Design Principles for Coordination in the Metaverse

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Accepted for presentation at the 82nd Annual Meeting of the Academy of Management

August 2022

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ABSTRACT

The Metaverse represents the next generation of the Internet that, at this instant in time, is still a concept. It is envisioned to provide interconnected experiences that are immersive and varied. This vision challenges both designers and users to understand its possible coordination architecture and develop strategies for participation. One way to understand the concept and affect its instantiation is to take a design science approach that articulates design principles that might guide the exploration of different architectures. We apply concepts related to platforms and business ecosystems as well as ideas about facilitating technologies including choreography and orchestration as ways of blending together experiences, providing transitions between virtual locations. We derive three design principles from an analysis of Metaverse scenarios: narrative composability, social assortativity, and path discoverability. Thinking through these aspects of design leads to a discussion about the tradeoffs that will face designers of the Metaverse.

Keywords: metaverse; design science; design principles; platforms; business ecosystems; business processes; narrative composability; social assortativity; path discoverability

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"This Metaverse is going to be far more pervasive and powerful than anything else. If one central company gains control of this, they will become more powerful than any government and be a god on Earth." - Tim Sweeney, Epic Games CEO, in 2016

INTRODUCTION

Recently, Facebook changed the name of its parent company to Meta, which ushered the term Metaverse into common parlance. But the Metaverse is not a new idea. As the quote above indicates, many organizations in the gaming and virtual reality community have been using the term for some time. It is typically traced back to Neil Stephenson's 1992 book *Snow Crash*, where he describes a dystopian future where people escape to a virtual world. Since then, the term has been used in a variety of different ways (Ball, 2020; Dionisio, Burns, & Gilbert, 2013; Hamilton, 2021; Kanematsu et al., 2009; Zuckerberg, 2021). Together, these and related writings constitute an early vision of the Metaverse—messy, utopian, exciting, and sometimes incongruent. A common claim is that the Metaverse represents the next generation of the Internet where physical and digital realities converge. It uses platform technologies, augmented reality, virtual reality, and artificial intelligence methods to provide interconnected experiences at unprecedented variety and depth (Seidel, Berente, Yepes, & Nickerson 2022). In this sense, it can be viewed as an ecosystem (Kapoor 2018), but an ecosystem that connects a variety of digital ecosystems. It is an ecosystem of digital ecosystems, where each ecosystem can be conceived of as a universe with its own material and symbolic elements.

Thus, the Metaverse is an intriguing idea, and it should be no surprise that many leading technology companies including Microsoft, Meta, Epic Games, and others, are scrambling to develop strategies to actively shape the Metaverse. Tim Sweeney, Epic Games' CEO, highlights the Metaverse's economic potential and points out that the race for the Metaverse has started: "It's kind of a race to get to a billion users, whoever brings on a billion users first, would be the presumed leader in setting the standards" (Hamilton, 2021). In the eyes of many organizations—including not only companies but also nations (Upadhyay, 2021)—there is tremendous value to be generated through the Metaverse, and different organizations are taking different approaches.

Existing research on ecosystems provides a way to think about Metaverse strategies. The Metaverse, as a sort of meta-ecosystem, inherits many of the characteristics of any other ecosystem. Therefore organizations that wish to compete in this domain need to focus on coordinating with complementors and customers, and they do this with the aid of standardized technical interfaces (Kapoor 2018; Tiwana 2013). A key difference for the Metaverse is that, due to its rich virtual, experiential nature , these interfaces need to accommodate *transitions* between a growing and unbounded number of experiences (Seidel et al 2022). The transitions between experiences—for example, moving from playing Minecraft to playing Roblox—are themselves experiences. *Rich transition experiences* are one way that the Metaverse departs from the rather cross-sectional interface standards implied by much of the literature on ecosystem coordination. But we know little about the design for the coordination of rich transition experiences, and this is important because the structure of transitions is essentially the architecture of the Metaverse (just as the structure of interfaces comprise the architecture of any ecosystem: see: (Baldwin & Woodard, 2009; Ghazawneh & Henfridsson, 2013; Kapoor, 2018; Tiwana, 2013). Given that Metaverse experience transitions are conceivably different from traditional, cross-sectional interfaces, we ask: *what are the unique elements of transitions that enable the coordination of rich experiences in the Metaverse?*

To answer this question, we conceptually explore key elements of the Metaverse and transitions among experiences to generate design principles for these transitions. Design principles are the prevalent way in information systems research to specify design knowledge—that is, prescriptive knowledge about the design of systems (Gregor, Chandra Kruse, & Seidel 2020). Design principles have been invoked, for instance, to explore the design and development of virtual worlds (Chaturvedi, Dolk, & Drnevich, 2011) as well as of platforms (Seidel et al. 2019). They are the outcome of design-oriented studies that do not seek to explain phenomena but develop prescriptive knowledge about classes of sociotechnical systems (Baskerville, Baiyere, Gregor, Hevner, & Rossi, 2018; Chandra, Seidel, & Gregor, 2015; Hevner, March, Park, & Ram, 2004; Schoormann, Möller, & Hansen, 2021). The focus is thus on intervention (van den Akker, 1999). The idea of using a prescriptive approach to design studies was argued by Herbert Simon, who noted that technologies are designed, and that we don't need to discover natural laws when we can create artificial laws (Simon, 1996). We consider this approach to be appropriate to study the Metaverse at its early stage—currently there is no one single Metaverse but rather some proto-metaverses, and so there is little opportunity to sample for studying Metaverse causes, interactions, and consequences. Still, it is important to develop a conceptual language that bridges the phenomenon to other phenomena studied in information systems and organizational research.

To this end, in this essay, we characterize the nature of the Metaverse as a proto-ecosystem of ecosystems that involves transitions among rich, nested experiences. Building on key ideas from research on platforms and business ecosystems, we develop a set of design principles for the Metaverse's possible architectural configurations. We seek to lay out abstract types of such configurations, while the Metaverse is still malleable, not yet in debt to contingency (Meyer, Tsui,

& Hinings, 1993). We identify three design principles for the Metaverse: narrative composability, social assortativity, and path discovery.

The vision of the Metaverse calls for a kind of freedom of movement from place to place, episode to episode. Just as a city dweller can move from a bar to a restaurant, users of the Metaverse should be able to move from game to game, or, in an enterprise, from a warehouse simulation to a transportation simulation. Content creators and users will be involved in creating and participating in multiple linked narratives. This is *narrative composability*.

The vision of the Metaverse also calls for universal participation. In order to allow this, there needs to be a way for people to drop in and out, to form new relationships. And the Metaverse is not just about individuals: groups and institutions will also participate, and so there needs to be a way for people to identify as individuals and as groups, along the way taking advantage of the mixing that can happen through multiple memberships. This is *social assortativity*.

In order for the Metaverse to be generative, there needs to be a way for people to discover new paths, to plan their journeys, and to change plans if they want to. Given the scale of the Metaverse, there may need to be external curation, recommendation engines, and search tools. This is *path discovery.*

These principles are important from a theoretical standpoint because they help us understand if the phenomena we are confronting—the specific implementations and their configurations—are only superficially different from previous phenomena or if they are qualitatively different, calling for more theory.

