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Article

Incoming Metaverses: Digital Mirrors for Urban Planning

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Abstract
The planning process has been, arguably, slow to adapt and adopt new technologies: It is perhaps only now that it is starting to move into a more digitally focused era. Yet, it is not the current thinking around the digital that is going to change planning; it is the emerging metaverse. It is a change on the near horizon that is there but is currently largely unseen in the urban planning profession. The metaverse is, at first sight, a mirror to the current world, a digital twin, but it is more than this: It is an inhabited mirror world where the physical dimensions and rules of time and space do not necessarily apply. Operating across scales, from the change of use of a building up to a local plan and onwards to the scale of future cities, these emerging metaverses will exist either directly within computational space or emerge into our physical space via augmented reality. With economic systems operating via blockchain technology and the ability to instigate aspects of planning law, interspaced with design fiction type scenarios, they represent a new tool kit for the urban planner, spatial, economic, and social. We explore these emerging spaces, taking a look at their origins and how the use of game engines have allowed participation and design to become part of the workflow of these 3D spaces. Via a series of examples, we look at the current state of the art, explore the short term future, and speculate on digital planning using these incoming metaverses 10 years from now.

Keywords
digital mirrors; Meta; metaverse; planning; virtual

Issue
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1. Introduction

The digital toolkit available to the planning professional is vast. In this article, we explore, through examples, many personally developed, that multi-user 3D worlds and emerging collaborative spaces have the potential to change how the planning system operates. Yet, the reality of day to day practice for those involved in the planning system, from the professional through to the public at large is a predominance of the use of architectural drawings, 2D plans, and planning applications published in PDF. In short, it is as far from the vision of an emerging metaverse which we explore and suggest is the future of the digital planning system. Yet, these tools are out there, ready to be used, being developed by teams building digital worlds for virtual reality headsets such as the Oculus Quest from Meta, the company formerly known as Facebook. These tools, currently on the edge of the planning system, have the potential to fundamentally change how the planning process works, but they require a step-change in thinking by the profession. In April 1997, an article in *The Planner*, the monthly publication of the Royal Town Planning Institute in the UK, was written to introduce the planning to the then-emerging World Wide Web. Entitled "The World Wide Web: A Guide for the Urban Planner," the publication contained a look at visualisation online, including an early emerging 3D virtual environment. The article was published but it was retitled by the then editor as "The World Wide Web: Not Just for Nerds"; while a mildly assuming title change, it could be seen, at the time, as reflecting the mood of the planning community and their view of this new emerging technology. Almost 25 years on and the planning profession has arguably failed to grasp the concept of digital; only now is the system coming online with documents often provided in non-machine readable formats such as PDF and the system, arguably, still operating in a similar way to back in 1997, albeit with the ability to submit applications online.

In this article we explore the rise of digital planning, with a focus on 3D, collaborative worlds, known as the metaverse, a term which has perhaps only recently become notable due to Facebook rebranding itself as Meta (Bosworth, 2021) and making a notable move towards developing an occupied metaverse. These metaverses have been developing since the early 1990s and we explore examples we have developed for urban planning. However, before exploring the concepts of the metaverse, it is worth noting the current trends not only in digital planning but in the wider built environment profession. Digital twins and the Internet of Things are arguably the current driving force in the field of the built environment; these represent two different but overlapping concepts relating to our representation and understanding of place and space. Firstly, the concept of the digital twin was initially linked to product manufacturing by Grieves (2015) in 2002 with the concept of linking digital versions of manufactured products to their physical counterparts throughout their life cycle via a digital twin concept model. The model, according to Grieves (2015), consists of three main parts: (a) physical products in the real space, (b) virtual products in virtual space, and (c) the connections of data and information that tie the virtual and real products together. The concept of digital twins can additionally be traced back to the "mirror world" first promoted by Gelernter (1991) in his seminal book *Mirror Worlds: Or: The Day Software Puts the Universe in a Shoebox*. Gelernter (1991) defines "mirror worlds" as software models of some chunk of reality, some piece of the real world going on "outside your window" which can be represented digitally and then rescaled again and again into a form that you can enter and manipulate. A mirror world is grounded in some real space and its power comes from the way we manipulate reality, linking it away from not only a physical product but into wider places and spaces. Ultimately Gelernter (1991) predicted that a:

