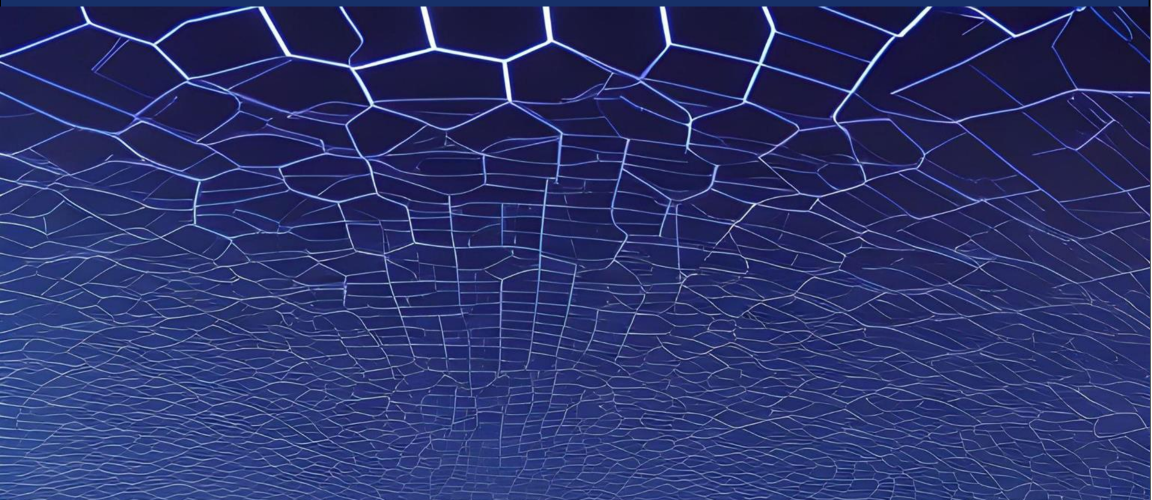
The Rise of the Intelligent Metaverse



Ramesh Ramloll PhD

A New Dimension of Human Existence

The Rise of the Intelligent Metaverse: A New Dimension of Human Existence

by Ramesh Ramloll

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First Edition

The Rise of the Intelligent Metaverse: A New Dimension of Human Existence

After years of dedicated research in fields relevant to the Metaverse, this book represents the culmination of my work, collecting essential results, insights, and visions for the future of this exciting and rapidly evolving field.

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by Rameshsharma Ramloll

Dedication

"It is not that I'm so smart. But I stay with the questions much longer." - Albert Einstein

(to add)

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Preface

In mainstream media, most of the ongoing discussions regarding the Metaverse seem to be motivated by Wall Street experts, blockchain technology developers, and speculators. Their concerns are mostly financial in nature. Making financial projections about a technology that we do not yet grasp satisfactorily has been puzzling for many to say the least. The mainstream media has portrayed the Metaverse as a fully immersive virtual environment where many people can share experiences at the same time. This has been amplified by movies and social media influencers. While these perspectives are valid, they don't tell the whole story.

The Metaverse is so much more than a tool for mass entertainment, socialization or making money. It can help us to connect with each other in ways that were previously impossible. It can change the way we perceive and interact with the real world. It can revolutionize the ways we learn. It has the potential to make visible aspects of ourselves that usually remain hidden in the real world. It can help us expand our self-identity. The Metaverse can be a force for good in the world, and that is something that we should all be excited about.

However, the double-edged nature of every technological advancement is well known. The negative impacts of the Metaverse are therefore anticipated, and plans should be made to mitigate their effects. In this book, we explore the Metaverse from a productivity and utilitarian perspective without diminishing its social dimension. The perspectives we offer are influenced by research findings in fields related to collaborative computing technology, human-computer interfaces, cognitive science, and engineering. Let's begin by exploring the origins of the Metaverse.

Who is this book for?

The aim of this book is to provide a comprehensive understanding of the Metaverse to a broad audience. We intend to reach educators, multimedia artists, virtual world architects, gamers, students, investors, and entrepreneurs who are interested in gaining a deep understanding of the Metaverse. We believe that this book should be accessible to both lay and expert audiences.

For lay readers, this book will provide a glimpse into the direction the Metaverse is likely to unfold, while for expert readers, it will inspire them to advance areas that are of driving significance for the Metaverse. However, we do not view this book as a technical or implementation document that describes specific tools, programming environments, or platforms.

One of the fundamental premises of this book is that content creation is not limited to developers and 3D modelers. When designing virtual environments to support learning, ideation processes tend to be very conservative, and there is often an impulse to translate linear approaches to creating content into a virtual environment. Unfortunately, this approach results in virtual PowerPoint presentations in virtual worlds, which do not take advantage of the full potential of the Metaverse.

By the end of this book, we aim to establish a solid understanding of how humans process information and how tools developed in the real world can enhance cognition. When attempting to expand the application design space for virtual environments, adding a cognitive science perspective to the design process can catalyze fearless experimentation and innovation.

We approach the Metaverse from the standpoint of human-computer interface design and cognitive psychology, which focuses on the brain as a processor for information reaching our sense organs. While we do not equate the brain with a computer, we use the abstractions used to describe information processes in a computer to describe brain functions in general that come into play during interactions with virtual content. By providing this perspective, readers will gain a deeper understanding of how the Metaverse can be designed to provide a more engaging and immersive experience.

Skip the theory

This book aims to provide readers with a comprehensive understanding of the Metaverse from multiple perspectives. However, we acknowledge that not all readers may be interested in all aspects of the Metaverse, and some may prefer to focus on actionable recommendations or guidance. For those readers, we recommend jumping straight to Chapter 6, which provides specific information and guidance on practical aspects of the Metaverse.

Additionally, in the Appendix, we provide information about online platform tools and solutions that readers can access immediately, which may be especially useful for those looking for quick and practical guidance.

However, we caution readers against skipping sections of the book that may not immediately apply to their interests. By doing so, they may miss out on valuable insights and perspectives that could shape their approach to designing for the Metaverse. For instance, the content that may not seem directly applicable at first glance, such as the philosophical and theoretical aspects of the Metaverse, can provide a broader perspective on what the Metaverse could be and inform readers' design choices.

In addition, by reading through the design stories presented in this book, readers may gain valuable insights into how others have approached Metaverse design challenges and be inspired to develop new technologies or extend existing ones. Therefore, we encourage readers to consider reading the entire book to gain a comprehensive understanding of the Metaverse and to inform their approach to designing for it.

Origins of the Metaverse?

The 1935 novel Pygmalion's Spectacles by Stanley G. Weinbaum presented a convincing early model for virtual reality. According to the story, the main character, Dan Burke, encountered Albert Ludwig, an eccentric professor who invented a pair of goggles. This appears to be a fairly accurate description of what is expected from VR head mounted displays.

> Albert invented a pair of goggles which enabled "a movie that gives one sight and sound [...] taste, smell, and touch. [...] You are in the story, you speak to the shadows (characters) and they reply, and instead of being on a screen, the story is all about you, and you are in it." Stanley G. Weinbaum – Pygmalion's Spectacles.

Neal Stephenson coined the term Metaverse in his 1992 novel "Snow Crash" while others believe that it was William Gibson's groundbreaking 1984 novel "Neuromancer" that popularized the idea of a Metaverse.

> “Cyberspace. A consensual hallucination experienced daily by billions of legitimate operators, in every nation, by children being taught mathematical concepts... A graphic representation of data abstracted from banks of every computer in the human system. Unthinkable complexity. Lines of light ranged in the nonspace of the mind, clusters and constellations of data. Like city lights, receding...”
>
> —— William Gibson, Neuromancer

The concept of the Metaverse has been a topic of discussion for several years, and its potential to create a new reality that combines virtual and physical elements has intrigued many developers. However, the idea of creating alternative realities is not new, and people have been exploring this concept for decades. It is essential to keep in mind that despite the various descriptions of the Metaverse, there has been no universal interpretation of the term.

To understand the concept of the Metaverse, it is crucial to clarify what it means. The Metaverse can be defined as a collection of shared virtual spaces created by combining virtual reality, physical reality, and the internet. The defining characteristic of the Metaverse is the embodiment of fellow users and the facilitation of social interaction between them. The presence of user avatars is one of the most crucial features of the Metaverse.

It is important to note that any application designed as a single-user application, such as a banking application or a Solitaire game, would not be considered part of the Metaverse unless they are available on a 2D display while sharing the same 3D environment with other avatars. In other words, the Metaverse is a shared space that allows for social interaction and the embodiment of users in a virtual world, rather than a simple 2D application.

Age old myths coming to life?

The idea of many worlds, some even contained within others, and how beings incarnate in them for limited periods is prevalent across many cultures. Although it is challenging to pinpoint the origins of the Metaverse as a concept, one could say that it represents the universal human desire for worlds beyond the one we know. As such, it does seem that the Metaverse was originally rooted either in escapism or a hunger for causal stories that would explain various life conundrums. It is not uncommon for ancient cultures to include notions such as spirits and realms or other worlds, and sometimes avatars in their stories.

"The metaverse, in some sense, is an escape from the physical world." - Tim Sweeney, founder and CEO of Epic Games, creator of the Unreal Engine a game development platform.

Humans have fantasized about living in other realms or worlds throughout history. Ancient Hindu and Buddhist texts mention the existence of many lokas, one of which is Brahma-lokha, for instance. According to Hindu belief, there are 14 lokas, or worlds in Sanskrit, that make up a multiverse. Many beings are believed to descend or manifest as avatars within these world systems. Lokas are not only viewed as habitable worlds but also as planes of existence. Each one of these planes can be a state of awareness/ consciousness. The plane is defined by the identity currently manifesting in its visitor. So, in this view, all these planes exist concurrently and can be navigated by 'login into' the relevant identity.

"To be yourself in a world that is constantly trying to make you something else is the greatest accomplishment." - Ralph Waldo Emerson

The concept of identity plays a key role in many ancient cultures because it is generally assumed that it is identity that shapes what is experienced. Virtual worlds provide a mechanism for sustaining suspension of disbelief and keep an individual locked into an identity in a very controlled manner.

For thousands of years, humans have used psychedelics as ritualistic, medicinal, social, and recreational tools. Psychedelic users often describe their experiences as trips in alternate realities and their encounters with beings from beyond. One of the differences between chemically induced alternate worlds and virtual ones is that we have no evidence of individuals traveling together on a trip or sharing a dream where they share experiences and validate them upon their return.

However, a persistent virtual reality shared by a lot of people, doesn't seem revolutionary anymore because we see glimpses of it every day even when using contemporary technology devices.

While the concept of realms or lokas in ancient religions and the metaverse in modern technology are fundamentally different in nature, some parallels can be drawn between the two.

Multiple layers or dimensions: Both ancient religious concepts of realms or lokas and the metaverse involve the idea of multiple layers or dimensions of existence. In ancient religions, these layers often represent various spiritual planes, while in the metaverse, they represent interconnected virtual worlds.

Interaction and influence: Entities from different realms or lokas in ancient religious beliefs are often thought to be able to influence or interact with one another, just as users in the metaverse can interact and collaborate with each other across different virtual spaces.

Transcending physical limitations: Both concepts involve the idea of transcending the physical world. In ancient religious beliefs, this transcendence is often spiritual in nature, while in the metaverse, it is achieved through digital technology that enables users to engage in immersive, shared virtual experiences.

Altered states of consciousness or perception: In some religious and spiritual traditions, practitioners may enter altered states of consciousness to access or interact with other realms. In the metaverse, users may experience an altered perception of reality through immersive virtual environments and the use of avatars.

It's important to note that these parallels are mostly metaphorical or thematic, as the underlying principles and purposes of realms or lokas in ancient religions and the metaverse in modern technology are quite different. Realms or lokas are typically part of spiritual or religious cosmologies, while the metaverse is a technological construct designed for entertainment, communication, and collaboration.

Nevertheless, the comparison highlights how human beings have long been fascinated by the idea of transcending the limitations of the physical world and exploring alternate dimensions or realities, whether through spiritual practices or modern technology. And we believe more than ever emerging technologies are going to make the construction of these different dimensions of existence a reality that can be accessed by anyone willing to do so. In this book, we will have the opportunity to build a vision of how such a future may manifest itself.

Faking hype, hyping fake

Every period of exuberance about any technology is most likely to be followed by a cooling off period. The Covid pandemic was a catalyst that amplified interest in a whole range of technologies that allowed individuals to connect for work, play and social reasons. Unfortunately, we are already seeing diminished interest after the Covid situation has been brought under control. A few early adopters, however, are staying around and trying to fully understand the myriad aspects of these technologies to make informed decisions about how to use or develop applications for the Metaverse.

Mapping the Metaverse ecosystem

The landscape of technology is constantly evolving, and many believe that the future internet or Metaverse will be built on various applications and platforms. However, navigating this complex ecosystem can be overwhelming for many people. This book aims to serve as a map to help readers understand the various technologies that will be integral to the Metaverse.

One of the challenges of understanding the future internet is that different scientific fields tend to evolve independently of each other. Areas such as AI, 3D modeling, photogrammetry, haptics, brain-computer interfaces, and others are all being researched at a rapid pace. However, linking these fields under a common framework with an overarching goal can be challenging.

Just as there are many different types of real-world maps, this book provides a variety of perspectives to help readers understand the complex world of the Metaverse. Some maps show landmarks of interest, others show resources, such as restrooms and restaurants, and others show dangers and things to watch out for. Unexplored territories may also be indicated on maps, which can be attractive to explorers.

Without maps, knowledge of relevant places would not be shared as efficiently as it is. Therefore, this book serves as a guide to help readers navigate the intricate world of the Metaverse and understand the inter-relationships between various scientific fields. By providing this map, readers will be better equipped to explore and navigate the Metaverse with greater understanding and ease.

Sources of influence

To provide readers with a better understanding of the author's perspective on the Metaverse, it would be helpful to share some of the relevant landmarks from their personal journey that influenced their opinions.

The author grew up playing video games, and the first interactive virtual world they encountered was Doom, a shoot them up game by John Carmack and John Romero. Their academic research in the

United Kingdom focused on human-computer interaction and computer-supported cooperative work during the late 1990s and early 2000s. They were influenced by academics such as John Mariani, Tom Rodden, Ben Schneiderman, Alan Dix, Steve Benford, Stephen Brewster, Hiroshi Ishii, Ivan Beale, and Cheryl Trepagnier, among others.

The author was also greatly influenced by early pioneers of the industry, such as Bruce Damer and Philip Rosedale, who were at the forefront of research into virtual worlds. Many of their ideas for virtual worlds came from spending time with friends at Lancaster University (UK), which had one of the best CSCW research departments in the world, and at the University of Nottingham, which was a center for VR research in the UK.

As a computer science and engineering student at the Indian Institute of Technology in Kanpur, the author was exposed to the theoretical aspects of computing sciences, which broadened their experience in the field. They also designed and developed applications for technologies associated with virtual or augmented reality, including 3D sound, immersive 3D headsets, haptics, and location sensing.

Although the term Metaverse originates from a desire to escape the dystopian unpleasantness of the meatspace, as described by the famous author Neal Stephenson, the author believes that the best days of the Metaverse will come when we are able to create virtual worlds that directly impact the physical world in a positive way.

They do not view escapism as the primary use case for virtual worlds and cannot recall many instances where they felt virtual worlds offered an escape.

By understanding the author's personal journey and perspective, readers will gain a better understanding of the context and background that informs the book's content and approach.

> The best days of the Metaverse will have arrived when it becomes obvious how virtual worlds are directly impacting the physical world (hopefully) in a positive way.

Over the years, the author had the opportunity to work on several academic research projects in the United States that allowed him to develop healthcare-oriented VR and virtual world solutions. Along with a team of talented individuals, the author established their startup with a wealth of knowledge and experience in virtual world design, 3D design, and education.

With their combined experiences, the team approached virtual reality applications from different angles and created strategies to facilitate the transition of applications between the two silos. They believe that their book should be titled 'View from the Darkest Corner of the Metaverse' because they utilize open-source tools that are not often discussed in the mainstream media.

In addition, the team emphasizes the importance of pausing along the trajectory to connect various dots that describe different projects accumulated over time, which may have initially appeared unrelated. This process was instrumental in helping them see and capture how each part of their efforts were connected.

The team hopes that the stories shared in their book will serve as inspiration for others in their quest to make the Metaverse a reality. Through their experiences and insights, readers can gain a better understanding of the potential of virtual reality and the steps needed to bring it to fruition.

Chapter cover 1 Reality divided: The Metaverse Mirage

1. Introduction

Exploring the Metaverse

Welcome to the intricate and multi-dimensional realm of the metaverse. This digital landscape, still in its nascent stages, is teeming with unexplored complexities and infinite possibilities. Indeed, we are living in an epoch of rapid technological evolution, a period of unparalleled innovation in computing, virtual reality, and, most notably, artificial intelligence.

In the forthcoming chapters, we shall embark on a rigorous exploration of the metaverse's various facets. We will probe its depths through diverse perspectives - the architect who designs it, the consumer who navigates its digital corridors, and the content producer who enriches it with their creations.

The advent of the metaverse brings with it a wave of disruptions, impacting social constructs, cognitive processes, and physiological responses. Functionality within the metaverse presents a delicate equilibrium between productivity and social interaction. This balance is further nuanced by the integration of artificial intelligence, particularly in the form of social and productivity tools and agents, which are gradually becoming integral cogs in the digital machinery of the metaverse.

We shall also delve into the apparatus of content creation and consumption within the metaverse, shedding light on the tools and techniques that facilitate these processes. Moreover, the importance of design theories and their relationship with cognitive dynamics will be analyzed, along with discussions on creative strategies within the digital landscape.

Prepare yourself, then, for this intellectual voyage into the metaverse. We stand at the threshold of a new reality, a reality that might just redefine the contours of human understanding and existence.

A Simple Way to View the Metaverse

"Metaverse: This just sounds kind of buzzword-y", Elon Musk

For this book, we use the term metaverse in its most basic sense. Here, the reader can assume that the Metaverse consists of many virtual worlds linked and inhabited by avatars representing people.

However, from a very general perspective, the Metaverse can be viewed as a composition of virtual embodiments designed to illustrate both non-abstract concepts, such as a building and a vehicle, and abstract concepts, such as a molecule or a mind map, so that they can be explored, controlled, manipulated, and inhabited by humans through various digital representations, also known as avatars.

In this view, the Metaverse ultimately aspires to accelerate the expansion of human consciousness by reducing the boundless complexity of any domain of interest to simpler forms that humans can occupy and/or process because of the inherently limited cognitive capacity of the brain. This appears to be a promising approach for enabling humans to gain a deeper understanding of all that is.

The Metaverse may help humans explore their inner worlds as much as their outer worlds. In addition, it provides opportunities to construct new remote collaborative approaches or to build social connections between geographically separated individuals.

> The Metaverse ultimately aspires to accelerate the expansion of human consciousness by reducing the boundless complexity of any domain of interest to simpler forms that humans can occupy and/or process because of the inherently limited cognitive capacity of the brain.

Owing to advancements in technology, we now not only have the capability to create shared virtual realities and discuss their wide range of applications but are also able to build them in a very controlled and repeatable manner for the mass market. While it is evident that there is still a long road ahead, the Metaverse is likely to disrupt four areas concurrently: social, cognitive, physiological, and technological.

Potential transformations caused by the Metaverse

Societal: Society's foundations will change

Social, because the reexamination of deeply ingrained assumptions about self-identity, social connections, intimacy, work ethics, remuneration, and governance issues will lead to deep changes in attitudes and behaviors in real life.

Selectable or modifiable self-identity

The idea that self-identity is malleable and replaceable is attractive to many. As we shall discover in this book, it will not be possible to alter our self-identity at the skin level but also at the level of cognition, as it becomes increasingly possible to delegate cognitively taxing tasks.

Using one's identity in a playful way is rooted in role-playing traditions in the arts as well as some religious rituals. Probably because these primitive concerns are typically thought of as off-topic by some Metaverse developers, these similarities rarely appear in Metaverse discussions. The only reason we choose to include this example is to explain the exploration of alternate versions of reality and transcending who we are deeply rooted in the human psyche and certainly is not a recent development.

The fact that self-identity can be reshaped and erased within compressed timelines in a controlled manner has attracted the attention of many researchers. This provides many opportunities to observe how one's sense of self changes in virtual experiences. As this understanding escapes into the 'real' world, we may become less vulnerable to the narratives we tell ourselves about who we really are.

This inevitably leads to feelings of being deeply connected with each other and the universe.

1. Introduction

"Virtual reality is the 'ultimate empathy machine.' These experiences are more than documentaries. They're opportunities to walk a mile in someone else's shoes." - Chris Milk, American entrepreneur, innovator, director and immersive artist.

Metaverse technologies have the potential to turn identity into an object that can be shared or sold. The implications can be frightening.

When it becomes possible for anyone to wear a celebrity's skin, or to look and behave like someone else, the nature of identity as an obvious means to differentiate between actors can become problematic. This will raise issues beyond the problem of verified identity, where we need to develop technologies that would create a counterpart to a user's DNA that could serve as a unique identifier.

A safe space to explore the self

Virtual worlds provide a safe space for individuals to explore aspects of their identity and personality that they might normally keep hidden or be ashamed of. They can try on different personas and roles, experiment with different behaviors, and confront their fears and anxieties in a safe and controlled environment. This freedom to explore can lead to a deeper understanding of the self and what one wants out of life.

In addition to providing a safe space for personal exploration, virtual worlds also offer a way for individuals to encounter different cultures and environments without having to physically travel to those places. They can also explore dangerous or difficult situations without putting themselves in actual danger, leading to a more accurate representation of reality than the real world.

Furthermore, virtual worlds allow individuals to come away from their experiences with a more precise idea of what is real and what is not. Overall, virtual worlds offer individuals the opportunity to explore their deepest and darkest secrets, discover hidden talents, and come to a greater understanding of themselves and the world around them.

Distributed identity and delegation to twins

It is becoming increasingly common for people to have multiple online identities, or avatars. In some cases, people have multiple concurrent avatars in a single virtual world.

This can be a good thing for several reasons. First, it allows people to delegate complex tasks. For example, if someone is running a business in a virtual world, they may have avatars that are responsible for different aspects of the business, such as customer service, accounting, and marketing. This allows the person to focus on the big picture and delegate complex tasks to others.

Second, it allows people to send instructions to a virtual non-player character (NPC). This can be helpful if the person is not available to do the task themselves. For example, if someone is running a business in a virtual world and they need to take a break, they can send instructions to their customer service avatar. This avatar can then take care of customer inquiries and problems.

Third, it allows people to have a humanoid-centric user interface. This can be helpful because it allows people to communicate with avatars in a more natural way. For example, if someone is trying to find a business in a virtual world, they can ask a human-like avatar for directions. This is more user-friendly than trying to figure out a complex map.

Overall, there are many advantages to being able to control multiple concurrent avatars in a virtual world. This can be a great way to delegate complex tasks, send instructions to NPCs, or have access to a more advanced form of productivity amplification.

Suffice to say that most currently are underestimating the social disruptions that a Metaverse could unleash.

Transcending geographic separation

As governments begin to realize the potential impact of technologies that make geographic separation increasingly irrelevant, they will start paying more attention to the Metaverse.

Many laws and regulations targeting areas such as technology and technology transfer are typically confined to physical territorial borders. The fact that technologies can transcend them is of concern to the power brokers. Regulators realize that it is time to re-evaluate and update laws and regulations related to transactions across physical borders and that they may end up colliding with developers of free and open metaverses.

Even within one physical geographic jurisdiction, as we begin embracing hybrid workplaces, where workers are allowed to work away from their normal work locations, new HR rules will have to be implemented. The work culture will also be under pressure to change. The boundaries between work and home life are increasingly blurred, and the line between work hours and personal time is becoming more fluid. These changes will require companies to re-evaluate and update their policies, procedures, and even their management styles to accommodate the new work reality.

As the Metaverse continues to evolve and grow, it is likely that these changes will only accelerate. With an increasing number of people spending more time in virtual worlds, new issues related to privacy, security, and ownership will need to be addressed. Governments and companies alike will need to adapt quickly to keep up with the changing landscape, or risk being left behind. As such, it is crucial that we begin thinking now about how to manage these changes, rather than waiting until they are upon us.

Amplifying diversity and inclusivity

Co-working in 3D worlds as avatars for significant periods convinced us that what we were doing in a virtual environment was not only cost-effective but also impactful. Such virtual environments can enable designers and service providers to collaborate efficiently across cultural, social, linguistic, geographical, governmental, and financial boundaries.

Based on our observations, we were convinced that these worlds have the natural ability to accelerate inclusivity by gracefully preventing and transcending stigmas while providing a more friendly workspace for neuroatypical labor.

These worlds have the natural ability to accelerate inclusivity by gracefully preventing and transcending stigmas while providing a more friendly workspace for neuroatypical labor.

Our team is an excellent example of individuals from various countries collaborating in a virtual world, investing their own time and money while facing sometimes extreme challenges in creating products that are both beneficial to virtual and real worlds.

Age, health problems, caregiving obligations for chronically ill family members, and financial strain are among the many challenges that can limit the scope of the potential contributions of many who may be in these situations. Adding to this issue, population aging has become a global concern and the time to retire increasingly never comes for many.

Virtual worlds play a significant role in making such invisible and trapped talents and skills accessible. Aging can unfortunately also be accompanied by a higher frequency of cognitive or physical issues.

Virtual worlds can arguably be more easily designed to be accessible for people with both physical and cognitive disabilities. For example, metaverses can be created with assistive technology features, such as speech recognition, to help those with mobility issues navigate the virtual environment.

In conclusion, virtual worlds have the potential to provide a solution to some of the challenges that limit individuals from contributing to society. As the world population continues to age, the importance of virtual worlds in enabling individuals to utilize their talents and skills, regardless of physical or cognitive limitations, will only increase.

Cognitive: It is unlikely that thinking habits will remain untouched

Pressures to evolve cognitive skills

Cognitive, because most of us will initially resent the change to cognitive habits that may have served us well.

Adapting to practices that may be completely foreign does not always proceed smoothly. For example, spatial thinking is the ability to visualize and mentally manipulate objects and ideas in space. It involves understanding the relationships between objects and their relative positions, sizes, shapes, and orientations. Spatial thinking is often used in tasks such as navigation, problem-solving, 3D design and understanding diagrams or maps.

The use of spatial thinking when creating or finding relevant content may be controversial in terms of finding common design solutions that are likely to satisfy the needs of most people. Such problems are probably rooted in the various ways brains process the same information or in the various ways people accumulated their knowledge.

The identification of these friction areas will inform future research efforts. Some of our attempts have been presented in this book.

> The use of spatial thinking when creating or finding relevant content may be controversial in terms of finding common design solutions that are likely to satisfy the needs of most people.

Detachment from reality risks

The concern about detachment from reality is multifaceted, with potential implications at both a surface level and a more profound level. At a cosmetic level, the use of headsets for complete immersion in public places can lead to feelings of vulnerability, as users are often unaware of the physical environment around them. The lack of situational awareness about the world around them can create a sense of detachment, making users more susceptible to potential dangers or threats.

However, the deeper issue at hand involves the potential long-term impact of spending extended periods of time in virtual environments. It is widely understood that the human brain is wired to adapt to the environments in which it operates. As such, we must question whether the adaptation of the brain to virtual worlds, which are not necessarily an accurate reflection of the physical world, could lead to negative effects on the brain's fundamental functioning.

This raises important questions about the balance between virtual and real-world experiences, and how we can ensure that our engagement with virtual environments doesn't come at the expense of our physical and emotional well-being. As the use of virtual environments becomes increasingly common in our daily lives, it is crucial that we continue to explore the potential risks and benefits associated with these experiences and develop strategies to ensure that they enhance, rather than detract from, our overall quality of life.

Bad design can erode cognitive function

We are already aware of the impact of existing social computing technologies on fundamental cognitive abilities, such as the shrinking attention span problem and addiction to content targeting the primal brain and expect to see more research in this domain. Mental health costs will be a major concern for metaverse users in the future. The unbridled appropriation of consumers’ working memory by advertising companies empowered by social media corporations is concerning.

Physiological impact: the cost of adapting to new interaction paradigms

After tech neck and back, what's next?

It is evident that the physical environment we design for ourselves has an impact on our health, and sometimes these designs have led to negative outcomes.

When one spends time interacting with a phone or computer screen for an extended period, prolonged sitting, and poor posture can be promoted, leading to many health issues. It is well known that many users experience discomfort after wearing head mounted displays for longer than 15 min.

People often experience discomfort in work environments caused by overheated wearable devices, eye strain, vertigo, headaches, and general musculoskeletal strain caused by maintaining an unbalanced body posture for extended periods. As immersive virtual worlds continue to develop, this problem is expected to become increasingly severe.

Even if the technical problems of HMDs with resolution and latency can be addressed, it is unlikely that those associated with the different stresses on the visual and balance systems will soon be resolved. Users of many productivity applications are expected to spend a considerable amount of time in the virtual world.

In addition to generating heat, heavy devices can also be tiring because discomfort compounds over time.

Cognitive disruption: Impact on Perception and Thought Processes

There is still much technology to be disrupted before Metaverse hardware interfaces, which do not physically strain or harm the human body, become available. Recently, there has been much discussion of brain-computer interfaces and their potential to render wearable hardware user interfaces irrelevant. Currently, the state-of-the-art suggests that this goal may be far off.

Establishing Metaverse Functionality

Despite the immense effort and resources required to engineer disruption in a particular market, the prospect of having so many fields to disrupt simultaneously makes us wonder whether it is even possible to develop a Metaverse that would be acceptable to most.

As we move forward, we can only hope that solutions engineered in various sectors will eventually synergize to enable a Metaverse that empowers its users and serves most of their needs.

It is important to recognize that currently, our information space is divided into two distinct clusters separated by an apparently impenetrable barrier.

Productivity-centric applications cluster

In the first cluster, we see applications very strong in their potential for utility (i.e., getting work with real-world impact done), but very weak in their potential for capturing, representing, and exchanging live and information-rich social cues.