We proceed as follows. First, we review research on platforms, ecosystems, and their architectures to ground the importance of interfaces and problematize the notion of transitions. We describe Metaverse scenarios, looking at narrative scenarios, social scenarios, discovery scenarios, and their combination. From these, we derive design principles of composability, assortativity, and discovery. We discuss the tradeoffs facing the designers of the Metaverse and conclude with some implications for theory.

BACKGROUND

Current discussions about the Metaverse revolve around issues related to ownership and governance. The recent renaming of Facebook to Meta is seen by some as the sign of a race toward a walled-garden model of the Metaverse by a company large enough to create a self-contained platform (Newitz, 2021). Not only large companies, but crypto-related startups are also operating in this space (Nabben, 2021). Virtual real estate is already going for high prices in anticipation of a virtual land grab for locations that might be centers for Metaverse activity (Chaudhari, Laddha, & Potdar, 2019). One central theme is the relative openness or closedness of Metaverse visions (Seidel, Berente, Yepes, & Nickerson, 2022). The caricature is that either we will have a Metaverse owned by one powerful company, or we will instead get a crypto-based Metaverse owned by everyone. But certainly many visions exist in between. Matthew Ball, as venture capitalist that operates EpyllionCo, articulates a vision where there is a kind of platform openness, in which individuals and small companies are free to offer competing services (Ball, 2020).

Much like how the recent debate on the Metaverse revolves around issues of ownership and governance, key questions about platforms and platform-based ecosystems involve related questions of coordination. These coordination questions take a variety of forms, including questions of control (Tiwana 2015) as well as openness (Bosch 2009)—but also architectural and development aspects (Tiwana 2018) that provide the foundation for platform evolution (Ghazawneh & Henfridsson, 2013) and scaling (Henfridsson & Bygstad, 2013). Platform ecosystems involve sets of complementors and customers that coordinate around extensible codebases of software-based systems providing functionalities shared by modules interoperating with each other as well as the interfaces for this interoperation (Tiwana, Konsynski, & Bush 2010). Although there are different sorts of relationships between ecosystems of organizations and the digital platforms that enable this coordination (Kapoor 2018), a fundamental insight of ecosystem research is that the interfaces between components that define the structure of technical architectures enable the often arm's length coordination among product and platform organizations with their complementors, customers, and each other (Eaton, Elaluf-Calderwood, Sørensen, & Yoo, 2015; Tiwana, 2013). Since technical interfaces essentially define the architecture of these digital ecosystems and how different organizations interact and coordinate their work, decisions around interfaces are fundamental to the implementation of ecosystem strategies (Baldwin & Woodard, 2009; Ghazawneh & Henfridsson, 2013). Interfaces define how value will be generated and captured in platform ecosystems (Tiwana, 2013).

However, much of the existing literature on the interfaces that define an ecosystem's architecture treats them rather cross-sectionally, and as a discrete decision. For example, one must decide on an interface, such as an application-programming interface (API), and then this becomes the standard for coordination. Essentially, the development of interfaces is a technical decision that implements a strategic direction (Baldwin & Clark 2000). There are two problems with this cross-sectional view. First, recent work is highlighting how platforms evolve (Agarwal & Tiwana, 2015), and this evolvability is, in part, enabled through dynamic and changing interfaces (Alaimo & Valderrama, 2020). Beyond this, however, in a Metaverse context, the traditional notion of an interface as a cross-sectional standard does not adequately account for the depth of interaction. The Metaverse involves transitions between rich experiences that are not merely a matter of an explicit and discrete interface standard (Seidel et al 2022). Moving from one rich experience to another is not simply a matter of clicking a button and traversing a boundary. The more in-depth the experience, the thicker the boundary, and the need for a transitional experience from one to the other (Ashforth, Kreiner, & Fugate, 2000)—just think of more or less seamlessly moving from an immersive 3D game experience to a 2D shopping scenario or a work-related video conference. The Metaverse will involve some aggregation of very diverse, immersive, and rich experiences, and the boundaries between these experiences will not be trivial and will require temporal transitions and spatial transitions in virtual worlds. Put simply, the interfaces of the Metaverse ecosystem will involve transitions rich in experience. Next we describe Metaverse scenarios: narrative scenarios, social scenarios, discovery scenarios, and their combination.

METAVERSE SCENARIOS

Overview

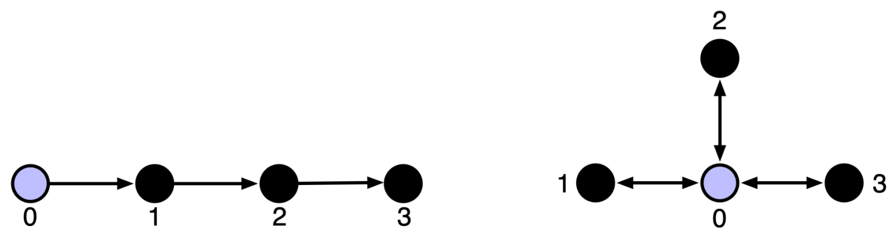
Interaction in the Metaverse will involve tightly intertwined experiences. We need to understand the ways that different experiences are composed. While we can conceive of various interactions within the Metaverse, including audio, textual, 2D visual, 3D visual, and any combination thereof, many models of the Metaverse call for 3D interaction in particular (Ball, 2020). 3D scenes are complex entities that are often made persistent through game engines sitting on complex hardware stacks. To compose one scene in one part of the Metaverse with a scene in another part of the Metaverse is conceptually complex. Are they to be seen as contiguous? Do they need connecting spatial tissue (enabling users to spatially traverse from one experience to another) or temporal tissue (where one experience temporally precedes another)? Do they need some kind of metaphoric translation—for example, how does an underwater game morph into a space game? Do submarines become rockets, like in a dream? Or do submarines more prosaically dock at ports where launch pads send up rockets? Composability issues like this are related to the compositionality of language, which uses a number of different methods to connect descriptions of experience. For example, stories can be concatenated, one after the other, with little transition. Or stories can be nested within each other, as when one story flashes back to a story at a previous time (Wolf, 2006). Or stories can be transformed through metaphor (Genette, 1983). All the techniques of rhetoric should be possible in the Metaverse, but may call for new kinds of technological standards. For example, what piece of software needs to know that an underwater experience is being composed with a space experience? And how is a method of transition chosen? What technology implements it?

Next we consider a series of scenarios that illustrate the challenges of designing the Metaverse. Narrative scenarios illustrate the challenges of combining experiences. Social scenarios highlight the potential for generative interaction between people. Discovery scenarios show the difficult combinatorics of choice in virtual and augmented worlds. Finally, all three are brought together in scenarios that illustrate the challenges of the design problem.