> Software model of your city, once set up, will be available (like a public park) to however many people are interested…it will sustain a million different views…each visitor will zoom in and pan around and roam through the model as he chooses. (Roush, 2007)

This in essence is the basis of the concept of the digital twin, a mirror on the world, but in software and occupied by people as they log into the system—a collaborative, multi-user digital space, which in turn, once connected to economic and social factors creates the concept of the metaverse.

Central to this concept is the definition of "space." Bell (1996) identifies three different kinds of space: visual, informational, and perceptual. Visual space is our view of physical real space, the space in which urban planning exists, from the colour and reflection of materials up to the construction of reality in which we live. In essence, as Mitchell (1995) noted, a series of primitives is made up of points, lines, and polygons, forming a 2D or 3D arrangement, and it is convenient to think of visual space as being populated by these tokens. This is central to the emerging digital twin, mirror worlds, as the machine—the mirror—needs to recreate these points lines and polygons in digital form. This is a notable task and one that is often overlooked in what is perhaps the current hyperbole on digital twins, that the construction of digital space is complex, computing-intensive, and ultimately expensive. We explore the construction of the digital mirror in the following sections, firstly exploring an increasingly important aspect of the digital twin, one of informational space. In Bell's (1996) definition, informational space is an overlay of the visual space where we receive information—everything from written signage through to sound—adding to the vision. As Borgmann (1999) states, information can illuminate, transform, or displace reality. In digital space it is the overlay and addition of data—data ranging from real-time feeds on, for example, environmental conditions or transport information through to the submission of a new planning application tied to a building, it is this informational space that is arguably the key aspect of the digital mirror. This is a crucial aspect as once the informational space is linked to the visual space it opens up multiple versions of the digital twin, depending on the space observed by the human eye from the digital screen—i.e., levels of reality. These levels of reality and with them the ability to plan are central to the development of digital planning. To illustrate where we currently are in the ability to plan digitally, Figure 1 provides an overview of the current state of play in the creation of this digital space.

The timeline in Figure 1 moves from traditional planning with paper and physical models through to the use of the internet and online documents and onwards to the creation of 3D spaces, its link to data, occupying the space, and then moving towards planning in the metaverse via digital twins. We suggest that the current state of the art is at the start of the creation of the digital twin, with the ability to augment space and overlay data technically possible; we provide examples of such developments in the following sections. The reality in relation to the planning system is however further back on the development line, arguably in the networked space with some more forward planning authorities moving into 3D data. It is between the networked space and the digital twins that can be seen as the current level of innovation. In relation to Bell (1996) and his perceptions of space, the information space is further augmented by social space, our social embedment in the digital environment. This ranges from the use of social media to