One could argue that most applications in the first cluster tend to address the needs of the prefrontal cortex. These include word processing, graphics applications, spreadsheets, and Internet applications from video conferencing to social media platforms. Most of these applications are two-dimensional (2D) displays, and users are not required to be tethered to hardware user interfaces.

Social-centric applications cluster

In the second cluster, which is much smaller than the other in terms of the diversity of applications, we see applications that appear weaker in utility but very strong in their potential for capturing, representing, and exchanging social cues.

Currently, most applications of the second cluster catering to the primal brain are primarily designed for recreation. The second silo currently attracts simulation environments in narrow domains, multiuser games, virtual worlds, and remote-sex centric platforms.

Unfortunately, most applications require users to be tethered to hardware user interfaces. We will likely see applications migrating from one silo to another, as if by osmosis, because as individuals become aware of the strengths and weaknesses of each silo, they will begin to demand what appears to be missing.

We expect this tendency to create a more balanced world of digital information which will add value to our lives. In the future, users will be able to fine-tune the extent and depth of the collaborative functionalities of applications in ways like how we fine-tune game graphics to suit hardware availability.

Users will be able to fine-tune the extent and depth of the collaborative functionalities of applications in ways like how we fine-tune game graphics to suit hardware availability.

The Metaverse: An obvious space to house embodiments of AI agents and their processes

The rise of robots or humanoid agents in society has been a topic of debate for many years. Some believe they will eventually take over many jobs currently done by humans, while others believe that they will simply supplement humans in the workforce.

However, there is one area where robots are already beginning to have a significant impact: social and productivity robots. Social robots are designed to interact with humans in a social setting. They are typically used in settings such as elder care, childcare, or therapy. These robots can provide companionship, assistance with daily activities, and even emotional support.

Productivity robots, on the other hand, are designed to help humans with tasks such as manufacturing, construction, or logistics. These robots can perform repetitive or dangerous tasks, improving efficiency and reducing the risk of injury to human workers.

In the virtual world, social and productivity robots are beginning to make their presence felt as well. Avatars, or virtual representations of real-world people, are increasingly being used in online games and social networking sites. These avatars can be automated so that they can perform tasks on behalf of their human users. This can free up users to perform other tasks, or simply to enjoy their game or social networking site without having to worry about their avatar.

The rise of social and productivity robots in the real and virtual world is having a profound impact on society. These robots are changing the way we interact with each other and with our environment. They have the potential to automate many tasks currently done by humans, freeing up our time for leisure and other pursuits.

While productivity robots can improve efficiency and reduce the risk of injury, they may also lead to job displacement for humans. Social robots can provide much-needed companionship and support, but they may also raise ethical questions about the nature of human-robot relationships.

In conclusion, the rise of social and productivity robots is a complex issue with far-reaching implications for society. It is important to continue exploring the potential benefits and risks of these robots and to ensure that they are used in a responsible and ethical manner.

Looking at the Metaverse from Multiple Perspectives

A builder's view of the Metaverse

Media outlets often portray virtual environments from the perspective of individuals who mostly use them for entertainment such as gaming and social interactions (e.g., dating). We will break from tradition and present one perspective from an admittedly smaller community of users who spend more time creating these environments than consuming them. They can be referred to as virtual-world architects and builders.

Residents of virtual worlds from my generation have had their first taste of the Metaverse through games, or more accurately virtual worlds, like Activeworlds™, Minecraft™ and Second Life™. We were blown away when these platforms were introduced because they allowed users to create large-scale shared artifacts or living spaces in a world unconstrained by physical reality. This was no longer an abstract notion to be entertained anymore, it occurred.

Back then, we became aware of the challenges of virtual economies and their impact on real-world economies. Many people are drawn to virtual environments, as they like collaborating with like-minded individuals. Co-creation and community appear to be the heart and soul of the virtual world, respectively.

1. Introduction

Our team has been creating virtual world experiences and applications for over a decade. Otherwise, our observations, insights, and findings can provide a more comprehensive picture of what is happening. In the best-case scenario, our research could serve as inspiration for putting resources into avenues that we believe show promise or for identifying potential dead ends to avoid.

A content consumer view of the Metaverse

There are users who are satisfied with existing virtual worlds and have no interest in building in 3D. These users often view virtual environments purely as entertainment, like interactive TV shows. Their exposure to AAA games with clear storylines contributes to this view. However, there is also a group of users interested in building, but they tend to specialize in narrow niches.

Certain games allow users to build and test rockets, while other virtual worlds like Second Life™, OpenSimulator™, and Minecraft™ attract communities of builders. These communities are essential precursors to the Metaverse, a virtual reality space where users can interact with a computer-generated environment and other users in real-time. As technology continues to improve, the Metaverse is becoming an increasingly realistic possibility, and these early builders and communities are laying the groundwork for its development.

Creating and Consuming Content in the Metaverse

Focusing on end user content production

In contrast to many of our colleagues, we have a different focus when it comes to virtual worlds. While others may see them primarily as entertainment or gaming venues, we are more interested in their social and productivity features. We don't view virtual worlds as a refuge or an escape, but rather as a tool that can help users solve real-world problems more efficiently.

To achieve this objective, we have developed our own infrastructure on top of the free open-source and decentralized Metaverse platform, OpenSimulator. This allows us to operate independently, with the assurance that we will retain control over how we share our intellectual property. We believe that the use of an open-source platform is consistent with the current belief that experts and users from a wide range of backgrounds and intellectual traditions will collaboratively develop the future web.

We are not convinced that the future web will be a product of the selection of corporate technology providers. Instead, we believe that a scalable, diverse, and resilient future web infrastructure is most likely to result from the contributions of an ecosystem of independent developers and users. These contributions can come from a wide range of sources, rather than just a few companies with enormous resources. By streamlining and accelerating user content production and consumption in virtual worlds, we hope to contribute to this vision of a more decentralized and collaborative future web.

Tools for content creation and consumption

Designers should be encouraged to come up with controversial ideas that may fail, because many ideas fail for reasons that cannot be anticipated. The stories we share include both those with both positive and negative outcomes. Discovering the reasons for failure could lead to revolutions. Therefore, failure under controlled conditions provides learning and growth opportunities. Most importantly, failure stories should be deemed as informative and as valuable as success stories.

> Designers should be encouraged to come up with controversial ideas that may fail because many ideas fail for reasons that cannot be anticipated. Publishing failures, particularly unanticipated ones, are of great value.

In many fields, ranging from architecture to human–computer interface design, architects and engineers have attempted to create design theories that would help accelerate the design process and shorten the time between ideation and the final product.

Design theories and strategies

Several approaches can be used to guide Metaverse design processes. As veteran application designers for the Metaverse, we observed several approaches and practice patterns that emerged organically and appeared to be significant.

We organize our understanding under two umbrella theories: cognitive outsourcing and composition. Many designers instinctively achieve good designs without relying on design principles and theories. However, in our opinion, design theories that either explain or inform design can narrow the search space for effective solutions to design problems.

The ability to discover patterns in content and processes is a key skill of designers. This will help them construct design theories of their own or make it easier to share their lessons learned and recommendations with their peers in a very effective way. Discovering repetitive patterns of objects or events in Metaverse is a good first step toward motivating automation. This process can not only help simplify the user interface because there will be fewer control points required, but it will also free the working memory of content creators so that they can focus better on what they want.

Throughout this book, we examine and demonstrate the design of tools that we create to accelerate content production and consumption. We hope that readers will be motivated to create their own design theories or adopt ours when ideating how to advance their goals for the Metaverse. We intend to share our design journey without shying away from discussing deeper philosophical and theoretical foundations, while providing enough examples to guide new and upcoming Metaverse builders in coming up with their own design approaches.

To familiarize readers with the complexities surrounding the design challenges of the Metaverse, we have developed an informative infographic that highlights the numerous issues and associated disciplines involved, as well as their interconnections. In order to enhance understanding, we present a comprehensive list of definitions for key terms found within the infographic. Throughout the book, we strive to address and discuss these topics in depth, striking a balance between theoretical foundations and practical applications. By providing a wealth of real-world examples, we aim to bring the subject matter to life and facilitate a deeper understanding of the intricate Metaverse landscape.

Here are the main areas to keep in mind as we explore various Metaverse design trajectories:

Cognitive Dynamics: Exploring limits and opportunities

- **Cognitive Constraints Determination**: Identifying the cognitive limitations and challenges that users may face within the Metaverse.

- **Native Cognitive Strengths Discovery**: Uncovering the inherent cognitive abilities and strengths that users can leverage for an enhanced Metaverse experience.

- **Cognitive Support Approaches**: Strategies and techniques for providing cognitive assistance, such as offloading or outsourcing tasks, to improve user experience and interaction within the Metaverse.

- **Cognitive Amplification**: Enhancing users' cognitive abilities and performance by leveraging technology and design within the Metaverse.

Design Concerns: These could fuel research for years to come

- **Abstraction in Design**: The use of simplified, minimalist visuals and elements to convey complex ideas and concepts within the Metaverse.

- **Multimedia Content Composition**: Creating and organizing diverse multimedia content, such as visuals, audio, and text, for effective communication and interaction within the Metaverse.

- **Sensory Adaptation:** Designing applications that adjust or shift sensory information (e.g., visual, auditory, tactile) to match a user's unique perceptual abilities, ensuring accessibility and user-friendliness.

- **Mutual Emotional Responsiveness**: Facilitating a two-way emotional interaction between users and humanoid agents or interfaces, where both parties can recognize and react to each other's emotional cues.

- **Socially Enhanced Productivity**: Designing Metaverse applications that promote both social interactions and productive work, supporting collaboration and communication.

Creative Strategies: Enhancing process efficiency

- **Optimized Creative Control**: Efficient management and organization of creative processes, including human-centered creativity and collaboration with AI systems.

- **Content Production Pipeline Efficiency**: Improving the production pipeline of content creation processes, focusing on streamlining workflows and enhancing productivity.

- **Content Composition Principles**: Fundamental guidelines and rules for constructing and organizing content effectively, enabling users to communicate content ideas and structures to the machine using a modular system.

1. Introduction

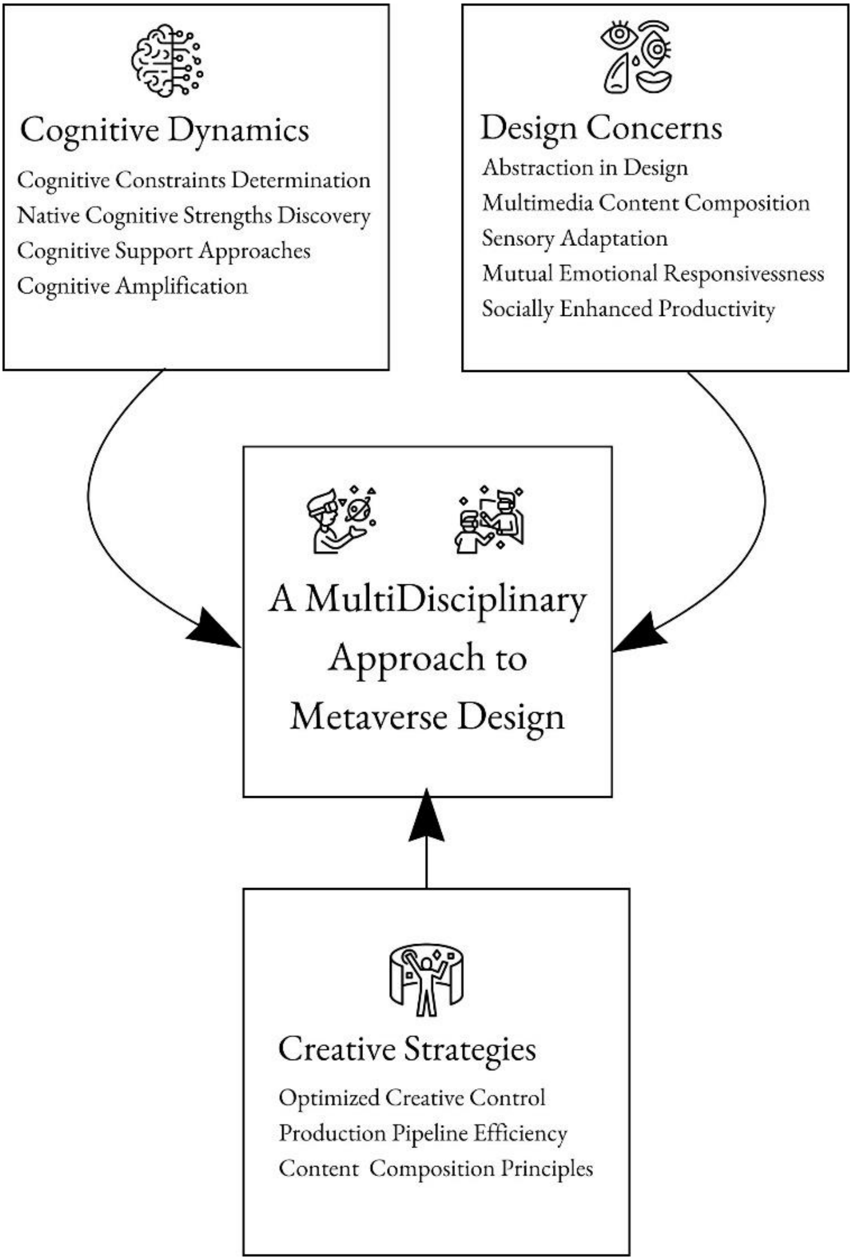


Figure 1 A Multidisciplinary Approach to Advance Metaverse Design

1. Introduction

The next chapter discusses the resurgence of interest in the Metaverse and its promises, potential, and outstanding challenges.

Chapter cover 2 Digital Chains: The Addiction Paradox

2. Challenging User Experience Design

From addictive to collaborative engagement

The Internet's Future as a Metaverse?

These days, Wall Street, especially, seems disproportionately interested in the Metaverse. However, even the most enthusiastic of its technology analysts are not convinced that we are ready for the kind of experience predicted.

Metaverse advocates tend to expect high-fidelity virtual representations and large numbers of participants in a common virtual space. However, when asked to clarify their expectations, specific use cases are seldom discussed.

The number of people who take a closer look at Metaverse fluctuates between viewing it as a niche market and viewing it as the future of the web.

Manufactured hype?

Recently, metaverse creators, along with many others, have been intrigued by the stream of demos from the most prestigious companies. This is primarily because they have not taken the risk of presenting new potential use cases but chose to showcase demos that appeared nearly a decade ago.

Even so, we should take comfort in the fact that some old ideas that failed to gain traction for various reasons, such as technological constraints, may get a second shot at success as a new generation of users or designers show interest in them.

Several leading social media companies are also experiencing market saturation. They are desperate to pivot, and the Metaverse seems to be an ideal next-frontier initiative.

Many from this crowd believe that the Metaverse is a new advertising and marketing platform. How a platform ends up being is determined by the primary underlying motivations that inevitably finds its way into the architecture of the system. Whether this is a good thing or bad remains to be determined.

Merging of application domains

VR continues to be niched into dedicated simulations characterized by narrow but high-fidelity application domains, such as flight simulators for airlines and military or healthcare training applications. Can we envision a future in which such highly specialized VR applications will converge with social virtual worlds and become a part of the Metaverse? Currently, the goal of achieving a continuous homogeneous world that would accommodate every type of application appears to be of a very high order, and the computing resources needed would probably be an order of magnitude greater than they are today.

Surely it could be much more than gaming!

Innovating ways to work together

So far, the most popular idea among developers and users is to use virtual worlds for entertainment and socialization. It is understandable why we mostly see incremental innovations around virtual concerts, quests, and sometimes museums rather than true breakthroughs.

Several blockbuster gaming environments have undergone frequent re-engineering to improve their social and collaborative aspects. However, the success of these modifications remains unclear. As it turns out, it isn't possible to easily transform a story-driven game into a collaborative space that can be used for a far wider range of generic activities.

When developing a platform for deep collaboration, special attention must be paid to the lowest architectural layers. The implementation requirements for behaviors faced by the end user in virtual collaborative settings are often rooted in the deepest layers of the technology stack.

The great engagement confusion

In recent years, there has been an increased focus on "engagement" as a key metric for success in the technology industry. Venture capitalists seem to value companies purely based on their so-called "traction", which is often a measure of how many hours users spend using their product. This has influenced designers to try and develop products that are aimed at being addictive, rather than empowering.

Everyone seems to be interested in maximizing the engagement of their offering. There is a misunderstanding of what healthy engagement is, and many designers who have studied how addiction works design products that trap users in experiences long after they have stopped finding it enjoyable. Some game designers apply lessons learned from behavioral psychology, such as Skinner's box, to make games addictive. They understand that by changing the schedule of rewards or punishments, the addictive nature of a game can be amplified.

Engagement considerations alone do not necessarily lead to experiences that feel empowering. In fact, in most cases, the gamer feels spent, unfulfilled, and guilty about the time wasted on a game that, in retrospect, was not intrinsically fun in the first place. Unfortunately, this problem goes way beyond the gaming arena. When it comes to social media applications, design professionals often face the challenge of balancing engagement and empowerment.

On one hand, it is important to create an engaging experience that encourages users to return to the app and continue using it. On the other hand, it is also important to empower users by giving them the tools they need to interact with the app in a meaningful way. There are a few key reasons why engagement appears favored over empowerment in social media applications. First, engagement is relatively easy to measure. Empowerment, on the other hand, is more difficult to quantify. Second, designing for engagement is often less resource-intensive than designing for empowerment. This is because engagement can be achieved through simple tricks, such as notifications and likes, while empowerment requires a more thoughtful approach.

When designing social media applications, it is important to consider the potential risks of creating a platform that encourages engagement at the expense of empowerment. While increased engagement can lead to more users and more opportunities for monetization, it can also create negative outcomes such as echo chambers, filter bubbles, and addiction.

Echo chambers are created when users only see content that confirms their existing beliefs. This can lead to a reinforcement of false information and confirmation bias. Filter bubbles are similar in that they also show users content that is tailored to their interests, but the content is not necessarily accurate or representative of all viewpoints. This can create a distorted view of the world and the people in it. Addiction is another potential peril of social media engagement.

When users are constantly checking for new content and notifications, they can become addicted to the dopamine hit that comes with it. This can lead to decreased productivity, mental health problems, and even physical health problems. It is important to consider these potential risks when designing social media applications.

While it is possible to create a platform that encourages both engagement and empowerment, it is important to strike a balance. Too much engagement can lead to negative outcomes, but too little engagement can also be detrimental. By finding the right balance, social media applications can be designed in a way that encourages healthy user behavior.

Designing to satisfy online interaction's most addictive aspects is an old-school way to create a steady flow of returns, while making sure users do not feel lost and unguided in a virtual space. Thus, success in this domain usually involves reaching out to a large base of consumers who expect instant gratification, either by reflexively eliminating obstacles or peer competitors or by engaging players in quests where they get to gather artificially and reliably scarce commodities, through blockchain technologies, to be traded later for money or power. Among the key aspects of these types of environments is that the footprint that comes with deep user content creation is bypassed thereby allowing them to be very fast and responsive.

In our opinion, we will never be able to realize the dream of making the metaverse the future of the internet so long as we rely on such entertainment-centric views of the metaverse.

> We will never be able to realize the dream of making the metaverse the future of the Internet if we rely on such entertainment-centric views of the metaverse.

One approach to making social media platforms successful is by eliminating the need for advanced content production and incentivizing content that appeals to the primal brain. This can create a space where many users feel entertained and in control of their social media experience. However, many of these users may eventually regret spending their time on content that has limited value to them.

Participating in this addiction can consume valuable cognitive resources that could have been used for other personal pursuits. As a result, social media addiction can have a negative impact on consumer well-being and productivity. While this strategy may benefit social platform owners and businesses, it is not always in the best interest of consumers.

Unethical growth strategy: cultivating addiction

There is a growing consensus that consumer-generated content is essential for the success of virtual world technology in supporting the next generation of the Internet. Game and virtual world developers are increasingly exploring the use of these environments for applications beyond computer games to expand their total addressable market (TAM).

However, a paradigm shift in design approach is required, moving away from catering to the predictably addictive entertainment and towards improving collaboration and productivity. Many researchers have proposed gamification [ref.] to motivate productivity, but past attempts have failed due to the distraction caused by adding an extra layer of reward dispensing mechanisms to motivate individuals to accomplish tasks more enthusiastically.

To generate engagement and monetization, we must transcend the instant gratification approach and find new ways to improve productivity while avoiding distraction.

Abundance of applications fit for the Metaverse

Metaverse low-hanging fruits are problems that can be solved here and now on very short notice.

Show and tell opportunities

When developing applications for the metaverse, our primary focus is on creating a collaborative environment that is both social and productive. A critical aspect of group work is the ability to display what one wants or is allowed to display. In the virtual world, achieving this goal may be easier than with traditional desktop and multiuser tools.

The conventional practice of having users park their avatars in virtual chairs to watch a slideshow or park their dancing avatars in a virtual club to socialize is unlikely to be the ultimate use of 3D virtual worlds. In a future section, we will provide examples of advanced show-and-tell scenarios.

> The usual practice of letting users park their avatar on a virtual

chair to watch a slideshow presentation or letting users park a dancing avatar in a virtual club to socialize is unlikely to be the ultimate utility of 3D virtual worlds.

Expanding social information bandwidth

There is much more bandwidth available for collaborative communication in the real world than when using multiuser applications on a 2D virtual desktop. Collaborating with a coworker across a desk or around a water cooler in the real world can be much more engaging than seeing each other as green dots in an instant messaging application.

In research literature from the late 2000s, the importance of peer awareness, both gaze and gesture, in collaborative spaces has been regularly emphasized. Trying to capture such information to represent them meaningfully in 2D spaces is fraught with fundamental problems that cannot be solved (Ramloll, 2001).

By representing people as humanoid avatars, it is only natural to display their activities and emotional states using familiar gestures and facial expressions. Thus, the humanoid form can be viewed as a rich information display, and most humans do not require training to decode facial expressions or gestures.

Owing to human evolution for thousands of years, it is not necessary to create and learn a new social language to support deep collaboration when humans are represented as 3d avatars in a virtual world. Otherwise, in 2D environments, new social languages must be recreated to represent the type of social information we are familiar with in 3D worlds.

Architects who attempt to achieve this in a 2D environment, using animated icons and spatial sound, for example, soon find out how rapidly users become overloaded with symbolic information that they cannot decode quickly and painlessly in real time.

Avoiding physical world costs

At first glance, 3D virtual workplaces appear to be more affordable than real ones. No buildings need to be rented or purchased, and workers do not have to travel. Space constraints cease to exist when the space to be occupied becomes decoupled from physical reality.

However, this is not a significant enough advantage to encourage people to work in virtual worlds under normal real-world conditions. Although a pandemic can push people into this environment, it shouldn't be viewed as a permanent catalyst, but as a temporary one.

Amplifying cognition

There are clear advantages to working in non-immersive 3D-spaces even if they are rendered on a familiar 2D desktop environment. We expect many designers to try to leverage this affordance to make remote workplaces significantly better in the 3D world.

With its natural affordance as a memory palace, 3D space is better for locating and searching things. For example, a 3D version control system would allow users to view inventories in a 3D space.

In addition, users can experience sharing of the same virtual space through their 3d avatars. One major advantage of this approach is that it does not require the user to wear a hardware user interface for extended periods.

We explore this topic in later chapters of this book.

Metaverse Outstanding Challenges

Marginalization of remote workers

As designers, we aim to bring people closer together through virtual spaces, but often end up driving them apart. The polarization and fragmentation of online communities can be traced back to the technological choices we make, both consciously and unconsciously.

One of the most notorious culprits is social media algorithms, which prioritize provocation over genuine engagement. Only recently has the power of these algorithms to shape society and behavior been acknowledged.

However, we should also pay attention to seemingly innocent design choices, particularly in user interfaces, that have a significant impact on weakening social connections between individuals in virtual spaces.

> Designers often set out to create virtual spaces to connect people across geographic separation, only to find that they are driving them further apart as human beings. It seems that there is a natural tendency for virtual channels of communication between individuals to turn into barriers of separation between tribes with amplified voices. How can this trend be reversed?

Social bonds between collocated workers and their peers, as well as their employers in the real world, were observed to be stronger than those between remote workers. Compared to remote workers who are based at the employer's designated office, social distancing appears to reduce the influence of remote workers on their physical work environments or general work processes.

It is conceivable that this may be because remote workers do not have a sustained or permanent presence in a shared physical work environment. Their contributions are sometimes assumed to be less significant because of their invisibility in a shared physical office environment.

Building utilitarian worlds is hard

Open floor offices were once a popular workspace design for big corporations because they believed that increased visibility of peers would encourage collaboration. However, many people were not surprised when this trend shifted.

One primary concern of remote work opponents is the lack of social information exchanges that occur naturally in the real world, which cannot be replicated in virtual environments. This problem has negative effects on creativity, connections between team members, and productivity.

Creators of virtual worlds struggle to design 3D virtual worlds that have a direct real-world impact. Examples include a 3D world that enhances the end user's productivity in the real world or one that anticipates the cognitive limitations of users and is cleverly designed to bypass them.

Designing a virtual world with a broad utility that directly meets physical or real-world needs is more challenging than creating a shooter, racing game, or plot-based virtual world.

> A plot-based virtual world is significantly easier to construct than a virtual world with a broad utility that directly meets physical or real-world needs.

Bending laws of physics without confusing users

Changing the laws of physics won't benefit a metaverse much if cognitive limitations and conditioning can't be changed. Virtual spaces offer higher degrees of freedom but don't always translate to higher levels of freedom experienced. Creating a reality-replacing metaverse that people will love is complicated by technical problems and people assuming they can automatically take advantage of the extra degrees of freedom. However, people often struggle with basic tasks like camera control or movement in a virtual world while focusing on a task. And in situations where physical laws are altered, users can feel lost or confused, eroding their immersion.

While virtual worlds offer a lot of freedom, cognitive abilities can limit us when system constraints are relaxed. For example, it may be acceptable for avatars to fly or teleport, but changing how light or sound propagates can result in incomprehensible worlds.

> There is not much correlation between higher degrees of freedom provided by a virtual space and higher levels of freedom experienced.

Less is often more

Over the course of decades, researchers have found that, in most cases, assuming a 3D data visualization will provide more value than a set of 2D visualizations is probably a mistake. Numerous occlusion-related issues can obscure or distort the relationships between variables. It is vital to remember that every design that appears to be a good fit for a 3D space requires rigorous testing with a target audience.

2D to 3D Migration Struggles

In the 3D Metaverse, the applications could either be redesigned from scratch so that they appear as some new mind-blowing 3D versions of themselves, or they can stay in their current state and remain on a 2D plane.

No designer, we believe, will relish at the thought of redesigning a word processor as a 3D application or even reforming a drawing application into its 3D version. However, we have already seen design attempts to create music-sequencing applications in immersive 3D environments. There is still some question as to whether the added dimension makes it easier to accomplish relevant tasks than in the traditional 2D versions of the application.

Any small friction in the user interface will compound, resulting in poor overall user experience. For example, the camera control problem does not arise in 2D desktop metaphors; however, in immersive 3D or desktop 3-D worlds, control of the camera during intricate tasks makes it more difficult to complete.

Using simple examples, the following section illustrates our design philosophy for enhancing the utility of virtual environments. Our experience in this domain has strengthened our conviction of never giving up the search for more efficient end-user content creation, in addition to finding new ways to empower users in virtual worlds so that their activities can more effectively influence the real world.

Current desktop applications must migrate to the Metaverse if it is to compete with the World Wide Web. Although virtual worlds can become more collaborative with the migration, it is impossible to predict the final form factor of these applications without conducting an experiment. Let us look back at the 2D desktop GUI that we are all familiar with, but with a perspective informed by what we now know is possible in 3D spaces.

Current desktop applications must migrate effectively to the Metaverse if it is to stand a chance of competing with the World Wide Web.

Stickiness of the 2D desktop GUI

Many believe that virtual worlds are virtual sandboxes or welcome refugees from the real world. This is not a generic characteristic of virtual environments; it depends on how they are designed and for what purpose.

In the case of a desktop graphics user interface, one could easily argue that we already spend a lot of time in virtual 2D environments that have a direct real-world impact. In addition, even if a virtual world is designed to be a refuge and a self-contained environment, the user will always have both feet in the real world, and once done with their virtual adventure, will certainly carry a memory of the virtual experience into the real world.

Application designers often move applications between domains characterized by their dimensions. Let us examine this migration history through the eyes of a designer deeply ensconced in a 3D virtual reality worldview.

Common command line interfaces can be thought of as the 1D version of user interfaces, in that they are linear and have implicit logical ordering for commands to execute. It is also noteworthy that 2D display technologies have been improving, making it possible to migrate some aspects of the 1D user interface to 2D. Graphical user interfaces are an excellent example of this.

The familiar world of 3D objects, such as the desk, and the tools on it, such as the calendar, calculator, and clock, can be thought of as having been migrated to a 2D interface that we have been calling the virtual desktop for half a century. The move from 3D real to 2D virtual was arguably the biggest leap forward in virtualization in history.

The user camera can be easily navigated around this 2D space with a mouse by clicking on 2D UI elements and scrolling. Users can interact with objects via mouse clicking and/or dragging. The mouse cursor is perfectly adequate as an avatar representation of the user. The right-hand is especially important for representation. Even today, the default cursor points to the upper left corner of the screen.

With 2D virtualization, one also obtains an untethered virtual experience, which is not true for 3D virtualization. This virtualization effort was designed to increase productivity and has proven to be very successful in this regard.

With the advent of touch screens, the cursor has become a vestigial representation that has to be removed. It perfectly complies with the perspective that if an environment is not designed for concurrent use by several users, it is pointless to represent the user in it.

Why change if not broken?

There is a strong argument that the transition from desktops to 3D is unlikely because most productivity applications do just fine through the 2D desktop metaphor. Even so, as previously discussed, capturing, and representing awareness information in a 2D setting can be very challenging, as opposed to when the performers are in a 3D shared environment.