Narrative Scenarios

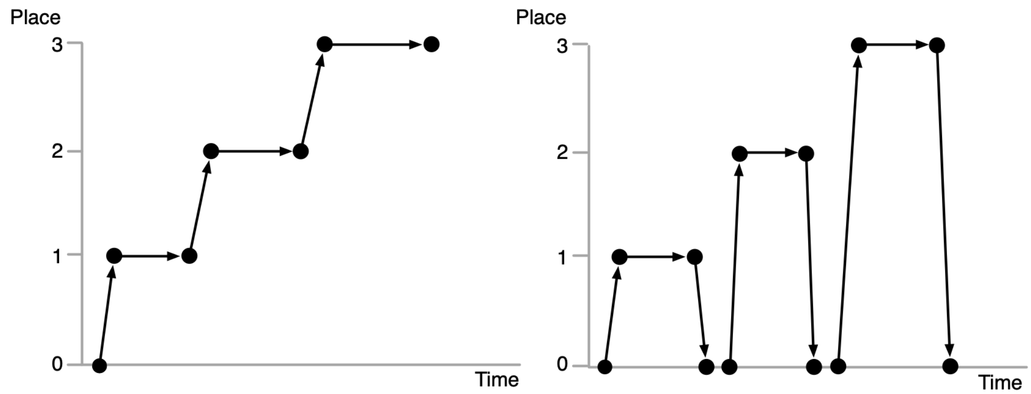
One way of conceptualizing the alternative configurations of the Metaverse is through graphs that are related to narrative. The narrative often used to describe the potential of the Metaverse is one of a journey across several virtual worlds. As with any form of narrative, this journey can be represented by a graph, in which individuals traverse a set of locations. An abstract graph can quickly explain two simple topologies (Figure 1). On the left, there is a sequential journey from base 0 to three other places. On the right are three forays from base zero to three other places.

FIGURE 1
Journeys and Forays in Space



This visualization suggests the different nature of the topology, but does not fully express the timing of the experiences. An alternative formalism is a time-space network in which one dimension is time and the other dimension is distance. These networks are often used to analyze and design logistics and transportation problems such as delivery schedules (Wang et al., 2021). In the case of the Metaverse, distances are not necessarily metric, and so we have modified the convention to show places rather than distances along one axis. Figure 2 shows such a modified time-space network for the graphs of Figure 1, assuming some time is spent in transitions between places (note the transitions can be experiences in themselves), but not as much as in those places. On the left, from a starting point, a group visits three other places in sequences. On the right, the group starts from a base and makes three forays, returning to the base and regrouping before going back out.

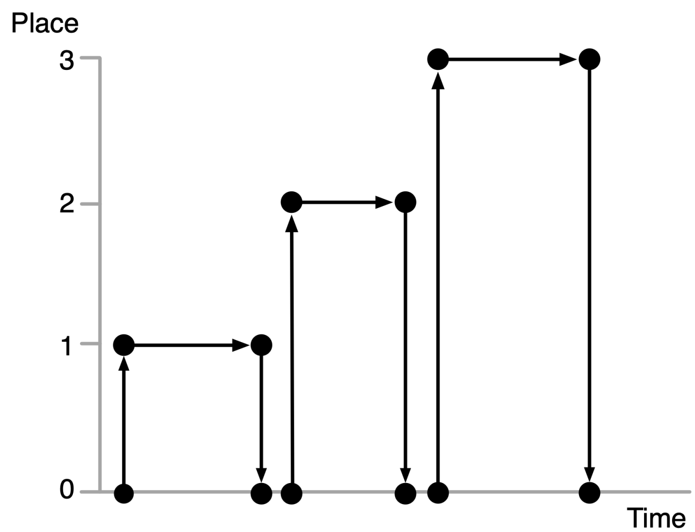
FIGURE 2
Journeys and Forays in Space-Time



The versions of the Metaverse that imagine immersive linked experiences, a free and continuous traversal from place to place, are generally based on the diagram on the left. But today, a small group playing video games together would do the second: they would play, exit, regroup, and play a different game. The transition between the home base, the place they assemble to start, and the game itself could be practically instant, as there is no expectation of continuity from the physical world to the game. Even in some games, there is something like the second, where a portal takes one back out of a level to the starting entry point. This second vision of the Metaverse has been described by the founders of Second Life, the prototypical early metaverse, as a more realistic imagining of the Metaverse, because it is much easier to build (Gurley & Rosedale, 2021). They argue that the Metaverse might end up being more like the audio based environments of Discord or Clubhouse than like the original Second Life. That is, the Metaverse might be based around verbal rather than visual communication, and it might simply involve dropping in and out of locations that are persistent, and where synchronous communication can happen.

The combinatorics of each scheme are very different. If there are 100 locations, all presenting opportunities for experiences, then there are 100 * 99 possible transitions: for *n* locations, the number of transitions is $n * (n-1)$, which is $O(n^2)$. So a metaverse with full freedom of recombination would need to either think all these transitions through in case they are taken, or create them on the fly in some automatic way, both of which are costly and difficult to do. By contrast, in a foray scenario, only *n* transitions are needed. Moreover, if the time between these later transitions approaches zero (Figure 3), then there is no need for any transition other than entry and exit from the game. Transitions between places are instantaneous (as shown by vertical lines), as in entering or exiting a game or online meeting. Forays from a base are much less expensive. On the other hand, full transitions between all places is a way of introducing variety into the Metaverse; it is a kind of recombination.

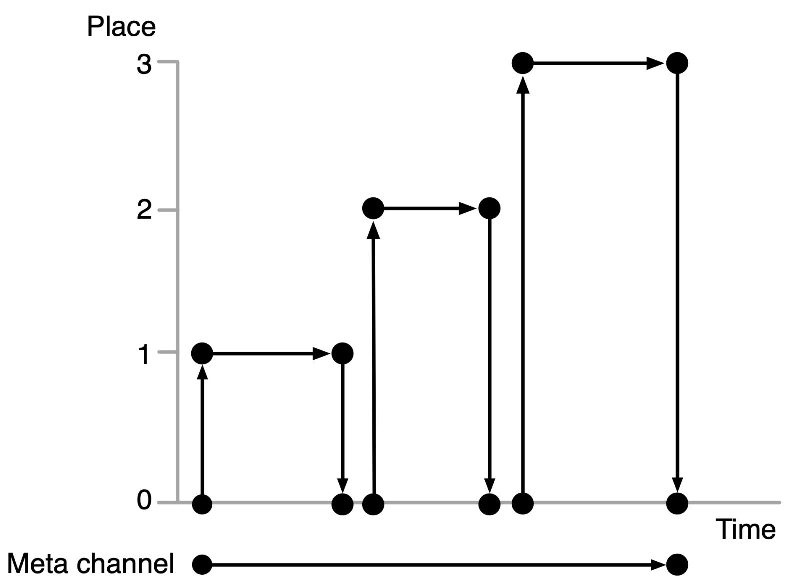
FIGURE 3.
Instantaneous transitions



Proto versions of this are combined in contemporary open-world video games (Dale & Shawn Green, 2017). For instance, players in a large game world can choose between traveling from location to location, thus creating an integrated experience composed of experiences made in each location, or they can choose to return to bases from where they then jump to new locations (and thus foray into those locations). Players might also just jump from location to location (and not travel the physical distance). Depending on the transitions chosen, and based on the experiences they have in each location, different narratives unfold.