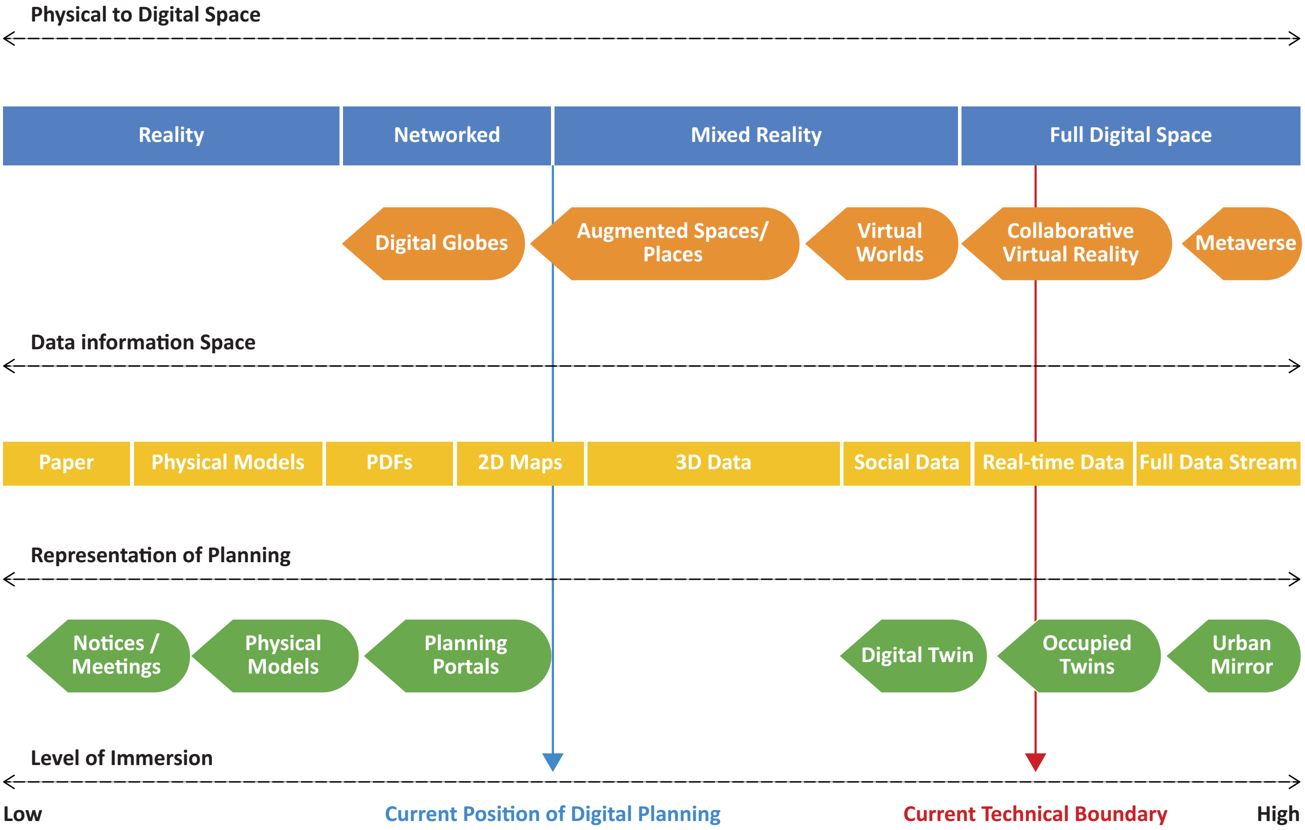

Figure 1. A timeline and current position of digital planning and its move towards the metaverse.

a 3D representation of ourselves in digital space, our own digital twin. It is the overlapping of these three types of space—visual, and informational with the addition of social—that creates perceptual space. This space, once created, allows us to perceive place and space and thus use it for the application of urban planning but with the benefits of digital. As Benedikt (1996) argues that because virtual worlds are not real in the material sense, many of the axioms of topology and geometry so compellingly observed to be an integral part of nature can therefore be violated or reinvented as can many of the laws of physics—creating almost a digital sandpit for urban planning.

At the time of writing (December 2021) there are over 160 companies building the metaverse (XR Today, 2021), a term which arguably implies one singular space, but, in reality, there are many, coexisting metaverses under development. The term metaverse is relatively new, emerging from Stephenson's (1992, p. 35) vision in his novel *Snow Crash* where he first describes the metaverse:

> As Hiro approaches the Street, he sees two young couples, probably using their parents' computer for a double date in the Metaverse, climbing down out of Port Zero, which is the local port of entry and monorail stop. He is not seeing real people of course. This is all part of the moving illustration drawn by his computer according to the specification coming down the fiber-optic cable. The people are pieces of software called avatars.