This is because our brain is well trained to read gazes, gestures, and emotional responses from others. However, although this design works well in single-user settings, it has many limitations when viewed in terms of multiple user or group settings. Humans have had about 300,000 years to perfect their face processing skills and are able to use this information ubiquitously and informally in 3D interactions with peers.

During group activities, awareness of peer gaze, facial expressions, mood, and micro and macro-body gestures is crucial. Brains have evolved to be able to produce this information and consume it efficiently and effortlessly in 3D space. Thus far, there has been no success in capturing this rich and wide spectrum of emotional and gestural information in 2D where user representations are omitted. In fact, current wisdom holds that this goal cannot be achieved without representing users in a virtual world in 3D.

Most arguments against remote work center around the fact that the social aspects of teamwork suffer greatly. It is not possible to virtualize and access the social clues that are crucial in social interactions. When team members do not share a common physical space, they become unfocused and easily distracted. This is deemed true even if video conferencing is used.

Chapter cover 3 Innate Architects: The Human Creative Urge

3. Creativity for All

Content creation, a basic human right!

People typically dislike being boxed into content consumer only roles. Currently, we estimate that for every content producer, we have around 10 content consumers. This is true for social multimedia content and virtual worlds that allow users to create 3d content.

A growing number of automated content production tools will change this situation. Tools that facilitate or automate content production for end users currently do not generate content that strictly satisfies content design requests.

Too often, end users will settle for what an AI content production application creates, for example, simply because the results are coherent, even if they somewhat diverge from what end users originally wanted. We need to find a way to balance the cohesion of what is generated by an AI system with the amount of control that the end user expects.

Lack of support for subject matter experts

Creating 3D experiences to facilitate teaching, explaining, and testing a given subject is difficult for teachers. Most would prefer to limit their tools to editable slides to be displayed in front of an audience of avatars that their owners have typically parked on virtual seats. Many real-world observers in this case may find it odd why such rituals are necessary only to listen to a speaker running through a slide presentation.

Creating 3D platforms to facilitate content creation by subject matter experts is as difficult as creating a 3D visual-programming language. There are not many successful trajectories to describe on that front; therefore, there are many opportunities and room for progress here.

Many teachers find it challenging to construct 3D immersive environments to effectively illustrate abstract concepts or to support their courses. This is not a criticism of teachers' abilities; rather, it is acknowledged that there are a wide variety of opinions regarding the best methods of compressing and transmitting knowledge.

It remains to be seen whether we need specialist courses to encourage or to demonstrate to teachers how to translate their linear teaching paradigms to exploratory ones. Linear teaching paradigms put teachers front and center as the source of knowledge that needs to be absorbed by students. With exploratory immersive learning approaches, both teachers and students share a common learning experience. In the first case, the cost of instruction, both in terms of needed technology and preparation time, is typically much less than in the second case.

To reduce the costs associated with immersive teaching, we have implemented tools that allow subject matter experts, for example, to create museums, treasure hunts, quests, shareable virtual locations of real-world locations, and subject matter-specific training simulations on the fly in virtual worlds. These tools will be described in the next chapter. We introduce this topic here to encourage teachers to start thinking about how they would implement immersive learning in their practice.

Transforming text into a 3D representation is a novel concept with a variety of potential applications. For instance, a CV or biography can be transformed into a virtual museum exhibit by parsing the text and using it to specify the 3D content. This idea of using language to describe 3D environments is not new and has been implemented in the past using languages like VRML, which translates descriptive text into an actual 3D place.

The end user content creation process

User content creation is one of the most challenging and misunderstood concepts in virtual-world design. It may be considered too self-evident and paradoxically too complex to be deconstructed meaningfully.

Currently, there is no general theoretical framework for describing user-generated content, and there appears to be little interest in developing one. But since any process that can be accurately described is more likely to be optimized or improved, we must at least attempt to examine content creation from a theoretical standpoint.

There is currently no general theoretical framework for describing user-generated content and there appears to be little interest in developing one.

A theoretical framework would probably emerge as designers carefully monitor how end users craft content and attempt to automate the process. A standard approach involves identifying steps in content production processes that are often repeated and reducing them into a single one.

Streamlining content production

These problems are often encountered by designers in practice. A trivial example, just for illustration, is the creation of natural landscapes. In this scenario, trees, stones, and terrain can be manually adjusted in terms of orientation and size, after they have been introduced into a virtual world, to avoid scenes with trees and stores that look unreal because they are all in exactly the same orientation and size.

The process of deploying content in this manner is time consuming and tedious. Automatically randomizing sizes and orientations of these landscape objects lead to the generation of a more organic looking landscape. Various small improvements, such as in this trivial example, significantly reduce content creation fatigue.

Using this strategy of condensing repeated patterns into a single step may also help balance the user control and automation. When this simple approach is applied to as many tasks as end users need to complete to reach their goals, content production efficiencies can be achieved quickly.

Sometimes, it is possible to create tools to streamline content creation directly without automation but through better application design choices.

Using our system, for example, we reduced the amount of camera motion required in the virtual world to deploy content. Moving the camera over long distances to find the target placement locations is time consuming and slows content deployment.

By placing the corresponding icons on a board in a virtual room, users can deploy objects, buildings, flora, fauna, and NPCs over large-scale terrains. This simplification resulted in significant efficiency gains regarding the deployment of content in large-scale virtual worlds by users, who were not modelers or programmers.

> The concept of task granularity is important for designers to build tools to accelerate user-content creation. It can be said that the granularity of a task is of order N if it requires N steps to be completed.

Accelerating content production

Task granularity

The concept of task granularity is important for designers to build tools to accelerate user-content creation. It can be said that the granularity of a task is of order N if it requires N steps to be completed. Tasks of the lowest granularity are of order 1, that is, they require a single step to complete. Automation tends to decrease the granularity of tasks.

End users lose control when the granularity decreases, but the tasks are completed faster. This may provide them with the opportunity to focus more on their primary goal.

Creating large scale content rapidly: e.g., a virtual 3D town

When constructing a virtual town for a class, a teacher may have access to a grid of roads that they can first deploy on an empty plot of 3D virtual land. In the next step, they can place a city block, which is a randomly generated set of floras and buildings.

It takes 16 steps to create the town if there are 16 blocks to build. Therefore, the granularity of this town-building task is 16.

However, if we automate the creation of the town in one step, we reduce the task granularity to one.

Hunting for optimal granularity

The same approach can be applied to a wide range of use cases, from deploying exhibit space in a virtual museum to deploying seating arrangements for large virtual conferences.

The optimal level of granularity for a content production task depends on the expertise of the end users or the amount of cognitive bandwidth that they can commit to this task.

When discussing content production automation, either procedurally or with the aid of artificial intelligence, it is helpful to keep in mind the desired granularity of relevant tasks to be better prepared to address any problems that result from over-automation.

Avatar embodiment customization

Embellishing identity

Crafting user representations is often overlooked as a critical component in user-facing content creation. It is our experience that end users tend to search for ways to quickly establish an identity after logging into the virtual environment, either by customizing their avatars or acquiring objects that would make them stand out.

Using AI techniques, avatars can now be generated from a single image. Naturally, this opens more questions concerning identity and ownership, as it is becoming increasingly easier to create representations of celebrities using deep fake technologies or avatars based on their images.

Capturing and representing live social data

Another crucial aspect of the equation is to provide tools that allow users to capture and map their facial expressions in real-time.

In most cases, users seem to prefer controlling their avatar's emotional responses manually, only if it does not result in an undue cognitive burden over time. For example, pushing keyboard buttons or clicking on menus to animate your avatar quickly becomes a chore and is quickly abandoned.

In our experience, it is best for the user to generate face animations or body gestures as automatically as possible. Efforts to improve the process of creating satisfactory avatars for end users are underway and typically involve face and body tracking technologies.

This problem becomes more challenging in non-immersive 3D virtual environments where the user is comfortably sitting while their avatar is standing in the virtual world.

Fidelity: Sensory, Physical and Social

Fidelity is another concept that is difficult to understand. It can be assumed that fidelity describes the degree to which a virtual object or behavior is like its corresponding real-world counterpart. It has long been assumed that higher fidelity, in this sense, will automatically lead to greater immersion and engagement.

However, it appears that this is not the case. The stickiness and allure of blocky virtual worlds, such as Minecraft and Roblox, has shown that fidelity in this narrow sense is less important for increasing engagement.

The current lack of discussion around social fidelity is concerning. We hope to fill this gap in later chapters.

Our multi-sensory system to access the world

The concept of fidelity can be explored from a sensory perspective, such as visual, auditory, or haptic. Simulating the physics of the visual, auditory, and haptic domains is certainly one way to approach fidelity.

In any case, we are quite far from virtual touch or smell at this point, so we will not discuss them. It does appear that we are not at liberty to stray far from the physical behaviors we experience in the real world.

Optimized 3d content for immersive worlds

Response time is probably the biggest factor when it comes to raising virtual content fidelity. When creating VR content, special attention must be paid to prevent overloading or slowing down the VR environment.

> Response time is probably the biggest factor when it comes to virtual content fidelity.

It is challenging for content creators to create content that satisfies both aesthetic and functional requirements while utilizing minimal resources. Achieving this is very challenging especially for non-professional 3d modelers.

One approach to deal with this issue is to design content composition tools that allow users to compose complex environments from optimized simpler parts. We will demonstrate this approach by referring to our very own content composition platform, RezMela.

3D spatial audio

Virtual worlds are becoming increasingly popular as a means of entertainment, education, and even business. As the technology continues to develop, so too do the possibilities for how these virtual worlds can be used. One area that is particularly important in virtual worlds is the design of the soundscape.

The soundscape of a virtual world can have a significant impact on the user experience. Good sound design can make a world more immersive, while bad sound design can make it feel jarring and artificial. One of the key elements of sound design is 3D spatial audio.

3D spatial audio is the process of creating audio that sounds like it is coming from specific locations in three-dimensional space. This can be done using a variety of different techniques, such as binaural recording, sound propagation, and head-related transfer functions (HRTFs).

Binaural recording is a technique that uses two microphones to capture sound from different directions. This allows the sound to be reproduced with more realism, as it captures the way that sound waves interact with the human head and ears.

Sound propagation is the process of simulating how sound waves travel through the environment. This can be used to create realistic echoes and reverberation.

HRTFs are a set of algorithms that are used to simulate how sound is heard by a human listener. This includes factors such as the shape of the head and the size of the ears. HRTFs are often used in virtual reality headsets to create a more immersive experience.

The use of 3D spatial audio can make a virtual world feel more realistic and immersive. It can also be used to create a sense of place and atmosphere. In some cases, it can even be used to guide the user through the world.

Soundscape design is a relatively new field, and there is still much to learn about how to create effective soundscapes. However, the use of 3D spatial audio is a promising start, and it is likely that we will see more and more use of this technology in the future.

[Insert haptics research here]

Supporting end user content creation is hard

External vs In-world content creation tools

If content creation is separated from in-world experiences, the platform's potential for growth into the future internet seems to be reduced. Several AAA game companies have attempted to convert game-level editors into content creation platforms for end users. While this effort has resulted in some educational environments, none seems to have taken hold. Using external tools may be better suited for allowing experts to create content, but this also robs end users of content creation opportunities. This leads one to ponder whether it is possible for a virtual world optimized for a particular game to evolve into the Internet of the future.

Designing building tools from ground up

Platforms designed to include user content creation have proven to be more successful in opening up a range of new possible application domains. Many of these platforms are currently being used by educators to meet each other and share content, but none of them are emerging as generic platforms that could potentially replace the Internet of tomorrow.

Limited end user content creation opportunities

The challenge here is that maintaining content creation in the world places a lot of strain on limited resources, which even impacts immersion and usability. At the same time, companies are incentivized to make their platforms available through thin clients so that they can be accessed easily through a web browser or smartphone. Providing deep content creation tools within the virtual world but via a browser or smartphone designed to have limited access to resources, often for security reasons, is therefore very challenging, given the current ecosystem of technologies.

The web browser as a gateway to the metaverse

Every major industry contender in virtual reality started out with tools that could only be accessed through a powerful computer or console, but no matter how hard they tried to make their tools and worlds available via a browser, they never succeeded without having to cut down core functions, such as world building. Video streaming console experiences through web browsers have been attempted successfully to bypass browser limitations, but these services are very costly.

Mobile access to the metaverse

Content creation in three-dimensional virtual worlds often negatively impacts the experience of users because it slows the platform's overall performance, which affects the frame rate and immersion. In addition, the creation of content may make a virtual world unsuitable for access through most popular end-user devices and smartphones with limited screen real estate. One can imagine bypassing these limitations by making content available through an

HMD connected to the phone; however, we must deal with the HMD issues that we discuss in a forthcoming section.

Unnecessary barrier between creators and consumers

In the past, solutions to this tension were either to keep building tools outside of the shared virtual world or to create a viewer version of the shared virtual world. As a result, there is an artificial technological barrier that separates content creators from consumers. This wall negatively impacts communication between creators and consumers, which usually results in suboptimal products resulting from an extended path between ideas and products. Because of this segregation, collaboration is the first casualty, which justifies the cost of optimizing the use of limited distributed computing resources.

> Providing deep content creation tools in-world and via a browser or smartphone is therefore very challenging given the current ecosystem of technologies unless the smartphone is a conduit to a 3D immersive world.

Future of content production is bright

We are at the cusp of revolution in user-generated content production. For too long, the opportunity for end users to create content was restricted to writing, speaking, photography, and video recording. Now, they will have access to tools that will allow them to create content with similar efficiency as professionals. It is certainly going to be very interesting to observe how content creation will evolve now that AI plays a big role in this domain. As illustrated by the Dall-E software, AI has already produced an extensive collection of paintings that have drawn the attention of experts. Similar approaches are likely to work in 3D as well. There are already apps that scan Lego blocks and use artificial intelligence to suggest what to build with them [ref.].

The future of the creative process

AI systems can generate questions that were previously unknown due to their lack of cognitive biases. This ability to explore a larger space of possibilities can lead to asking better questions, as the answers are often encoded within them.

The role of AI in the creative process is becoming increasingly important, with possibilities ranging from AI replacing humans to augmenting or enhancing human creativity. To ensure that AI enhances human creativity, it's crucial to embrace AI and learn how to use it to generate better questions and answers.

The goal should be to use AI to create better answers in the creative process.

We have recently seen an explosion of AI art production algorithms. For example, the stable diffusion algorithm has allowed anyone to generate various kinds of artwork. This space has seen an explosion of applications in open-source AI communities.

We noted the emergence of many sketches to image applications where users can use a text prompt and their scribbles to explain what they need in finished art that expresses. A text prompt is a description of what you need to see.

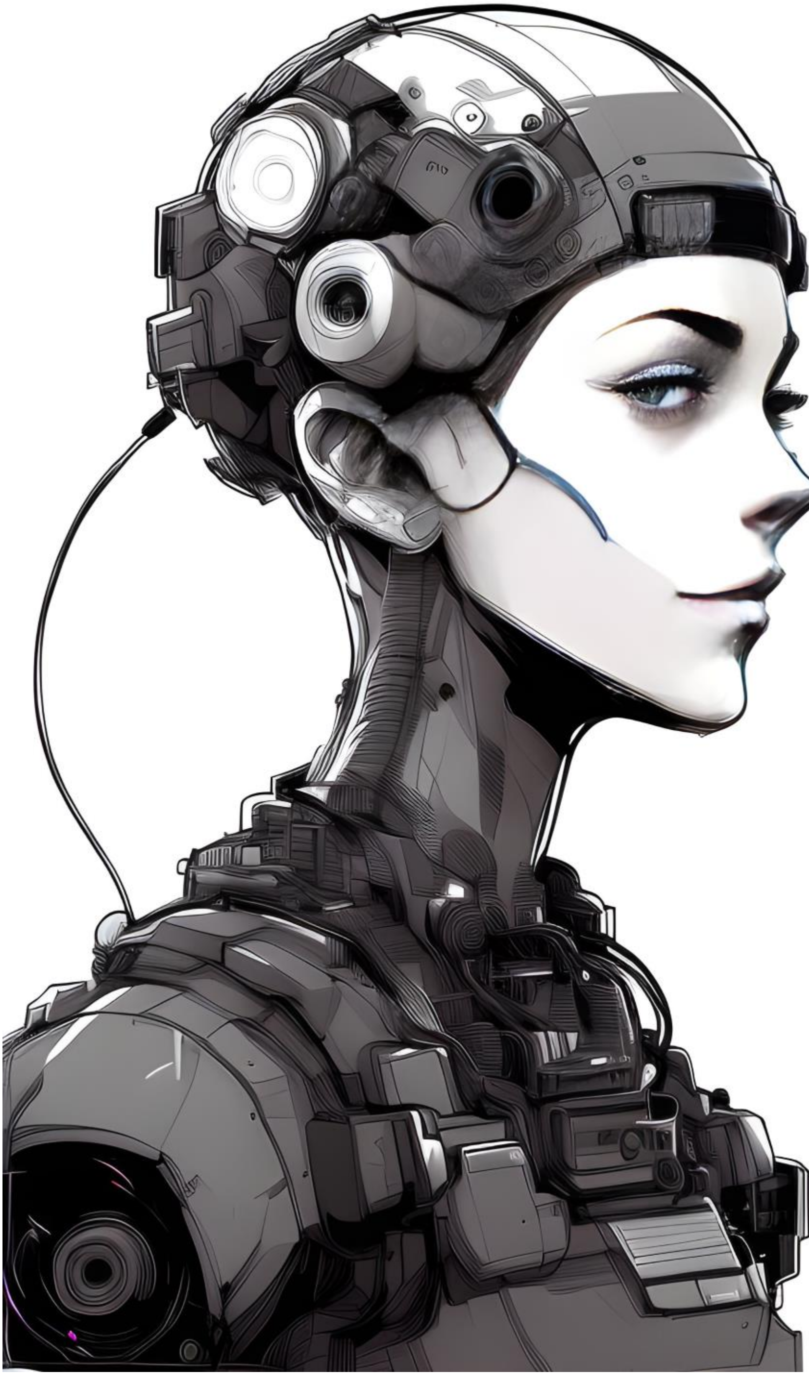
At the time of the publication of this book, it is unlikely that applications that can translate scribbles with text prompts into 3D models.

The field of AI art production has witnessed remarkable advancements in recent years. One of the major driving forces behind this progress is the development of algorithms like the stable diffusion algorithm. These algorithms enable anyone to generate various types of art using AI-based tools and techniques. The open-source AI community has been instrumental in fostering innovation in this area, leading to the emergence of new applications and tools.

One of the most exciting developments in AI art production is the emergence of sketch-to-image applications. These applications allow users to input a text description or their own sketches to generate finished art that meets their vision. With the help of AI, users can now create stunning images and artworks even if they lack traditional artistic skills.

While AI-based tools have been successful in creating 2D content, converting scribbles with text prompts into 3D models is still a challenge. However, researchers are exploring new methods for creating 3D content using AI. One promising approach is to use vocal instructions to help end-users create 3D models. By using voice commands, users can create more complex models and shapes than they would be able to with traditional input methods.

In conclusion, the field of AI art production is rapidly evolving, and we can expect to see many exciting developments in the years to come. With the emergence of new applications and tools, AI is transforming the way we create and appreciate art, making it more accessible and inclusive for everyone.



Chapter cover 4 Cognitive augmentation strategies

4. Mindful Design

Adapting design to cognitive constraints

The Metaverse has the potential to transform how humans interact with digital environments. However, to realize its full potential, designers must consider human cognitive limitations during the early design stages. By viewing design problems through a cognitive science lens, designers can accelerate innovation and experimentation while avoiding fundamental obstacles that could hinder the development of the Metaverse.

Considering human cognitive constraints in the design process can lead to the creation of more user-friendly and enjoyable environments. By understanding how humans process and interact with information, designers can create Metaverse experiences that are optimized for the user's cognitive capacity. This approach can lead to improved learning outcomes and peak performance for users, ultimately enhancing the overall experience.

Designing with cognitive limitations in mind also encourages experimentation and innovation. By acknowledging the constraints of the human cognitive apparatus, designers can identify and explore alternative design solutions that might not have been considered otherwise. This can lead to the development of new and innovative approaches to creating immersive digital environments that are optimized for human cognition.

Overall, taking a cognitive science perspective during the design stages of the Metaverse can lead to the creation of more user-friendly, enjoyable, and innovative environments. By considering human cognitive limitations, designers can optimize the Metaverse experience for users, ultimately enhancing the potential of this emerging technology.

Throughout history, one of the favorite tactics of engineers has been to start crafting solutions for immediate problems without waiting for the science to be fully developed. This approach has led to many remarkable innovations, from the steam engine to the internet. However, it has also led to some failures, such as the famous bridge collapse in Tacoma, Washington. Nevertheless, engineers continue to push the boundaries of what is possible, sometimes relying on intuition and sometimes on science.

Cognitive science is a relatively new field that has emerged in the last century. It draws on insights from psychology, neuroscience, computer science, linguistics, and philosophy to study the mind and brain. While cognitive science is still in its early stages, it has already yielded many fascinating discoveries, such as the concept of working memory and the role of mirror neurons in empathy.

Given the potential of the Metaverse to transform how we interact with each other and with technology, it is important to consider how cognitive science can inform the design of virtual environments. While there are many challenges to designing for the Metaverse, such as the need for seamless integration across devices and platforms, understanding the cognitive mechanisms underlying human perception, attention, memory, and decision-making can help designers create more effective and engaging experiences.

In this chapter, we will introduce a few theoretical design terminology and concepts from a cognitive science perspective that Metaverse designers need to be aware of. These include mental models, attentional resources, affordances, and feedback. By understanding these concepts and applying them to virtual environments, designers can create experiences that are intuitive, informative, and rewarding for users.

Neuroergonomics and its potential impact on Metaverse design

Harnessing cognitive psychology, designers have masterfully crafted addictive digital experiences, fueling the rise of engrossing smartphone games and social media platforms. This lucrative strategy, however, has left a trail of concerning consequences, ensnaring users in the throes of gaming addiction and other problematic behaviors.

Neuroergonomics emerges as a beacon of hope, weaving together neuroscience, psychology, and engineering to sculpt technology that nurtures user well-being and empowerment. By embracing neuroergonomic principles, designers can pivot away from addiction-driven models, crafting products that bolster user health, satisfaction, and autonomy.

The future of this design revolution hinges on market forces and a collective shift in priorities. As consumers awaken to the perils of digital addiction, their clamor for well-being-focused products may spur companies to abandon short-term gains in favor of healthier, more autonomous user experiences.

Ergonomics and neuroergonomics are both concerned with the study of human factors in relation to the design of systems, products, and environments. Both approaches aim to optimize human performance and reduce errors, injuries, and fatalities. However, there are some key differences between the two approaches. Ergonomics is primarily concerned with the physical aspects of human factors, such as body mechanics, anthropometrics, and biomechanics. Neuroergonomics, on the other hand, takes a more cognitive focus, examining issues such as human information processing, decision making, and mental workload. In recent years, there has been an increased focus on the role of neuroscience in understanding human factors, leading to the development of neuroergonomics as a distinct field.

Neuroergonomics is the study of how the nervous system interacts with the work environment. It is a relatively new field that is growing in popularity, as it has the potential to greatly improve the design of assistive technologies and virtual worlds.

4. Mindful Design

There are several lessons that can be learned from neuroergonomics that can be applied to the design of virtual worlds.

1. First, it is important to understand how the nervous system works to design technologies that are compatible with it.
2. Second, neuroergonomics can help to identify the most efficient and effective ways to perform tasks. This information can be used to design virtual worlds that are more user-friendly and efficient.
3. Third, neuroergonomics can provide insight into how people learn and remember information. This information can be used to design virtual worlds that are more effective for learning and retention.
4. Fourth, neuroergonomics can help to identify the potential risks and hazards associated with using certain technologies. This information can be used to design virtual worlds that are safer and more user-friendly.
5. Overall, neuroergonomics is a valuable tool that can be used to improve the design of assistive technologies for virtual worlds. By understanding how the nervous system works, designers can create technologies and virtual environments that can adapt to our changing cognitive abilities over the course of our lives.

6. Neuroergonomics can be used to evaluate the effectiveness of training programs or other educational materials that are designed to be used in virtual worlds. By understanding how the nervous system responds to different stimuli, it is possible to develop more effective and efficient methods for teaching people how to use virtual worlds.

What informs neuroergonomics studies

In this field, a wide range of human data is collected to inform research and design decisions. This data can be divided into three main categories: physiological data, behavioral data, and cognitive data.

Physiological data includes measures such as brain activity (via EEG or fMRI), eye movements (via eye tracking), and body movements (via kinematic measures). This type of data can provide insight into how the brain and body respond to various tasks and demands and can be used to optimize workplace design and performance.

Behavioral data includes measures of task performance, such as accuracy and efficiency. This type of data can be used to identify areas of improvement in task design or execution and can also be used to evaluate the effectiveness of neuroergonomic interventions.

Cognitive data includes measures of attention, memory, and decision-making. This type of data can be used to understand how different areas of the brain contribute to these cognitive processes, and can also be used to inform the design of cognitive training and rehabilitation programs.

Subjective workload assessments are a vital part of ergonomics. They allow us to identify how much work an individual is doing and how this compares to their mental and physical capacity. Subjective workload can be assessed in a number of ways, with two of the most common being to ask individuals to rate their level of mental and physical effort on a scale from 1 to 10, or to use the NASA-TLX (Task Load Index) to rate different aspects of workload including mental demand, physical demand, temporal demand, performance, and effort. Subjective workload assessments are used to compare the workloads of different jobs or tasks, and to assess the impact of changes in the work environment on workload.

Subjective workload assessments have many advantages, including that they are quick and easy to complete, do not require special equipment, and can be adapted to different types of tasks and work environments. Subjective workload assessments have the potential to be inaccurate because they rely on self-reports from workers. They may also be influenced by the workers' current mood or level of fatigue. When used correctly, they can provide valuable insights into how workers feel about their workload and help identify potential issues that need to be addressed.

Collecting all this data can be a challenge, but it is essential for the field of neuroergonomics to continue to grow and improve.

Cognitive limitations

Every communication channel is measured by its capacity, and the amount of noise it is associated with. Claude Shannon identified a hard limit that can be determined for any communication channel. If the communication link is subject to random transmission errors, the Shannon limit or Shannon capacity refers to the maximum amount of error-free data that can theoretically be transmitted over the link for a particular noise level. This limitation is expected to play a major role in determining the upper bound for all communication channels, including neuron-level communications.

What are the causes?

The upper bound on cognitive abilities is determined primarily by brain physiology and the physics of signal transmission through noisy biological networks. Without data abstraction processes that allow a limited mind to make sense of the world, it would be impossible for humans to assimilate all the information that constitutes the universe, even if we adjust the sensitivity and range of our biological sensors to infinity through technology.

It appears that most of the abstraction processes that help us make sense of the world are the result of brain function, occur outside our conscious or probably unconscious awareness, and appear to be fortunate products of evolution. Perception mechanisms in various domains, from vision to touch, are examples of natural abstraction processes that cannot be altered intentionally. This creates a very stable, common and shareable illusion that we label reality. So, in a way, the foundation of reality is rooted in our cognitive limitations.

How to measure cognitive limitations?

Despite our understanding of how these cognitive limitations emerge and play a role in creating the illusion of reality, we do not yet know how they emerge and how to measure them directly. We can only estimate them by designing tasks at different difficulty levels and measuring how successfully these tasks are solved, for example, the visual span test. There are many examples in Cognitive science where attempts are made to measure aspects of our sensory systems. For example, just-noticeable-difference (jnd)studies for every sensory media is common. One of the classic psychoacoustic jnd experiments involves a subject being asked to compare two sounds and to indicate which is higher in level or frequency.

What is cognitive bandwidth?

The two most common definitions of cognitive bandwidth are as follows: bandwidth refers to our cognitive capacity and ability to pay attention, make good decisions, stick with our plans, and resist temptations [ref.]. Cognitive bandwidth can also be viewed as the bandwidth for conscious activity (mental or physical). It is easy to verify through self-experience that it is finite [ref]. Working memory capacity appears to be an important constraint on cognitive bandwidth.

Working memory as key constraint

The working memory model proposed by Baddeley and Hitch (1974) consists of three components: the central executive, the phonological loop, and the visuo-spatial sketchpad. The central executive is responsible for attention and control.

The central executive is responsible for overseeing and coordinating the activities of the other two components. It is also responsible for the coordination of information and processing between the short-term and long-term memory systems.

> The central executive is believed to be a limited-capacity system, and it has been suggested that it is the bottleneck of the working memory system.

The phonological loop is responsible for the temporary storage and rehearsal of verbal information, while the visuo-spatial sketchpad is responsible for the temporary storage and manipulation of visual and spatial information. This component is thought to be located in the right hemisphere of the brain. Studies have shown that damage to this area can lead to difficulties in tasks that require mental rotation or visualization, such as imagining how an object would look from a different angle.

The visuo-spatial sketchpad is believed to play an important role in many everyday activities. For example, when we drive, we constantly need to update our mental map of the environment in order to navigate effectively. Similarly, when we read a text, we use the visuo-spatial sketchpad to visualize the layout of the page in order to follow the flow of the argument. There is still much about the visuo-spatial sketchpad that remains unknown. For example, it is not clear how information is represented in this component, or how it is accessed during problem solving. However, the visuo-spatial sketchpad is a key part of working memory, and a better understanding of its role in cognition will help us to understand how we think and learn.

Working memory is a cognitive system that allows us to temporarily store and manipulate information in order to complete complex tasks such as reasoning, problem solving, and comprehension.

Quantitative estimates about the working memory system

The central executive, phonological loop and visual sketchpad are all important working memory systems in the human brain. However, they all have limitations in terms of capacity. These limitations can be measured using a variety of tests.

