods, money flows from client to company and company to worker, involving a minimum of 3 parties, though, in reality, the money moves from bank to bank. The proposed blockchain system works between client and worker where they don't need to trust each other, just the platform, whose code is public. This way, the client's money is locked on the platform while the worker executes the job. By submitting the job back to the client through the platform, the money will be directed to the worker for a successful job. This system is very similar to what platforms like Fiverr⁽¹⁷⁾ rely on, just with the added technologies that would allow the removal of middleman fees. Users are protected by a rating system. By platforms implementing a Know Your Customer, KYC, system, those who cheat the system, by trying to scam others and taking their money without being honest with their work, are punished by being removed from the platform and not allowed to get back in.

Metaverse Architect

This new alternate reality of architecture design leads to questions about how current architects and offices will approach the space. With the metaverse being new, it will undoubtedly leave some with a foot behind, waiting to see how the field develops before getting involved. Others, more noticeably newer generations, grown on video games and other digital platforms, are more likely to take part sooner and get the advantages of being early in a new space. Some, meanwhile, will never want to get involved, either as a consumer or a creator. Each aspect can have an impact in the current field of architecture on different degrees, from how companies are formed and organised to how traditional architecture is produced.

Hybrid vs Exclusive Companies

Even without the emerging digital version of architecture, companies can be composed in multiple ways. Despite this, the end goal is the same, to design buildings and projects that will eventually be built in the physical world which humans and non-human animals can inhabit and use. The company in charge will work with people from different arts and sciences to make projects happen. Generally, an architecture company is formed by a group of architects that conceptualise the buildings and all their characteristics, like organisation, construction and design, and formulate those into blueprints with all the information from how that concept can be executed, from material choices to construction techniques, on the plot it was designed for.

Although metaverse architecture resembles it on the conceptualisation phase, it takes its own path on the execution side. Creating for the metaverse requires a different mindset which might, in the long term, separate both branches of architecture. While existent companies might explore the metaverse with small branches of dedicated architects working on metaverse projects, those entirely focusing on the space will get a clear advantage in experience and knowledge in technologies and which designs work best in a digital environment, which are different than what we are used to.

Existent architecture firms owned by reputable architects, with long track records of quality projects still have some advantages. An architect known by his peers and general population is more likely to gain trust on new projects, which is a decent way of getting exposure to the new space. However, a great experienced traditional architect doesn't necessarily translate well in the metaverse. Those who understand the space will be more successful and, even by starting experimenting under more reputable traditional architects, by gaining exposure, confidence and experience, they will soon eventually start exercising their own path and either create a dedicated firm for the metaverse, independently find their own clients or work under a DAO.

Decentralised Autonomous Organisations

With the decentralisation of the web and potential of workers getting independent from companies, possible through applications of the new web, some are exploring how code on the blockchain can impact management of jobs and tasks. Through a DAO, short for Decentralised Autonomous Organisation^[1], the technology seems to point that, somehow, it might be possible to replace a company with automatisisation.

A DAO is a group of users, represented on the blockchain by their cryptographic wallets, being governed by a set of instructions programmed on a dApp that simulates the way a real organisation would work. Orders are managed and given by the smart contracts-based code instead of a real human leader. The code is open source and transparent, posted on free platforms like GitHub, and anyone can analyse and understand how it works and what's the goal before associating themselves with it. It cannot be shut down after being in the blockchain and third party entities like the FBI or the government can't control it, like they could by reasoning with the CEO of a company. The only way to control a DAO is via the governance model.

An individual user or collective can create a DAO by defining the purpose or concept, for example, a DAO which goal is to manage a freelance group of artists and distribute work and income across them, and the set of rules by which it will work upon. The technical part can be done by a programmer or an available DAO-creating dApp. Although the former can be of better quality and more precise to the creators' vision, the later is simpler to comprehend, which allows almost anyone to use. It will then be put on the blockchain with a group of smart contracts managing tasks like "hire user", "set user wage" or "assign job to". These can be managed automatically to create a fast link between client and worker, by removing routine operations requiring manual input to allow a more fluid work, or manually via voting power.

The tokens of the organisation can be used as a paying method, although other methods can be used as well, like CBDCs, stablecoins or bitcoin, and also give participants of the DAO more voting power on future decisions that happen through the governance protocol. This method can raise the interest of participants to positively impact the DAO and remain long term to raise the value of the held token. Removing manual input of human making decisions allows for unbiased management and the governance protocol promotes democracy, permitting that everyone participating can have a voice in how the DAO runs. Organisations always change with time according to the surrounding circumstances and, with this method, everyone can have an impact other than just the leader or a small group of decision makers.

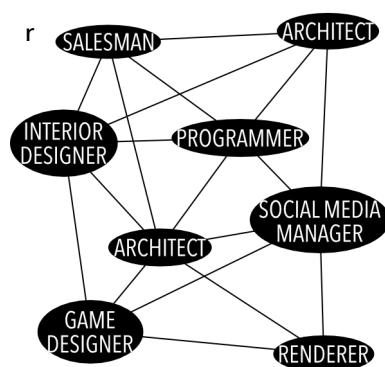
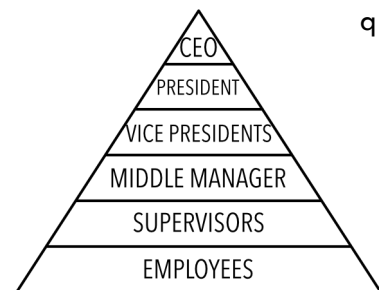
Currently, however, there are flaws with DAOs that might impact how business would be made. The open nature of the blockchain promotes transparency in information which, occasionally, is required to stay confidential, as most often is the case in traditional firms. Although transparency in what's happening with the organisation can be positive for those working within it and seeking to participate in improving it, such information is also transparent to others who are not contributing and malicious users can read the code and try to hack the DAO. The first of its kind, designated The DAO, was hacked in 2016 and about \$60 million worth of Ethereum got stolen from users^[2].

The technology behind it is improving however, and bigger DAOs are currently actively functioning, worth billions of dollars, like UniSwap, ConstitutionDAO and the metaverse project Decentraland.

An Architecture DAO

Companies, historically, are created by individuals who are able to start their own business, due to their skill in the art or management, and tackling the market by starting small, either by themselves or hiring/collaborating with a small group of like minded local workers. By executing good work and establishing themselves in the market, it is possible to expand, hiring more employees and making more money in the process. Many of the most valuable companies in the world right now have started this way. As an example, Apple started by an association between Steve Jobs and Steve Wozniak, growing from Jobs' bedroom and garage^[3] into a multi-trillion dollar company with a workplace costing about \$5 billion^[4].

This traditional model is based around a pyramid. It starts with the top, the CEO and sometimes founder, and extends all the way to the bottom, where workers support the business but have little to no say, the further away from the top it goes, depending on the size of the company. Although higher rankings are usually earned by proof of past work, not all get the chance due to life circumstances.



Metaverse based and traditional companies entering the metaverse have the option to keep this business model and create an hybrid of the physical and virtual work space, however, a DAO business model following the governance protocol might become popular, specially in organisations starting through the virtual world, allowing a group of highly skilled individuals to be valued on their skilled other than rank, delegating mundane tasks to the code and allow workers to do what they do best, produce.

The metaverse allowing users from distant physical locations to have a closer connection than possible with bidimensional screens will have an effect job hunting. There is no longer the constraint about distance to work when working from home becomes the norm, which would allow someone from Portugal to work for an organisation from Japan on a project destined for a client from Canada, instead of accepting a smaller local offer due to physical limitations. The metaverse has no borders and work location all becomes the same. Running this company while trying to manually micromanage every task might become impossible, or at least demanding too much of our time. Communication would need to be super tightly scheduled, money flow becomes tedious and job distribution needs additional control due to data servers becoming more broad with the influx of connections from all around the globe. A DAO makes it so users aren't working for someone else but themselves, there is no company per se, but your income still depends on how well

you perform. Automating the company managing process allows the communication, money flow and server problems to be pushed to a machine, while connecting client and worker to communicate between themselves.