Although this is the first use of the term, taking a step back from the concept of the Street and Port Zero the metaverse can perhaps be defined as a digital space with an economic structure, occupied by avatars, sometimes mirroring the real world but with multiple representations of the physical world and the ability to change time, physics, and space. Radoff (2021) suggests that the metaverse relies on seven distinct layers:

1. Infrastructure: Connectivity technologies like 5G, Wi-Fi, cloud, and hi-tech materials like GPUs;
2. Human interface: Virtual reality headsets, augmented reality glasses, haptics, and other technologies users will leverage to join the metaverse;
3. Decentralisation: Blockchain, artificial intelligence, edge computing, and other tools of democratisation;
4. Spatial computing: 3D visualisation and modelling frameworks;
5. Creator economy: An assortment of design tools, digital assets, and e-commerce establishments;
6. Discovery: The content engine driving engagement, including ads, social media, ratings, reviews, etc.;
7. Experiences: Virtual reality equivalents of digital apps for gaming, events, work, shopping, etc.

It is these concepts and layers that make the metaverse perhaps the ultimate sandpit for urban planning, the ability to shape a world, plan, design, and open it up for consultation across the professions and the public at large, regardless of physical location. With the early concept of collaborative virtual spaces known then as the collaborative virtual design studio (CVDS), Batty et al. (1999) noted that, although digital worlds may form an entirely automated form of design and planning, through computation, there are five key aspects of the process where digital tools will develop. These involve:

1. Representing the geometric and geographic form of the system in question in terms of buildings, streets, land uses, etc., at different geographic and geometric scales, using different types of media;
2. Modelling movements and relationships between the various components of the built environment;
3. Enabling the designer to sketch different alternative designs which address the problem in question;
4. Visualizing the 2D map geometry or geography in 3D at different scales;
5. Tying together all this various software in a networked participatory digital environment—a CVDS—where various users might participate and collaborate in the process of design.

Perhaps the most popular recent reference point for the metaverse is *Ready Player One*, the novel by Cline (2011), adapted, in 2018, into a film directed by Steven Spielberg. In Cline's metaverse, the environment is known as "Oasis," a utopian virtual environment the population log into in order to escape the current dystopian real environment. Ball (2021) defines the metaverse as an expansive network of persistent, real-time rendered 3D worlds, simulations that support continuity of identity, objects, history, payments, and entitlements, and which can be experienced synchronously by an effectively unlimited number of users, each with an individual sense of presence. Robertson and Peters (2021) note that the metaverse is an aspirational term for a future digital world that is more tangibly connected to our real lives and bodies. They also note the following attributes:

- Feature sets that overlap with older web services or real-world activities;
- Real-time 3D computer graphics and personalized avatars;
- A variety of person-to-person social interactions that are less competitive and goal-oriented than stereotypical games;
- Support for users creating their own virtual items and environments;
- Links with outside economic systems so people can profit from virtual goods;
- Designs that seem well-suited to virtual and augmented reality headsets, even if they usually support other hardware as well.

Despite being in development since the late 1990s, as we will explore, the term is perhaps at the peak of the hype cycle. In September 2021, Facebook announced a $50 million investment in a global research programme to build the metaverse and, in October 2021, changed its name to Meta. Andrew Bosworth, the Vice President of the then Facebook Reality Labs noted in 2021 that it would take 10 to 15 years to build their vision of the Metaverse, additionally defining the metaverse as a set of virtual space where you can create and explore with other people who are not in the same physical space as you (Bosworth, 2021).

Before looking at the current state of the art, it is worth taking a step back to look at past developments in collaborative 3D spaces for urban planning. These examples are from ones we have developed and represent an ongoing timeline into the development of digital representation in what can be termed "early metaverses." Our first example used one of the first popular multi-user world systems in the late 1990s and arguably provided a first take on developing a metaverse in a system known as ActiveWorlds (https://www.activeworlds.com).