Taking these two distinct Metaverse models, it is possible to imagine important variants. One model imagines parallel channels. For example, it is possible to use an auditory channel as a kind of base camp. Figure 4 looks much like the right of Figure 3, the difference being that the meta channel in Figure 4 is continuous and needs no transition: all the transitions will be primarily visual, exiting the game to find another and invoke it. Thus, a tool like Discord can be used for talking *about* the experience as it happens.

FIGURE 4
A continuous meta channel

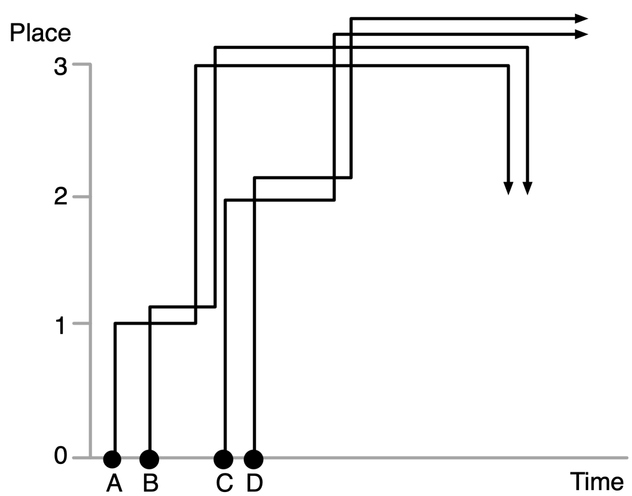


This idea of multiple channels brings up the issue of sensory overlap. If an activity in the Metaverse is purely visual and the meta channel is purely auditory, then there is no overlap at the media level. But sound may be important for many experiences, and so there may be competition for the auditory channel.

Social Scenarios

Mingling scenarios occur when individuals are traversing many places, each potentially with different actors joining in at different points in time. That is, the previous scenarios have imagined a group of people all engaged in a series of activities in different places over a period of time. In some situations, such as in conferences, individuals take different paths, and part of the point of the event is to allow for assortativity—for mixing. Figure 5 shows individuals rather than groups as the nodes, and close-together or overlapping lines at a place indicate the same individuals are at the same place. Two people, labeled A and B, meet up at Place 1, and then go together to Place 3. Meanwhile, C and D meet at Place 2, and eventually leave to meet A and B at place 3. Eventually, A and B break off and visit Place 2.

FIGURE 5
Four individuals mingling



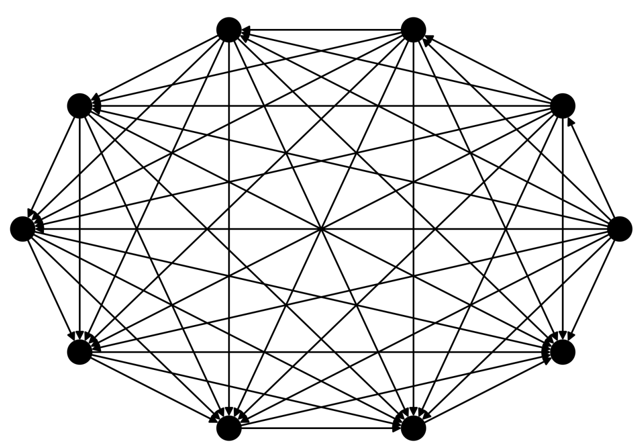
Everyday scenarios are often like this: working couples might rendezvous with each other first before meeting another couple for dinner, for example. In business situations, like at conferences, this might represent colleagues who travel together meeting up with co-authors from another institution after meeting with each other first.

The figure suggests the assortativity that can be had through co-location in time and space. It also suggests a difficulty inherent in the Metaverse: it may be hard to predict how many people will appear in each location. Each person needs to be rendered in a virtual world, and so the joining of thousands of people in one location presents a logistic challenge. One of the largest online events, a concert within the game environment Fortnite—originally designed as a shooter-survival game but then extended to also host other events—solved this problem by breaking up the large crowd into smaller groups so that there was no need to render thousands of moving avatars (Breese, 2020). But this limited the ability for the kind of fortuitous meetings that can happen at a large concert.

Discovery Scenarios

The Metaverse is designed to allow for multiple user journeys simultaneously: millions of users will be in the Metaverse. And there will be many locations. How does the journey translate in this view? How does a user discover the next step in a journey? At its most general, the journey allows for many possible paths from each location to each other location. This means the locations form a complete graph, as in Figure 6, that shows all places connected to all other places.

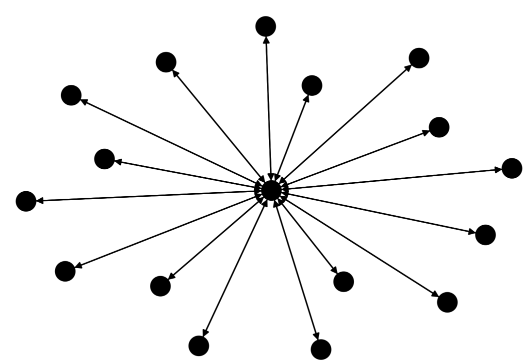
FIGURE 6
Complete graph



From a movement perspective, this is wonderful. From a design perspective, it is daunting: any new place in the Metaverse would need to build interfaces to every other place. Or be able to generate an interface in real time. And discovering the next step is also hard: there are so many options.

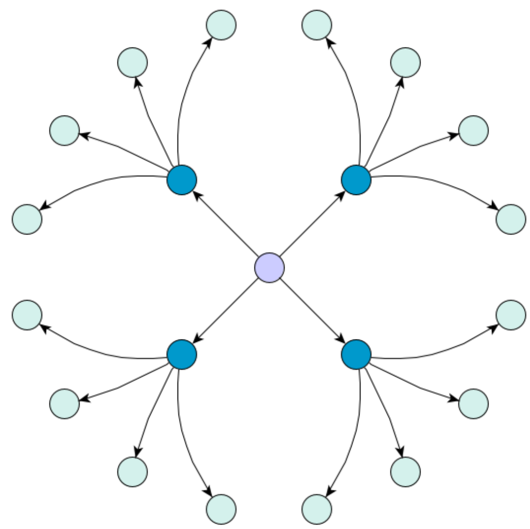
By contrast, the foray creates a hub and spoke arrangement, as in Figure 7. Each foray involves a return to the base and then back out again. In this arrangement, each new place only needs to build two interfaces: a transition from the base and a transition back to the base. In many cases this can simply be a begin button and an end button, as when a game or application launches and exits. It doesn't change the number of options users need to discover, but it does provide a kind of buffer, a place to search and figure out what to do next.

FIGURE 7
Hub and Spoke



Networks, though, are seldom as simple as these. Some networks are scale-free, or close to scale free (Barabási, 2009). In such networks there are multiple centers, or hubs, of varying size. These networks naturally occur through preferential attachment: if links tend to be made to the nodes that have many links, one gets varying hub sizes. Designed networks are often of intermediate complexity, more like a hierarchical hub and spoke, as in Figure 8. Note there are many centers, which might correspond to alternate bases as well as places to be visited. Note the hierarchy: there is a clear start point, and then a set of options, which lead to other options, as are seen in many video games.