Recently graduated architects are required to gain experience in lower level tiers while progressing on their careers. The profession is legally managed by third party entities, to assure safety and regulation of the world. Architecture incorporates a lot of infrastructure to keep buildings safe to occupy, but also to allow citizens to actually use them in the case of their utilities. Therefore, it's not expected from a 24 year old architect to have big jumpstarts in their career to manage big projects for large cities, needing instead to hone their skills under tutelage of more experienced architects. Although metaverse architecture has a very complex degree of its own, it doesn't have the same utility or life threatening accidents which might happen in the physical world. A metaverse architect focuses on creating great designs, with spatial and 3D modelling skills, to serve as utility spaces for experiences and activities.

Without management from legal entities and nuances that a physical building has, added with the high speed the digital world moves, metaverse architects can progress faster on their careers than their traditional counterparts, with support from a DAO to get jobs without requiring to follow a pattern defined by a traditional firm. The metaverse architect can create quality projects as fast as his drive, motivation and time allows. With more projects associated with their name, recognition starts earlier in the career, building larger portfolios. This is not possible with traditional architecture. Examples show that architects start getting recognition when reaching a mature stage in their careers, some well past their 50s, and elite class architects, winners of the Pritzker Award^[5], are often in the mid to late stage of their careers.

The majority of architects are working under someone else's brand, which is the de facto creator of the designs/artworks/buildings, the name that stands behind that project. Removing the limits of regulations, it allows the independence of younger artists since there are less obstacles between the creative vision and the final project. Just like Bitcoin and Proof-of-Work cryptocurrencies allowed Peer-2-Peer monetary transactions between users, decentralisation allowed in the metaverse by smart contracts and blockchains can create the same Peer-2-Peer connections between a client and an artist.

By removing CEOs and corporate decisions from the equation and replacing them with DAOs, focus is moved to the quality of work. The model can fall back into remission if too many clients are demanding the same architect because of his reputation and skill, leading back to the traditional format of hiring someone to assist with designs. With metaverse architecture, the flow of projects moves faster from request to completion, specially removing municipal legality from the equation. However, if the assistant architect cryptographic ID is registered into the project, their value will still go up from association with the more reputable architect, similar to how working under the guidance of traditional architects would. Accessibility and transparency with blockchain data would more focus on the youngling and their name would forever be registered for such project.

Running an architecture firm as a DAO could still share a lot of the same values as a traditional one by changing the decision making from the lead architect/CEO into the token holders. A job entering the DAO can be defined a value by the community and distributed to one of the architects automatically. Someone can be fired from a DAO via voting if they are not being beneficial to the organisation, as well as having a replacement coming in. It is possible to extend the automation to another level. A group of 100 architects under a DAO can be connected to clients automatically utilising artificial intelligence. As the DAO understands the skills and characteristics of each "employee", it can analyse the requested project and associate it with the ideal available worker from the list. A project that requires input from different arts can be submitted back and redistributed between the different parties, where every individual would get their ID etched as part of that project.

Work from home environments have risen in popularity due to the start of the COVID-19 pandemic in 2020 and there's reason to believe that will eventually become even more prominent or standard in some professions in years to come. Many freelancing jobs already experienced this even before the pandemic and jobs that explore the metaverse and develop it may even thrive in this scenario. While work in some formats has created bonds between different colleagues, some tasks are very individualistic by design. The metaverse allows people to connect with others around the world as if they're in the same room, which can expand work relationships across the globe, but it might also isolate others if badly implemented. Understanding how these relationships between different parties can integrate and be implemented in the metaverse will be key for DAOs' future in becoming an organisation alternative.

Artificial Intelligence

Artificial intelligence has been implemented in devices for years now, mostly to assist users with routine tasks, while using a phone or a computer, that we barely notice its activity. However, AI has become so powerful that humans have started to question their own intelligence. Normally, intelligence develops from a database that gives the computer information on the topic in question. In a chess experiment, by giving AI the rules, it was able to play against itself thousands of times quickly, learning game patterns that are beyond human capacity that would give it the win while playing against top class players. AI doesn't have conscience or self awareness, just plays by the rules and what it analyses.

This technology is being implemented everywhere and it's expected to be utilised by architects, specially those designing the metaverse. AI experiments created tools that design floor plans^[6], adapting the interiors to what the general design is.

In the future, architecture might become more focused on giving instructions to software than tasks like drawing or modelling. This method increases the speed in which projects develop by allowing the computer to do the long hardworking tasks automatically. Instead of manually drawing and trying to visualise the projects, orders are given to the software that quickly creates a 3D visualisation of what the architect describes. By telling AI to create a 'white plaster house with big sliding windows, facing a garden with a non geometric pool and pavements in stone', the AI can quickly

generate a 3D model of the concept. By adding extra instruction to the generated model, like 'curve that wall and add a window there, I want the kitchen there with a small exterior cooking area', the AI reworks the model by integrating every instruction and blending it with the previous ones.

Although with this method it may look that the computer becomes the architect, in fact we've only moved the way architects experiment their creative ideas into a different method. Instead of physically experimenting ourselves, we input our ideas into a software that speeds up the process. The company Meta has showed a prototype where Mark Zuckerberg is designing his island using speech^[7]. Although very basic in graphics quality, it's only a matter of time until the code is matched with graphics.

AI has the chance of becoming a bigger tool in the metaverse than in traditional architecture. While it can help speed up the process for designs meant to be built in the physical world, the process of creating the blueprints and detailing projects with information for construction will likely keep requiring human input for a large amount of years. Without those limitations in the metaverse, an AI equipped design tool can lead the project from scratch into the finished product. The architect can control not only the model itself, but also the environment around, instructing the tool to change lighting, the time of the day, location, among others. It allows designs to branch out of human's range of creativity, since AI does not rationalise the same way as us.

A tool using AI requires a database and rules to work, as well as humans, who base their creativity on past experience and research. An architect can input any kind of data to the software, which will change how the end result comes out. A collection of photos of Mies Van Der Rohe and Frank Lloyd Wright projects being inputted would, by result, lead to designs inspired around those. By inputting photos of certain objects or nature, they would start integrating characteristics from those. By having rules and data on how buildings and space works, organises itself and some general ideas on architecture, AI uses the information it has and understands to output an end result. It can be a very powerful tool in expanding architecture design.

Although a tool like this can become a game changer in architecture workflow, it can also lead to demand for metaverse architects to lower if it becomes widely available to average users. By having access to a tool that's able to automatically 3D model following your voice, anyone would be able to create their own creative and functional designs in the metaverse. The knowledge that architects have in spatial design required for metaverse architecture becomes instead implemented on the tool itself. Although some can have a job in upgrading the tool, by developing the database the AI revolves on, the wide landscape of architects that would otherwise be designing directly for clients in the metaverse could start losing their job to such tool.

It's worth noting that this reality might indeed happen, with the rush towards AI that many fields are having, already having replaced jobs in other fields, and it's up to architects to find a way of adapting and finding new ways of working with the change the technology brings.

Game Designing

Throughout this dissertation, video games have been mentioned often. The metaverse and video games have a lot in common, even though they are not quite the same. In that sense, there is similarities between game designers and metaverse architects, both are creating virtual environments to be experienced by users all around the world. The difference comes down to what the CEO of Second Life mentioned back in the day, the platform wasn't a game as it didn't have any pre determined objectives. However, the metaverse is also being gamified^[8] with platforms like The Sandbox and it's common to allow games to be built on top of the underlying code on the blockchain.