ActiveWorlds was, and indeed still is, a multiuser "chat and build" system where objects in the world can be either imported from external 3D software or by building "block by block" using cubes and derived shapes, similar to the now popular Minecraft, which we explore later in this article. Figure 2 details 30 days in ActiveWorlds (see Hudson-Smith, 2002), where an initial short term experiment into "online planning" in a 3D space led to the building of a community, full public participation in the planning process, and a dense network of streets, houses, and social environments being built over a year. ActiveWorlds, while still online, maintains the virtual spaces, but is greatly reduced in its number of users with unoccupied spaces as users have moved onto the next system. Digital spaces need to be able to transfer into the next metaverse and while ActiveWorlds was used for our first urban planning experiments, the concept moved on to a system known as Second Life. Second Life, as Jamison (2017) noted, was supposed to be the future of the internet, a 3D inhabited collaborative space with millions of people spending many hours building and shaping a new, occupied world. Set up in 2003 by Linden Labs, Second Life created an online digital space covering over 700 square miles in space with 36 million user accounts. Land and objects in the world were traded using Linden Dollars, an early example of a digital currency. Jamison's (2017) article was entitled "The Digital Ruins of a Forgotten Future" as Second Life followed ActiveWorlds in being more uninhabited than habited digital space. In more current developed examples, which we explore later, the digital currency is now crypto, with land being traded and sold above the equivalent physical cost.

In 2007, the University College London's Barlett Centre for Advanced Spatial Analysis (CASA) partnered with Nature Publishing and their Second Nature Island to

Figure 2. Fashioning the CVDS in which users appear as avatars and are able to manipulate the elements of their environment, c. 1999.

provide early examples of placing urban planning examples via its then Virtual London project in a collaborative virtual environment. Figure 3 details two avatars in Second Life within a block model of a part of London. The model could be queried for data, such as land use, and manipulated to show possible development options. Beyond the block model are step inside globes, to provide immersive photographic urban landscapes, captured in a similar way to the now familiar Google Street View. Land in Second Life was built block by block and, as Batty et al. (2009) state, although Linden Labs developed the program, it is the population of avatars that is creating the hamlets and towns that form its 750 square kilometres and its economy. Millions of Linden Dollars

Figure 3. Building virtual London in Second Life.

change hands every month for the goods and services residents create and provide. This unit-of-trade may then be bought and sold on LindeX (Second Life's official Linden Dollar exchange), or other unaffiliated third party sites where real currency changes hands (Linden Labs, 2007). Currency in the new emerging worlds has become all-important, as can be seen, for example, in Decentraland (see Ordano et al., 2017). As Goldberg et al. (2021) note, it was created as the first large-scale virtual world, built on a public blockchain and smart contract infrastructure. This is beyond the scope of this article but of note is the price of land in these emerging metaverses. While in Second Life whole islands could be purchased for a minimal amount for urban planning experimentations, the price of land could become a restricting factor in the creation of digital twins. Indeed, in Decentraland, a 96-square meter plot had a market value of $13,000 with the most expensive real estate selling for $4.3 million (Dailey, 2022).

In these new worlds, the population is in flux as users can "jack in" and "jack out," to adopt the now remerging terminology of the metaverse and *Snow Crash*. In August 2007, 23 million man-hours were spent in Second Life; the time was spent by over 974,000 users, with an average of 23.6 hours per user. Hof (2006) stated that as the residents spend:

> A total of nearly 23,000 hours a day creating things, it would take a paid 4,100-person software team to do all that. Think of it: The company charges customers anywhere from $6 to thousands of dollars a month for the privilege of doing most of the work....In other words, your next cubicle could well be inside a virtual world.

ActiveWorlds, Second Life, and many others laid the foundation for the current state of play and the reemergence of the term "metaverse." The concept is the same: a collaborative, occupied virtual space where users can build anything, own land, edit, and inhabit the environment. Arguably, it is the future of digital urban planning; the hard part is building it, which we explore next.