The capacity of the phonological loop is typically measured with the use of the digit span task. In this task, participants are presented with a list of digits, and they are asked to remember the sequence of digits. The list of digits is then repeated, and the participants are asked to recall the sequence. The capacity of the phonological loop is measured by the number of digits that the participants are able to correctly recall.

The capacity of the visual sketchpad is typically measured with the use of the change detection task. In this task, participants are presented with a display of items, and they are asked to remember the items. The display is then changed, and the participants are asked to identify the changed items. The capacity of the visual sketchpad is measured by the number of items that the participants are able to correctly identify.

The capacity of the central executive is estimated to be around 4-7 items. The phonological loop is estimated to have a capacity of around 2-4 items, and the visual sketchpad is estimated to have a capacity of around 4 items. These estimates are based on a variety of tests, including the digit span test, the phonemic awareness test, and the visuo-spatial sketchpad test.

The capacity of the central executive is often measured with the use of the Stroop task. In this task, participants are presented with a list of words, with each word printed in a different color. They are then asked to name the color of the ink in which the word is printed, as quickly as possible. The task is a measure of the capacity of the central executive because it requires participants to inhibit the natural tendency to read the word. The reaction time is measured from the onset of the cue (the color of the ink) to the time the button is pressed.

Now that we have an approximate idea about the fundamental limitations of the cognitive system we must work with, we are in a better position to discuss the various design theories.

Metaverse content creators are, of course, not expected to become cognitive science experts, but it is certainly sufficient for them to be mindful of potential cognitive constraints and their impact on design. This impact can then be confirmed or disproved through traditional human–computer interface studies, many of which are well-known.

Why design theories?

It is often argued in many creative domains, that theory is certainly not necessary, that good design is primarily Art and that any attempt to create guidelines or steps to engineer Art is bound to cripple it. For instance, experts in music theory are not often known for the music they compose. But many musicians with little background in music theory have been known to produce ground-breaking and memorable music. We do not believe theory and practice to be enemies. For example, music theory opens doors to creativity and shortens the path to something that is cogent and acceptable efficiently, especially when improvising with others. Designing for the Metaverse presents us with a similar challenge. While some prefer theories to guide them, others will prefer to treat design purely as art, stumbling through discoveries as they go. A good balance between theory and practice is desirable.

In many fields ranging from architecture to human–computer interface design, architects and engineers have attempted to create design theories that would help accelerate the design process to shorten the time between ideation and the final product. Design theory has several stages.

The initial stage typically involves the identification of repeated patterns during the design process. The relationships between the various patterns that arise are captured and studied. Causal relationships between the various patterns are also discussed. The best design theory is the one that leads to the most aesthetically pleasing and most functional products in the shortest time possible.

It is perhaps ambitious to suggest that we can design, produce, and distribute content intended for easy and efficient consumption by applying design laws, conjectures, or guidelines, but we think that it is an important goal to strive for. Currently, few outstanding design theories exist for Metaverse design. We invite peer experts to add their own theories to those we propose. It is likely that we will see a set of theories powerful enough to guide the development of the metaverse in the future. (Call for action) Hopefully, the examples presented in this book will motivate others to collaborate and discover them.

Types of design theories: Explanatory and Practice

Theories of design generally fall into two broad categories: explanatory and practice. Explanatory theories aim to provide a coherent account of how designers actually go about their work, while practice theories offer explicit advice or guidance on how designers should work.

The cognitive outsourcing theory we propose is a good example of an explanatory design theory. Such theories allow designers to offload much of the cognitive load associated with design tasks, and thus makes the design process more efficient and effective. In this chapter, we describe how designers can rely on the lessons learned in the fields of cognitive engineering and neuroergonomics to narrow down the design solution search space.

The theory of composition that we also propose, on the other hand, is more direct and narrowly focused, and thus serves as a good example of design practice theory. The theory provides explicit advice on how designers should go about their work, specifically in the domain of composition. The theory prescribes a specific process for deconstruction of complex objects or concepts into simpler ones that can be reassembled rapidly and effectively often with zero coding to produce more complex entities that can satisfy a wide range of needs.

In order to realize the full potential of the Metaverse, we need to develop new theories and tools for content creation. We invite all practitioners involved in the creation of 3D content for the Metaverse to collaborate and advance new theories so that we can come up with tools that will help improve the quality of content creation tools. Ref
https://link.springer.com/article/10.1007/s12599-010-0118-4

Theory of cognitive outsourcing

After years designing content production software, we could not avoid recognizing the need for a theory of control delegation that would help us figure out where to draw the line between design processes that need to be automated and those that do not. Too much automation can kill the creative process of designers and marginalize them; too little can freeze the creative process because the tasks are so labor-intensive that, in some cases, the trajectory from ideation to product is so long that it cannot be completed without a lot of blood and tears.

We also realize the central role of information-processing theory when designing virtual content to represent selected aspects of complexity to make it more generally accessible. Multimedia data visualization would be a good example of this class of problems. Here, the relevance of the fundamental Shannon's limit of our sensory channels for information when creating content cannot be understated. Our aim should always be to create content or applications that will not overwhelm the capacity of our sensory channels as this would hurt the quality and utility of the consumption experience. For example, having too many animated icons to represent external events might be difficult to follow because either there are too many of them or they are changing too fast.

The design process also involves ethical dimensions that we may not always pay attention to. For example, designing content to appropriate the working memory of unsuspected content consumers is probably acceptable today and even incentivized, as in the online advertising community, but such practice is likely to be regulated in the future. The attention or cognitive bandwidth allocation problem required for task demands is traditionally assumed to be in control of the consumer of content. But in practice this responsibility is slowly being transferred to external software systems such as social media algorithms.

Theory of composition

Composition is the process of assembling reusable components typically efficiently and easily into entities of higher complexity. In other words, it is the process of taking smaller, simpler pieces and assembling them into a more complex whole. This process is what allows us to build things, not only Lego toys and Meccano machines, but also mental models, software programs, really anything that we can imagine.

The reverse process of composition - deconstruction - is what allows us to take a complex object and break it down into its simpler parts. This process is much more difficult to understand and conceptualize. In order to deconstruct something, one must first understand the composition of the object - how it was put together in the first place. Once the composition of the object is understood, the deconstruction process becomes much easier. However, an added layer of complexity arises when the composition process is unknown or unknowable. Then it becomes the responsibility of the designer to divide the object into meaningful simpler parts.

There are many reasons why someone might want to deconstruct a complex object into its simpler parts. For example, they may want to understand how the object works, or they may want to reuse the parts for other purposes. In this chapter, we will discuss how this theory of composition could help inform tools and approaches to help the end user create content for the Metaverse easily and efficiently.

What is cognitive outsourcing?

Before we discuss how cognitive amplification can be achieved through cognitive outsourcing, we describe three main areas that are the pillars of the theory of cognitive outsourcing.

1. Cognitive offloading: Cognitive offloading is traditionally described as the transfer of brain functions to external devices so that the brain can focus more effectively on tasks that require creative control.

2. Abstraction capturing or prototyping: This is the process of discovering repeated patterns to create concepts, modules, or components.

3. Sensory channel load optimization: This is the process of choosing representations to embody abstractions, either as symbols, text, images, sounds, or tactile cues, in order to make optimal use of human perceptual channels and working memory.

4. Control delegation: Outsourcing control of sub or lower level tasks to external party, often a device or AI system, to reduce cognitive footprint

Let us consider each aspect of cognitive outsourcing theory in more detail.

Cognitive offloading

Numerous devices have been created throughout history to reduce the cognitive load that would otherwise have made the accomplishment of complex tasks impossible. We invented writing tools and paper to relieve the memory burden. With the advent of clocks, it has become much easier to track time. Modern technology has given us access to computers, calculators, and advanced cameras, as well as a wide range of other technological advancements aimed at reducing our need to memorize, while ensuring that the brain still has enough resources to meet new and immediate task demands.

Cognitive offloading [ref.] is traditionally described as the transfer of brain functions to external devices so that the brain can focus more effectively on tasks that require more creative control.

Cognitive offloading as a concept satisfactorily explains how a brain can transcend its inherent cognitive limitations. However, we currently believe that cognitive outsourcing more elegantly expresses the control delegation aspects, which have grown in importance as we delegate an increasing number of cognitive functions to AI systems. Most importantly, we believe that considerations of cognitive outsourcing when designing the Metaverse will emphasize the importance of delegation control in the Metaverse.

Abstraction design

Abstraction capturing or prototyping relates to the reduction of complexity into interconnected abstractions, which often serve as building blocks for the assembly or construction of explanatory stories. It is also common for abstractions to efficiently reduce the working memory demands for many tasks that humans have identified.

Abstraction capturing

We consider abstraction to be an emergent phenomenon, as it can arise as a result of natural evolution and not only by human-led design. For example, it can be argued that the illusion of reality is itself an example of abstraction at work and is simply the product of the evolution of our sensory apparatus and brain.

It is abundantly clear that the brain has a number of areas dedicated to specific cognitive functions, and it is not entirely inaccurate to consider them as 'bio' firmware which does not need conscious intervention or control for them to serve their function in the background, for example, vision and sound processing will fall under this category. Successful abstractions enable reasonable and reliable expectations to be constructed regarding what lies beyond our limited cognitive window. The ability to connect these abstractions into causal or descriptive stories probably makes the human brain unique.

In summary, we have argued that there is a close connection between the quest for meaning and the cognitive limitations of the brain. We believe that it is these limitations that motivate the emergence of abstractions or concepts, which are essential for storytelling. Without abstractions and concepts, we would not have languages to express our quests and our pleasure of finding things out, just to mention two out of the many drivers of the human experience.

Our cognitive limitations are perhaps an evolutionary blessing in disguise. Donald Huffman (mathematically proved): 'An organism that sees reality as-it-is is never more fit than an organism of equal complexity that sees none of reality and is just tuned to the fitness payoffs.' Translated, that means if you see the truth, you'll go extinct. However, as engineers or designers, we are generally more concerned with making things with what is known, rather than trying to explain them away to their core. We believe that this is the best way to make use of the limited cognitive resources available to us.

Abstraction prototyping

What is the relevance of 'abstractions' to the construction of the Metaverse? When we set out to accelerate the production of content and make it easier for everyone to access it, we must determine how to help users create their own worlds, and whether they want to use them for social, productivity, or other purposes without coding or 3D modeling.

When the Metaverse becomes a reality, we expect users to have the flexibility to experiment with various embodiments of abstractions to amplify social connections with others in order to enhance learning or productivity. Thus, the Metaverse provides immense opportunities for prototyping and for evolving abstractions.

Can these devices be programmed using natural speech in the future? Can interactive 3D world builders simply drag, drop, and snap 3D objects to create Metaverses that most will enjoy using and visiting?

After the design framework has been established, there are no shortcomings in creative ideas that can be experimented with. When it comes to research, every failure is a learning opportunity and a steppingstone to higher ground.

In any medium of perception, right abstraction can yield powerful mental objects that do not strain working memory. We can remember the shape of a graph more easily than the table of numbers used to create it. Students of the Soroban abacus can perform advanced calculations even if they do not have access to the device or were blindfolded. We can recall the shapes of molecules and perhaps rotate them mentally to check whether two apparently different-looking molecules are isomers.

Sensory channel load optimization

The second area is related to how we allocate the bandwidth of our perception channels to maximize information flow while avoiding overwhelming the working memory.

Every communication channel is measured by its capacity, and the amount of noise it is associated with. Claude Shannon identified a fundamental or hard limit that can be determined for any communication channel. If the communication link is subject to random transmission errors, the Shannon limit or Shannon capacity refers to the maximum amount of error-free data that can theoretically be transmitted over the link for a particular noise level. This limitation is expected to play a major role in determining the upper bound for all communication channels, including neuron-level communications.

Delegation control

The third area involves the delegation of control so that a task can be divided into subcomponents, which are then individually addressed by third-party experts. As the outsourcer will partially use its working memory for communication with external collaborators, a cost is incurred. However, when properly implemented, delegation increases productivity.

Sensory channel load optimization

The need to devise data visualizations often arises during product development flow. Understanding how our brain processes vision, sound and touch, can help designers develop data visualizations that actually work.

As we age, our sensory channels become less effective, due to aging, congenital issues, lifestyle, and injury stress. This can lead to problems ranging from mild tinnitus to partial loss of auditory perception. If we design interfaces based on an information-processing view of cognition, we can better accommodate these changes in perception. For example, we designed sonified or auditory graphs for the blind and visually impaired.

Figure 1 illustrates a simple system designed to make mathematical data more accessible to the visually impaired. This system uses position sensors placed on the left (B) and right fingers of the user. A virtual sound source is created and located at the position of the right finger tip, while a virtual listener is positioned at the left finger tip. The sound is rendered in 3D and can be heard through a headset la (A.) This approach enables users to perceive the data through sound, using the relative position of their fingers as a means of navigation. Keep this set up in mind as we present the following examples.

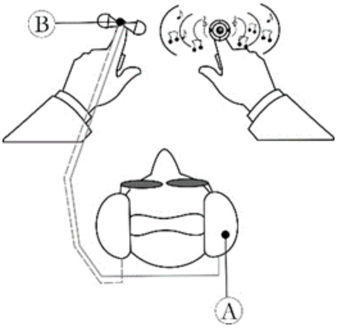


Figure 2 User listening to real time 3D virtual sound located at right finger tip

We transformed a long table of numbers into an auditory experience by mapping each value to a piano pitch. This innovative approach created an audible range from 0 to H, where h represented the data value. We also designed a tactile curve, allowing the user to feel its shape through touch. The tactile curve could be a raised diagram or one that could be felt through a VR haptic device.

To achieve this, we placed a sensor (A) at the curve's origin and another sensor (B) on the user's right finger. As the finger glided along the curve, our sound mapping system converted the graph's value at each point into a distinct pitch. This enabled the visually impaired user to audibly perceive the curve's shape as their hand moved from left to right, distinguishing higher peaks from their surroundings with ease.

This pioneering example of augmented reality for mathematical data visualization for the blind demonstrates our ability to identify a problem space, devise an adaptive tool, and cater to the cognitive needs of our target users.

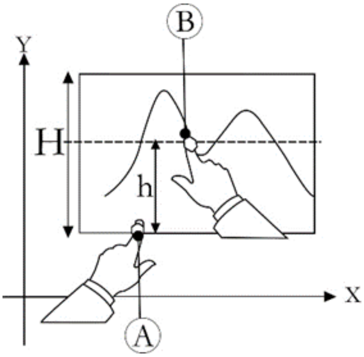


Figure 3 A simple sound mapping strategy: Pitch heard at B as a function of h

The figure provides more details about how we were able to track the position of finger tips. We use an early-generation Polhemus motion tracking device that we attached to the finger so that the position of its tip could be tracked.

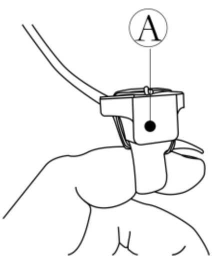


Figure 4 An early-generation Polhemus motion tracking device (c. 1999-2001)

In this figure, we illustrate a tactile graph created by affixing a thick string to a board, to represent the curve of the data. To enhance the user experience, the axes of the graph can be felt with both hands. A user would typically position sensor E at the origin and move sensor C along the curve, experiencing the changes in pitch as they navigate the graph. Intriguingly, some users devised creative techniques to compare local maxima by manipulating the positions of sensors E and C. This discovery opens up a world of possibilities, suggesting that numerous other experimental approaches could be developed to translate tabular numerical values into pitch variations for deeper understanding.

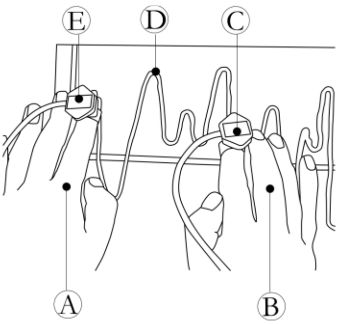


Figure 5 A visually impaired person using motion tracking to read a raised line graph (c. 1999-2001)

In the forthcoming figure, we present an innovative experiment that compares auditory graphs generated from tactile interactions with a raised bar chart. This tactile chart is meticulously crafted using strips of thick paper pasted onto a background sheet to form distinguishable axes and bars. Employing a similar sound mapping technique, the results demonstrate the potential usefulness of audio-enhanced real-world features for visually impaired graph readers, opening up new avenues of accessibility and understanding.

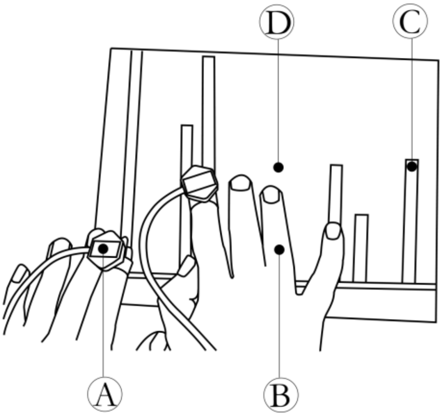


Figure 6 A visually impaired person using motion tracking to read a raised bar chart (c. 1999-2001)

The upcoming figure highlights an intriguing experiment designed to explore the ability of individuals to simultaneously comprehend multiple auditory graphs, with each sound source representing a distinct variable. In this inventive approach, a sound sensor is attached to the user's finger, enabling them to browse and compare various variables across different sound sources. Positioned at the center of a triangle, users can discern auditory graphs on the left, right, and front. What truly sets this experiment apart is the fascinating insight it provides into the limits of human perception within complex soundscapes, opening the door to new possibilities for understanding and interpreting data.

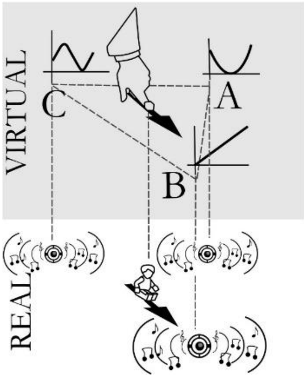


Figure 7 Listening to three audio graphs at the same time

In the accompanying illustration, we see a user seated at a table wearing a blindfold A and and a headset G, engaging with a unique user interface (UI) that presents three variables at the corners of an elevated triangular configuration, E. The UI, referred to as "C," features three buttons enabling the user to navigate and explore the variables' values. The left and right buttons allow for forward and backward navigation, while the central button prompts the system to verbally announce the current values of the variables under examination.The user attached a position sensor D to her left finger and the connecting cable was held securely using a strap F.

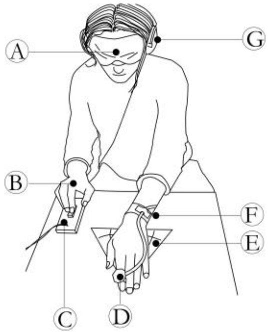


Figure 8Experimenting with spatial 3D sound graphs (c. 1999-2001)

The subsequent figure illustrates an engaging, collaborative environment involving two visually impaired users A and D, from wearing eye masks F, seated at a table, immersed in a shared auditory landscape akin to the one previously detailed. Within this setting, the participants can converse through a directional microphone E, with the sound of their voices appaearing to emanate from their fingertips' location thanks to some clever sound mapping strategy. This captivating auditory experience enables concurrent exploration of datasets and spatial awareness of each user's position, thereby enriching collaborative discussions with valuable contextual insights.

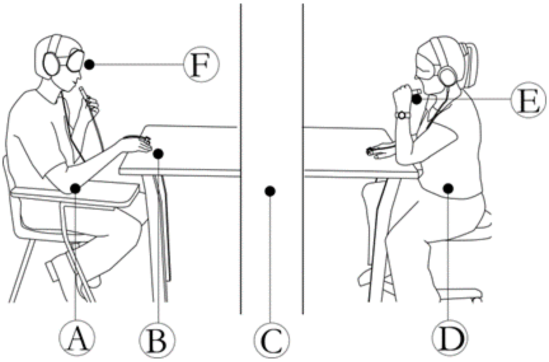


Figure 9 Two users browsing and discussing about spatialized sound graphs

In the early days of data sonification research, we were among the first to explore the potential of augmented reality in non-visual media. As we embarked on this journey, we encountered numerous challenges in designing data representations for individuals with atypical sensory profiles, such as the visually impaired.

Our pursuit of this research highlighted the critical need for understanding the limits of auditory perception. This included grasping how well people could localize sounds, as well as their ability to discriminate between different yet concurrent sound sources. The creation of sound graphs required us to invent new data abstractions and innovative ways to convey complex information through audio alone.

As we delved deeper into this relatively unexplored territory, we came to appreciate the importance of a thorough understanding of the human brain and its role in processing information. In designing any tool or system, it became increasingly evident that grasping the intricacies of the brain's inner workings was essential for success.

Through our work in data sonification and auditory perception, we not only expanded the horizons of augmented reality but also paved the way for more inclusive and accessible data representations. Our research serves as a testament to the power of interdisciplinary collaboration and the importance of understanding the human brain when creating innovative solutions to complex challenges.

Assistive technologies

The best virtual world architects and designers will strive to create systems that can adapt to such evolving needs, which are expected during the natural course of a human lifetime. Additionally, this strategy can lead to systems that are accessible to a wider set of users with diverse perceptual and cognitive profiles.

Control substitution

We can use control substitution techniques to allow users to interact with a computer using atypical switches. In our own work, we demonstrated how tracking gaze position and applying carefully chosen smoothing functions can enable users to control applications using eye movements. In addition, we studied the possibility of users to listen to spatialized sound sources representing activities of others through gaze. [Ref. to Gaze control application here, 3d sound immersive worlds here]

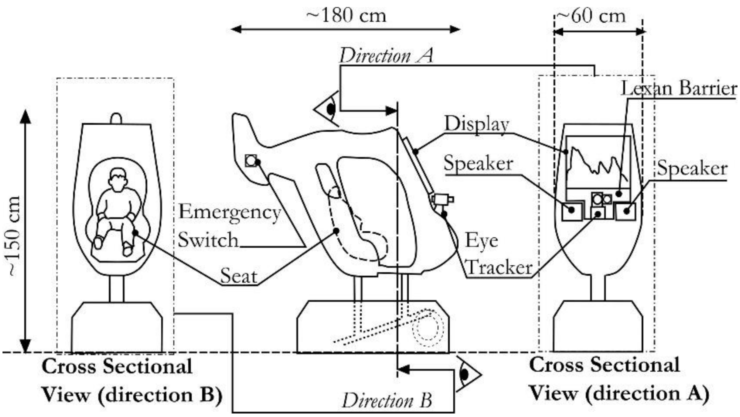


Figure 10 An amusement ride fitted with an eye tracker, its behavior contingent with gaze

Delegation control

The brain and executives of big corporations delegate tasks in similar ways, with the less creative and repeatable tasks being delegated first, and eventually higher-level tasks.

Over delegation

It's important to view content production and consumption in future Metaverse using an information processing lens because creative tasks are increasingly being outsourced to AI computer systems, and the concern about shifting the locus of cognition outside the human brain is more relevant than ever. [ref.]

Loss of creative control

When designing computing systems, it is important to consider what could happen if we outsource too many cognitive functions to external entities that we cannot control, as this could sever the connection between our intentions and our actions, causing distress.

Technologies say that we will reach AI singularity when the AI either becomes self-aware or is able to improve continuously on their own without human intervention; however, we believe AI could take over most of our creative functions leaving us with the marginal role of content consumption even before AI becomes self-aware.

The role of artificial intelligence in our lives will either be that our identity expands to encompass our cognitive AI tools, or that our AI tools will do all the cognitive heavy lifting and we will be left by standing with a marginal role as an observer. The use of artificial intelligence in content creation has the potential to change the way we think about intellectual property and the law may need to adapt accordingly.

Our cognitive outsourcing theory is an example of a design theory that is mostly explanatory but can also make the design process more efficient by highlighting possible cognitive challenges. The theory of composition introduced next can serve as a foundation for collaborative and facilitated user generated content for a 3D Metaverse that users occupy through their avatars. Composition is simply the process of assembling smaller, simpler pieces into a more complex whole. As we will soon discover, there are cases where these simpler parts are conceptual architectures and in other cases where they become embodied as 3D objects that can be directly manipulated.

Towards a theory of composition

We have a long history of developing conceptual architectures of knowledge domains, such as the periodic table of elements or the taxonomy of living things. These architectures, as it were, allow us to organize and understand the vast amount of knowledge that we have acquired over time. They also allow us to build new knowledge on top of existing knowledge, which can lead to breakthroughs in our understanding of the world.

The modularization of knowledge has several benefits. First, it allows for a more agile and iterative approach to developing new knowledge. Second, it enables different experts to work on different aspects of a problem, which can lead to a more comprehensive solution. Finally, it allows for the integration of new knowledge into existing systems, which can make those systems more efficient and effective.

In the computing industry, there is a trend of developing conceptual architectures of knowledge domains after a period of modularization and encapsulation of a range of insights, discoveries, and meanings. This trend is deeply human, as there are many examples of this in different industries. For example, Block Inc. which is a popular financial services company, labels many of its services as microservice blocks that can be assembled to create many different enterprises level applications. To take a perhaps more familiar example, WordPress makes use of plugins that users can add to their websites to increase its functionality.

Collaborative content creation

The brain is amazing but has limitations. It's impossible for anyone to know everything, which is why we need domain experts. Domain experts are people who have knowledge in a particular area and can help us understand the abstractions, concepts and symbols used in their field.

Collaboration is important because it allows us to share our knowledge and ideas. When we work together, we can achieve more than we could on our own. However, collaboration can be difficult because there can be many fields, each with their own language.

Metaverse developers need to be able to translate between the various languages in order to create a virtual environment that is understandable to domain experts. By studying a particular domain and finding out the various concepts and symbols used, developers can create a virtual environment that is meaningful to domain experts and allows them to share their knowledge with others. We choose to anchor these abstract concepts in 3d content creation examples.

> Specialization is necessary because of the various cognitive limitations of the human brain that prevent one from being an expert in all domains.

In the case of 3d content creation, there are two types of workflows: advanced 3d modelers and artists creating content with external but powerful sophisticated tools that require specialized training, and end users constructing environments and expressing themselves using this content to others about subjects they are knowledgeable about.

Using primitives from lower levels of abstraction and reusing them in multiple ways is essential for story-telling (as we have defined it). Imagine what happens with most current end-user content on various social media platforms. Creating fonts and emojis is the work of advanced content creators; however, end users do not have to know how to create fonts or emojis to create phrases that express stories. The same pattern occurs for 3D user content creation. In the early days, Second Life users created content utilizing 3D primitives such as cubes, spheres, and many other simple objects, and we found that designers currently sell architectural mesh primitives that can be assembled into buildings.

> This general theory of composition will uncover the process of how to construct optimally complex objects from simpler parts in order to address identified requirements in a given field of abstraction.

Deconstructing into parts for re-composition

There are many ways to decompose a complex entity into simpler parts. The choice of decomposition strategy depends on the application domain and the specific goals of the content decomposition. In general, the goal is to decompose the complex entity into parts that can be reused in different contexts. For example, in the case of a software system, we may want to decompose the system into modules that can be reused in different applications. In the case of a 3D virtual object, we may want to decompose the object into its constituent 3D parts so that it can be recycled or reused in different contexts. Deconstructing complex content into its component parts is a valuable skill that can have several applications. By understanding how to deconstruct content, we can develop automated content creation processes and workflows. If in some cases, it is found that over automation is hurting creative control, we can opt for discovering ways to facilitate the assembly process from a user interface perspective. In our experience, there are always opportunities to do so.

Currently, the process of simplifying complexity is largely driven by human effort. Identifying the boundaries between objects and fragmenting large objects, such as buildings, into reusable parts is a subjective and tedious process. There may be a machine learning technique capable of handling the most difficult and repetitive aspects of this task, but we will still rely on human arbiters to decide which sets of components produced are of the best quality and most expressive.

It is important to consider the fact that, although machine learning may be able to take on some of the grunt work in terms of simplifying complexity, the final product will still need to be reviewed and approved by humans. This is due to the fact that, while machines may be able to identify patterns and trends, they are not yet capable of making the same level of judgment calls as humans. Therefore, it is still necessary to have humans involved in the process in order to ensure that the final product is of the highest quality.

> Identifying the boundaries between objects and fragmenting large objects such as buildings into reusable parts is by and large a very subjective and tedious process.

Complex behaviors can be assembled from simpler ones. This is a key principle of many successful systems, from the gears in a machine to the neurons in a brain. There are a few challenges that need to be addressed when using this approach. First, it is important to design the interfaces between the objects in a way that makes it easy to assemble them into more complex structures. Second, it is necessary to define the behavior of the objects in a way that allows them to interact correctly with each other. And third, it is often necessary to optimize the objects for the specific task at hand, which can be a challenge in itself. However, these challenges are not insurmountable, and the benefits of this approach make it worth pursuing.

Next, we use LEGO as an example to anchor a few of the ideas introduced more deeply. LEGO is a perfect example of modularization and encapsulation, as the bricks can be assembled in many different ways to create different structures. This flexibility is one of the reasons why LEGO is so popular. In addition, LEGO bricks are also standardized, which makes it easy for people to purchase LEGO bricks from different manufacturers and still be able to use them together. Let's consider what we can learn from LEGO and how it can inspire us to identify ways to facilitate content production in virtual worlds.

Lessons learned from LEGO

In the 1930s, Danish carpenter Ole Kirk Christiansen started making wooden toys in his carpentry workshop. He named his company LEGO, based on the Danish words "leg godt," meaning "play well." By 1934, LEGO was producing plastic toys, which became wildly popular. It wasn't until 1949 that LEGO began producing the interlocking blocks that are now known around the world. The LEGO Group realized that by producing standardized, interchangeable blocks, they could greatly increase the number of combinations that could be made from a limited number of parts. In other words, they modularized the design of their product. This increased the flexibility and usability of LEGO blocks, and helped LEGO to become the global phenomenon it is today. Mindstorms is a LEGO set that includes programmable bricks, sensors, and motors. It allows users to build and program robots. The modularity of Mindstorms makes it possible to create a wide variety of robots, from simple to complex. Now that we have a fairly clear idea of what LEGO is, let’s try this thought experiment.