There's a huge market behind video games and, as the lines blur in the metaverse between platforms with them running on top of the same code, actual jobs to develop spaces lose the need to categorise themselves. There's no skill that an artist creating environments for a video game has that a metaverse architect doesn't. While video games have a lot of coding involved, those skills are part of a different team. That said, architects can take advantage of any platform hosting the metaverse, independent on what its purpose is. While everyone can have a different focus and specialty in the field, the general skills are the same. Metaverse architects and game designers don't necessarily need to become the same job, and they probably shouldn't. Just like in traditional architecture, architects have different understandings and visions of how things should be, and some are better at creating one thing and some are better at others, the same happens in this scenario.

Collaboration between both sides will be a standard while creating the metaverse. With all the platforms available, there's gonna be some destined for architects while others towards game designers. Projects can even be collaborated between both sides to get higher quality with input from different specialties. Game designers can focus more on the environmental side of creating a world while an architect can focus on buildings and monuments. By sharing tools and file standards, interoperability allows work in the virtual world to be actively modified by different artists.

Video games have involved the creation of virtual worlds for decades, specially from the moment 3D games became standard. Though there's reasons to claim the metaverse is just another video game and that the concept isn't new, it's important to understand that the metaverse is closely related to social media more than video games. The social aspect added to games throughout the years, with online and multiplayer gaming aspect that developed through time, which lead to *Minecraft*® and *Fortnite*® coming to life. Younger generations communicate while playing these games, instead of relying on messaging or video calls. The metaverse will switch focus and develop a platform which goal is to socialise, but offers the possibility to share experiences with others while doing so, and not the other way around.

Creating for the Metaverse

The metaverse will become a huge business for everyone participating^[1], both for those creating the experiences and platforms, but also for those using it. Architects will become an important part in how the metaverse is designed and feels spatially. The digital world should feel human and architects have the tools and knowledge for it. Creating metaverse architecture is a skill that can be easily adapted from the traditional architecture we've inhabited for millennia. With digitalisation of the creation process that happened in the last few years, the tools and workflow share the traits required for both sides. While those using the space don't need to understand the technicalities of the framework that supports the metaverse, those actively creating the platform, both technologically and artistically, need to understand the basics of what the metaverse is and how it works. Only then should we get involved.

Now with the basic knowledge required to become a metaverse architect, comes the steps and requirements to bring the creations that will populate the virtual world to life. These are research and conceptualisation, 3D modelling and creating and selling the project. These major steps take us from the start of a project into the finalised version, as well as selling it to a client.

Research & Conceptualisation

Metaverse architecture starts in the conceptualisation phase, just like any other art. This step doesn't differ from how traditional architecture approaches their designs in early phases. It's important to note that, even though the methodology is the same, the way we think about the project isn't. Traditional architects need to keep in their mind certain traits that buildings require, like room divisions and furniture that make them functional. Function and form go hand in hand very aggressively. If one is focused too much on, the other may suffer from it.

Although still existent in metaverse architecture, function drops down in importance in favour of form. Most rooms present in buildings have very specific requirements to function properly, like bathrooms and laundries. Design flexibility is restricted with guidelines needing to be met with. The digital realm avoids those function specific rooms and focuses more on those who promote social interaction. Architects designing digital spaces can have more focus on creativity. Even simple concepts like connecting and organising certain spaces sequentially is not a necessity when transportation between them in the metaverse can be instant with tele transportation, which allows architects to design each space independently to bring out the best design they can out of that concept, as we have seen with Samsung's 837x at Decentraland. Assuming the determined experience functions properly, design becomes the central characteristic of metaverse architecture, it allows the artist to show up more than the technician.

Creativity can come from anywhere to let diverse designs flourish. Architects occasionally design around unconventional concepts, like anthropomorphic shapes and nature, that lead to original projects. By removing the limitations from traditional architecture, there is a new design dimension to explore these concepts even further.

Materialisation in a digital space becomes more diverse than the physical counterpart. There is no material that is too expensive or too fragile to choose from, intrinsically they are all the same, just a digital representation simulated by a computer. Focus is on the colour, texture and patterns. A wider pallet is available to match the vision of the artist. Instead of thinking on what material each component will be finished with, selections starts instead from the colour, then moving into the texture and finally the patterns or sizing. Designs can focus more on what they want to achieve other than what they need.

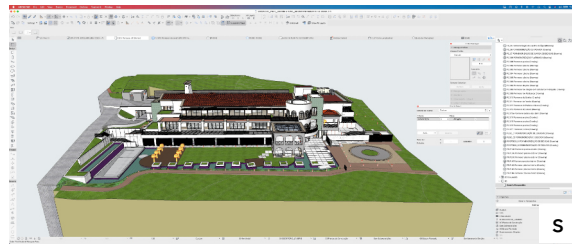
The process still requires architects to think their designs with limitations. Platforms have restrictions on file sizes, visual design characteristics and land size. Architects need to come up with the concepts already planning for the 3D modelling step to meet the necessary requirements. The same happens to traditional architects, having to design buildings with legal matters integrated and construction planned out. Designing a building that then needs to be radically changed at a later stage is basically doing the same work twice. The metaverse allows for high levels of creativity and freedom in design, but it will still require discipline in the way we work and it's important to understand and work by the different guidelines the digital space has.

3D Modelling

The major development phase for metaverse architects is 3D modelling, taking the largest portion of time of the creation process. It shares a lot of similarities with how traditional architecture has worked for years on the production part with the use of BIM software^[2], although the end goal is different in some aspects. While traditional architects design buildings with the goal of constructing, making the 3D digital model a tool in the process of reaching there, metaverse architects instead have the 3D digital model as the goal itself. The way the file is developed and designed becomes different, of course, and may require a different amount of detail, depending on the end goal or request of the client, as well as the platform it's destined for. The level of care with 3D models for the metaverse should be higher than those for traditional architecture, the models themselves are the product and what will eventually be used and exposed. Despite the tools and process looking similar, metaverse 3D models should be compared more towards the physical buildings we inhabit than their BIM counterparts. It's important that no imperfection exists, just like on a physical building, as they will be able to be seen and might be complicated to fix once on the blockchain.

It can be done with any software that allows to 3D model, whatever the complexity or amount of features it has. Like anything, the creativity of the artist is more important than the tools being used. While transitioning from traditional architecture, either a student who wants to start his career by developing environments in the metaverse or an experienced architect who wants to experiment something new, the same tools that have been used still function.

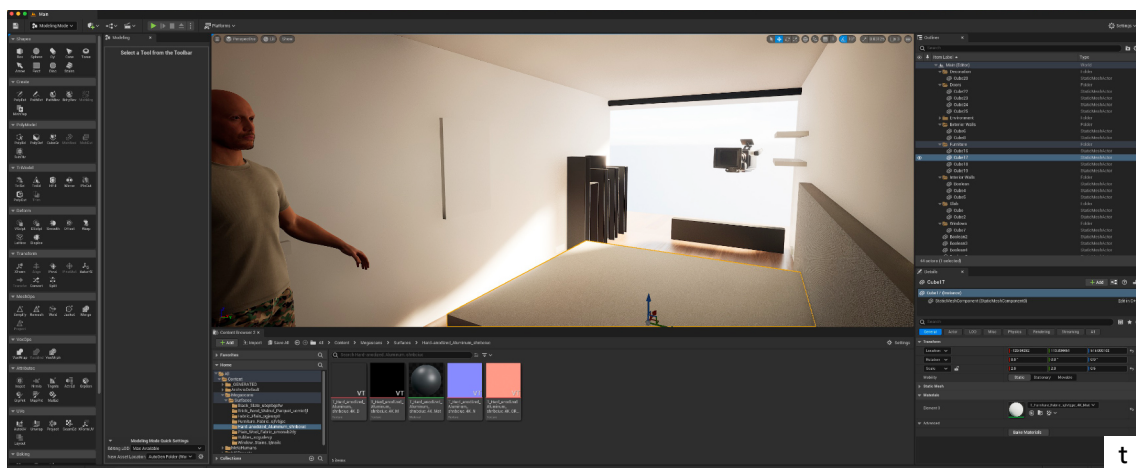
Software like ArchiCAD^[3] and Revit^[4] are great tools in traditional architecture due to their goal of simplifying 3D modelling by offering architectural components as the designing tools. While other 3D modelling software, due to their wide range of use cases, has basic shapes as the tools to start designing, BIM software is a great tool that allows architects to focus on the components buildings actually are made off right from the start.