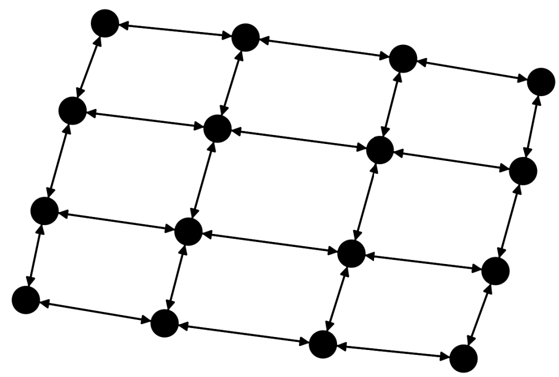
FIGURE 8
Multi-hub network



Transportation theory has long observed that cities have this nature: from large cities to regional cities to towns to villages (Cooley, 1893) there is this kind of distribution. This in turn can guide urban planning, including the design of transportation hubs (Batty & Longley, 1994). Even in virtual worlds, this kind of arrangement occurs. Second Life, for example, has primary and secondary portals, analogous to major and minor transportation hubs.

Building out a hierarchical hub and spoke network is less hard than building out a complete graph, but any new node has to figure out how many centers to connect to, the same way a new airline has to pick its flight routes. And the number of potential hubs can be very high. An alternative structure is the grid, in which the degree of each node is bounded. In two dimensions, a square grid is often used, as in Figure 9. This grid minimizes interfaces: a new node needs to build at most four interfaces to neighboring nodes. Moreover, users are presented with at most four choices on where to move next.

FIGURE 9
A grid of locations



If the different places are arranged on a grid then the grid is $\sqrt{n}$ wide, and the overall number of transitions is $2\sqrt{n}\,(\sqrt{n}-1)$. That is, the complexity is *O(n)*, and there is still some variety for players to explore. Moreover, the transitions can take advantage of cinematic-based tricks—hallways, tunnels, elevators, roads, bridges, rivers—all make the transitions easier to render.

The grid is important for two other reasons. First, it is modular. The entire map can be easily extended with uniform costs for each extension. Second, it invites a Euclidean mapping. Before now, we have been considering links as being purely topological. But once a grid is put into place, there is an implication of a metric: distances will be symmetric, and distances will obey a triangle law that corresponds to our intuitions about space: moving 2 over and 3 up will take at least as long as moving 2 up and 2 over.

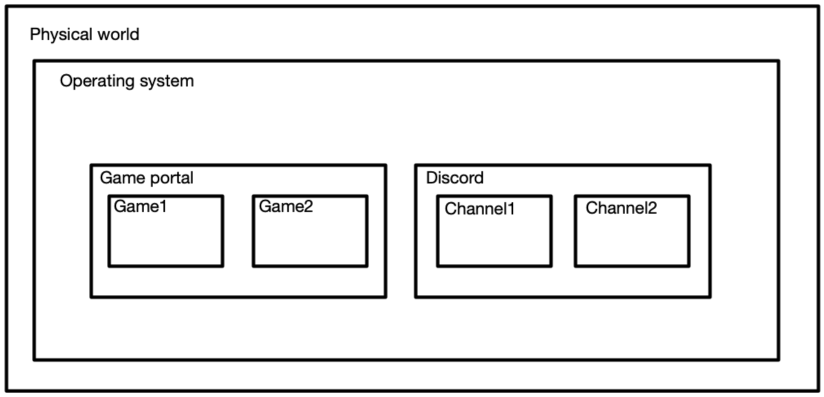
The natural thing to do is to try to map virtual spaces into something that corresponds to our intuitions about 2D and 3D space. And that is what many contenders for the Metaverse are doing. Second Life has a grid, as do the modern crypto real estate environments like Decentraland (Chaudhari et al., 2019; Goanta, 2020). An advantage of this is related to gaming engines. These engines can represent and render 3D space. Once there is a 3D Euclidean representation, game engines can show all users a point of view perspective generated in real time. There is no longer a huge need to generate custom links between each node, because the engine itself can handle the spatial aspects of a transition. There are, however, still issues of transitioning currency, costumes, and artifacts. Currencies might transition through exchanges. Other aspects might use some kind of interpolation or transformation through analogy, a kind of conceptual blend (Fauconnier & Turner, 2008).

Scenarios in Practice: Nested Experiences

Consider a scenario where two players are going to play a game, each remotely. Each player has their own physical world, and their laptop, which runs an operating system (Figure 10). On that laptop there may be a game portal, like Steam, and on that portal, there may be multiple games. Also on the laptop are other applications such as Discord. Discord might be used to communicate during a game—to have a meta conversation (Anderson, Fister, Lee, Tardia, & Wang, 2004; Ricoeur, 1971). This phenomenon of meta conversation has been noticed not only in language studies, but also in organizational studies—the organization can be seen as a set of conversations at different levels involving different frames (Mandelli & Snehota, 2008; Taylor, Cooren, Giroux, & Robichaud, 1996).

The process of getting ready to play involves a set of entering commands. Ann is in the physical room, and enters the operating system by booting up. She then enters the Discord app, and opens a channel within Discord to talk to Bob. Then she starts her game platform, Steam, and within the platform starts a game. Any decision to try a different game might involve exiting the game and starting another. It might indeed be more complex: the next game might be on the Playstation platform, and therefore may involve starting up a console device. While all this is going on, there may be activity in the physical room, email chimes, text message notifications, and the like.

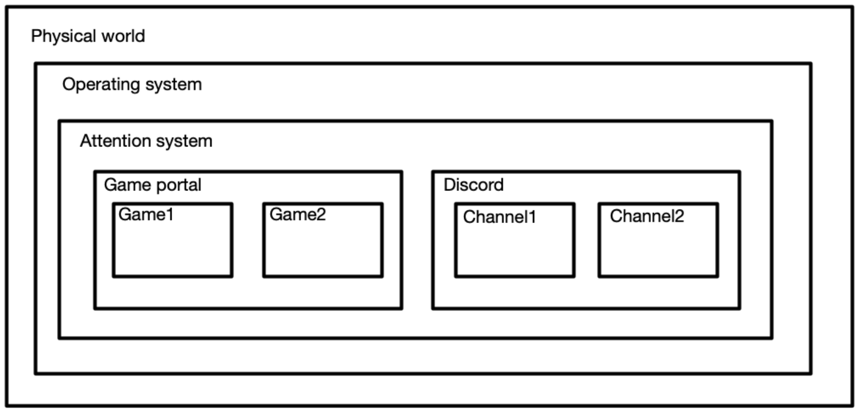
FIGURE 10
Nesting



There is another level of complexity possible, and it highlights both the potential and complexity of the Metaverse concept. In many video games, it is possible to play a game within a game: for example, in the 2010 game Call of Duty: Black Ops, a player who is being interrogated can break free and then play through the 1980 adventure game Zork on a convenient computer behind the interrogation chair. In the 2013 Grand Auto Theft 5, players can frequent bars—and in the bars play Tetris (Baker, 2021). The examples usually involve games that are within the franchise or games that are in the public domain. But the Metaverse concept implies that all games—and thus different experiences—might be available in such a nested way, and transitions need to exist to move from one to another: incompatibilities related to hardware could be handled with virtual machines on the cloud, and IP issues (and payments, if needed) would be resolved by Metaverse infrastructure. So the way to imagine Figure 10 is as multiple sets of nested boxes. As if when opening up a box there were two boxes, each containing two boxes, all the way down. Note that Figure 10 is just one illustration, we can conceive of many different ways that different systems are nested to provide nested experiences.