2. Building the Mirror

The construction of digital space for the use of urban planning is a specialised topic. From a UK point of view, the current curriculum to become a member of the Royal Town Planning Institute, and thus a qualified urban planner, is notably lacking in digital skills and incorporates almost no reference to 3D modelling. This will of course change, but, at the present time, the skillset is multi-faceted. The first requirement for any true digital representation for use in urban planning, we would argue, is a 3D model of the environment—just past the current state of play in our timeline of digital planning (Figure 1). These environments form the basis of either recreating the space via photogrammetry methods or more standard computer-aided design. Both methods are time-consuming and expensive when looking at the urban planning system and thus have developed as a "service" mode by companies providing access to digital models. One typical example is VU.CITY, providing access to 3D models for both architects and urban planners. Figure 4 illustrates a subset of their London model, for which they also use the term "digital twin."

From the ability to import designs, see protected views, overlay data from GIS through to height and massing assessments, and the ability to annotate and

Create or import designs securely and analyse them in situ

Add, search and explore and proposed developments

Provide AVR scope to determine which views to assess

Real time transport overlays

LVMF protected views

Overlay historic buildings, borough boundary and GIS data

Figure 4. VU.CITY 3D London model with example applications and data overlays. Note: AVR—Acurate visual representation; LVMF—Landscape visual impact assesment.

collaborate on projects with notes and images, the system provides access to urban planners to a full 3D model. As noted by VU.CITY (2021), one such example is its work in the London Borough of Southwark, where it is helping the borough design and test ideas for the development and growth in the area over the next 20 years by providing locations for 20,000 new homes; revitalising the high street with shopping and town centre facilities; assessing the design and heights of buildings and spaces; creating improvements for pedestrians and cyclists, including new links and making existing routes safer; and improving public transport, which includes an extension to the Bakerloo Line and two new underground stations. These are core planning functions, being carried out, digitally with access to the 3D dimensional model.

The service level model is perhaps inevitable due to the ongoing debate on the cost vs. the use of a 3D model. The Ordnance Survey, the UK's national mapping agency, has perhaps lost the edge it had in providing data for use by urban planners, with 3D not being seen as a priority. While this is understandable with the inevitable resource constraints, in terms of the incoming metaverse and the newly emerging digital environments and marketplaces for trusted data providers, the focus on still representing our environment in 2D is, in our view, concerning. At the same time, it indirectly constrains the urban planning system as the Ordnance Survey remains the main provider of location-based data with the gap being filled by third-party providers and thus without the quality assurance and standards that come as part of data being provided by a national mapping agency.

At the other end of the spectrum from national mapping agencies and service providers are the smaller development teams. One such example is our own ongoing development of the Virtual London model at CASA, which is taking it to the next step, while still using the same concepts as we noted in the CVDS in ActiveWorlds. The model, known as ViLo, builds it on earlier research at CASA into the creation of a comprehensive 3D model of London's built environment (Batty & Hudson-Smith, 2005). The current model supplements static spatial data about the cities' built environment and infrastructure with dynamic elements representing different kinds of events as they occur in real-time. Buses, tubes, and trains can be seen moving across the city while more abstract visualisations show the locations and availability of different services like bikes at local bike-share stations. Sensors transmitting data about environmental factors can also be accessed to show changes in natural phenomena ranging from variations in local microclimate to the patterns in behaviour of particular wildlife species (Dawkins, 2017). Figure 5 illustrates the ViLo model with the inclusion of real-time transport data. The model was developed as an early proof of the concept of a digital twin, in 2017, in association with the Future Cities Catapult, a government-funded organisation with a focus on exploring cities in the UK. The model was arguably ahead of its time with the inclusion of above ground and underground data allowing not only urban planning type scenarios but also operational use in an urban context. The system was focused on the Queen Elizabeth Olympic Park, in East London, a region of new development with a mix of uses.