This way, they are a great starting point for those with previous experience in architecture to dwell into the metaverse by maintaining a similar workflow. While BIM is feature-rich in tools that help development and construction of physical buildings, like material identification, engineering calculations, quantifications, construction detailing, it does lack a lot of features that become essential when creating for the metaverse that are existent in many other softwares.

There are a plethora of tools available currently for 3D modelling, both free and paid, for any type of device. An app that is getting very popular is Shapr3D^[5]. It works on iPads and allows to take use of the Apple Pencil to basically draw in 3D, just on a flat 2D screen. With the advancements in AR, this app might become one of the first to showcase 3D models virtually in front of the designer and maybe even allow them to directly manipulate them. However, it lacks many essential features to make the most out of the metaverse right now.

Although there are many professional level softwares available, from Blender^[6], Maya^[7] or SketchUp^[8], it's believed that the industry standard is becoming Unreal Engine^[9]. It is very different from the BIM software architects are used to and the learning curve is much bigger, however, the possibilities with it are close to limitless. Unreal Engine was created in 1998 by Tim Sweeney^[10], CEO of Epic Games, that owns the engine and the massively popular game *Fortnite*®. The gaming industry has used UE for decades and has produced great results.



With the official release of Unreal Engine 5 in 2022^[11], virtual images have reached a level of realism that is sometimes hard to distinguish from actual reality. The release demo showcased a rocky old temple that could fool people into thinking it's a photograph. Being able to use these almost photorealistic models in the metaverse will allow for experiences that really feel real.



Although other softwares are able to achieve similar results, UE5 has developed some features that streamline the process while getting better results. The underlying code of the engine allows the artists to focus on building the scenes without having to worry if the assets are blending correctly. A big advantage UE5 has over BIM software for metaverse architecture is the control over lighting^[12]. The built in tools allow to create a virtual environment by manipulating the sun, atmosphere and other characteristics present on nature that affect light, as well as having realistic reflections that bounce across all materials and objects in a scene realistically. Not only are assets and materials customisable, either manually or parametrically by users, but it's also possible to download thousands of photorealistic materials already programmed to react to lighting accordingly, as well as objects or vegetation. UE5 allows architects to be able to create designs and the virtual environments around them with such realism that can make private world metaverses a virtual paradise for their owners.

The process of adding parametrisation adds more dynamics to designs and speed in the creation process. Metaverse architects may start working in conjunction with programmers in this stage to allow designs to reach higher potential. Although this has a different purpose, it's not any different than the collaboration work between architects and engineers in traditional architecture. Simple designs don't require a lot of effort and may be manually done, but complex buildings with many shapes and patterns become too much of a hassle to do everything manually, leading to errors and imperfections to pass by unnoticed. UE5's parametrisation features allows for large designs to be created from simple and limited inputs. Architects can learn this skill and not require others, but collaboration will lead to higher quality results due to inputs from different skills merging into a single great design.

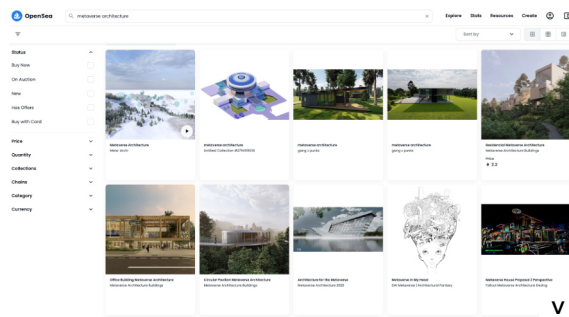
Although with more traditional tools it's possible to create metaverse architecture, those who go beyond into learning how to take best use of more advance tools will clearly have an edge.

Selling The Project

For a 3D design model to become an architectural piece in the metaverse, it's required for it to exist inside the blockchain. With the way current metaverse platforms work, they are able to read data from a smart contract to integrate the files associated within onto the world. Therefore, the files need to be turned into an NFT. By creating an NFT, platforms are able to import the design, as long as it's compatible with their limitations. Platforms like *Fortnite*® and Second Life, due to them running on privately hosted servers, allow for users to create and submit their own files at will, without the need to turning them into an NFT. While this can be a faster and more seamless way for young users to try out their designs while experimenting with 3D modelling, it doesn't work with a decentralised metaverse that runs on a blockchain. While blockchains can read data from the outside, if it's inputted through a verified third party, reading files is a different matter. For someone who's looking to work for the metaverse and sell their designs, that method hinders sales due to the lack of ownership. By buying a 3D model that has been turned into an NFT, and knowing that the metaverse in a blockchain can only read and input data from other blockchain assets, the buyer knows that design has a limited amount of editions, which can be just one, and other people can't use the same file as the blockchain simply will not accept them.

Selling the project can be done in multiple ways, but the safest one is to use a marketplace with built-in smart contracts. This way, that works similar to the freelance work platform Fiverr^[13], both parties have a layer of protection from scamming each other. For the transaction to be made, both sides need to submit their part of the deal, one side inputs the project files and the other inputs the money.

On marketplaces, we find millions of NFTs, ranging from music and art pieces to membership passes, already listed for sale and submitted to the platform. That method works similar to Amazon, it allows users to browse through different pieces and buy which one they like the most. In the world of architecture, it has a resemblance with buying an existing house, just one that is digital and isn't placed anywhere, we can use it in whatever platform we fancy.