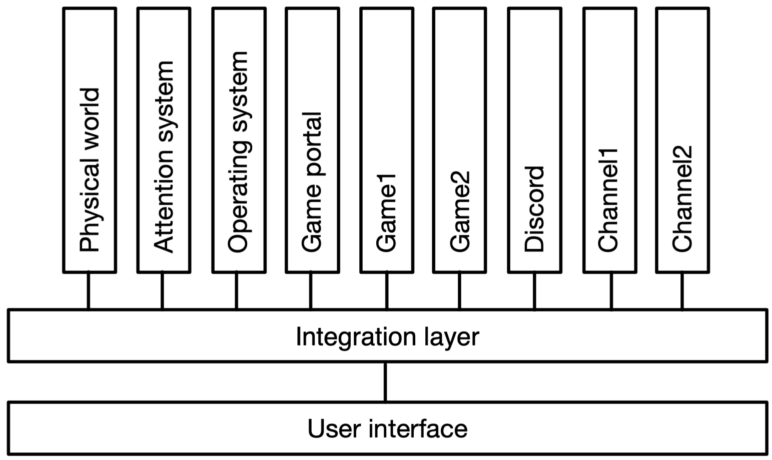
Because of this nestedness, increasingly operating systems are incorporating some kind of attention management system (Figure 11). This can take the form of predefined focus rules. Or of notification settings. Or, more elaborately, the system may use machine learning to figure out what messages to let through.

FIGURE 11
Nesting with an attention frame



How can these complex nested boxes possibly be implemented? One technique is to use a microservices architecture, and some other process to bind together all the services. This typically is done with either choreography or orchestration, the former asynchronous and light weight, the later synchronous, implying a more active form of control (Megargel, Poskitt, & Shankararaman, 2021). This can be used to create the illusion that games are nested in each other, when in fact they are separately hosted in the cloud and integrated into the user interface through a merging of streams (Figure 12).

FIGURE 12
Microservices version of Figure 11



The advantage of a microservices architecture with such an integration layer is that it can allow for all permutations of nestings of experiences. The integration layer could utilize well-understood general principles of choreography or orchestration, articulated in the information systems literature (Brocke & Rosemann, 2014; Daniel et al., 2012; Decker & Weske, 2011; Shaw, 2007; Zur Muehlen, Nickerson, & Swenson, 2005). But there are challenges, because the nature of experiences in the Metaverse may stress a sense of immersion, which creates the need for low latency communication. The synchronous nature of orchestration may be more appropriate than the asynchronous nature of choreography. But even with a synchronous model, there is a very real computation challenge if the Metaverse is to be as some imagine it: a three dimensional high fidelity environment, matching or surpassing the current state of the art in video games and virtual worlds. In such environments, every layer can add discernable delay. Indeed, even though Amazon and others have tried to implement such cloud-based schemes (Hyseni & Ibrahimi, 2017), there have been serious problems (Bankhurst, 2021). On the other hand, cloud based infrastructures are improving rapidly. It used to be unimaginable for a video game to be hosted on the cloud, with graphics projected across the network to end user devices. Now this is possible: Amazon's latest cloud-based game New World has close to 17 million players (Tassi, 2022). And such a model has the advantage of allowing the integration of very different technologies hosted by different companies, something not possible with console-based games. Indeed, this innovation is a result of a form of digital transformation happening within the video gaming industry (Walther & Sörhammar, 2021).

DESIGN PRINCIPLES

These scenarios suggest the nature of the Metaverse and highlight key design challenges. Certainly past theories of modular architecture and past experience with game design will be helpful. But the scenarios suggest that the Metaverse presents challenges that will require concentrated exploration of the vast design space, specifically around the issues of coordination: how experiences can be composed, how users can meet, and how new paths can be discovered.

We now enumerate design principles as a type of nascent design knowledge (Gregor & Hevner, 2013) in terms of means-ends relationship (Bunge, 1967; Gregor, Kruse, & Seidel, 2020). We assert this is an appropriate step for researchers to take at this early stage of the Metaverse. There is no one Metaverse to conduct empirical tests on, and certainly no large population of metaverses on top of which we can create matched samples. There is no realistic way to perform experiments at the scale necessary to truly understand candidate metaverses. Yet it is important to study the Metaverse before an instantiation is fully built out: once built, its contingent structure will make it hard to modify (Lessig, 1999). Design principles in other fields have been useful: in architecture, *form follows function* and *less is more* focused designers away from the staid and ornamental facades of the Beaux Art era (Sullivan, 2010).

Principles that are used in the design process can begin to delineate the design space (Nickerson & Yu, 2014). They are generally vague, heuristic, and directional. They don’t constitute functional requirements, and they are not requirements per se, albeit they can be informed by such requirements (Gregor et al., 2020): the evaluation of designs comes later. Rather, they are guideposts, places to start when envisioning the design space. They also are used to discover features of the design space that may be key, that may deserve attention. The principles can't be wrong: they can either be helpful or not—the focus is on usefulness, not truth (Gregor et al., 2020; Hevner et al., 2004). In the academic sense, design principles for technologies are like design principles for theories: they guide the search and their concrete instantiation is contingent on the development context. Next, we propose three design principles for the coordination of these experience-rich Metaverse transitions: narrative composability, social assortativity, and path discovery, summarized in Table 1.

TABLE 1
Design Principles for Coordination in the Metaverse

Name	**Principle**
Narrative Composability	The Metaverse should allow users to move from experience to experience in a natural and frictionless way, and in a way that allows for the emergence of new combinations of experience.
Social Assortativity	The Metaverse should allow users to mix with those they want to mix with, and allow for the serendipity of chance encounters
Path Discoverability	The Metaverse should provide infrastructure that supports the discovery of paths through the Metaverse landscape that are tailored to the interests of users and groups of users

Narrative Composability

The narrative scenarios discussed illustrated the journey-like nature of envisioned Metaverse experiences. An experience that involves going to three places one after another is the composition of the experiences and the narrative emerges from the user's path.

In systems theory, the notion of composability refers to how systems are composed of parts. Every system is made of components, including subsystems, which are, in turn, made of components in a nested fashion (Churchman, 1968). Composable systems are open ended and extensible—configurable from the components—and the interaction of these components is defined by an architecture. The same idea is used in a variety of fields, such as linguistics where it is argued that languages are by their nature places where meanings can be composed from parts (Werning, Hinzen, & Machery, 2012). In linguistics, the meaning of a sentence is composed from words, and the meaning of paragraphs is composed from sentences: this is called compositionality. While there are grammatical rules that constrain well formed sentences, the nature of language allows for an infinite exploration of meaning through the concatenation of words. This principle appears to be universal in human languages. Formal languages, however, are sometimes restricted: machines such as vending machines are not compositional. There is no user innovation possible.