Thought experiment

Imagine a universal LEGO block creator that allows end users to print as many 3D LEGO blocks as needed. With this technology, advanced LEGO users would have the opportunity to learn how to use the various commands that the LEGO block creator understands to create custom blocks. As a result, we might expect a wider variety of blocks and assemblies/compositions to be produced down the road. In addition, it would not be a big surprise if we see the emergence of two separate communities: block-makers and block users. In fact, we may even witness the emergence of a creative economy.

> Imagine a universal LEGO block creator that allows end users to print as many 3D LEGO blocks as needed. Further, advanced LEGO users have the opportunity to learn how to use the various commands that the LEGO block creator understands to create custom blocks.

All of these blocks may be grouped together organically by user communities in sets that appear useful for particular use cases. Various sets may become popular over time. For instance, one set may be the most popular because it allows for a wide range of compositions, while another might be more popular because of the color scheme used or the style of its objects.

For convenience, we will look at each set as a language in which each block is a word and each composition is a sentence. Thus, the LEGO block creator can be viewed as a meta-language engine that can be used to create new languages, that is, new Lego sets. The metaphor of language suggests that each set of objects created has some measure of expressivity, and some end up being better than others.

If history is a guide, the drive to automate content production is likely to spread at all levels wherever an opportunity arises. We are already seeing applications designed to scan a pile of Lego blocks in the real world and to make suggestions on possible compositions that could yield interesting objects. It is also likely that we will see AI approaches applied to generate good candidates for Lego sets after examining a series of possible Lego builds that are found to be popular in various communities. Meta-languages will be evaluated based on various parameters such as expressivity or aesthetics. How does all this Lego talk concern Metaverse design? The next section will provide some answers.

Walking the Talk

To enhance the utility value of Metaverse, we believe that this approach will become popular when designing tools to facilitate end-user content creation. We experimented with this approach and created a Composer app that uses objects from different sets stored in libraries we call 3D modules to create virtual world setups. In this case, the counterpart to LEGO blocks are virtual objects with varying degrees of interactivity. Examples of objects with low levels of interactivity are stones and terrains of different kinds, whereas examples of objects with higher levels of interactivity include virtual post-it notes, non-player characters with conversational behaviors controlled by external AI engines, and flora that change with the weather. Just like LEGO, these 3D virtual world contents can be snapped together to quickly create a wide range of advanced 3D scenes.

Within a decade, we expect many Metaverse's content creation processes to follow a similar trajectory. There will be a convergence of technologies, including photogrammetry, which will lead to an explosion of low-cost but high-quality user-captured or user-generated content. We will also see the AI rendering of 3D objects based on end user text prompts. It might seem too simplistic to imagine a user-generated Metaverse as assembled blocks that are shared, traded, duplicated, and evolved, but we believe that this is the most probable scenario.

> It might seem too simplistic to imagine a user generated Metaverse as assembled blocks that are shared, traded, duplicated, and evolved, but we believe this is the most probable scenario.

Concluding remarks for this chapter

Our limited cognitive system can only cope with so much information, and as we experience more and more of the world, we need ways to build improved models of the world based on the increasing new information that we encounter. Cognitive amplifiers are systems or devices that can help us do this by making information more accessible and easier to process. Some of these devices are natural brain systems that evolved over thousands of years, while others are man-made. It is in our interest to understand how they work, especially when it comes to how the limited brain ingests the very large stream of information it receives through its various constrained sensory channels. This understanding could then inform the design of more powerful and efficient cognitive amplifiers outside the brain that would expand the influence and reach of the human brain even further.

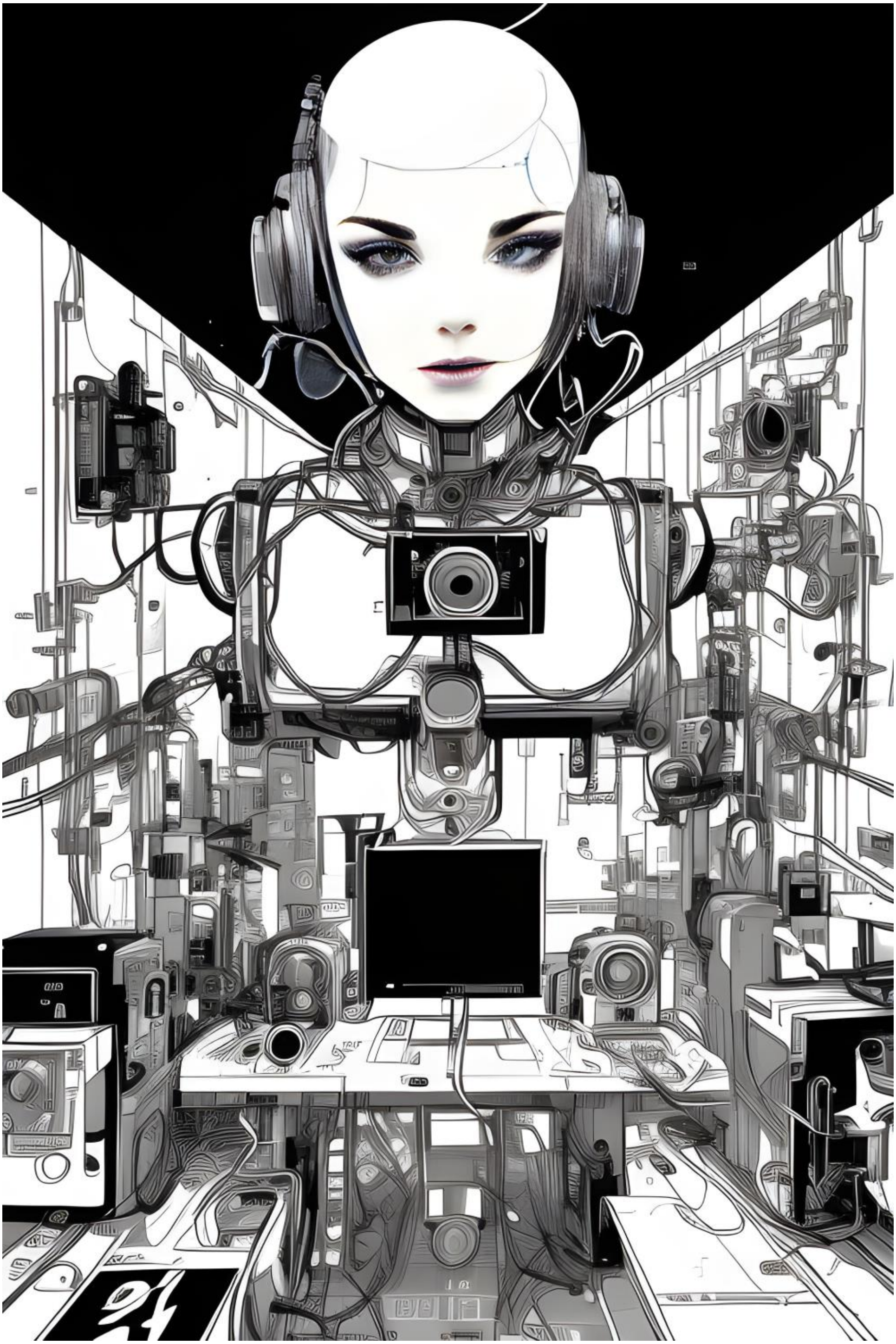
Abstractions qualify as a type of a cognitive amplifier in that it is geared towards creating a concise body of knowledge that can be used to explain the world within its boundaries. This allows for fields of study to emerge with the necessary tools needed to create explanatory and predictive stories. Abstractions not merely compress information, but also allow different fields of study to develop their own unique perspectives and explanations for how the world works.

Another type of cognitive amplifier includes data visualization techniques that play a major role in abstracting or compressing very large data sets. Visualizations when well designed for example allow us to get a near instantaneous insight into the nature of a large data set.

Yet another type of cognitive amplifier would include computer user interfaces, which can be viewed as a tactile language that allows us to communicate our needs to an external device. User interfaces can also act as a language to represent the internal state of the system through feedback information. Thus, this language sometimes functions both as an instrument for control and expression.

One can consider Artificial intelligence as a cognitive amplifier and it is something that we are constantly improving upon to make our lives easier. We are taking the cognitive load off of our brains by creating machines that can think, learn and create for us. In order to create a Metaverse that would serve most of its users well, we need to be aware of the rapid development in the Artificial intelligence space.

The aim of this chapter was to explore how we can design cognitive amplifiers so that we can further expand the range of human experience and influence. By grounding the design in the lessons learned or discoveries from the fields of cognitive science and engineering, and neuro-ergonomics, we can create powerful tools to amplify our abilities.



Chapter cover 5 Brain Balance: Leveraging Strengths and Weaknesses

5. Harnessing the Brain

Making better use of hidden or forgotten potential

The human brain took millions of years to evolve into this amazing tool that we often may take for granted. As we learn new things and experience new environments, our brain adapts and changes to better suit our needs.

As designers, it is important that we keep in touch with the latest explorations, discoveries, and studies about the attributes of the brain so that we can design for the brain better. Brain attributes are qualities or characteristics of the brain that can be measured or observed.

When it comes to the virtual worlds of the Metaverse, it is important to make the best of the brain's existing strengths, rather than try to force it to learn new ways to interact with interfaces that we design. By taking advantage of the brain's existing strengths, we can create virtual environments that are more user-friendly and enjoyable to use. None of us certainly want to design interfaces or systems which can exacerbate frustration and fatigue. First, let us begin by examining some of them.

> "Our technology, our machines, is part of our humanity. We created them to extend ourselves, and that is what is unique about human beings." - Ray Kurzweil, American computer scientist, author, inventor, and futurist.

The brain can be very good at certain tasks, such as pattern recognition, and not so good at others, such as arithmetic (for most people). When we try to force the brain to do something it is not good at, we are inevitably disappointed. By understanding the brain and its limitations, we can reduce the likelihood of making design blunders. By recognizing precisely what makes the brain a powerful sensing and thinking machine, we can begin to draw efficient and effective trajectories to improve our quality of life.

Clearly, virtual worlds lack the social bandwidth we are used to in the real world. Identifying the underlying causes of this problem is important. Let us first examine how the depth of social connection we experience in the real world comes about. The social brain is the part of the brain that is responsible for social cognition, providing people with the ability to interact with peers. It is this ability that allows us to communicate, cooperate, and collaborate with others. The social brain is made up of many different regions, each of which plays a role in social cognition. For example, while the temporal lobe is involved in processing emotions and facial expressions, the prefrontal cortex is responsible for executive functions such as planning and decision-making.

The brain as a formidable face processing machine

"Artificial intelligence is growing up fast, as are robots whose facial expressions can elicit empathy and make your mirror neurons quiver." - Diane Ackerman, American poet, essayist and naturalist

Perhaps, dedicating specific regions of the brain for face processing for example, is nature's way of indicating the importance of this feature in human-to-human interaction. We should therefore recognize the necessity to try to create avatars that can support facial expressions that are as rich as what we are used to in the real world. These expressions should of course be reproduced with as minimal lag and end user stress as possible in the virtual world.

If we want general purpose 3D virtual worlds to be successful, we need to at least find ways to increase its social bandwidth. By doing this, we can make 3D virtual worlds more appealing to users and increase the likelihood of them being used for more than just gaming. General purpose 3D virtual worlds are so much harder to implement than 3D collaborative gaming worlds where narrow storylines and very simple game mechanics are enough to keep users engaged through tight challenge-reward loops. We do not believe that this gaming approach will serve users who are looking to use the Metaverse as a place to work or to build and share content at their pace for real world impact. Even though it is likely that most can intuitively understand why social bandwidth is key for general purpose virtual worlds, it is still useful to examine this assumption from the perspective of cognitive science.

R. S. Feldman and S. Rosenthal (1997) found that people use a variety of social cues to understand the emotions and intentions of others. These cues include facial expressions, gaze direction, and mouth gestures. The use of these cues is especially important in infancy and early childhood, when verbal communication skills are not yet developed.

The processing of faces requires significant cognitive resources. Studies have shown that face processing takes up a large amount of cognitive bandwidth, especially when we are trying to identify a specific person. This suggests that the face is a very important part of our social cognition, and it does seem humans are wired for empathy. The face is so important for social communication that we have evolved specialized neural mechanisms for processing faces. These mechanisms are highly efficient and allow us to process faces quickly and accurately.

In the late 90s, there was a lot of discussion about how the absence of gaze awareness in virtual environments would negatively impact communication between avatars. Gaze awareness is basically analyzing someone's gaze to figure out what they're looking at and what their feelings are about it. It was believed that gaze awareness was a key cue in interhuman communication and had deixis properties. Gestural deixis is the use of gestures to refer to specific people or objects. For example, pointing to someone while saying their name is a form of gestural deixis. This type of deixis is often used in child-directed speech, as children are more likely to respond to gestures than to words alone.

A human face can reveal several clues about a person's interests concerning objects in the world. The gaze at an object of interest and facial expressions convey the subject's emotions and perhaps thoughts about the object being observed in the world. Therefore, the human face is probably the most efficient platform for representing social cues in a virtual world. This facial gestural language, as it were, does not require explicit learning for typical human beings and happens unconsciously. A face is indeed worth a thousand social cues.

HMDs: opportunities and challenges

The all-surrounding immersive display enabled by a head mounted display (HMD) is one of its primary advantages for accessing a 3D virtual world. Zooming in or in-world navigation opportunities functionalities make an infinite amount of space for presenting information possible. However, the same technology that enables immersion in the virtual world also makes sharing of visual social cues within the virtual world challenging. It may be tempting to set up cameras inside HMDs to track features of the face, gaze motion or mouth movements, but we don't yet know if adding more hardware on the face is what users will appreciate. Meta has recently demonstrated a headset that implements these functions. However, HMDs are not yet known for their ubiquity and cannot be worn for long durations. To enjoy a similar level of social connection in fully immersive virtual worlds as in the real world appears doable but it might take more time than we expect especially if the device is expected to be used for extensive durations.

The desktop VR advantage?

In order to create truly realistic avatars, it may be necessary to capture facial expressions at a desktop and have them applied in real time to the faces of avatars. This would ensure that the avatars would be able to convincingly convey a wide range of emotions and would add a new level of immersion to virtual reality experiences. One advantage of this approach is that the user does not need to wear an HMD that would also act as a blind fold to real world events. This would free up the user's hands for real world keyboard interaction with less worries about virtual force feedback and allow them to interact with the virtual world in a more natural way. Additionally, this would allow for a more comfortable experience as the user would not need to worry about the weight of the HMD on their head. Face tracking technology currently allows the face of a user to be tracked while the user is sitting at a computer desk. The tracked information is used to change in real time the face of the user's avatar in a virtual world. Avatars can now blink and have rich facial expressions that mirror those of the user comfortably sitting at the desktop without having to wear an HMD for extended durations.

Designing to support empathy

Existing social media is proof of the deep structural damage that can be inflicted on society by reducing social bandwidth to zero and reducing human to human interaction through limited strings of text like tweets.

It is important to remember that everyone experiences the world differently and that there is no single right or wrong way to design for empathy. The best approach depends on the situation and audience. In general, it is helpful to think about how you can create an experience that allows people to see things from another perspective. This could involve using storytelling, interactivity, or other methods to help people understand what someone else may be feeling or thinking. It is also important to consider the overall tone of your design and whether it will promote feelings of understanding and compassion or further division and misunderstanding.

Mirror neurons are a type of brain cell that activates when an individual performs an action as well as when the individual observes another performing the same action. These cells were first found in monkeys, and they have also been found in humans. Scientists believe that mirror neurons may play a role in social cognition, language development, and motor learning. The neural basis for empathy may be a system of mirror neurons.

Adventures in non-facial social cue design

In a virtual world, users cannot see each other's facial expressions or body language. This means that the design of a collaborative virtual environment must provide some other way for users to share social cues. One approach is to use 3D displays to create shared virtual environments. 3D displays allow users to see each other in three-dimensional space and can provide information about body language and facial expressions. We have seen that so far this approach is hard to implement at this stage in totally immersive virtual worlds but somewhat doable for desktop virtual environments.

Another approach to designing for collaboration is to use eye trackers to capture social cues. Eye trackers are devices that track the movement of your eyes and can be used to infer what you are looking at. This information can be used to design collaborative virtual environments that provide users with relevant information about what others are looking at and thinking about. Since it is still hard to create high fidelity avatars that express facial gestures to mirror those in the real world, in the past, we tried to explore the possibility of social cues without using facial gestures.

Between the late 90s and early 2000s, we ran a few experiments using s, 3D displays, and haptics technologies to learn what it would take to create collaborative virtual environments that were first and foremost designed to be predominantly 'utilitarian' in nature but that would also support the exchange of social cues that were believed to be so important for teamwork. Let's examine the challenges involved as we attempt to adapt single user applications for collaboration within and outside virtual worlds.

Capturing and representing peer visual awareness

We therefore explored a few ways where such information could be captured and shared without losing contextual information. For example, we decided to capture the gaze position of a user as they use a multiuser interface, in this case, a multiuser desktop prototype, and used gaze data to determine using our own algorithm attention weights for each object in the scene [ref.]. This information was then overlaid on these shared objects. Even after smoothing the gaze data out, the information overlays change too fast for comprehension. So, the lesson here is that it's easier to capture social information than developing visualizations that are easily understandable by end users.

Soundscapes to represent activities of others.

Multiuser desktop

An application for a shared whiteboard followed a similar strategy. Each drawing object and tool was assigned a sound. Although it was able to hear the activities of others, it was difficult to interpret the complex soundscapes that arose when the drawing application was used by the group. End users had to learn not just the sound mapping choices but also interpret this new 'auditory language' in real time. In this situation, too, recording peer activities and representing them for peers proved to be more difficult than we expected.

Gaze auditory browsing

The cursor was controlled by the mouse in one mode of interaction, and the cursor was synchronized with the user gaze position in another. Even though users were able to locate sound sources using gaze, it was not as intuitive as we expected.

Soundscape for a shared whiteboard

Using sounds as a representation of others' activities in shared environments, sonicons or auditory icons, was also explored. In our experiments, we used a drawing application and a multi-user desktop that could be considered a 2D virtual world. This multiuser desktop could be seen as a metaphor for an open floor office or factory floor. Ears to see as example application to support assistive technologies to support the blind.

Limited capacity of perceptual channels

The human brain, despite its remarkable abilities, as we have observerved, has a limited capacity for processing information. This limitation in conscious perceptual awareness impacts how we interact with the world around us. Recognizing these constraints, we tried to apply these lessons to the design of new multidesktop environments, shared applications, and groundbreaking experiments aimed at exploiting the untapped potential of the brain. We share some of the lessons learned here.

The multidesktop environment featured animated icons representing the activities of peers, along with 3D sound to provide users with information about what was happening to documents even if they were hidden in folders. This concept was extended to various shared applications, such as a drawing application, where users could collaborate in real-time. It was believed at that time that such a design would foster a collaborative environment where individuals working in large teams would be peripherally aware of activities around. Not unlike how human beings absorb information while standing a busy city square surrounded by a cacophony of sounds, sights, and scents. There may be street performers, bustling crowds, vendors selling their wares, and traffic whizzing by. Amidst all this sensory input, the brain is working hard to process the information in order to overcome its inherent limitations. While it cannot pay attention to every single detail of the environment it is immersed in, human beings have developed strategies, some conscious and others not, for focusing only on salient events of interest. For example, moving through a party of people having conversations is a conscious way to mediate access to information and the properties of 3D sound perception itself allows one to focus on only certain conversations and not others. This is known as the cocktail party effect.

Soundscapes to represent data

The evaluation of these bold designs led to several important insights:

User Preference: Users found it challenging to explore their soundscape through gaze listenter location control, preferring to use the mouse to position their listener. This indicates that leveraging perceptual awareness may require more intuitive and familiar methods for users to adapt quickly.

Sound Complexity: The experiments highlighted the difficulty of creating synthetic sounds to represent complex events and the challenge for users to understand them with ease. Future research should focus on developing more recognizable and meaningful sound representations.

Gradual Change: The groundbreaking experiments demonstrated that fully exploiting the brain's untapped potential may require a gradual process of adaptation and learning. Introducing new methods of interaction and representation should be done incrementally to allow users to become accustomed to the changes.

These experiments that we conducted more than two decades ago and that were aimed at leveraging the understanding of the brain's limited capacity for perceptual awareness, uncovered both challenges and valuable lessons. As we continue to explore the untapped potential of the brain, we must consider user preferences, the complexity of representing information, and the importance of gradual change. By learning from these lessons, we can move forward in designing more efficient and intuitive technologies that maximize our cognitive resources and transform the way we interact with the digital world.

Building on previous experiments in multidesktop environments, we sought to leverage our experience in designing collaborative spaces for blind and visually impaired individuals. By utilizing 3D auditory landscapes to represent mathematical information, we aimed to create an accessible and intuitive environment where users were represented solely by their voices. In a series of experiments, we focused on designing collaborative environments without visual representations of peer avatars. We created 3D auditory landscapes to convey mathematical information. Users navigated these information spaces using their voices, with the soundscape reflecting the position and activities of each participant.

While the experiments demonstrated the potential for using 3D auditory landscapes in collaborative environments, they also revealed several challenges. The most significant issue was the overwhelming nature of the auditory information for users, as they struggled to pay attention to all sound sources simultaneously. This finding echoed the earlier discovery of the brain's limited capacity for perceptual awareness, reinforcing the need for a careful balance between presenting information and overloading the user's cognitive resources.

The groundbreaking experiments we carried out, focusing on 3D auditory landscapes for collaborative environments, demonstrated both the potential and challenges of designing accessible spaces for blind and visually impaired individuals. By learning from these experiments, we can continue to refine our understanding of the brain's limited perceptual capacity and work towards creating more inclusive and effective collaborative tools.

This experience has likely contributed to solidifying our belief that high-fidelity avatars will be essential in the Metaverse to enhance its social bandwidth. If our goal is to improve the quality and depth of social interactions in this virtual environment, the incorporation of detailed and realistic avatars will be crucial.

No compelling Metaverse without high fidelity avatars

It is important to have accurate facial expressions in 3D virtual worlds for many reasons. Humans are social animals, and we rely heavily on nonverbal cues to communicate with each other. One reason is that our existing neural pathways for interpreting social information are designed to interpret faces. If we were to try to interpret social information in any other way, it would likely overwhelm our working memory. Faces are an important part of how we communicate. They allow us to convey a wide range of emotions, from happiness and excitement to sadness and anger. They also allow us to gauge the emotions of others. This is why it is so important that the faces of characters in 3D virtual worlds are accurately represented. If they are not, it can be very difficult for users to interpret the emotions of those characters, and this can lead to misunderstandings and communication difficulties. Another reason why it is important to have accurate facial expressions in 3D virtual worlds is that they help to create a sense of presence. When we see a character with a realistic face, it helps us to feel as though we are in their presence. This is important for immersion and for making the virtual world feel like a real place. One could try to use live video streams of real-world people into the virtual world if high fidelity humanoids don't become available or feasible. This approach has received mixed reception so far, with some people finding it helpful and others finding it confusing.

Brain's latent ability to build spatial cognitive maps.

Cognitive maps are mental representations of the layout of our surroundings. They help us orient ourselves in space, keep track of where we are, and plan efficient routes from one place to another. Beyond navigation, cognitive maps also play an important role in memory and learning. For example, when we try to remember the location of a specific item in a store, we are relying on our cognitive map of that store. Studies have also shown that having a detailed cognitive map of an environment can help us learn and remember new information about that environment more effectively.

The hippocampus is a brain region that is thought to be important for the formation and retrieval of cognitive maps. This is supported by evidence from studies in humans and animals. For example, damage to the hippocampus can lead to impairments in memory and navigation. Additionally, the hippocampus is active when we are performing tasks that require us to use cognitive maps, such as remembering the location of an object or imagining future events.

The evidence suggests that the hippocampus is important for our ability to navigate our environment and remember where we left our keys. It is also involved in more complex tasks, such as imagining future events or remembering past events.

Cognitive maps are mental representations of the world that allow us to store and retrieve information about our surroundings. There are two main types of cognitive maps: spatial and nonspatial. Spatial cognitive maps are those that represent physical space, such as a map of a city. Nonspatial cognitive maps are those that represent other kinds of information, such as a map of a website or a sequence of events. Spatial cognitive maps are especially important for helping us to navigate our way through the world. By representing information in a spatial way, we are able to take in a large amount of information at once and to see the relationships between different places. This allows us to form a mental picture of the world around us, which we can use to plan our movements and to find our way around. Nonspatial cognitive maps are also important for helping us to remember and use information effectively.

Capturing spatial cognitive maps

Currently, users can navigate virtual worlds very quickly and easily, but they can also get lost very easily in them. By designing tools to help them navigate these worlds, we were able to capture their spatial cognitive maps as they navigated. They could also be shared like travelogs.

The specific steps we took (such as building maps) to address cognitive challenges caused by current user interface shortcomings are described in more detail. The explanation explains the challenges and solutions encountered, as well as the current state of those efforts.

There is great interest in understanding how people navigate their surroundings and learn spatial layouts. A cognitive map is a mental representation of the layout of one's surroundings, thought to be stored in the brain's hippocampus. It is thought that people use cognitive maps to remember where they have been and to plan routes to new destinations. Researchers have proposed that there are two types of spatial memory: landmark-based and route-based. Landmark-based memory relies on the use of salient environmental features, such as buildings or trees, to remember the layout of an area. Route-based memory, on the other hand, relies on the sequence of turns taken to reach a destination. It is believed that people use a combination of both landmark-based and route-based memory to navigate their surroundings.

The first step in designing an application to capture the spatial cognitive map by capturing sensory snapshots of an explorer as he navigates an environment is to understand the nature of the explorer's cognitive map.

The next step is to determine how to capture the explorer's sensory snapshots. One way to do this is to use a camera to take pictures of the explorer as he navigates the environment. Another way to capture the explorer's sensory snapshots is to use a GPS system to track the explorer's movements.

Once the explorer's sensory snapshots have been captured, the next step is to create a spatial representation of the environment from the explorer's perspective. This can be done by creating a map of the environment from the explorer's perspective. The map should include the explorer's position, the direction he is facing, and the landmarks he sees.

As discussed previously, we do know that the human brain appears to have evolved, thanks to the discovery of place cells, to organize information spatially in the brain efficiently. Researchers have discovered that our brains contain "place cells," specialized neurons that help us navigate and store information about our environment. This discovery has led to a deeper understanding of how our brains efficiently process and store information through the use of spatial relationships.

Many of us have personally experienced the benefits of organizing information in this way, such as through the use of Memory Palaces. A Memory Palace is a mnemonic technique that involves associating pieces of information with specific locations within an imagined space. This method not only helps us remember information more effectively but also capitalizes on the brain's natural propensity for spatial organization.

The brain's ability to navigate its internal spatial cognitive map has practical applications in various information-seeking tasks. For example, when we are trying to recall a piece of information, our brains can quickly search through this spatial map to find the appropriate memory. This leads us to wonder whether it is possible to create tools that can amplify this innate brain function.

Recent advancements in neuroscience and technology have opened up new possibilities for developing tools that can enhance our spatial memory abilities. One such tool is the concept of "augmented memory" systems, which use a combination of wearable devices and artificial intelligence to help users better navigate their cognitive maps and access stored information.

Our understanding of the human brain's ability to organize information spatially, as evidenced by the discovery of place cells and the use of Memory Palaces, highlights the potential for creating tools that can enhance this function. As technology continues to advance, we may see a future where our ability to navigate our internal spatial cognitive maps is amplified, ultimately improving our capacity for information-seeking tasks and memory retention.

This approach has potential for real world and virtual world settings but for now, let's explore a virtual world one because it does not require the need wearable devices or any other additional underlying technologies. To further simplify the example we will choose a Museum example because these buildings typically have a lot of content which are spatialized meaningfully across the many rooms they contain. The approach is also applicable to open environments without walls but let's keep things simple for now.

In this illustration, we present a detailed floor plan of a museum, complete with the locations of its diverse exhibits and amenities. The diagram traces the path of a visitor, as depicted by an arrow, upon entering the museum and arriving at position P. Shortly, we will delve into a method for capturing the individual's spatial cognitive map, shedding light on their navigation experience.

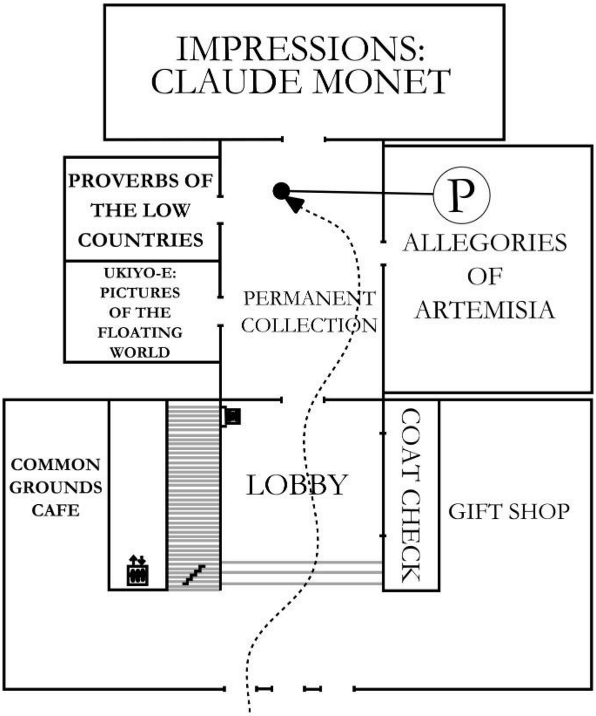


Figure 11 Map of a museum floor and path of a visitor

In this figure, we showcase an interactive user interface designed to record a navigator's spatial cognitive map as they explore a virtual museum. The interface features a central 3D view, with three groups of thumbnail images surrounding it, and navigation controls. To fit the entire diagram on one page, the 3D view is scaled down.