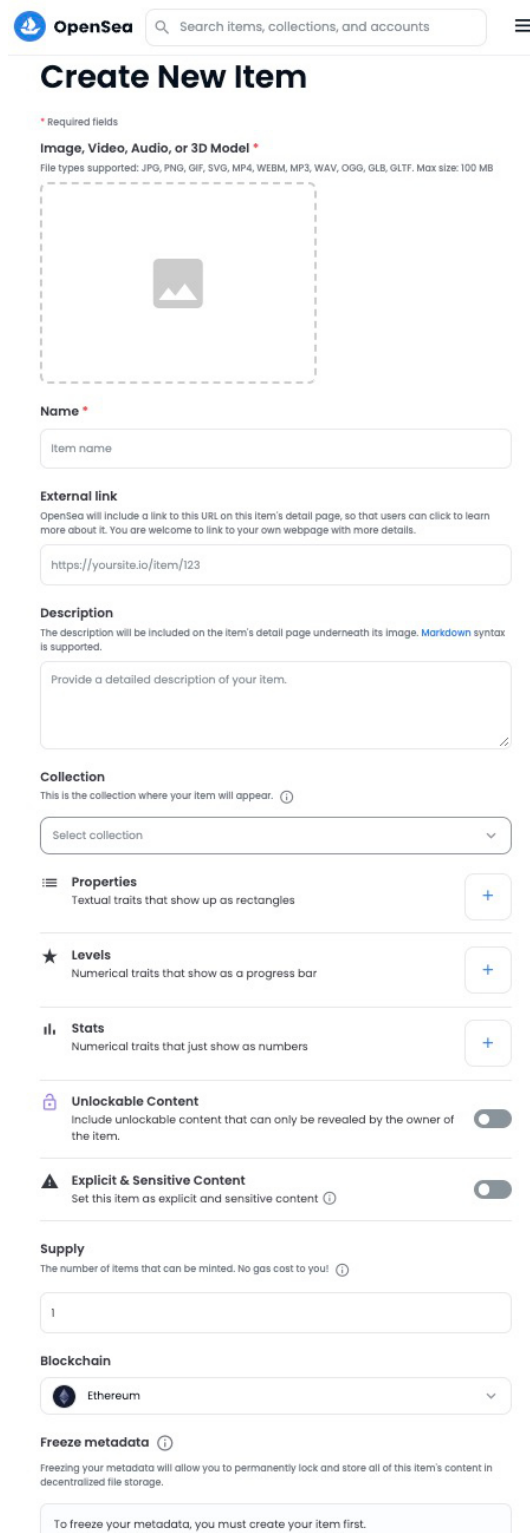
This is currently the most common way of selling an NFT, but there's also more traditional and direct ways of making a deal. If there's trust between 2 parties, a deal can be made by directly transferring money to the creators account while they send the project, already as an NFT, to the buyer. This method can have upsides when projects are more personalised, like designing a space, building or experience specifically for that buyer. Due to the nature of blockchain, the data of the transferring of the NFT will still be readable on marketplace platforms, so, for safety reasons, it might still be suggested that the deal would be made in there.

Some very popular NFT marketplaces currently are OpenSea^[14], Rarible^[15] and SuperRare^[16].

The process to create an NFT can be too complicated for someone that doesn't code, luckily NFT marketplaces offer their own built-in dApps that make the process super easy. The process of creating the smart contract that holds the digital file and verifies its validity and ownership on the blockchain is called minting^[17]. For architects, it is recommended to just use one of these platforms, despite the very small fees, unless they have a partnership or a member of the team who can code and can do the technical process of minting. Doing something wrong on this process is not recommended.

The interesting and innovative part that this process brings to the process of selling something is the continuous royalties and percentages of every sale that the creator, and the first buyer if determined that way, can get on future sales, as mentioned on a previous chapter. With this, a project that does well in the future can still benefit the architect more, from recognition of course, but also financially. All that is required on this process from the architect's point of view is his cryptographic wallet and the file of the project he wants to sell.

Using the Opensea platform, or others, minting the NFT becomes seamless and, by setting the sale to be at fixed, it allows the project to be sold without any more input from the user. It's also possible to set the sale to be a highest bidder, which might be preferable in some scenarios, like highly anticipated releases.



The screenshot shows the 'Create New Item' form on the OpenSea website. At the top, there's a search bar and the OpenSea logo. The form is titled 'Create New Item' and has a 'Required fields' note. The first section is 'Image, Video, Audio, or 3D Model', with a note about supported file types (JPG, PNG, GIF, SVG, MP4, WEBM, MP3, WAV, OGG, GLB, GLTF) and a max size of 100 MB. Below this is a large dashed box for the image. The next section is 'Name', with a text input field labeled 'Item name'. This is followed by 'External link', with a note that OpenSea will include a link to this URL on the item's detail page, and a text input field containing 'https://yoursite.io/item/123'. The 'Description' section has a note that the description will be included on the item's detail page and that Markdown syntax is supported, followed by a large text area labeled 'Provide a detailed description of your item.' Below this is the 'Collection' section, with a note 'This is the collection where your item will appear.' and a dropdown menu labeled 'Select collection'. The form then has several sections with expandable options: 'Properties' (Textual traits that show up as rectangles), 'Levels' (Numerical traits that show as a progress bar), 'Stats' (Numerical traits that just show as numbers), 'Unlockable Content' (Include unlockable content that can only be revealed by the owner of the item), and 'Explicit & Sensitive Content' (Set this item as explicit and sensitive content). Each of these sections has a '+' button to expand. The 'Supply' section has a note 'The number of items that can be minted. No gas cost to you!' and a text input field containing '1'. The 'Blockchain' section has a dropdown menu showing 'Ethereum'. The 'Freeze metadata' section has a note 'Freezing your metadata will allow you to permanently lock and store all of this item's content in decentralized file storage.' and a text input field containing 'To freeze your metadata, you must create your item first.'

W

Glossary

Arts

Architecture	5; 30; 36-37; 42; 44; 51; 55-56; 58-64; 66
Cinema	17; 37; 39-41; 43
Digital Art	17; 19; 20-21; 67
Music	14; 17; 19; 36-39; 46-47; 67

Companies

Apple	9; 15; 58
ATARI	23
Epic Games	15-16; 19; 65
Google	15; 25; 28-29; 54
Microsoft	9; 13; 18; 23; 25

Personalities

Ariana Grande	14; 19; 38
Satoshi Nakamoto	25
Snoop Dogg	23; 38
Tim Sweeney	19; 65
Travis Scott	14; 19; 38

Platforms

Decentraland	14; 16; 21-24; 27-28; 36-39; 44; 46-47; 63
<i>Fortnite</i>	14; 16; 19; 23; 28; 38; 47; 62; 65; 67
GitHub	32; 57
Instagram	17
<i>Minecraft</i>	14; 16; 18; 23; 62
OpenSea	28; 68
Second Life	13-14; 16-18; 62; 67
Somnium Space	46
Spatial	16; 20-21; 46; 53
The Sandbox	14; 16; 21; 23; 27; 38; 47; 62
Voxels	21; 23-24
Youtube	17; 29; 31; 35; 37-38; 52; 54

Gadgets

Augmented Reality Glasses	15; 31; 44; 52-53
Computer	9; 14; 16; 20; 26; 28; 42-43; 51-53; 60
iPad	65
iPhone	13
Virtual Reality Headset	15; 30; 43; 53

Professions

Architect (Metaverse)	5; 11-12; 21; 24-25; 28; 31; 37-41; 45-47; 53; 55-56; 59; 60-66; 68
Architect (Traditional)	5; 11; 25; 31-32; 37; 41-42; 46; 51-53; 56; 59; 61-66
Engineer	9; 44; 66
Film Maker	39-40
Musician	14; 19; 23; 37-38; 46-47
Programmer	38; 42; 57; 66

Softwares

ArchiCAD	65
ARki	52
BIMx Viewer	52
Blender	46; 65
Maya	65
Revit	65
Unreal Engine	20; 45-46; 65-66

Technologies

3D Modelling	5; 17; 38; 40; 53; 59-60; 63-65; 67
3D Rendering	11
Artificial Intelligence	44-45; 60-61
Augmented Reality	5; 10; 15; 20; 24-25; 30-31; 43-45; 52-53
Bitcoin	14; 25-27; 32; 57; 59
Blockchain	14-16; 19-29; 31-32; 48; 54-55; 57; 59; 67-68
Building Information Modelling (BIM)	64-66
Central Bank Digital Currencies	32; 55; 57
Cryptocurrencies	14; 21-22; 24-28; 32; 57; 59
dApps	15; 28-29; 54; 57; 68
Decentralised Autonomous Organisation	22-23; 55-60
Ethereum	14; 21-24; 26-28; 57
Internet	9; 13-15; 17; 25; 29; 31; 35; 37; 45; 54
Marketplace	28-29; 67-68
Metaverse	5; 9; 11-13; 16-17; 19-20; 24; 32; 35-41; 44-48; 52-53; 58-61; 64
Non-Fungible Token (NFT)	20; 23-24; 28-29; 31-32; 46-47; 67-68
Polkadot	27
Smart Contracts	14; 19; 22; 26-28; 31; 39; 54; 57; 59; 67
Social Media	5; 10; 14-15; 17; 28-29; 31; 35; 52; 62
Virtual Reality	9-10; 13; 15; 20-21; 24; 30-31; 37; 39-41; 43; 52-53
Web 3	15-16; 20-21; 24-25; 28-29; 31; 54
Windows	9