Some technologies are composable (Attie, Baranov, Bliudze, Jaber, & Sifakis, 2016; Kopetz & Obermaisser, 2002; Page & Opper, 1999; Tran et al., 2017). In particular, the set of standards that constitute the Internet created a composable system (Hafner & Lyon, 1998). It was easy to add a node to the Internet. It was easy to originate as well as receive content. It was easy to extend the protocols for what content could be sent between machines on the network. In its initial stages, it was practically impossible to censor, because key technologies like domain name services were not controlled by local governments. Over time, the Internet has been resilient, and it is still composable, but governments have been resourceful in figuring out ways to censor and restrict some forms of content, and this has led scholars to consider the intersection between infrastructure technologies and law (Lessig, 1999).

Some platforms are composable within, but are restrictive outside the platform. For example, the Facebook and Linked in social networks allow for strong kinds of recombination of content within the respective platforms, but a company wanting a presence on both networks needs to create two different sites: they don't interoperate, even though the mechanics of what they do are very similar. Researchers have argued that regulations encouraging information flow across platform boundaries would be a step in the right direction (Aral, 2021).

Users want, or at least venture capitalists think users want, composable experiences (Ball 2020). For example, if you are part of the Metaverse doing something with your friends, and you then want to partake of some other activity, the principle of composability suggests that the system should allow you to do that second thing in a way that was not foreordained. That is, your overall experience with you and your friends is now composed of two sequential experiences, one after the other, with a minimum of friction involved in moving from one experience to the other. In systems theory, these transitions would involve architecting in a way that allows a direct move from one component to the other. However, as linguistic theories point out, such transitions between stories may make little sense. There are well established theories of narrative about how to go from one story to another—essentially they distinguish between sequences of events in the narrative and the way those sequences are presented (Genette, 1983). Related to these are theories of semiotics, and in particular theories that consider sign systems and the way they are assembled into configurations and sequences (Nadin, 1984).

> ***Principle 1: Narrative Composability:*** *The Metaverse should allow users to move from experience to experience in a natural and frictionless way in order to allow for the emergence of new combinations of experience.*

Composability can happen in real time, as when a player can see what another player is seeing. Or it can happen sequentially, as in one situation leading to another. Indeed, in some sense it is not a Metaverse if experiences can't be composed. With no composition, there is just one universe, one game, one event. Moreover, the way the transitions happen may add to the experience. You can open a door and be in the new experience, or you can walk down a hallway between two rooms. The latter is the way many people imagine the Metaverse.

Social Assortativity

The social scenario highlighted the social nature of the Metaverse. It is envisaged as a place where people who know each other can meet, but also where people can be introduced to each other, or meet at random. This kind of social assortativity is an important part of life, but it is in reality highly structured. One of the ways we form links is through introductions, and introductions happen sometimes because of social memberships in clubs, attendance in company meetings, and the like (Watts, Dodds, & Newman, 2002). That is, there is a great deal of structure to the physical world, and we would expect that some of this structure will carry over into the Metaverse, as it has in virtual worlds (Burt, 2012).

What features are important to encourage social assortativity? One set of features has to do with identity. It is hard to compose experiences if, for example, IDs in one universe are entirely different from those in another universe. The physical world solves such problems with state sponsored IDs and immigration control, but this is a very heavy-weight solution. Moreover, gamers may want identities distinct from their work identities, and may even want to have distinct ways of representing themselves in different worlds. So allowing composition depends on working through issues of identity: how identity is expressed, how two identities held by the same person can be linked, the extent to which this is public or private information, and how people can discover the corresponding Metaverse identities of people they kno, for the purposes of inviting them into experiences.

Principle 2: Social Assortativity: *The Metaverse should allow users to mix with those they want to mix with, and allow for the serendipity of chance encounters, in order to allow for varying degrees of social assortativity.*

This assumes something about the nature of start points for activities, and the nature of discovery of things to do and people to meet. The advantage of social mixing is that it is a kind of recombination, and it can lead to emergent behavior. The disadvantage of mixing is it makes control more difficult. Small doses of mixing can go a long way.

One kind of mixing comes from spectatorship. Twitch allows thousands of people to watch experienced gamers play. The gamers take on three roles at once: playing, talking to their teammates about what to do next in the game, and also providing a meta commentary to the spectators on what they think about the game design. Spectatorship is itself an experience, and can be a way to meet other users and eventually participate in more active ways (Hamilton, Garretson, & Kerne, 2014; Hilvert-Bruce, Neill, Sjöblom, & Hamari, 2018). Metaverse designers may consider building in spectatorship and its related features, which include ways of communicating to the players and to the other spectators.

Path Discoverability

In physical social situations, transitions from one venue to another are bounded by what is in the vicinity. Walking from a dinner restaurant to a dessert place might have only a few options even in a large city. In virtual worlds, there may be many options available, and the problem might be just discovering what is possible, and discovering within that what is desirable. So there need to be ways of finding where the next place to go is. That might be, for example, a Discord channel where players can have a conversation about where to go next. This leads to the following principle.

> ***Principle 3: Path Discoverability:*** *The Metaverse should provide infrastructure that supports the discovery of paths through the Metaverse landscape that are tailored to the interests of users and groups of users in order to allow for the emergence of new patterns of experience.*

One way to think about this infrastructure is in terms of search. In a city, one can just trawl a few blocks looking for a restaurant. Or, alternatively one can use Yelp or some other online service. On Netflix, one can follow a recommendation. Recommendation engines look at behavior and try to match interests; recommendations for movies, it has been found, is challenging (Gomez-Uribe & Hunt, 2016). This probably means that recommending experiences in the Metaverse will also be difficult. In many aesthetic fields, there is a process of curation (Patrick & Peracchio, 2010). The infrastructure of the Metaverse might allow for curation services: experts who will recommend an evening in the Metaverse, a composed set of experiences. In order to do so, the curators will also need to be able to search, and the infrastructure to allow such recommendations while respecting privacy may be a complex but necessary part of making sure that users have good experiences.

Further, the thicker the boundaries between experiences (Ashforth et al 2000), the more sensemaking is required in understanding alternative experiences. This could involve complex processes of mutual interaction among people (Boland & Tenkasi, 1995) or conceptual conventions for conveying those experiences (Berente, Hansen, Pike, & Bateman, 2011). Short representations of rich transition experiences, like movie trailers, would need to convey both cognitive and affective elements (Te'Eni, 2001) of potential experiences and guide those transition experiences.