The 3D view includes standard navigation buttons (G) for turning and moving, as well as a camera button to capture points of interest.

As the user explores the virtual environment, the central 3D view updates accordingly.

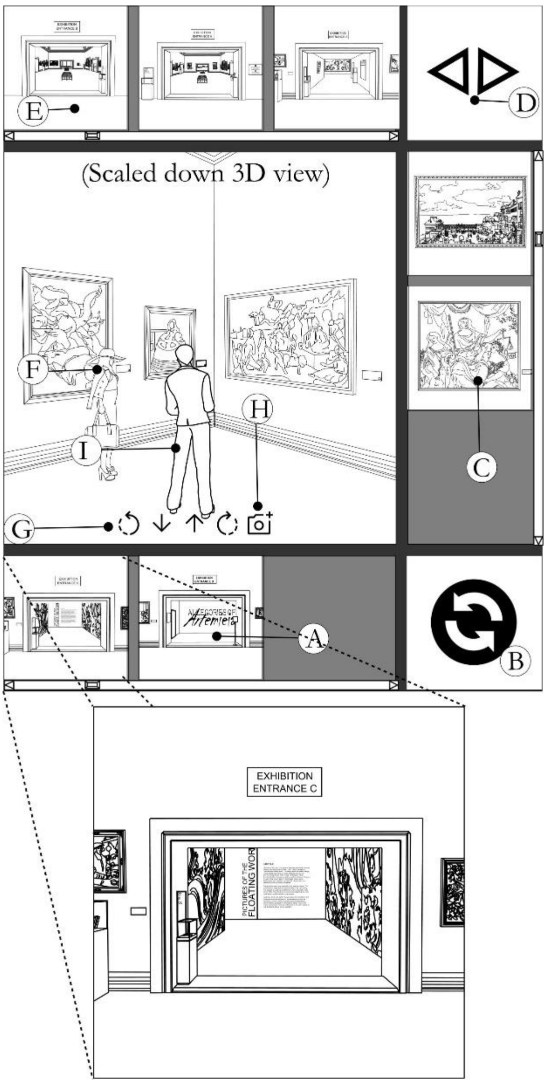


Figure 12Example designo of an application that captures a navigator's spatial cognitive map

Three panels of thumbnails provide vital information: Panel E displays images of entrances to the current space, Panel A shows exits from the current space, and Panel C contains user-captured images of notable objects encountered within the room. The entrance and exit images are automatically generated by the spatial cognitive map capture algorithm.

As users navigate through the museum, entrance and exit thumbnails update, and new objects of interest are added to Panel C. Users can click on the images to teleport to corresponding locations, or disable syncing with navigation by clicking on button B. In the latter mode, users can plan or rehearse navigation without physically moving in the virtual world.

Additionally, this interface allows users to navigate their own or others' trajectory with the forward and back buttons in Panel D. While the current setup only captures images, future implementations could potentially record auditory information as well. This innovative interface enables users to document their virtual experiences, which can be shared with others as a travelogue for collaborative exploration.

How is cognitive bandwidth allocated?

The brain constantly processes information from the five senses and decides what is important and what can be ignored. The amount of cognitive bandwidth allocated to each channel varies depending on the situation. Touch is the least used of the five senses, but it is still important. The sense of touch provides information about texture, temperature, and pressure. This information is important for daily activities such as cooking, cleaning, and typing on a keyboard.

The brain constantly receives information from the five senses. It uses a complex model to decide which input to pay attention to, based on factors such as novelty, importance, and expectation. The amount of cognitive bandwidth allocated to each sense varies depending on the situation and the information that is being received.

Conversational user interfaces

In line with the approach to exploit as much as possible the latent function of the social brain, it makes sense to make good use of conversational interfaces which are on the rise due to better and cheaper speech recognition technology. This has led to the development of humanoid non player characters in virtual worlds who need to understand instructions from users. There are many potential applications for conversational interfaces, especially in virtual worlds. For example, they could be used to help players navigate through a game or to provide information about the game world. They could also be used to create more realistic and believable interactions between players and non-player characters.

Assistive technology

As virtual worlds become more realistic and immersive, the role of assistive technology will also grow. Assistive technology provides tools that people with disabilities need to communicate and navigate virtual worlds, allowing them to enjoy these environments fully. Assistive technologies have the potential to revolutionize how people with disabilities interact with virtual worlds. By providing tools that allow disabled users to more easily navigate and interact with virtual environments, assistive technologies can help make virtual worlds inclusive for everyone. There are a number of different types of assistive technology which could be used in virtual worlds including speech-to-text tools for those who are hearing impaired, text-to-speech for those with visual impairments, and physical disability controllers. Assistive technologies not only improve accessibility but they also create new opportunities educationally and vocationally for people with disabilities.

Sensory substitution

We cannot rely on training the brain to do things it wasn't meant to do. This is why we must discover the limitations of perception. Only then can we find user interface designs that work within those limitations. There are various promising techniques for training the perceptual system. For example, it is possible to use sonification of visual information or vibrations to simulate touch in order to enable deaf people to see conversations using augmented reality technologies. However, we need to discover more about the general laws of perception before being able to pin down the specific limitations that apply in different cases and identify which user interface designs will be most effective overall.

Assistive technology for the blind

There are a number of different types of assistive technologies that can be used by visually impaired or blind individuals. These technologies can be used to access trend information, to explore data using virtual touch, or to provide auditory or tactile feedback.

There is an increasing interest in using data sonification and haptics technology to make mathematical information more accessible to visually impaired individuals. Data sonification is the process of converting data into sound, while haptics technology is used to create tactile feedback. These approaches have the potential to provide a more multimodal and effective way for students to engage with mathematical concepts.

In this figure, we present Research A, where a simulated groove (C) is explored within a virtual environment, employing the sophisticated Phantom haptic device.

The Phantom haptic device is a remarkable piece of technology that enables users to interact with and receive feedback from virtual objects in a simulated environment. It achieves this by providing the user with tactile sensations, such as resistance and texture, mimicking the feel of real objects. In this example the user only experiences kinesthetic haptic feed back.

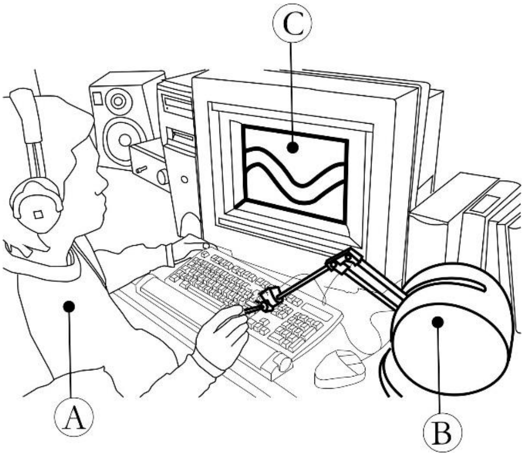


Figure 13 Researcher using a haptic device to explore a curve that represents data

Kinesthetic feedback, that is haptic feedback experienced through the held pen, is not as rich as touch feedback, but is quite useful in helping a visually impaired user experience a curved groove or raised surface. The raised surface is less effective as a haptic representation for graphs that a groove which traps the haptic pen and prevents it from slipping away.

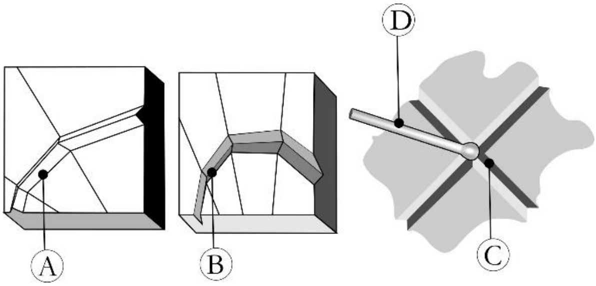


Figure 14 Exploring different types of surfaces to represent data

Concluding remarks

After making efforts to maximize the sharing of social cues, the next aspect that seems to be of high priority is how do we design virtual worlds that provide enough value directly to end users that they would want to come back. Here the focus is not on the social element but on the productivity and creativity aspects. This journey begins with our understanding of how humans historically have been able to augment their cognition. Then we can use these approaches to develop and evolve applications for the virtual world.

Chapter cover 6 Visual Power: Unlocking Abstraction and Data

6. Simplifying Complexity

Art of abstraction

Amplifying cognition refers to the enhancement of cognitive processes using external aids. This can include the use of technology, drugs, abstractions, or other means to improve memory, attention, or other cognitive functions. In this chapter we will introduce some low tech or no-tech tools and approaches humans have developed for amplifying their cognition; however, we will not be discussing drugs or brain computer interfaces that attempt to change the nature of the brain itself as these efforts are out of scope of this book.

Enduring abstractions in various fields

> "Visualization gives you answers to questions you didn't know you had." - Ben Shneiderman, American computer scientist

In every field of study, symbols, equations, visualizations are examples of abstractions created by humans to help us simplify, organize, and represent concepts at appropriate levels of 'detail' or granularity. Successful abstractions can be useful not only for describing complex situations, but also for articulating predictions. Creating tools to amplify cognition and productivity in virtual worlds requires a deep understanding of abstraction design. Abstraction is a powerful cognitive tool that allows us to filter out irrelevant information and focus on what is important. It enables us to generalize from specific instances and identify underlying patterns. For abstraction to be effective, it must be well-designed.

This chapter discusses the various successful abstraction designs in history before addressing the role of abstraction design in virtual worlds and how it is a critical component to focus on when creating applications for the Metaverse that amplify cognition and productivity.

Abstractions from a philosophical perspective

In the most basic sense, an abstraction is a model of something that represents its essential characteristics but is not necessarily an exact replica of that thing. Upfront, it can be viewed as a form of data compression. When applied to the world view, creating abstractions helps us to understand and explain our surroundings in a way that is simplified, but still accurate. It allows us to see the world in a way that makes sense to us, and makes it easier to communicate our observations to others.

The key to using abstractions effectively is to find the right balance. We need to use enough abstraction to make the system manageable, but not so much that we lose sight of how the system works. By carefully choosing the right abstractions and using them in the right way, we can build complex systems that are both easy to use and easy to understand.

Abstractions can be useful because they allow us to deal with complex problems in a simplified way. However, they can also be dangerous because they can lead to oversimplification. When we use an abstraction, we need to be aware of its limitations and make sure that we do not make assumptions that are not valid.

Abstractions are one of the key ways we humans develop an understanding of the world around us. The process of abstraction can be thought of as moving from the concrete to the general. Concrete observations are the starting point for abstraction. By observing the world around us, we notice patterns and regularities. These patterns can be captured in concepts or abstractions, which are then used to communicate, monitor, or advance complex systems. Abstractions are not static; they can evolve over time as our understanding of the world changes. As new observations are made, old abstractions may be modified or replaced entirely. In some cases, an abstraction may become so entrenched that it becomes difficult to change. This can lead to problems if the real-world system changes in a way that is not captured by the abstraction.

One way to create an abstraction is to use a mental model. A mental model is a simplified representation of something that we create in our minds to understand and work with it. We use mental models all the time in everyday life, often unconsciously. For example, when we drive a car, we are using a mental model of how the car works in order to operate it.

Abstraction from a STEM perspective

An abstraction is an idea, concept, or principle that can be represented by a model or a formal system. Abstractions are key to understanding complex systems, as they allow us to represent and manipulate them in simpler ways. There are many ways in which abstractions can be discovered. One way is by observing and analyzing the behavior of a system. Another way is by using a process of abstraction, in which we systematically remove details from a system to identify the essential components and their relationships. Once an abstraction is discovered, it can be embodied in several ways. One way is by using a mathematical or logical model. Another way is by creating a computer program that implements the abstraction.

Abstractions in teaching processes

The right level of abstraction to teach in when developing a learning objective will depend on the type of objective being developed, as well as the level of the students' understanding.

For example, if the objective is to teach students how to add two numbers, the level of abstraction would be low, and the steps involved would be concrete and specific. However, if the objective is to teach students how to solve a mathematical problem, the level of abstraction would be higher, and the steps involved would be more general and abstract.

The key is to start with the most basic concepts and gradually introduce more abstract concepts as the students' understanding grows. This will ensure that the students are able to understand the material and are not overwhelmed by too much information at once. Data abstraction is the process of representing data in a way that is more general and easier to understand. For example, instead of teaching students the specific details of how a computer stores data, data abstraction would focus on the general concepts of how data is stored and retrieved.

Abstractions are used to represent the relationships between different concepts, the sequence of activities, and the learning goals of the course. By using a concept map, timeline, or rubric, designers can help learners to understand the overall structure of the course and how to complete it. This can aid in retention and comprehension of the material.

The role of abstraction in collaboration

The brain uses abstraction to cope with its cognitive limitations. For example, when we see a chair, our brain does not need to identify all of its individual parts (legs, back, seat, etc.), it can simply recognize it as a "chair" and move on. This is a very efficient way for the brain to operate and it allows us to deal with the vast amount of information that we are constantly bombarded with.

We divide and conquer high-level problems by dividing them and outsourcing them to other devices or users, who then return the intermediate results at an abstraction level we can understand and share with others.

The process of understanding the current domain of exploration can be repeated iteratively with the returning set of results. This process can happen within a single individual, a single brain as it were, or within a community or ecosystem of brains.

This human brain's capacity to collaborate deeply across space and time is the result of the evolution of the human brain in addition to the tools the brain developed to amplify some of its functions. This mechanism provides humans with a significant evolutionary advantage.

The high capacity of humans to collaborate deeply across space and time is the result of the evolution of the human brain in addition to the tools the brain developed to amplify some of its functions.

Games and Music

The human brain is particularly effective at using abstractions to remember complex information. For example, a chess player memorizes the position patterns and corresponding strategies to deal with each situation. This allows them to play faster so that they can dedicate more time to the most difficult stages of a game. Guitar players find it easier to memorize shapes that point to the locations of notes over the entire fretboard. This allows a lead guitar player to improvise in real time and be in sync with the ongoing chord progression.

Science, Mathematics and Art

We do not know why abstractions seem to reduce cognitive load from an information-processing perspective, but it is very clear that they do.

Abstractions include diagrams such as Feynman's diagrams that led to many discoveries in physics, new ways to organize data such as Mendeleev's periodic table, which listed elements before they were discovered in nature, new ways to visualize imaginary numbers, such as Argand graphs, and new ways to capture music and dance.

In physics, students are very familiar with free body diagrams to represent objects and forces that act on them and have a good understanding of the importance of visualization of situations in order to solve problems. In their studies, chemistry students had to learn about the molecular structures and draw diagrams to represent them.

Most understand that abstraction is a very useful pointer for an object or a concept of interest. Maps and plans are also good examples of abstractions, where diagrams are meant to capture and represent salient aspects of buildings and places. The urge to abstract is also present in the field of fine art.

Computing

Abstractions as building blocks of languages

A language can be considered a collection of related abstractions. Often, a set of abstractions from a language need to be connected or combined to express a complex idea. Expressivity and ease of use of a language to communicate the situation or needs are two factors that determine its quality and utility. Computing history provides numerous examples of how different languages must be developed and implemented to make programmable devices behave in ways that meet user needs. In addition to machine languages, which allow engineers to communicate directly with hardware, we also needed to create programming languages that subject matter experts or end users could use to implement programs relevant to their domains of interest.

Command line vs Graphical user interface

Command line instructions that manage a file system or batch files that contain parameters and commands can also be considered computing languages that are available to everyone, including the end user.

We realized that we needed to expand our understanding of computing languages beyond textual ones to include visual ones. The use of computing platforms and AI tools to perform outsourced cognitive functions has always necessitated languages to communicate task requirements.

In many ways, the desktop graphics user interface is a language that can be used to instruct computers on how to handle their data. With the growing number of tasks being outsourced to AI computing systems, whether they are robots, nonplayer characters, or software, we see the urgency of developing new languages to help describe our needs for these new entities.

> In many ways, the desktop graphics user interface is also a language that users can use to instruct computers how to handle their data.

Abstraction design for the Metaverse

Applying theory to design can help create a more cohesive and effective design.

Our solution is simple: we needed reusable libraries of virtual objects for our interactive virtual world composition application. While creating these reusable components, we must look for recurring patterns of 3D virtual world objects and behaviors we encounter in the Metaverse. Once we identify them, we abstract them into concepts and develop software architectures for transforming the concepts into tangible and interactive library objects for building virtual world applications.

The design of our abstraction layer led to the development of a composition tool; we refer to as the Composer. The Composer allows users to generate a wide variety of applications from a point and click assembly of modules, or libraries of simpler 3D objects, in a

3D world. These applications range from an object-oriented drawing program in the shared virtual world, to large-scale interactive 3D scene builders. This flexibility is made possible by the fact that our abstraction layer hides much of the complexity associated with these different types of applications behind a simple interface; As such, it becomes trivial for creators to create new applications without having to worry about low-level details or their programming skills or their 3D modeling abilities.

[Ref. RezMela composition application summed up here with a pointer to the actual chapter that describes it in detail.]

It is very likely users will have to navigate a large number of 3D worlds. [Insert here information about spatial cognitive maps] One of the problems with these large-scale worlds is that it is easy to get lost in them.

By determining the upper bound of various cognitive functions under varying circumstances, we can create better interfaces between humans, intelligent computers, and the world around us.

Designing cognition amplifying technologies requires more than just reducing complexity to abstractions. Next, we review from a sensory channel perspective some of the thinking behind our approach to utilize this limited resource most efficiently.

[Ref. to Data sonification and Haptic data visualization work appear here]

Advantages of 2D representations

In spite of living in a 3D world, 2D representations are still useful in countless instances. So we often find value in reducing 3D into 2D, either for productivity reasons or to better understand complexity. No one can deny the value 2D maps, blueprints, or even mind maps bring to day-to-day life. GUIs on our desktops and phones would be another example of a 2D interface, which are often inspired by 3D objects that have been repurposed into 2D widgets that add value to our interactions with the world around us.

We learned that such translations were necessary more frequently than expected even when designing in 3D virtual worlds. In many cases, immersive 3D virtual worlds are argued to be intrinsically superior as a medium. However, even in immersive 3D virtual worlds, we need interactive 2D virtual maps.

After several experiments and user studies, we found ourselves having to convert 3D inworld interfaces to 2D Heads Up Displays (HUDs) and using 2D Maps to facilitate interactions on a large scale with in-world content. Some of these approaches were also patented. We found that end users gain very significant productivity gains when they can use a map to add content to a large virtual space without having to move the camera or navigate over a very large virtual area, which is both tiring and time-consuming.

To accelerate end-user content creation, we focused on designing a user interface that is accessible as a HUD. The quality of experience in a 3D virtual world can be greatly improved by minimizing camera motion.

Chapter cover 7 Social Bandwidth: Physical and Virtual Connection

7. Supporting Collaboration

Designing effective virtual environments

Creating, using, evolving virtual collaborative environments

It has been our belief for a while that the best way to come up with design solutions that will maximize 3D virtual worlds' utility is to iteratively design solutions while immersed in them to meet our own needs.

Consequently, we would be better equipped to understand how this space can be utilized, how it was evolving and how to develop effective solutions. We would learn something from this that would impact the design of future workspaces or shed light on the future of work. Thus, our plan for creating a virtual workplace consisted simply of the following:

1. Create one for our team and see how it works

2. Identify the needs as they arise

3. Create in-world products to address those needs

4. Iterate and evaluate the product design

5. Establish a content creation infrastructure to facilitate the creation of products, and

6. Distribute successful products to other teams.

Look at some of the applications that we implemented as part of this plan. Many of these applications are directly utilitarian in nature, that is, they are not mere props but can also be used to solve actual problems.

Establishing a content creation infrastructure is the most challenging step of this plan. Software that supports content creation is continually evolving to meet new needs as they arise. We will focus in this section on the products that this infrastructure supports, while its architecture will be explained in detail in a future section.

This infrastructure can be considered, for now, as software that coordinates communication between base objects (e.g., trees, post-it notes, chairs, models of atoms of molecules, non-player characters) grouped into modules and a set of composer applications deployed on the virtual land. Each of these Composer applications can be used for a specific purpose. The modules are like 3D boxes, and a collection of modules represents an inventory of objects that end users can access for a particular application controlled by a particular composer.

The Composer App offers users a versatile and interactive experience. Upon clicking the button (B) to sign in, users are presented with a heads-up display (HUD) that showcases the available content from nearby modules (C). These modules house a diverse array of objects, including natural elements like trees and stones, as well as display and layout objects that aid in the arrangement of items within the interface. Advanced users can create their modules and sell them on an online market place.

The app boasts user-friendly features such as "snap to object" and "snap to grid" functionalities, simplifying the placement of objects and streamlining the overall design process. Furthermore, the Composer App supports multiple instances, allowing users to sign in individually and collaborate on shared projects, promoting teamwork and fostering creativity.

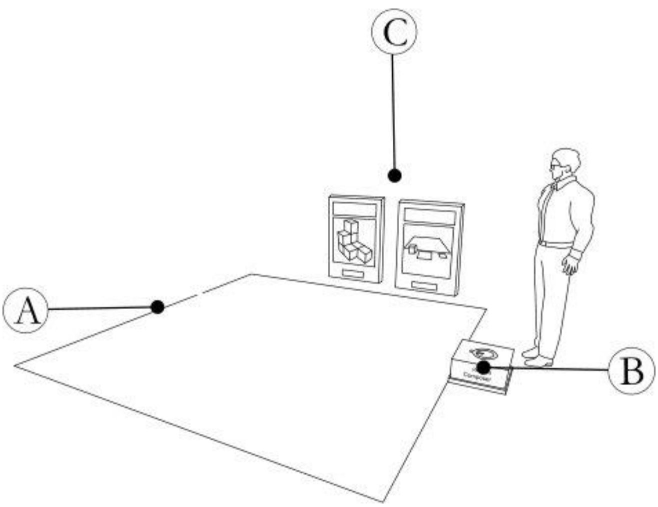


Figure 15 Look and feel of a basic Composer App

The next figure illustrates the Universal HUD, which is displayed for every user upon logging into their unique instance of the Composer App. Objects created using the app can be saved as files and accessed at any time in the future. These files can be easily shared among content creators, who can then utilize them as-is or modify them according to their requirements. In any given scene, objects can be selected with a single click, enabling users to perform a variety of operations on them.

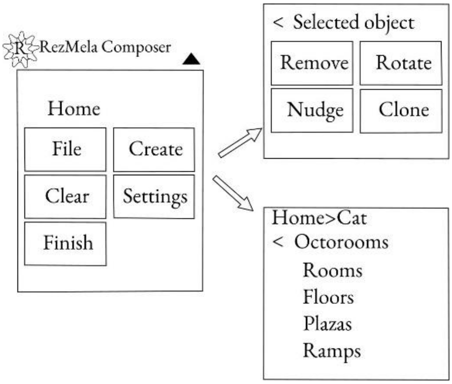


Figure 16 Universal HUD for the Composer App

It is worth mentioning that this versatile application, capable of creating extensive towns, cities, road networks, or museum exhibits, can also be adapted for simpler tasks, such as generating a board with sticky notes for project management purposes. This flexibility demonstrates the wide-ranging applicability of our HUD design.

Redesigning a web browser

As part of our experimentation, we created a 3D version of an internet browser within a virtual world. To take advantage of the affordances that come with the 3D space, we developed several possible designs. A design feature worth noting is how bookmarks are created and managed. While we represented URL bookmarks as 3D objects, we maintained the traditional web browser design of a browser on a flat surface. Each web browser object could be cloned, moved, and placed anywhere. Whenever a site or online video was bookmarked, a 3D bookmark object was created.

Having arranged them in racks and labeled them, the set up quickly resembled a library. When clicking on the 3D bookmark, each of which was embodied as a book with the necessary labels on the covers and seam, the associated URL would be displayed in the closest in-world browser. It was demonstrated tangibly through this design that adding a spatial dimension could add value to a traditional web viewer.

First, bookmarks could be organized so that they could be browsed easily. Second, people could invite others to view this 3D library of bookmarks. Our view is that the ability to search for objects as well as to browse them is equally important and browsing is certainly an activity that lends itself to 3D spaces.

Earlier work on the memory palace suggests it is easier to find a given entity in a 3D place than in a menu system. Anecdotally and from my experience, I have also noticed that it is easier to remember where objects are when they're located in 3D, helping us build a mental cognitive map of the location that tends to last longer.

Redesigning office tools

The process of migrating simple objects from the real world into 3D virtual space yields not only a broader range of applications but also improves interoperability between them. Mind mapping tools, or project management tools for 2D desktop environments, are familiar to many. These applications are traditionally considered separately and are implemented by separate firms. It is not typically possible to move or port a post-it note from a mind map application by one company to, say, a project management application by a different company. Let's check out how this can be simply done when designing for a 3D space. The illustration presents a typical example meeting setup we encounter frequently during our regular collaborative discussion sessions.

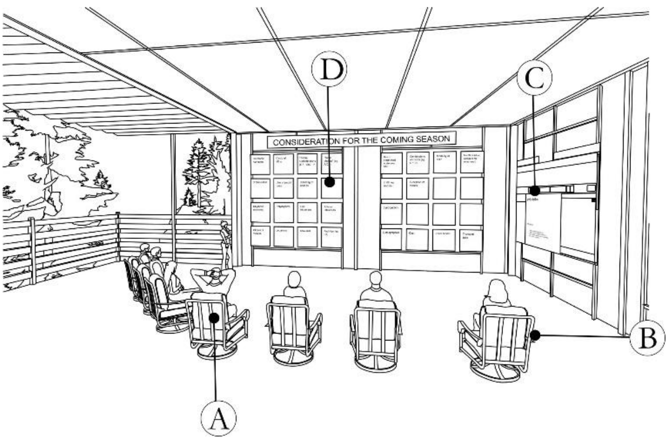


Figure 17 Designing using their own tools during regular meetings in their virtual world

The virtual post-it note D we designed can display both images and text in a variety of colors and fonts. A user may create, select, copy, clone, edit, or move these post-it notes and place them on boards, walls, or anywhere else he or she chooses. Therefore, creating meeting tools, agenda preparation tools, note taking tools, and ways to capture and display brainstorming sessions became very easy. We had access to a video screen that can be used to display video streams.

Even our object-oriented drawing app was powered by the same content creation and management infrastructure as the virtual post-it notes. Every application we listed would traditionally be considered a distinct product segment. Here, however, their natural convergence appears to be a given and the conceptual boundaries between them appear to be very permeable. <u>We believe that once applications migrate into 3D environments, the traditional boundaries that separate them in the desktop world will dissolve.</u>

Effective prototyping environment

As content creation tools become more user-friendly and accessible, prototyping evolves into a routine activity for users. Our program enables the design of virtual gardens, landscapes, and buildings, while also allowing experimentation with various elements such as lighting, seating, and navigation paths, proving valuable to architects and landscape designers in the real world.

The Composer App, for instance, expedites the process of constructing museums, conference campuses, and poster exhibits. Rapid content creation and customization capabilities theoretically drive adoption. As long as the demand for utilizing virtual 3D worlds continues, we expect the need for accelerated content production to remain a priority.

Large scale 3D content creation and customization

This important need for direct customization by the end user is not an afterthought in our design approach. Rather, it revolves around this critical need. Users feel empowered when they have access to well-designed parts they can assemble to create something new quickly, as many designers have realized before us. In almost every field, this principle rings true. Emojis or strings of them are often used to express ideas forcefully and succinctly. In the same way, it is also possible to create drawings, exhibits, or even whole worlds from simpler parts. Reached here

In the forthcoming figure, we unveil an innovative approach to content creation and deployment within expansive virtual environments, such as sprawling urban landscapes or extensive conference and trade show campuses. Traditional methods of populating these vast spaces can be cumbersome, necessitating constant navigation and camera repositioning. Our solution streamlines this process with the aid of a map-based Composer application.

The Composer application enables users to place iconic representations on a map, with each icon corresponding to a large-scale object that materializes in the virtual world at the designated location. This scalable method is adaptable to any environment size, simply by adjusting the map's scale. Furthermore, the map can accommodate three-dimensional data to capture elevation information.

Imagine a collaborative teaching scenario, wherein an instructor (C) discusses a situation with trainees (A) as they all face a board (F) displaying the map. The instructor can effortlessly introduce content onto the map, simultaneously constructing a 3D world beyond the confines of the room (B). In the subsequent phase of the training session, students can explore this newly formed virtual realm.

Functioning as a Wizard of Oz, instructor C assumes complete control over the virtual world's activities. This patented design incorporates a feedback loop, allowing the instructor to monitor the trainees' actions in the virtual environment via the map. Thus, our inventive strategy harnesses the Metaverse's potential to revolutionize tabletop exercises and elevate them to an unprecedented level.

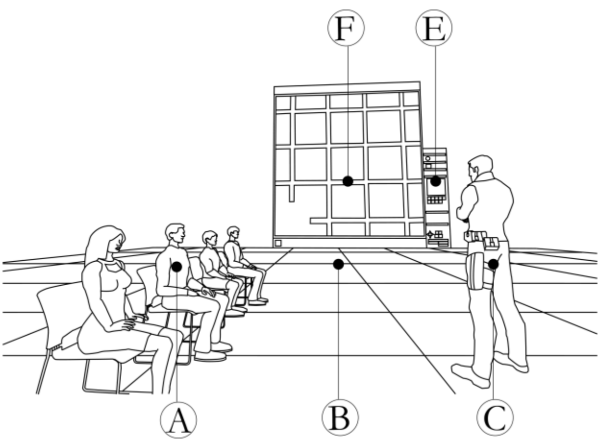


Figure 18 An instructor with his students as avatars facing a content creation and student activity monitoring board (c. 2016-2021)

In the following illustration, we delve deeper into the menu adjacent to Map F from the preceding figure, revealing a variety of distinct sections. This particular embodiment empowers the instructor to manipulate multiple aspects of the virtual environment.

Section A permits the adjustment of wind direction, while section B enables the modification of the water table level. In section C, the instructor can alter the time within the world, adjusting lighting conditions to suit their needs.