Figure 5. The ViLo digital twin model with real-time data.

Developed in cooperation with the Mayor of London's Smart London Board it operated across a number of platforms, covering desktop usage, virtual reality, and augmented reality. This is possible due to the development infrastructure being focused on Unity, a cross-platform game engine designed to support and develop 2D and 3D video games, simulations for computers virtual reality, consoles, and mobile devices platforms (Unity, 2017). The availability of game engine technologies is beginning to bring together the multiple professions involved in creating the built environment, from architects to surveyors, urban designers, and back to the urban planner. The main players at the current time are both Unity and Unreal (another game engine), offering access to the ability to import and visualise data relating to the built environment. It is still in its infancy but the game engine provides the catalyst for an integrated visualisation system. This is required due to the current arguably similar but diverse worlds from building information systems through to GIS, working at different scales but with location and data at the centre of both systems. In the geographic information arena, one should note that, in late 2020, ESRI released an open beta release of their ArcGIS maps software development kit for both Unity and Unreal Engine. As the vice president of Unity, Julien Faure, states:

> As gaming technology is increasingly adopted in many industrial sectors including AEC, government, energy, and transportation, we are excited to partner with ESRI to bridge the world of GIS and real-time 3D. The addition of ESRI's best-in-class real-world geospatial data into Unity's real-time 3D development platform will help create real-time digital twins of an unprecedented scale, to better operate and manage massive infrastructure and entire cities in immersive environments. (Hansen, 2020)

We illustrate an early example of this in Figure 6.

The examples thus far have concentrated on using 3D systems to import more traditional digital urban data, in the form of building footprints, height data, etc., to create the urban mirror. This is a development in the timeline of computer-aided design software and the natural integration of GIS along with the merging of building information systems. Using similar technologies but in a directly opposite manner (which could be argued as its own mirror) is the development of urban space directly within computer games, to which we briefly turn.

Minecraft is an open-ended "sandbox" game designed by Markus Persson and published by Mojang, where players build constructions of textured cubes in a world with its own laws of physics (Overby & Jones, 2015). It is perhaps the best example of urban space created in a gaming environment by the players. Currently owned by Microsoft and available across multiple gaming platforms, as of April 2021 there were up to 139 million monthly active players with 238 copies of the game sold worldwide (Microsoft, 2021). The system has been compared to digital LEGO (Olmedo, 2013). The LEGO comparison is not just due to the block-based nature of Minecraft, but also a reference to its open-endedness (Hervé & Salge, 2021). Operating in a virtual space, the dimensions of Minecraft consist of over 3.6 billion square kilometres, or seven times the size of planet Earth (Milakovic, 2021).

These online virtual environments, or metaverses, operate in their own space, limited only by the physical

Figure 6. New York GIS data in the Unreal game engine via ArcGIS.

characteristics of the physical hardware they run on. Minecraft additionally crosses over into physical space via its Minecraft Earth iteration. Working via augmented reality, it links a real-world location to digital space to overlay information. Such overlaps fall into the genre defined by Ahlqvist et al. (2018) as GIS–multiplayer online games (GIS-MOG). These in addition fall within the remit of geogames—games with a spatial aspect. de Andrade et al. (2020) summarising the work of Yamu et al. (2019) define the characteristics of geogames as: (a) anchorage in a certain place, in which the game environment and spatial components can be represented and visualized; (b) focus on solving a spatial problem relevant to the citizens of the selected place; (c) inclusion of rules and elements of enjoyment to attract citizens to play and continue to return to the game; and (d) enabling the engagement and participation of citizens in an urban planning process.

Underlining the potential of Minecraft to build the urban mirror is the BuildTheEarth project, where over 210,000 people participated in one Minecraft mega-project (BuildTheEarth, 2020). Figure 7 illustrates New York City in Minecraft, illustrating the output of BuildTheEarth.