DISCUSSION

Design principles function as a kind of Gedanken experiment: given the principles, one can imagine how the investigation of the design space might go. From that, one can draw some conclusions about what might be some of the attractors, good and bad, in the design space. We discuss now what dimensions might trade off. Once we are in the realm of tradeoffs, we have moved from design space to evaluation space. That is, we are saying that the dimensions of the design may become one of the ways we evaluate the design. If we increase one direction, we will need to decrease another direction, even given that both are potentially desirable. For example, in investment, expected returns and the risk of an investment trade off: low risk investments generally have lower returns. There are good underlying economic reasons for this to be the case. In our case, the tradeoffs will be less obviously true. The industrial designer Amory Lovins pointed out that there are plenty of examples of accepted design tradeoffs that can in fact be shown untrue (Lovins, 2005). One of his examples relates to insulation in homes: at some point, the cost of insulation, it was thought, produces decreasing returns in cost savings related to heating. But it turns out that if the insulation is sufficiently tight the need for a furnace disappears, which causes a steep drop in both capital and ongoing energy costs.

The design principles involve combinatorics, and it is clear, everything else being equal, that more choices will make the Metaverse more interesting. But the history of technology has shown that not everything else will remain equal. For example, one can imagine a way of handling online streaming content in which one can seamlessly move from Netflix to Amazon to Hulu. But that does not happen: those vendors have different memberships and different interfaces. Remembering where to find streaming content, or how to discover streaming content, becomes a job in and of itself. The Metaverse may end up with a kind of fragmented feel. Likewise, there are apps that can be found on Android but not on IOS and vice versa. It would be great to be able to utilize all the apps. Some companies like Unity have systems that enable developers to develop once and compile into different operating systems. But not all developers use Unity: there are sometimes reasons to work closely with vendors, or use new features of their operating systems.

Vendors like Apple argue that their control of the app store means they create safer experiences. The idea is that through app store vetting apps that are antisocial in some way are restricted from participating in the ecosystem. Antisocial apps in the Metaverse will be very undesirable for most participants. The same way game players can be turned off by trash talk in a game, most of those experiencing the Metaverse probably don't want to experience extremes that include abusive language and behavior. Second Life was notorious for enabling undesirable content (Meek-Prieto, 2007). So safety of the experience may be important, which gives large companies some cover to create their own platforms and vetting processes. Could these be more or less universal? They potentially could, but right now they are not: how Android and Apple handle new products is different. The tradeoff in this is that highly curated experiences can be high quality, but curation restricts the combinatorics, and can lead to Balkanization. The Scylla and Charybdis of the Metaverse will be on one side the barren rock, that of no options, and the other the whirlpool of potentially abusive experiences.

The designers of the Internet had such a decision to make. They favored the combinatorics, and eschewed the concept of strong identity and authentication as a basis for the Internet. Their decision meant the Internet evolved in ways that they could not estimate: good in the sense of creating an explosion of user-generated content, and bad in the sense of granting a playground for trolling and abuse by individuals, as well as providing a propaganda machine for state actors bent on destabilizing the politics of other countries. The Metaverse, if owned by one company, can be uniform but dull. The Metaverse, if totally decentralized, can be exciting but anarchic.

This is many ways akin to the larger problem of speech in society: free speech allows for combinatorics, but can be uncomfortable. And standards for free speech are different in different countries. What one can say in a public park is often wider than what one can say in a private business. If the Metaverse is to be just an aggrandized platform for first person shooters, then there is not as much of an issue. If, however, the Metaverse is the place where everyone engages in activities both civic and personal, then there is indeed a problem. Single ownership makes the Metaverse like a company town. But, on the other side, the idea of decentralized ownership is also complex. One mechanism being considered is crypto ownership where everyone has a stake. Early experiments, for example, the crypto game Axie Infinity, stretch the concept of play. They create activities that effectively pay in crypto, but at the same create the potential for abuse (Servando & Sayson, 2021). Behind many of these experiments is the concept of a distributed autonomous organization, an active area of research and development: for example, some are prototyping a crypto-based university in the metaverse (Duan et al., 2021). At the same time, scholars are debating the potential of these new forms of governance (Hassan & De Filippi, 2021; Nabben, 2021; Vijayakumaran, 2021)

Lessig argued in 1999 that the code, the architecture, underlying complex systems like the Internet effectively work like laws (Lessig, 1999). This observation is also true of the Metaverse. The way through the maze is not obvious. A principled investigation of the design space before the code is frozen is perhaps the most optimistic path we can take.

Even with all these high level concerns, there is room for innovation at the more actionable levels of design. Entirely immersive environments may tradeoff with overlapping environments that let the physical world leak through. The auditory may be important for providing a sense of what is around: better spatial audio may make it possible to position many conversations in a space that allows for the gradual tuning of attention. The issue here is how the architectures evolve. Game designers generally want their players entirely focused inside the game. But they also know that gamers enjoy engaging in conversations about the game. At one extreme, a game could be designed so that any lapse in either visual or auditory attention results in losing the game. At the other extreme, a game could be designed to allow for layering: players could convert sounds and voices to captions, leaving the auditory channel open for other stimuli. Is this a true design tradeoff? Or is there a way to think about the problem differently? The design challenge is to find a way of allowing full immersion in the metaverse while allowing for the kinds of metalevel conversations people may want in either entertainment or business scenarios.

CONCLUDING THOUGHTS

We are already experiencing proto-metaverses. Initial experiences of phenomena like hybrid academic conferences are not fully satisfying. They suggest there is a lot of design exploration to come. Intriguingly, designing the Metaverse may work like the space program: by pushing the envelope on immersive experience, on the collaging of virtual and augmented realities, we may learn more about current technology and organization.

Besides general work on narrative and semiotics (Genette, 1983; Nadin, 1984), specific research has been performed on virtual communities (Crowston & Fagnot, 2008) and virtual worlds (Chaturvedi et al., 2011; Wasko, Teigland, Leidner, & Jarvenpaa, 2011). Undergirding this research are ideas on the economics of attention (Lanham, 2006). From a practical standpoint, there is a new kind of infrastructure to be designed, so past work on standards (Nickerson & Muehlen, 2006), modularity (Baldwin, 2019), infrastructure (Star & Ruhleder, 1996), workflow choreography (Megargel et al., 2021), platforms and ecosystems (Eisenmann, Parker, & Van Alstyne, 2009; Tiwana, 2013), organizations (Lawrence & Lorsch, 1967; Mintzberg, 1980; Thompson, Zald, & Scott, 2017), and institutional fields (Zietsma, Groenewegen, Logue, & Hinings, 2017) are also sources of possible theories to guide the understanding of the Metaverse.

These perspectives are all different. They can be roughly organized along a spectrum from the economic to the contextual. On one end are technological studies that view all parts of the Metaverse as being essentially interchangeable, commensurate. In such a view, we should be able to cross from any universe to any other. On the other end is contextual research, situated. The context dominates. In this view, there is no reason to think we can generalize across these contexts: each will have its own institutional logic. In between there is a wide territory of possible approaches that try to generalize across clusters of universes but also pay attention to the experience and logic within each universe—and within particular people's experiences in such universes. For example, each universe may not be contextually distinct at a deeper level. It may be that there are classes of universe, their characteristics determined by a kind of conceptual DNA constituted by decisions about ownership and governance. For example, this may involve walled garden approaches versus marketplaces, central bank currencies versus crypto currencies. Proto-metaverses are upon us. It is up to organizations and organizational researchers to inform their design.

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