An object picker, denoted as section D, provides the instructor or content creator with the ability to select objects from a diverse range of categories, represented by section F. These objects may include buildings, non-player characters, interactive equipment, and even drivable vehicles.

The Map serves a dual purpose: not only does it function as a surface for placing iconic representations, but it also acts as a control interface. The instructor, much like the Wizard of Oz, can modify various events or conditions, thereby influencing the occurrences within the virtual world.

Lastly, section H encompasses controls for saving and loading different scenes as required, offering a convenient way to manage the ever-evolving virtual landscape.

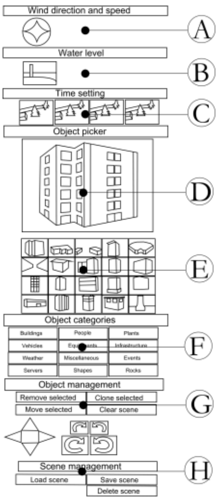


Figure 19 An example menu for the content creation board (c. 2016-2021)

In the accompanying illustration, our perspective widens to reveal a more comprehensive view. At the heart of the scene, an individual operates board C, deftly manipulating its controls. The observer can now discern that this person is situated within a sophisticated control room, denoted as B, surrounded by a myriad of iconic elements E placed meticulously on the board.

The layout of the roads forms an orderly grid, while an eclectic mix of architectural styles populates the cityscape. As our gaze extends beyond the boundaries of control room B, the true scale of this urban landscape comes into focus. In the distance, a three-dimensional metropolis emerges, its towering edifices A, D and bustling streets serving as a testament to human ingenuity and the power of creative design. All these objects can be navigated through and explored by avatars or non player characters.

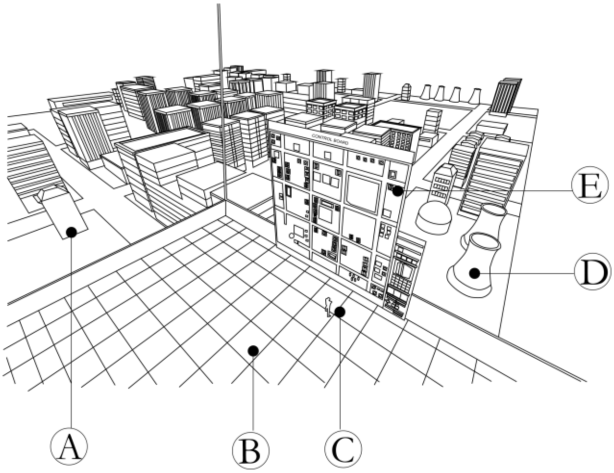


Figure 20 An instructor creating a large town by placing 3D icons represent larger scale objects such as buildings and vehicles on the board (c. 2016-2021)

(Description)

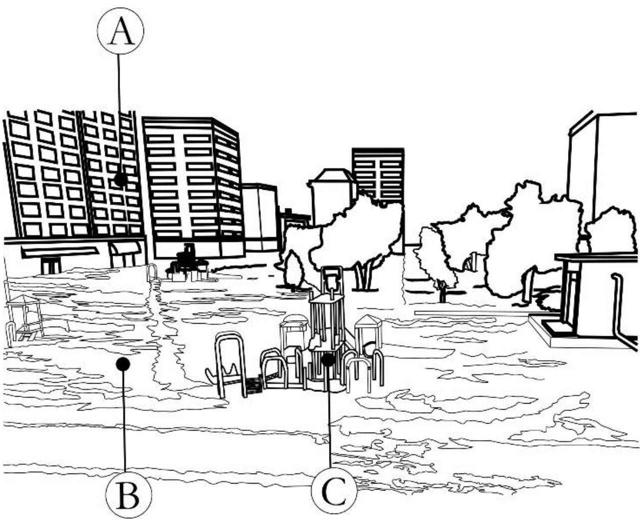


Figure 21 Flooded Town

(Description)

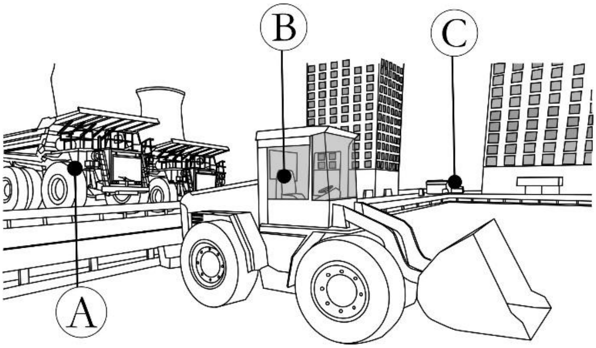


Figure 22 Drivable equipment, here tractor

(Description)

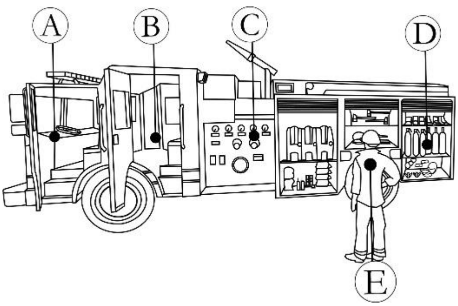


Figure 23 Fire truck and PPEs

(description)

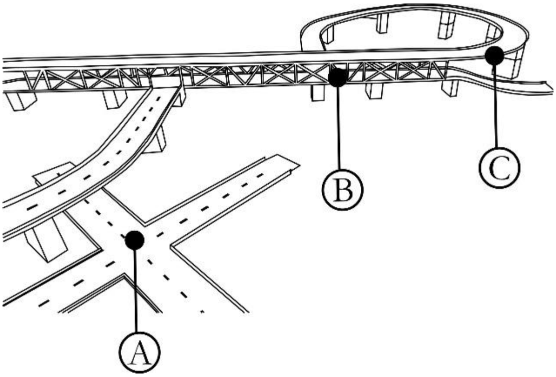


Figure 24 Modular road pieces

(Description)

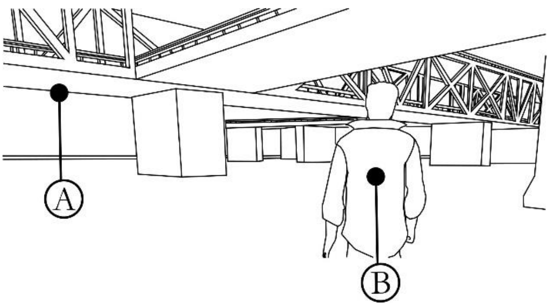


Figure 25 Avatar looking at fly over roads

The figure illustrates how various stakeholders collaborate in a 3D virtual world (F) using different maps (A, G, and E) to focus on specific data or aspects relevant to their respective goals. This demonstrates the flexibility and adaptability of real-time data visualization in such an environment.

Each group of collaborators uses their map as both an interface for creating content and a presentation surface for data. As they interact with the virtual world, the maps automatically update to reflect changes or new information. This seamless integration allows for enhanced collaboration and decision-making among the stakeholders.

The power of this approach lies in its ability to easily extend and adapt to diverse needs. By enabling multiple maps with distinct focuses, the system can cater to various stakeholders and their specific requirements. This flexibility allows for a more comprehensive understanding of the virtual world, supporting collaboration and promoting efficient problem-solving.

In summary, the figure highlights the advantages of real-time data visualization and the use of maps as both content creation interfaces and data presentation surfaces. By offering customizable maps tailored to different stakeholders, this approach becomes more powerful and adaptable, making it an effective tool for collaboration and decision-making in a 3D virtual environment.

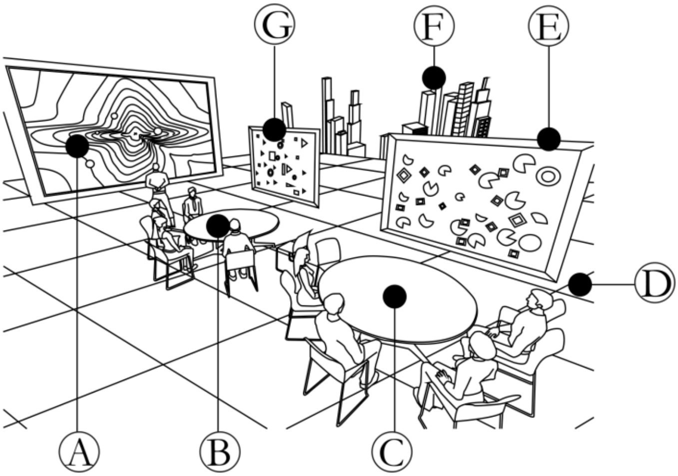


Figure 26 Emergency preparedness experts as avatars running a large scale exercise using multiple concurrent content creation and activity monitoring boards (future vision)

Quest for a universal interface to the world

A series of iterations contributed to the development of a common user interface with a minimal number of control points that can be used to deploy a wide range of objects. These objects can be notes on a board, seating arrangements on a rug, models of molecules on student desks, buildings, campuses, cities, sound sources, non-player characters and even worlds.

In short, we ended up with one HUD which functions as a universal interface that handles the creation of all content. The components that can be assembled to create these often more complex and larger objects play a critical role.

There is no doubt that the success of our approach depends to a large extent on the quality of the base objects collected in a module object that can be shared across applications and end users. The quality factors range from aesthetic to functionality aspects. A positive side effect of our approach is that now users or content creators can make use of a limited number of resources, for example, a limited virtual land area or number of objects and processing power, to create a very large number of experiences that can be loaded, modified or deleted at will.

The HUD is a versatile interface that facilitates the creation of various types of content, from landscapes and buildings to post-it notes. In the virtual world, relative dimensions are not critical. For aesthetic purposes, the 3D world will not be cluttered with thousands of buttons. Instead, the intelligent interface will expose necessary control points through the HUD, providing easy access to user interface points. Instead of having a separate menu for each application, a generic, intelligent HUD that can adapt to the virtual world's objects is needed.

Advanced scripted 3D assets/objects

The base objects in various modules can have complex programmable behaviors. The Panocube is one such library object that can be used to create advanced 360-degree virtual tours of real-world locations. The experiment revealed how we can use 2D data, about real-world locations from Google Views, in a 3D context and observe the advantages of doing so with regard to collaborative exploration of real-world places in a virtual environment. The historical street view images also allowed us to see the same real-world place at different periods of time. This provides an excellent educational opportunity.

In this captivating illustration, a 360-degree panoramic view of a real-world location is displayed in a cubic projection. The image offers a broad perspective of the surroundings, giving a detailed and accurate representation of the environment. This projection facilitates a seamless and immersive experience, as viewers can examine the area from various angles.

This illustration also demonstrates the potential of using these images to texture the inner faces of a virtual cube. By doing this, users can comfortably navigate a virtual rendition of the physical location, generating an immersive experience. Although this technique may not yield high-resolution 3D models, it remains notably cost-effective and resource-efficient.

It is important to mention that this image was created using Google Street Map API, which enabled the formation of an incredibly precise depiction of the location based on its geographical address. While cutting-edge technologies such as photogrammetry and generative AI may soon offer automated 3D virtual recreations of physical locations, they are likely to be more expensive. In this context, the illustration serves as an example of the significant potential of current technology in producing immersive and realistic experiences while remaining accessible and cost-conscious.

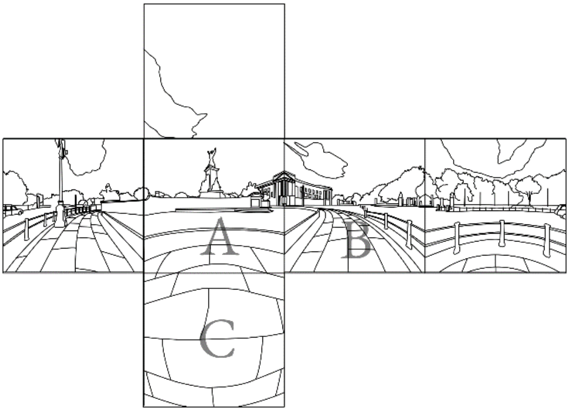


Figure 27 Cubic projection of a 360 panoramic projection of a real world view

In this intriguing illustration, we are introduced to the Panocube, an innovative manifestation of the Composer App. Avatars can enter the cube and generate a fully encompassing experience of a physical location by inputting its geographic coordinates. The cube's interior surfaces are adorned with images from the cubic projection, assigning a distinct picture to each face – Picture A for face A, Picture B for face B, and so on, until all six faces are textured.

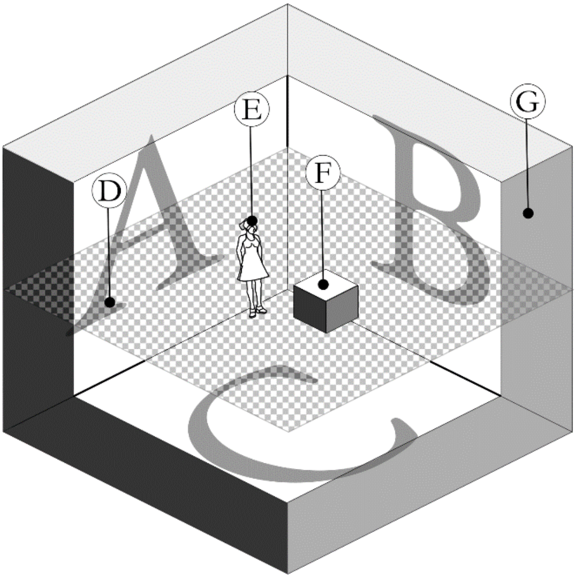


Figure 28 The Panocube: low cost application to create lofi experiences of a real world location

We also observe a transparent floor, marked as D, which enables avatars like E to maintain a level within the cube that yields an optimal 360-degree panoramic view. Despite its limitations, such as the ideal position for the avatar being the cube's center, to avoid any distortions in the view, this method still delivers a distinct and immersive experience.

Furthermore, as the Panocube is a component of the Composer App, it incorporates all the features we associate with the Composer. Avatars can sign in and generate content, including displaying signs, organizing seating, and labeling parts. The app also grants access to images from Google Street View API captured at various timestamps, facilitating the creation of panoramas that depict a location's historical transformations. The capability to craft a virtual representation of a physical location has potential in fields such as tourism, education, architecture, and urban planning.

In the image presented, an avatar is situated inside a Panocube, which features an immersive 360-degree view of a train station on its inner surfaces. When the avatar is not positioned at the cube's sweet spot—the center—the image may appear distorted. However, the cubic projections (E) on the walls still provide a satisfactory sense of immersion.

To access the Panocube, the user clicks on button (B). They can then add objects to the space using the menu (A) on the left. To render a specific location, the user clicks on the globe icon (D), prompting a dialog box where they can enter their desired destination. Additionally, the user can create signs (C) containing hotspots, which, when clicked, display corresponding 360-degree views.

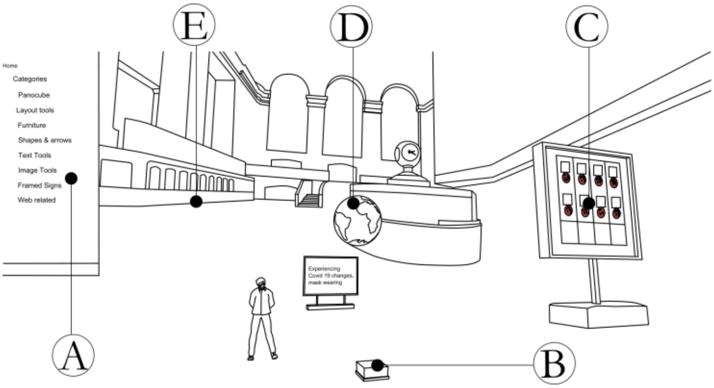


Figure 29 An avatar inside a 360 panorama of a real world location generated from Google Map Images

In this image, a group of visitors, including individuals C and D, are engaging with one another inside a Panocube at the historically significant Ryoanji Temple. They are surrounded by three interactive displays, each providing unique information about the temple and its famous Zen garden. The immersive 360-degree view, constructed from Google images, allows the visitors to fully appreciate the beauty and serenity of the location.

As they click on various hotspots on the signs, such as sign B, they access detailed maps and additional information. Sign B, for example, showcases a map of the temple grounds with numerous hotspots along the walkways. Clicking on these hotspots refreshes the 360-degree view, providing different perspectives of the iconic Zen rock garden. The visitors can easily grasp the layout of the temple and explore the various sites it has to offer.

This virtual environment offers an innovative and effective way to experience real-world locations, fostering a deeper understanding and appreciation for the place. As a learning tool, the Panocube brings history to life, making it an invaluable asset for education and cultural exchange.

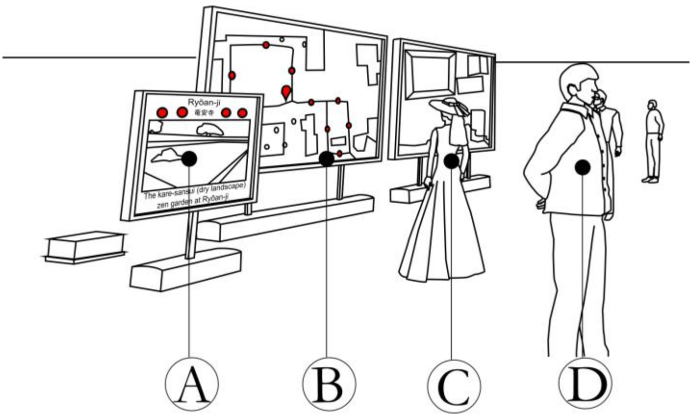


Figure 30 Avatars sharing a virtual world version of a physical location inside of a Panocube

In this captivating image, the individuals who had previously learned about the renowned Ryoanji rock garden through a collaborative virtual tour using the Panocube are now fully immersed in a 3D virtual representation of the garden itself. The transition between different representations of the physical location sparks thought-provoking discussions and offers deeper insights into the essence of these places.

We see avatars, including Avatar A, as they explore the meticulously arranged rock garden B, taking in the unique arrangement of stones C and the surrounding lush foliage. This lifelike 3D scene has been masterfully generated by the Composer application, demonstrating the potential for a single content-creation tool to produce a wide range of diverse and engaging educational content.

The thoughtful design of these immersive experiences not only enhances understanding but also promotes curiosity and fosters a deeper appreciation for the world's cultural and historical treasures.

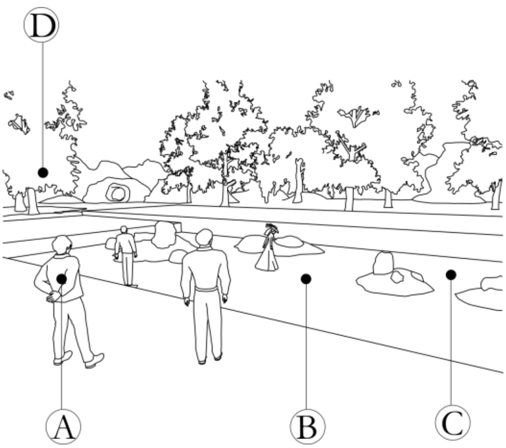


Figure 31 Avatars visiting a 3D virtual replica of a real world location, in this case a stone garden

In this evocative image, we capture just one example of the countless adventures made possible through immersive virtual experiences. Here, we find ourselves visiting the breathtaking Nasir al-Mulk Mosque, renowned for its stunning stained-glass windows. Avatar A is seen admiring the intricate artwork of Entrance C and the magnificent architectural details of the surrounding building structure B.

While it is impossible to document all of the expeditions enabled by this approach, this example underscores the potential for educators to integrate such immersive exercises into their curricula. By providing low-cost and engaging learning environments, these virtual experiences can inspire curiosity and enhance students' understanding of the world's rich cultural and historical heritage.

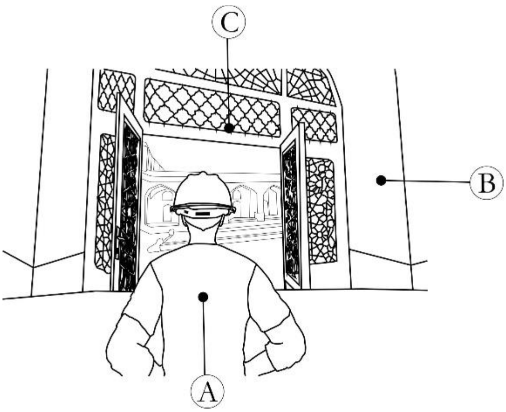


Figure 32 Exploring historical buildings

Future applications to consider.

The list of possible application candidates that can add utility value to the Metaverse is of course endless. We surmise that some candidates will migrate sooner than others. 3D design and modeling applications, device simulations, real world training exercises, 3D archiving and versioning tools, monitoring and control of real-world sensors and devices from virtual monitoring stations inside virtual worlds, Big data neural net data visualization (think of it as fmri for NNs) and control, machinima or 3d movie capturing and production. We believe that the success of the 3D Metaverse will take time, it will unfold slowly as existing applications migrate into it.

Moreover, we believe consumer content creation, let alone consumer content consumption, will have a major role to play.

Automation vs Control conundrum

In the era of 3D virtual worlds and advanced AI technologies, the future of office and workforce design is going to undergo a significant transformation. Let's examine briefly the critical factors likely to shape this new landscape, such as human avatars, AI non-player characters or agents, and the delicate balance between automation and control.

Delegation of Authority in Virtual Worlds

As virtual environments evolve, the concept of delegation and its relationship to authority and chain of command has become increasingly important. As tasks move through levels of delegation, visibility of processes may decrease, leading to challenges in control and implementation. Drawing parallels with biological systems, the article examines the balance between specialization and control in these virtual worlds.

Striking the Balance: End-User Control vs. Automation

Navigating virtual worlds requires users to find equilibrium between managing their avatars and relying on automation. Controlling a swarm of assistant NPCs offers increased engagement but raises critical concerns about intimacy and identity. Identifying activities that easily transition from 2D to 3D virtual reality may be the key to harnessing the potential of these new environments.

The Multiplication of Locus of Action

Controlling multiple NPCs offers increased efficiency and reduced reliance on synchronous interaction. Delegating tasks to geographically distributed agents allows users to achieve more in less time. This approach is particularly beneficial in situations requiring a swift response, such as interacting with an AI system.

Maintaining Social Bandwidth and Designing New Interaction Metaphors

Working in a 3D virtual world necessitates high-fidelity representation of human avatars and humanoid NPCs or agents to maintain adequate social bandwidth. This fidelity ensures that nonverbal cues, emotions, and other essential aspects of human communication are accurately conveyed. Additionally, significant effort will be invested in designing new interaction metaphors to represent data and their interrelationships more effectively in 3D space. For example, data visualization techniques may evolve to display complex information in a more immersive and intuitive manner, and gesture-based controls could become more prevalent for navigating and manipulating virtual environments.

Conclusion:

The future of office and workforce design in 3D virtual worlds presents both opportunities and challenges. As users strive to balance end-user control and automation, the implications for virtual communities, communication, and identity will become increasingly significant. Understanding these dynamics, along with the importance of maintaining social bandwidth and designing innovative interaction metaphors, is key to shaping a more inclusive and efficient work landscape.

Chapter cover 8 Boundless Learning: Education in 3D Worlds

8. Shaping the Educational Metaverse

Guide for next generation stake holders

Introduction

The purpose of this chapter is to provide guidance for subject matter experts, teachers, and other parties interested in transferring knowledge through virtual worlds. Our goal is to provide readers with the right pointers to locate the tools they need to begin their journey.

Virtual worlds are well suited for exploratory learning activities, as they provide a safe environment for learners to experiment and make mistakes. Additionally, virtual worlds can be used to create simulations of real-world scenarios, which can be used to teach learners about complex systems.

The main considerations when designing for productivity in the Metaverse are:

1. The user interface should be intuitive and easy to use.
2. The environment should be immersive and engaging.
3. The experience should be social and collaborative.
4. The content should be rich and interactive.

The most likely reason is that virtual environments for entertainment are more common because they are generally less expensive to produce than those for productivity applications. Additionally, entertainment virtual environments tend to be more immersive, which may make them more appealing to users.

Top concerns of teachers interested in virtual worlds

The top concerns of teachers who want to explore virtual worlds for learning are the following:

1. Will students be engaged in learning in a virtual world?

2. What are the pedagogical approaches that work best in a virtual world?

3. What kinds of learning activities are best suited for a virtual world?

4. How can we assess student learning in a virtual world?

5. What are the technical requirements for setting up and using a virtual world for learning?

6. What are the potential risks associated with using a virtual world for learning?

Pedagogical approaches that work best in virtual worlds

There are a number of pedagogical approaches that work well in a virtual world. Some approaches that work well include:

1. Social Constructivism: Social constructivism is a learning theory that emphasizes the importance of social interaction in

the development of knowledge and skills. In a virtual world, social constructivism can be used to create opportunities for learners to interact with each other and build on each other's ideas.

2. Problem-Based Learning: Problem-based learning is an instructional approach that focuses on solving real-world problems. In a virtual world, problem-based learning can be used to create opportunities for learners to work together to solve problems.
3. Inquiry-Based Learning: Inquiry-based learning is an instructional approach that emphasizes the importance of learners asking questions and pursuing answers through investigation. In a virtual world, inquiry-based learning can be used to create opportunities for learners to explore their surroundings and ask questions about the world around them.

Some examples of healthcare learning applications in 3D avatar based virtual worlds:

1. Patients with chronic pain can use avatars to distract themselves from their pain and to explore different coping strategies.
2. Patients with anxiety disorders can use avatars to confront their fears in a safe and controlled environment.

3. Patients with eating disorders can use avatars to explore their triggers and to learn new coping mechanisms.
4. Patients in rehabilitation can use avatars to practice new skills and to stay motivated.
5. Patients with dementia can use avatars to reminisce about past experiences and to connect with others.

Virtual worlds can provide health care educators with an immersive and realistic environment in which to train students. These worlds can be used to simulate real-world scenarios, allowing students to gain experience in a safe and controlled environment. Additionally, virtual worlds can be used to create custom educational content, such as interactive 3D tutorials. This content can be used to supplement traditional lectures and textbooks, providing a more engaging and interactive learning experience.

Virtual worlds can provide a fun and stimulating environment for cognitive behavior therapy education. They can help people learn about different concepts and skills related to cognitive behavior therapy and can also provide a way for people to practice what they have learned. Additionally, virtual worlds can help people to feel more comfortable and confident when working with others in a therapeutic setting.

The power of virtual worlds to impact all facets of education is often underestimated. Here, we show how virtual worlds have an impact on virtually every aspect of human knowledge.

Affordances of 3D virtual worlds

Supporting group work

There are a few ways that 3d avatar based virtual worlds can provide a great opportunity for supporting breakout group work sessions. First, virtual worlds can provide a shared space for group members to work together on tasks or projects. This can be beneficial because it can allow for more collaboration and communication than if group members were working in separate locations. Additionally, virtual worlds can offer a variety of tools and resources that can be used by group members to help with their work. Virtual worlds can be a great way to get group members to interact with each other on a more personal level, which can help to build relationships and trust within the group. Finally, such virtual worlds provide seamless transitions between private and public working spaces in ways similar to the physical world. Collaborative activities that require awareness of peer activities are best performed in public places. And similarly, activities that require privacy can be carried out in private spaces.

The importance of role playing

Some educators believe that role playing can be a valuable educational tool, as it can help students to better understand complex concepts and to think creatively about solutions to problems. Additionally, role playing in virtual worlds can also provide students with opportunities to rehearse social and communication skills in a safe and controlled environment.

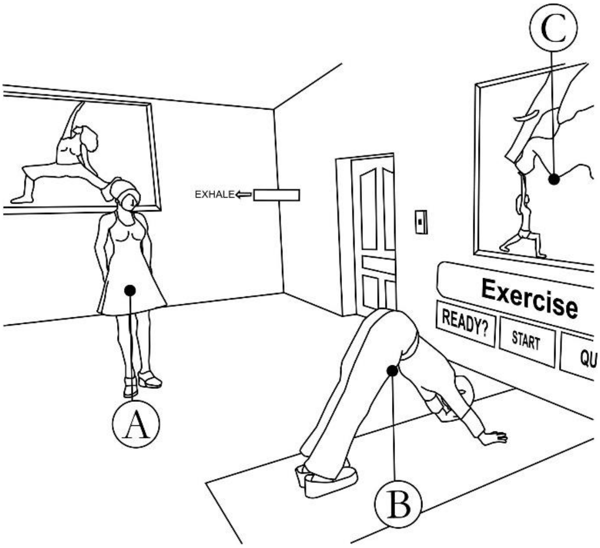


Figure 33 Teaching yoga

3D space to organize memory

The affordances in a 3D virtual world that are available to support learning can be identified by observing the environment and determining what actions are possible. For example, if there is a virtual world that contains a library, one can assume that the affordance for learning in that world would be the ability to read books. That would be an example of surface level affordance. A deeper level of affordance would be that the 3D virtual environment provides the opportunity for visitors to build a spatial cognitive map for the location of specific sources of information.

The memory palace can play several roles while learning in an avatar based 3d virtual world. First, it can serve as a repository for information that the learner wants to remember. This can be done by storing items in the memory palace that are associated with the information to be remembered. Second, the memory palace can be used to organize information. This can be done by creating a series of rooms or areas in the memory palace that are each associated with a different topic. Finally, the memory palace can be used as a tool for retrieval. This means that when the learner wants to recall the information, they can go to the memory palace and retrieve it from the associated location.

Expected challenges and solutions.

Creating or joining a community of practice

The use of virtual worlds for education is a relatively new phenomenon, and as such, there are not a lot of established practices or protocols for educators to follow. This lack of guidance can be a deterrent for some educators who may be interested in exploring virtual worlds for teaching and learning but are unsure of where to start. In this paper, we will discuss some of the tactics that can be employed to encourage educators to explore virtual worlds for education.

One tactic that can be used to encourage educators to explore virtual worlds for education is to showcase examples of successful virtual world projects. There are a few educators who have used virtual worlds in their classrooms and have written about their experiences [ref.]. Sharing these stories with other educators can help to show them that virtual worlds can be used effectively for education and can help to spark ideas for how they might use virtual worlds in their own classrooms.