References

Books

- STEPHENSON, N. (1992) Snow Crash. Audible Studios, 2000
- AMMOUS, S. (2018) The Bitcoin Standard: The Decentralized Alternative to Central Banking. Audible Studios, 2018
- KISSINGER, H.; SCHMIDT E.; HUTTENLOCHER D. (2021) The Age of AI and Our Human Future. London: John Murray (Publishers), 2021
- CHALMERS, D. (2022) Reality+: Virtual Worlds and the Problems of Philosophy. W. W. Norton Company, 2022
- BOELLSTORF, T. (2015) Coming of Age in Second Life: An Anthropologist Explores the Virtually Human. Princeton: Princeton University Press, 2015

Articles & Videos

All websites were verified as online the week of 26th to 30th of September 2022.

Chapter 1: Introduction to the Metaverse

The Metaverse

- [1] <https://www.gizbot.com/mobile/features/top-100-best-selling-mobile-phones-from-last-20-years-news-1992-2015-031151.html>
- [2] <https://www.computerhope.com/history/1992.htm>
- [3] <https://www.youtube.com/watch?v=SaJp66ArJVI>
- [4] <https://www.wired.com/2021/10/geeks-guide-snow-crash/>
- [5] <https://www.forbes.com/sites/frankfitzpatrick/2022/01/13/3-ways-spatial-audio-can-transform-the-future-of-digital-health/?sh=528acc69208f>
- [6] <https://medium.com/coinmonks/the-current-metaverse-is-a-scam-b577a8b29161>
- [7] <https://finance.yahoo.com/news/13-most-ambitious-metaverse-companies-143241978.html?>
- [8] <https://www.engadget.com/2007-06-27-why-the-iphone-will-fail.html?>
- [9] https://www.youtube.com/watch?v=eywi0h_Y5_U
- [10] https://usatoday30.usatoday.com/money/companies/management/2007-04-29-ballmer-ceo-forum-usat_N.htm
- [11] <https://www.newsweek.com/clifford-stoll-why-web-wont-be-nirvana-185306>
- [12] <https://quoteinvestigator.com/2020/03/09/collapse/>
- [13] <https://thereboot.com/internet-evolution-a-timeline-history-of-the-network/>
- [14] <https://metaverse-timeline.com/>
- [15] <https://www.internetworldstats.com/emarketing.htm>
- [16] [https://www.nbcnews.com/id/wbna17538999#U9uyeEi49yw](https://www.nbcnews.com/id/wbna17538999#.U9uyeEi49yw)
- [17] <https://archive.org/details/byte-magazine-1983-10/page/n219/mode/2up?view=theater>
- [18] <https://activeplayer.io/minecraft/>
- [19] <https://activeplayer.io/fornite/>
- [20] <https://www.forbes.com/sites/paultassi/2021/08/02/ariana-grande-should-earn-a-fortune-from-her-fornite-rift-tour-concert/?sh=38550bdc130b>
- [21] <https://www.geeksforgeeks.org/history-of-tcp-ip/>
- [22] <https://web.archive.org/web/20140115142013/http://szabo.best.vwh.net/securetitle.html>
- [23] <https://finance.yahoo.com/news/decentraland-holds-first-mover-advantage-190349112.html>

- [24] <https://medium.datadriveninvestor.com/the-dotcom-bubble-d33d429addcc>
- [25] <https://www.investopedia.com/news/dr-doom-suggests-99-cryptocurrencies-are-worthless/>
- [26] <https://www.banklesstimes.com/cryptocurrency/cryptocurrency-adoption-rates-in-the-us/>
- [27] <https://finance.yahoo.com/news/dappradar-q1-2022-report-2-140000647.html>
- [28] <https://www.bustle.com/articles/117928-10-things-that-were-considered-weird-in-1995-but-are-totally-normal-now-according-to-reddit>
- [29] <https://www.ibtimes.com/instagram-copying-tiktok-meta-faces-backlash-platform-changes-3588396>
- [30] <https://www.bbc.com/worklife/article/20210615-is-the-great-digital-nomad-workforce-actually-coming>
- [31] <https://secondlife.com/>
- [32] https://en.wikipedia.org/wiki/Second_Life
- [33] <https://www.youtube.com/watch?v=DrSCjSRMY64>
- [34] <https://www.youtube.com/watch?v=Ot1XR-LrgyM>
- [35] <https://time.com/6123333/metaverse-second-life-lessons/>
- [36] <https://www.minecraft.net>
- [37] <https://www.gamespot.com/articles/minecraft-reached-140-million-monthly-users-and-generated-over-350-million-to-date/1100-6490962/>
- [38] <https://www.ign.com/articles/2011/11/24/minecraft-review>
- [39] <https://www.blockbyblock.org/our-work>
- [40] <https://www.bbc.com/news/technology-29281051>
- [41] <https://www.wired.co.uk/article/minecrafterd>
- [42] <https://finance.yahoo.com/news/microsoft-acquire-minecraft-maker-mojang-132642985.html>
- [43] <https://www.forbes.com/sites/paultassi/2022/07/21/minecraft-and-microsoft-rejecting-nfts-is-a-watershed-metaverse-moment/?sh=1e08ea211861>
- [44] <https://www.epicgames.com/fornite/>
- [45] <https://en.wikipedia.org/wiki/Fortnite>
- [46] <https://www.gmw3.com/2022/01/life-in-the-metaverse-fortnite-keeps-growing/>
- [47] <https://www.forbes.com/sites/paultassi/2019/12/27/fornite-is-building-the-metaverse-whether-you-realize-it-or-not>
- [48] <https://www.digitaltrends.com/gaming/what-is-fortnite/>
- [49] <https://spatial.io/>
- [50] <https://www.youtube.com/watch?v=PG3tQYIZ6JQ>
- [51] <https://www.freethink.com/technology/spatial-metaverse>
- [52] <https://www.youtube.com/watch?v=S3F1vZYpH8c>
- [53] <https://readyplayer.me>
- [54] <https://support.spatial.io>
- [55] https://medium.com/@detlef_VRmaster/spatial-io-vs-mozilla-hubs-7327e287244d
- [56] <https://www.investopedia.com/tech/governance-why-crypto-investors-should-care/>
- [57] <https://decentraland.org/blog/announcements/decentraland-announces-publish-launch/>
- [58] <https://www.nasdaq.com/articles/decentraland-holds-first-mover-advantage-in-battle-against-meta>
- [59] <https://dao.decentraland.org/en/#lean-more>
- [60] <https://www.kraken.com/learn/what-is-decentraland-mana>
- [61] <https://republic.com/blog/real-estate/investing-in-decentraland-in-2021>
- [62] <https://docs.decentraland.org/decentraland/faq/>