Minecraft is arguably the most used metaverse for urban planning, especially in developing countries, thanks to the work of the United Nations habitat programme Block by Block. The first workshop by Block by Block was held in 2021 in Nairobi after technical models and architectural drawings proved to be assessable and unengaging in local forums (Arnarsdóttir, 2020). Von Puttkamer (2020) notes that the rationale for using Minecraft is twofold: It is very appealing for younger generations, who can be included in urban topics and participatory processes via the game, and it is a very easy tool to use. The audience of Block by Block projects is very mixed and often consists of all age groups and different religions. Within 20 minutes, it is possible to teach even illiterate people to move blocks around in the game. It arguably allows the urban form to become accessible and proposed changes understandable and—perhaps more importantly—editable. Bjarke Ingels, a Danish architect, notes in Winston (2015) that these fictional worlds empower people with the tools to transform their own environments and that this is what architecture ought to be. As the side by side view of the community housing in Figure 8 and the work by Block by Block illustrates, Minecraft can be used successfully to create a twin of the physical world and allow it to be used for future planning. Compared to more traditional architectural models the worlds built in Minecraft are rough and blocky, giving an approximation of space and place. It is perhaps this approximation that makes it so successful: It focuses on the overall impression of the urban environment rather than the fine details. Block by block, Minecraft is building a digital mirror of the real world but in an abstract form; it is this form, along with its playful aspect, that has made it the most successful 3D platform for the built environment.

Location is the key factor across the multiple genres: As Ahlqvist et al. (2018) noted, in terms of GIS-MOG, location in the game is important in the same way that location is important in geography. Location in building the digital mirror is important, not only in terms of knowing where the “player,” “avatar,” or “user” are but equally in terms of representing the place and space in terms of points, lines, and pixels. It is this representation that is central to the building of the digital mirror.

Figure 7. BuildTheEarth New York City. Source: BuildTheEarth (2020).

Figure 8. Block by block mirroring community housing.

3. Multiple Mirrors

Digital twins, and with them the emerging metaverses, are being built piecemeal, in multiple pieces of software, visualised in multiple ways, and often replicated by multiple people at the same time. Each city around the world has multiple 3D models, developed either by municipalities, multinational companies, architects, local companies, academics, or simply interested individuals. Combined with these multiple representations are the multiple emerging platforms. The metaverse will potentially follow the growth of the World Wide Web, which grew rapidly by linking together individual hosted pages, which in terms of the metaverse will be the introduction of a "platform" linking together representations of place and space. Facebook (Meta) arguably have the view of a single platform, while games such as Minecraft exist in their own microcosm and individual examples exist in the current flow of open standards.

These environments are becoming graphically intensive; the technology is in place now whereas in 2002, with our early examples, it was niche. Worlds, metaverses, came, were occupied and then abandoned with early urban planning examples still existing somewhere in digital space, on a long-unused server. Yet, some of the largest global companies are now behind the next move into the metaverse, digital twins are being built, and the edge of the technical boundary in Figure 1 is arguably a decade away from a true, occupied digital mirror world. The blip on the horizon for urban planning may be simple economics, with the system cost out of representation or experimentation in these emerging spaces which are now increasingly driven by cryptocurrencies. However, with more than 160 incoming metaverses under development and digital planning finally gaining momentum, the use of game engines, avatars, collaborative design studios, and others may finally have reached its time and the current state of play we illustrated in Figure 1 will start to move towards the metaverse. What is needed to ensure this happens is a realisation from the practice of urban planning that digital technologies, game engines, and even background infrastructures such as cryptocurrencies need to become part of the planning curriculum. With this, the next generation of urban planners can lead the way into these emerging metaverses; without it, it will forever be playing catch up to technology and risks long term being a profession lost to the Digital Mirror rather than embracing it, in a similar point to where we started, back in 1997 and it turned out the World Wide Web was not just for nerds.

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Conflict of Interests

The author declares no conflict of interests.

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