- [63] <https://ice.decentral.games/>
- [64] <https://market.decentraland.org/>
- [65] <https://therealdeal.com/2021/11/24/this-2-4m-virtual-land-deal-is-largest-ever-for-digital-real-estate/>
- [66] <https://www.samsung.com/us/explore/metaverse-837x/>
- [67] <https://twitter.com/decentraland/status/1470561429543698432>
- [68] <https://nftart.medium.com/crypto-news-you-can-order-dominos-pizzas-in-decentraland-now-1c66787141fb>
- [69] <https://decentraland.org/blog/announcements/sotheby-s-opens-a-virtual-gallery-in-decentraland/>
- [70] <https://www.sandbox.game>
- [71] <https://medium.com/sandbox-game/what-is-the-sandbox-850de68d893e>
- [72] <https://metaverseinsider.tech/2022/07/25/a-complete-guide-to-the-sandbox-metaverse/>
- [73] <https://medium.com/sandbox-game/the-sandbox-partners-with-snoop-dogg-to-bring-legendary-rapper-into-the-metaverse-e064e866ed40>
- [74] <https://medium.com/sandbox-game/the-sandbox-partners-with-tony-hawk-and-autograph-to-create-the-worlds-biggest-skatepark-in-the-fdc4c9283d1c>
- [75] <https://venturebeat.com/business/the-sandbox-raises-2-million-more-to-build-out-blockchain-based-game-world/>
- [76] <https://medium.com/sandbox-game/partnership-announcement-the-sandbox-ft-atari-c0a828ed32c5>
- [77] <https://www.voxels.com/>
- [78] <https://medium.datadriveninvestor.com/cryptovoxels-this-is-the-future-of-the-metaverse-4467326d4102>
- [79] <https://thedapplist.com/learn/what-is-cryptovoxels/>

The Technology

- [1] <https://blog.seagate.com/intelligent/the-world-of-data-as-we-know-it-keeps-growing/>
- [2] <https://www.statista.com/statistics/871513/worldwide-data-created/>
- [3] <https://www.google.com/about/datacenters/locations/>
- [4] <https://azure.microsoft.com/pt-pt/global-infrastructure/>
- [5] <https://journals.sagepub.com/doi/10.1177/2053951714564228>
- [6] <https://thetrustedweb.org/what-is-a-timestamp/>
- [7] <https://bitcoin.org/bitcoin.pdf>
- [8] <https://www.investopedia.com/terms/p/proof-stake-pos.asp>
- [9] <https://bitcoin.org/en/full-node>
- [10] <https://garywoodfine.com/blockchain-cryptography/>
- [11] <https://brilliant.org/wiki/caesar-cipher/>
- [12] <https://www.quora.com/Is-it-possible-for-someone-to-guess-a-private-key-to-a-Bitcoin-wallet-and-steal-the-coins>
- [13] <https://www.investopedia.com/terms/e/ethereum.asp>
- [14] <https://www.investopedia.com/terms/o/onchain-governance.asp>
- [15] <https://www.investopedia.com/news/what-erc20-and-what-does-it-mean-ethereum/>
- [16] <https://polkadot.network/>
- [17] <https://medium.com/acycliclabs/why-are-smart-contracts-so-important-81883d93a0cc>
- [18] <https://www.gemini.com/cryptopedia/smart-contract-examples-smart-contract-use-cases#section-potential-smart-contract-advantages-in-other-industries>
- [19] <https://www.ibm.com/topics/smart-contracts>

- [20] <https://www.investopedia.com/terms/d/decentralized-applications-dapps.asp>
- [21] <https://www.minds.com/>
- [22] <https://uniswap.org/>
- [23] <https://www.presearch.io/>
- [24] <https://opensea.io/>
- [25] <https://decentraland.org/>
- [26] <https://en.wikipedia.org/wiki/BitTorrent>
- [27] <https://ethereum.org/en/developers/tutorials/how-to-write-and-deploy-an-nft/>
- [28] <https://www.forbes.com/advisor/ca/investing/cryptocurrency/nft-non-fungible-token/>
- [29] <https://www.history.com/news/the-worlds-first-web-site>
- [30] http://darcy.d.com/fragmented_future.pdf
- [31] <https://www.linux.com/news/web-20-possibly-best-it-business-conference-2004/>
- [32] <https://www.ictea.com/cs/index.php?rp=%2Fknowledgebase%2F2342%2FiQue-es-la-web-2.0.html&language=english>
- [33] <https://explainedideas.com/brief-history-of-youtube/>
- [34] <https://www.contentcreator.com/blog/what-is-a-content-creator>
- [35] <https://usercentrics.com/knowledge-hub/data-is-the-new-gold-how-and-why-it-is-collected-and-sold/>
- [36] <https://newsroom.unsw.edu.au/news/business-law/who-owns-content-social-media>
- [37] <https://forkast.news/how-web3-can-reshape-the-world/>
- [38] <https://en.wikipedia.org/wiki/Sensorama>
- [39] <https://www.webmd.com/a-to-z-guides/features/virtual-reality-medicine>
- [40] <https://www.forbes.com/sites/bernardmarr/2021/07/23/10-best-examples-of-vr-and-ar-in-education>
- [41] <https://www.affinityvr.com/virtual-reality-in-entertainment-is-changing-the-industry/>
- [42] <https://medium.com/geekculture/the-future-of-vr-in-tourism-a-blog-about-the-future-of-vr-in-tourism-c4a6add9fe44>
- [43] <https://medium.com/studiotmd/virtual-reality-uses-in-architecture-and-design-c5d54b7c1e89>
- [44] <https://www.business.com/articles/virtual-reality-changing-manufacturing/>
- [45] <https://www.wired.com/story/john-hanke-niantic-augmented-reality-real-metaverse/>
- [46] <https://nianticlabs.com/news/real-world-metaverse>
- [47] <https://www.museumnext.com/article/how-museums-are-using-augmented-reality/>
- [48] <https://hbr.org/2017/11/how-does-augmented-reality-work>
- [49] https://en.wikipedia.org/wiki/User-generated_content
- [50] <https://seekingalpha.com/article/4483346-nft-royalties>
- [51] <https://influencermarketinghub.com/nfts-creator-economy/>
- [52] <https://github.com/>
- [53] <https://www.federalreserve.gov/central-bank-digital-currency.htm>
- [54] <https://www.bankofengland.co.uk/research/digital-currencies>
- [55] <https://www.cbdc-eu.de/>
- [56] <https://www.investopedia.com/terms/c/central-bank-digital-currency-cbdc.asp>
- [57] <https://www.investopedia.com/terms/s/stablecoin.asp>
- [58] <https://www.theguardian.com/world/2021/jun/09/el-salvador-bitcoin-legal-tender-congress>

Chapter 2: Living in the Metaverse

Digital Experiences

- [1] <https://insights.samsung.com/2022/02/09/galaxy-unpacked-february-2022-watch-the-livestream-here>
- [2] <https://crypto.news/samsung-hosts-galaxy-unpacked-decentraland-metaverse/>
- [3] <https://www.samsung.com/us/explore/metaverse-837x/>
- [4] <https://samsung.veritree.com/>
- [5] <https://twitter.com/rammsteinworld/status/1131266538139529217?>
- [6] <https://www.nme.com/news/gaming-news/travis-scott-earned-20million-fortnite-concert-event-2829792>
- [7] <https://nftevening.com/snoop-dogg-announces-the-sandbox-concert-and-metaverse-music-video/>
- [8] <https://themetaversefestival.io/>
- [9] <https://www.indepthcine.com/videos/what-the-metaverse-means-for-the-future-of-cinema>
- [10] <https://www.scienceandmediamuseum.org.uk/objects-and-stories/very-short-history-of-cinema>
- [11] <https://youtu.be/JrOvtEZ2wuY>
- [12] <https://celluloidjunkie.com/digest/koreas-cgv-first-to-open-cinema-in-metaverse/>
- [13] <https://www.youtube.com/watch?v=UMBxESI38o0>
- [14] <https://www.youtube.com/watch?v=Uot5AAAcVlk>
- [15] <https://www.metagaming.com/2022/07/31/hong-kong-university-to-build-worlds-first-metaverse-campus/>
- [16] <https://ourplnt.com/metaverse-medical-education/>
- [17] <https://www.youtube.com/watch?v=KLOcj5qvOio>
- [18] <https://www.brookings.edu/research/a-whole-new-world-education-meets-the-metaverse/>
- [19] <https://www.euruni.edu/blog/how-can-the-metaverse-be-used-in-education/>

Articulating Worlds

- [1] <https://www.youtube.com/watch?v=GoCZnboThfk>
- [2] <https://www.linkedin.com/pulse/digital-transformation-importance-humans-janina-kugel/>
- [3] <https://www.forbes.com/sites/bryanrobinson/2022/02/01/remote-work-is-here-to-stay-and-will-increase-into-2023-experts-say>
- [4] <https://www.indeed.com/career-advice/finding-a-job/the-pros-and-cons-of-working-from-home>
- [5] <https://www.cbsnews.com/news/more-than-half-of-teens-make-new-friends-online-pew-poll/>
- [6] <https://www.oldhouseonline.com/interiors-and-decor/evolution-of-the-open-floor-plan/>
- [7] <https://www.maverickvr.com/post/how-much-space-is-needed-for-vr>
- [8] <https://www.newegg.com/insider/vr-setup-101-building-a-functional-room-for-vr/>
- [9] <https://www.online-tech-tips.com/gadgets/what-is-augmented-reality-and-could-it-replace-all-screens/>
- [10] <https://www.ibm.com/topics/what-is-a-digital-twin>
- [11] <https://www.bloomberg.com/news/features/2022-04-05/digital-twins-mark-cities-first-foray-into-the-metaverse>
- [12] <https://tiballds.co.uk/news/cities-skylines-game-over-for-town-planners-and-urban-designers-or-a-new-level-of-understanding-for-future-generations>

Metaverse Urbanism

- [1] <https://www.sidefx.com/products/houdini/>
- [2] <https://www.youtube.com/watch?v=usJrcwN6T4I>
- [3] <https://www.somniumspace.com/>

- [4] <https://www.kristakimstudio.com/marshouse>
- [5] <https://www.cryptochatter.net/crypto-fan-mark-cuban-says-buying-land-in-the-metaverse-is-the-dumbest-sht-ever>
- [6] <https://www.euronews.com/next/2022/02/11/the-price-of-virtual-land-in-the-metaverse-is-skyrocketing-but-is-the-market-overheating>

Chapter 3: Working in the Metaverse

Work Life in the Metaverse

- [1] <https://www.grunge.com/321858/what-it-was-really-like-as-a-worker-in-the-industrial-revolution/>
- [2] <https://www.forbes.com/sites/forbesstaff/2022/05/12/forbes-global-2000-list-2022-the-top-200>
- [3] <https://www.celebritynetworth.com/>
- [4] <https://www.publico.pt/2017/02/24/sociedade/noticia/emigracao-mantem-os-niveis-altos-da-crise-e-isso-e-devastador-para-o-pais-1763125>
- [5] <https://digital.hbs.edu/platform-rctom/submission/tesla-building-the-machine-that-builds-the-machine/>
- [6] <https://wccftech.com/apple-watch-series-4-as-fast-as-iphone-6s/>
- [7] <https://www.zmescience.com/science/news-science/smartphone-power-compared-to-apollo-432/>
- [8] <https://www.inc.com/don-reisinger/secret-apple-presentation-reveals-how-ar-glasses-will-eventually-replace-iphones.html>
- [9] <https://www.cdc.gov/workplacehealthpromotion/tools-resources/workplace-health/mental-health/index.html>
- [10] <https://www.theatlantic.com/health/archive/2011/12/the-psychology-of-home-why-where-you-live-means-so-much/249800/>
- [11] <https://www.youtube.com/watch?v=jke7gJiybcg>
- [12] <https://www.youtube.com/watch?v=mnole1J4lzc>
- [13] <https://www.youtube.com/watch?v=YohEKgaQWGI>
- [14] <https://www.youtube.com/watch?v=Q13CishCKXY>
- [15] <https://www.youtube.com/watch?v=lgj50IxRrKQ>
- [16] <https://files.eric.ed.gov/fulltext/EJ1266671.pdf>
- [17] <https://productmint.com/the-fiverr-business-model-how-does-fiverr-make-money/>

Metaverse Architect

- [1] <https://www.investopedia.com/tech/what-dao/>
- [2] <https://medium.com/swlh/the-story-of-the-dao-its-history-and-consequences-71e6a8a551ee>
- [3] https://en.wikipedia.org/wiki/History_of_Apple_Inc.#cite_note-partnership-1
- [4] https://en.wikipedia.org/wiki/Apple_Park
- [5] <https://www.pritzkerprize.com/>
- [6] <https://www.archdaily.com/918471/ai-creates-generative-floor-plans-and-styles-with-machine-learning-at-harvard>
- [7] <https://www.youtube.com/watch?v=XzKtaqSisnA>
- [8] <https://www.cnet.com/tech/computing/how-the-game-industry-is-charging-into-the-metaverse/>

Creating for the Metaverse

- [1] <https://www.bloomberg.com/professional/blog/metaverse-may-be-800-billion-market-next-tech-platform/>
- [2] <https://www.autodesk.com/industry/aec/bim#>

- [3] <https://graphisoft.com/solutions/archicad>
- [4] <https://www.autodesk.com/products/revit>
- [5] <https://www.shapr3d.com/>
- [6] <https://www.blender.org/>
- [7] <https://www.autodesk.com/products/maya>
- [8] <https://www.sketchup.com/>
- [9] <https://www.unrealengine.com>
- [10] <https://www.gamedeveloper.com/design/classic-tools-retrospective-tim-sweeney-on-the-first-version-of-the-unreal-editor>
- [11] <https://www.gamesindustry.biz/epic-launches-unreal-engine-5>
- [12] <https://www.youtube.com/watch?v=sfMG746hk3k>
- [13] <https://www.fiverr.com/>
- [14] <https://opensea.io/>
- [15] <https://rarible.com/>
- [16] <https://superrare.com/>
- [17] <https://medium.com/@thecointimes/how-to-mint-an-nft-on-opensea-7a89e300a2ec>

Images

- A - A short timeline of the metaverse, its important technological developments and platform releases.
- B - A screenshot from Second Life in a public location on the grid.
- C - A screenshot from Minecraft with a building designed by the author.
- D - A screenshot from *Fortnite* in a sea dock environment.
- E - A screenshot from Spatial inside the author's virtual gallery portfolio.
- F - A screenshot from Decentraland outside Southeby's virtual museum.
- G - A screenshot from The Sandbox in Sueco's private land, where a stage is located.
- H - A screenshot from Voxels in a public location.
- I - The exterior of Samsung's venue in Decentraland.
- J - The reception hall inside Samsung's venue in Decentraland.
- K - The theatre hall inside Samsung's venue in Decentraland.
- L - Travis Scott's performance in *Fortnite*. * <https://www.youtube.com/watch?v=wYeFAIVC8qU>
- M - A cinema theatre in Decentraland.
- N - Decentraland's map.
- O - Mars House by Krista Kim. * <https://www.lifo.gr/now/entertainment/poylithike-pto-nft-psifiako-spiti-ston-kosmo-gia-miso-ekatommyrio-eyro>
- P - A view of Arki, using AR to preview projects on site during the design phase. * <https://www.youtube.com/watch?v=mnole1J4lzc>
- Q - A sketch of a typical company hierarchy.
- R - A sketch of how a company works under a DAO.
- S - A screenshot from ArchiCAD.
- T - A screenshot from Unreal Engine.
- U - A view of Unreal Engine's release video, showcasing the image quality possible with the software. * <https://www.youtube.com/watch?v=qC5KtatMcUw>
- V - OpenSea's marketplace.
- W - The submission page to create an NFT on OpenSea.