Finally, it is important to create a community of practice around the use of virtual worlds for education. There are a few ways to do this, but one option is to create a virtual world specifically for educators to use for collaboration and sharing resources. This can provide a space for educators to ask questions, share ideas, and get feedback from others who are using virtual worlds for education. Creating a community of practice can help to normalize the use of virtual worlds for education and can make it more likely that educators will explore and use virtual worlds in their teaching.

Challenges for cultivating a community of practice.

The use of virtual worlds in education is still in its infancy, with many schools and teachers only beginning to explore the potential of these platforms. There are several difficulties that need to be considered when trying to create a community of practice to support teachers interested in virtual worlds. These include:

1. Lack of time – many teachers are already stretched for time and may not have the time to dedicate to exploring and using virtual worlds in their teaching.

2. Lack of resources – virtual worlds can be resource intensive, both in terms of hardware requirements and in terms of the time needed to create content. This can be a barrier for many teachers.

3. Lack of knowledge – many teachers may not be familiar with virtual worlds or how to use them effectively in education. This lack of knowledge can be a barrier to entry for many teachers.

4. Inadequate support – many teachers who are interested in using virtual worlds may not have access to adequate support. This can include technical support, as well as support from school administrators or national education departments.

5. Isolation – many teachers who are interested in virtual worlds may feel isolated from their colleagues who are not using these platforms. This isolation can make it difficult to share ideas and resources, and to collaborate.

There are several solutions that can be proposed in order to address these difficulties. These include:

1. Providing time for teachers to explore and use virtual worlds – this can be done through dedicated professional development time, or by releasing teachers from their regular duties for set periods.

2. Providing resources for teachers to use – this can include hardware resources, as well as funding for the creation of content.

3. Providing training and support for teachers – this can be done through professional development courses, webinars, or other means of training. Additionally, support networks can be created, such as online forums, where teachers can ask questions and share resources.

4. Encouraging collaboration – this can be done by creating opportunities for collaboration, such as online forums, meetups, or conferences. Additionally, social media can be used to connect teachers and encourage collaboration.

Common reasons why educators don't want to teach in virtual worlds.

There are a number of reasons why educators are discouraged or don't want to use virtual worlds to support learning. First, virtual worlds can be expensive to set up and maintain. Second, virtual worlds can be time-consuming for educators to learn and use. Third, virtual worlds can be distracting for some students and can lead to cheating and other forms of academic dishonesty. Fourth, virtual worlds can be used for inappropriate purposes, such as cyberbullying.

Virtual worlds can be expensive to set up and maintain. To use virtual worlds for learning, educators need to have access to high-end computers and software. Additionally, they need to be able to pay for the hosting fees associated with virtual worlds. For many educators, the cost of setting up and maintaining a virtual world is simply too high.

Virtual worlds can be time-consuming for educators to learn and use. Educators who want to use virtual worlds to support learning need to invest a significant amount of time in learning how to use the software. Additionally, they need to design engaging and effective learning activities that take advantage of the unique features of virtual worlds. For many educators, the time investment required to use virtual worlds is simply too high.

Virtual worlds can be distracting for some students and can lead to cheating and other forms of academic dishonesty. Some students find the immersive nature of virtual worlds to be distracting. Additionally, virtual worlds can make it easy for students to cheat on assignments and exams. For these reasons, many educators are reluctant to use virtual worlds to support learning.

Lack of traction for courses in virtual worlds

When it comes to education, the adage "time is money" is especially true. In today's world, teachers and professors are under immense pressure to get students through their courses as quickly and efficiently as possible. This often means using traditional methods such as lectures and textbooks, which can be quite boring for students.

Virtual worlds offer a more immersive and interactive way to learn, but this comes at a cost. The cost of content production turns out to be high and content customization to fit the needs of a class is hard. It takes a lot of effort to map a traditional course into one that is immersive and interactive.

Teachers or educators are incentivized to tick off learning objectives as fast as possible, in the seemingly most efficient ways possible. This typically involves PowerPoint slides and furious notetaking by students, followed by an intense period of memorizing, rehearsing and taking preparatory tests, so that students are trained for tests not to meet objectives in the wild.

In most cases, the traction of courses in virtual worlds is not achieved because the cost is simply too high. It is much easier and cheaper to just stick to traditional methods, even though they may be less effective in the long run.

Some notable failures of training in virtual worlds include:

1. Lack of immersion leading to less effective training
2. Lack of social interaction leading to less effective training
3. Technical difficulties leading to less effective training.
4. Some teachers find it hard to control student behavior in virtual worlds.

Dress code in virtual environments

As the world of education increasingly moves online in the wake of the COVID-19 pandemic, the question of what constitutes appropriate dress code in virtual learning environments has come to the fore. While there are no easy answers, there are a few guiding principles that educators can keep in mind as they make decisions about dress code in their online classrooms.

First and foremost, it is important to remember that virtual learning environments are still learning environments, and so the same standards of professionalism and respect should apply as in brick-and-mortar classrooms. That means that educators should dress in a way that is professional and respectful of their students.

That said, there is also a need to be mindful of the fact that students are learning in their homes, and so there may be a greater need for flexibility when it comes to dress code. In general, it is probably best to err on the side of caution and to avoid anything that could be construed as overly revealing or offensive.

Ultimately, the decision of what is appropriate to wear in a virtual learning environment will come down to the individual educator and the specific context of their classroom. However, by keeping the above principles in mind, educators can ensure that they are making decisions that are in the best interests of their students and that will create a respectful and professional learning environment.

This image portrays a group of students, such as avatar B, participating in a virtual language classroom. The instructor has meticulously designed the learning environment, from the seating arrangements and classroom structure to the educational materials, including posters, signboards E, and video displays C.

The room also features innovative 3D bookmarks A that, when clicked, load videos or websites as needed. These interactive bookmarks are easily movable, can be arranged on a virtual bookshelf, and are labeled with a description of the content they link to. This groundbreaking approach to managing web bookmarks in a

3D environment not only makes them simple to find and organize but also enhances the overall learning experience.

This early example of a 3D virtual classroom demonstrates the potential for immersive and engaging educational environments, showcasing the future of learning and teaching.

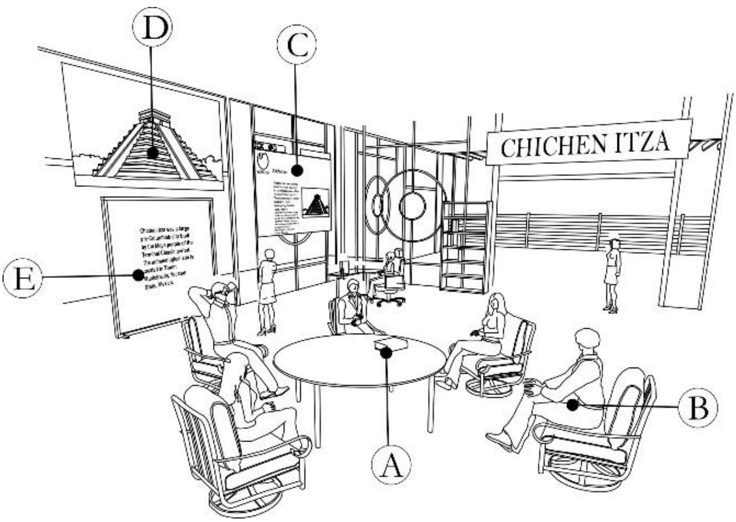


Figure 34 Language classroom in a virtual world

Cultivating a safe environment for students

There are several ways that teachers can create a safe environment for students in 3D virtual worlds:

1. Establish clear rules and guidelines for behavior in the virtual world.

2. Monitor student activity in the virtual world.

3. Create a safe space in the virtual world where students can go if they feel unsafe or uncomfortable.

4. Respond quickly and effectively to any incidents of harassment or bullying.

5. Use parental controls to limit student access to certain areas of the virtual world.

6. Educate students about responsible behavior in online environments.

Tips for implementing a learning plan.

The main issues to consider when designing a 3D world online course are how to create an engaging and immersive environment, how to use 3D technologies to create meaningful learning experiences, and how to ensure that the course is accessible to all learners.

When coming up with new innovative teaching approaches in virtual worlds, it is important to first consider the needs of your students and what you hope to achieve with the virtual world. Once you have a clear understanding of your goals, you can then begin to brainstorm ideas for how best to utilize the virtual world to meet those goals. This may involve coming up with new ways to use the space, incorporating new technologies, or even creating entirely new virtual worlds. The important thing is to be creative and think outside the box to come up with the most effective and innovative approaches possible.

Tips for implementing a learning plan for virtual worlds may include:

1. Make sure to set realistic goals that can be achieved within the timeframe of the learning plan.
2. Outline specific steps that need to be taken in order to complete the learning plan.
3. Create a timeline for completing the different steps of the learning plan.
4. Find a way to hold yourself accountable to completing the learning plan. This could involve finding an accountability partner or setting up reminders.

Here is a step-by-step list of instructions for a subject matter expert interested in creating a course in a 3D virtual world:

1. Choose the 3D virtual world you would like to create your course in.
2. Plan out the content and structure of your course.
3. Create your course in the 3D virtual world, adding in your content and structure as you go.

4. Test out your course to make sure everything works as intended.
5. Make any necessary adjustments to your course.
6. Once you are satisfied with your course, publish it so others can access and take it.

Designing learning scenarios

It is often the case that educators lack the time to experiment with educational technologies; they tend to need finished examples that they can assess before making decisions about the value of a given approach to learning. We are therefore particularly interested in helping educators design virtual world content to support their primary learning objectives. What are the 10 steps we recommend every educator should follow to create virtual world learning experiences?

The following are 10 steps we recommend every educator should follow to create virtual world learning experiences:

1. Understand your audience. It is important to understand your target audience to determine what type of content will be most appropriate and useful for them.

2. Define your learning objectives. What do you want your students to learn as a result of participating in your virtual world learning experience?

3. Choose a virtual world platform. There are a variety of different virtual world platforms available, each with its own strengths and weaknesses. It is important to choose a platform that will best support your learning objectives.

4. Create a learning scenario. A learning scenario is a detailed description of the steps involved in a particular learning experience. It is important to create a learning scenario before beginning to design your virtual world content.

5. Design your virtual world content. Once you have created a learning scenario, you can begin to design the content for your virtual world. This content should be aligned with your learning objectives.

6. Create assessment activities. Assessment activities are an important part of any virtual world learning experience. They should be designed to evaluate whether students are meeting the learning objectives.

7. Implement your virtual world learning experience. Once you have designed your virtual world content and assessment activities, you can begin to implement your learning experience.

8. Monitor student progress. It is important to monitor student progress throughout the virtual world learning experience. This will help you to identify any areas where students are struggling and make necessary adjustments. Competency evaluation is a key aspect of

learning environments. What you cannot measure cannot be improved.

9. Evaluate student learning. At the end of the virtual world learning experience, it is important to evaluate student learning. This will help you to determine the effectiveness of the experience.

10. Make improvements. Based on the evaluation of student learning, it is important to make improvements to the virtual world learning experience. This will help to ensure that future students have a more successful experience.

Abstractions

When teaching, it is important to understand how abstractions are created and shaped. This knowledge can help educators design more effective lessons and better assess student understanding. Abstractions are created when we take a complex concept and simplify it into something more manageable. This process can be useful when we need to quickly grasp a new idea or when we want to communicate a concept to others. However, abstractions can also distort our understanding of a concept if we are not careful.

When shaping an abstraction, we need to be aware of the potential for oversimplification. We also need to consider how our own biases and assumptions can distort the abstraction. It is important to be thoughtful and intentional when creating an abstraction.

Teachers can use abstractions to help students understand complex concepts. However, it is important to be aware of the potential for oversimplification and distortion. By being thoughtful and intentional in the creation of abstractions, teachers can help their students develop a deeper understanding of the concepts being taught.

Give examples please.

Importance of modular design

The ability to access a library of high-quality, interactive 3D objects is crucial for subject matter experts who wish to create custom virtual worlds. Without such a library, these experts would be forced to either create the objects themselves or find and purchase them from third-party sources. Not only would this be time-consuming and expensive, but it would also likely result in lower-quality virtual worlds.

A good library of 3D objects offers several advantages. First, it saves time and money by providing a ready-made set of objects that can be used to create a virtual world. Second, it ensures that the objects are of high quality, which is important for creating realistic and believable virtual worlds. Finally, it allows experts to create zero-coding and 3Dmodeling virtual worlds quickly and easily without having to learn how to program or create 3D objects themselves.

Breaking down course content for virtualization

To create a continuous virtual learning experience for students in a 3D virtual world, educators need to break down their course or topic into well-defined learning objectives. They can then gather virtual content to support the teaching and evaluation of these objectives. To create a continuous virtual learning experience, educators need to design their virtual world in such a way that students can move between different areas and engage with the content in a variety of ways.

The first step is to break down the course or topic into well-defined learning objectives. This will help to ensure that the virtual content is focused and relevant to the students. It is also important to consider how the learning objectives can be sequenced to create a cohesive and logical learning experience.

Once the learning objectives have been identified, the next step is to gather virtual content to support the teaching and evaluation of these objectives. This content can be in the form of text, images, audio, video, or interactive 3D simulations. It is important to select content that is of high quality and engaging for the students.

Once the content has been gathered, the next step is to design the virtual world in such a way that students can move between different areas and engage with the content in a variety of ways. This can be done by creating different types of learning experiences, such as tutorials, quizzes, and games. It is also important to provide students with a way to navigate the virtual world and to keep track of their progress.

The final step is to create a continuous virtual learning experience for students by providing them with feedback and support. This can be done by setting up a system for students to submit their work, such as an online forum or blog. It is also important to provide students with a way to contact the educator if they have any questions or need help.

Tools to amplify Teacher productivity.

Virtual office applications that allow users to hold meetings, collaborate on projects, and exchange files in a virtual environment.

3D modeling and design applications that allow users to create and modify 3D models and designs.

Virtual education applications that allow users to attend classes, complete assignments, and take exams in a virtual environment.

Virtual training applications that allow users to practice skills and procedures in a virtual environment.

Many collaborative applications are already available to support learning in virtual worlds. Many which already exist on desktops have gradually migrated to immersive worlds. We recommend that teachers get familiar with and start using them even before they integrate them in their classrooms.

1. Use online tools: There are many online tools that can help with brainstorming, such as mind mapping tools, online whiteboards, and virtual sticky notes.

2. Use video conferencing: Video conferencing can be a great way to brainstorm with others, as it allows for real-time collaboration and brainstorming.

3. Use social media: social media can be a great way to brainstorm ideas, as it allows for quick and easy idea sharing.

4. Use collaborative document editing: Collaborative document editing tools, such as Google Docs, can be a great way to brainstorm ideas with others in a virtual environment.

5. Use chat tools: Chat tools, such as Slack, can be a great way to brainstorm ideas with others in a virtual environment.

Examples of data visualization that appear to be suited for an avatar based virtual world.

1. A visualization of data that can be interacted with and explored in a three-dimensional virtual world.

2. A visualization of data that can be seen from different angles and perspectives in a virtual world.

3. A visualization of data that can be zoomed in and out of in a virtual world.

Creating content for virtual worlds

For engineers and 3D modelers

The fastest way to create content in a 3D virtual world is to use a game engine. A game engine is a software framework that provides functionality for game development. It includes a physics engine, a rendering engine, and a scripting language. Game engines are used to create video games, simulations, and other interactive 3D applications.

There are many commercial game engines available, such as the Unity engine and the Unreal engine. These engines can be used to create high-quality 3D content quickly and easily. There are also several free and open-source game engines available, such as the Godot engine and the Armory engine.

To create content in a 3D virtual world, you will need to create 3D models. There are many software applications that can be used to create 3D models, such as Blender and Maya. Once you have created your 3D models, you can then import them into your game engine and start creating your virtual world.

For teachers

How to create content quickly in a 3D virtual world includes using pre-made templates or models, utilizing automatic or procedural generation tools, and collaborating with other users. Additionally, it is often helpful to have a clear plan or vision for what needs to be created before starting to build it in the virtual world.

Prototyping information displays.

3D avatar based virtual worlds provide a great opportunity for prototyping information displays, exhibits, and poster sessions because they allow for a high degree of customization and flexibility. For example, a virtual world can be created that closely resembles a physical space, such as a museum or trade show floor. This allows for accurate testing of how users will interact with the displays and exhibits. Additionally, virtual worlds can be easily reconfigured to test different layouts or to simulate different user scenarios. This allows for a high degree of experimentation and iteration, which is essential for effective prototyping. The image illustrates an example of a user-friendly Composer Application, dubbed "Melacraft," designed to streamline content creation. Avatar A is shown signing into the app by clicking the button next to it, gaining access to various modules and resources available within the virtual landscape.

Avatar (A) interacts with a 2D HUD to effortlessly place cubes (B) on top of one another with single clicks. Thanks to the objects' optimal snapping capabilities, building and designing become seamless and intuitive. Users can also customize each cube with different colors, save their creations (C), and clear or load scenes as needed.

This snapshot of Melacraft highlights the potential for innovative, accessible content creation tools in virtual environments, empowering users to explore their creativity and engage with the digital world in new, exciting ways.

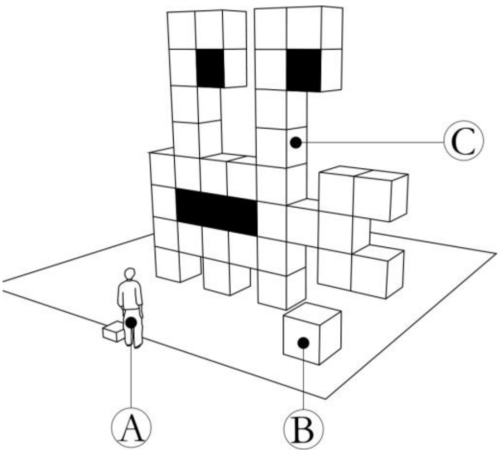


Figure 35 Uses can rapidly build 3D content through point-and-click operations using the Melacube (c. 2020)

This image showcases an avatar B skillfully utilizing the Composer App A to design an engaging 3D Pixel Art character using simple blocks. The avatar has the freedom to select the color of these blocks, as demonstrated by the varying shades of grey in blocks C and D.

Once completed, these creative scenes can be saved and shared with peers, fostering collaboration and inspiring others to explore the limitless possibilities of 3D art within the virtual environment. This example highlights the potential for innovative tools like the Composer App to empower users and transform the way they express themselves through digital art.

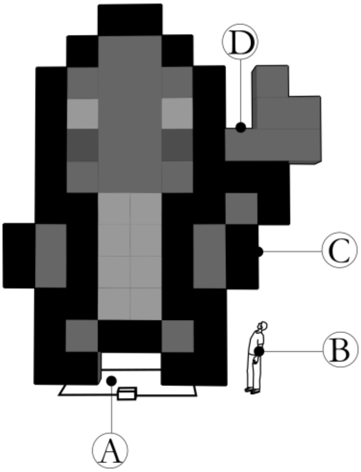


Figure 36 An avatar assembling a 3D sculpture from blocks with selectable textures (c. 2020)

In this intriguing image, avatar A is seen skillfully crafting an exhibit using the Melacraft Composer application by piecing together a series of blocks B. While the texture resolution per face for each object is restricted by the virtual world platform, the application allows users to apply individual textures to separate objects, enabling the display of much higher-resolution images.

In this particular scene, we observe a high-definition depiction of the renowned "Tower of Babel" painting C. To provide context and additional information, a cube with accompanying text D is included alongside the painting. This example highlights the impressive potential and versatility of a well-designed app in a 3D virtual world, empowering users to create and share immersive and visually engaging experiences.

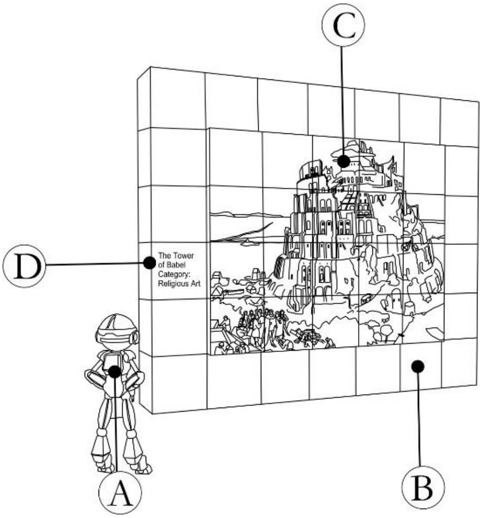


Figure 37 Using the Melacube to create museum exhibits such as this high definition picture of a famous painting

This image presents another example of how straightforward designs can enable the creation of a vast array of content using the Melacraft application. In this instance, the application has been employed to construct a periodic table of elements.

The figure displays a Composer app, which can be accessed by clicking on A. Each cube C is appropriately labeled with a letter representing a specific element. The information-laden cubes B, hovering above the others, provide relevant details about the periodic table. This seemingly floating appearance is achieved by cleverly removing the underlying cubes, demonstrating the versatility and creative potential of the Melacraft application in designing educational content.

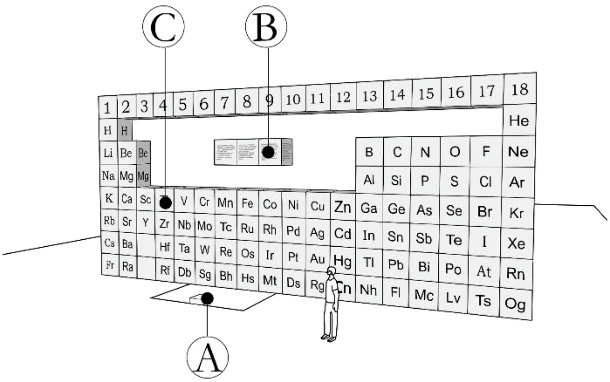


Figure 38An avatar exploring a Periodic table constructed from blocks (c. 2020)

The image showcases the versatility of the Melacraft application, highlighting its users' ability to create diverse 3D structures. Not only can they construct columns, such as column B, and roofs using blocks, but they can also enclose non-cubical objects within a transparent cube. By snapping these enclosed objects to others seamlessly, users can rapidly generate a wide array of content, demonstrating the power and adaptability of the Melacraft application in crafting unique and engaging designs.

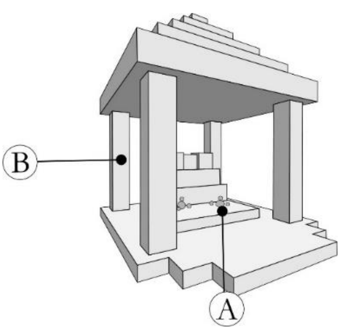


Figure 39 Using 3D cubes to build 3D buildings

Advantages of organizing information in 3D spaces

There are many cognitive implications of organizing files and bookmarks as 3d objects in a shared multiuser virtual world. One implication is that it can help people to better understand the relationships between different pieces of information. When information is organized in a three-dimensional space, it is easier to see how different pieces of information are related to each other. This can help people to better understand the overall structure of the information and how the different pieces fit together.

Another implication is that organizing information in a three-dimensional space can help people to remember the information better. When information is organized in a way that is easy to visualize, people can more easily recall the information later. This is because the brain is better able to remember information when it is presented in a visual format.

Finally, organizing information in a three-dimensional space can also help people to find the information they are looking for more easily. When information is organized in a three-dimensional space, it is easier to see where everything is located. Overall, there are many cognitive implications of organizing files and bookmarks as 3d objects in a shared multi user virtual world. This type of organization can help people to better understand the relationships between different pieces of information, remember the information better, and more easily find the information they are looking for.

Social bandwidth in 3D avatar-populated spaces is inherently wider than in spaces without avatars. In 3D information spaces, avatars provide opportunities for collaboration around points of access to information, in the real world, these are books in racks, in the virtual world, these could be 3D files or bookmarks.

Productivity tools

There are many project management and productivity tools that can be implemented using sticky notes on a board. Some of these tools include Kanban, Scrum, and others. Each tool has its own unique benefits that can help organizations improve their productivity.

Kanban is a tool that can help organizations visualize their workflows and identify bottlenecks. It can also help organizations track the progress of their work and ensure that work is evenly distributed among team members.

Scrum is a tool that can help organizations break down their work into smaller, manageable pieces. It can also help organizations track the progress of their work and ensure that work is completed on time.

Other tools that can be implemented using sticky notes on a board include task boards, which can help organizations track the progress of their work and ensure that work is evenly distributed among team members; and personal productivity systems, which can help individuals track their own work and progress.

Success stories

Some of the best success stories of learning in virtual worlds come from educational institutions that have used virtual worlds to supplement or replace traditional classroom instruction. For example, the University of Southern California has used virtual worlds to teach medical students about human anatomy, and the Massachusetts Institute of Technology has used virtual worlds to teach physics. Other success stories come from businesses that have used virtual worlds to train employees, such as Walmart, which has used virtual worlds to train its employees on customer service and safety procedures.

Simulating real world training exercises

We can migrate training exercises in the real world into the virtual world. Virtual exercises offer several advantages: learners can experience learning while immersed in the simulated problem space, more skills are retained and concepts are retained for longer periods, competency evaluation becomes easier since it is possible to monitor in real time the performance of students, and subject matter experts can build custom scenarios without having to hire a team of 3d content modelers or coders.

The importance of practicing on replicas of real-world objects becomes evident. It immerses students into the subject directly. Learning from simulations directly applies to real-life situations. Over the years, we have developed immersive training courses for emergency preparation or virtual therapeutic environments for young neurotypical users in a medical setting.

In this image, we see avatars A B and C donning nursing uniforms, engaging in a practice session to rehearse their response procedures in the event of a sudden influx of patients at a hospital. The avatars can communicate with one another via voice and interact with various objects in the virtual hospital environment, allowing them to locate appropriate clothing and equipment as needed.

This scene represents an early example of how virtual worlds can be utilized by hospital staff to learn and practice their responses to emergency situations. By offering a safe and controlled environment, these virtual simulations provide valuable training experiences for healthcare professionals, better preparing them for real-life crisis scenarios.

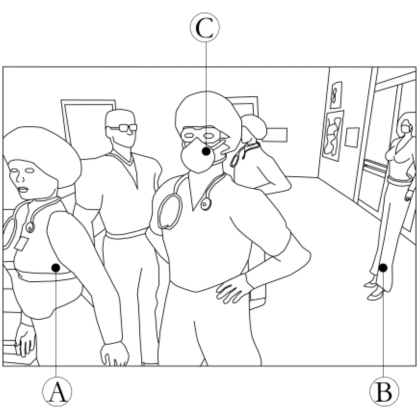


Figure 40 Nursing staff role-playing as avatars in a virtual hospital (c. 2010)

This image offers an alternative perspective of the nursing station, showcasing its various features designed to facilitate an efficient and organized healthcare environment. Visible within the scene are hospital navigation aids F, informative posters D reminding staff of personal protective equipment best practices, where to access them E, an assortment of available equipment B, a well-structured seating arrangement C, and conveniently placed hand sanitizers A.

Though simple in design, these virtual environments effectively trigger an immersion response in trainees, who must regularly participate in training and skill upgrades. By closely simulating real-world healthcare settings, these virtual spaces provide valuable learning opportunities and contribute to the ongoing professional development of medical personnel.

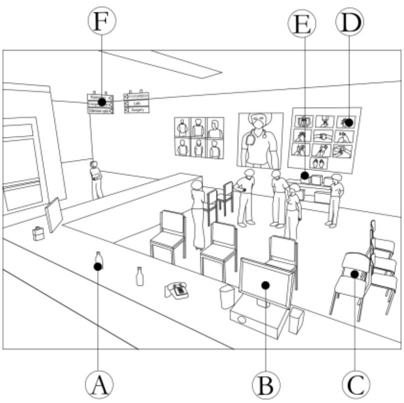


Figure 41 Nursing staff role practising the donning of PPEs at the nursing station (c. 2010)

The image depicts a typical hospital patient room, complete with various objects and amenities commonly found in such settings. Non-player characters are often used to simulate patients, providing hospital staff with realistic training experiences. In this virtual environment, staff members can familiarize themselves with the controls of modern hospital beds E, as well as gain an understanding of the location of patient drawers A and other appliances, such as the lamp C.

Having access to content creation tools enables hospital instructors to develop their own virtual training environments tailored to their specific needs. These immersive spaces provide valuable opportunities for staff to learn and practice essential skills, ultimately improving the quality of patient care.

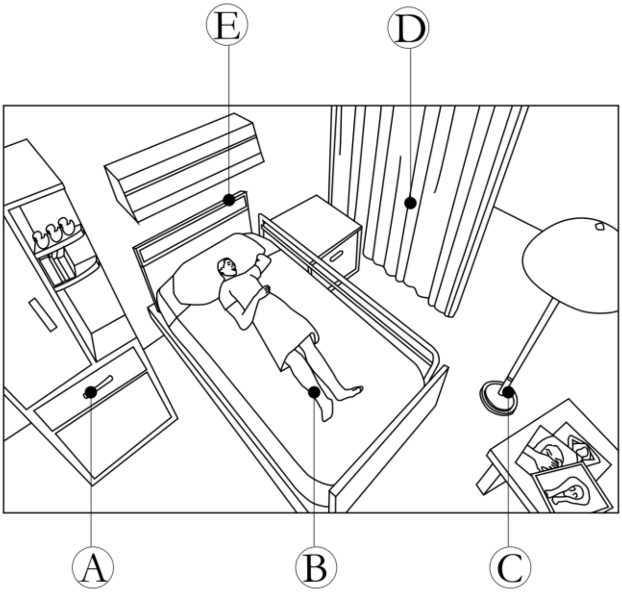


Figure 42 A non player character taking the role of a patient in the hospital (c. 2010)

Using quests to structure learning

There are many ways to organize the learning of a particular subject matter as a quest in a 3D avatar based virtual world. One way would be to create a quest that must be completed to learn the subject matter. This quest could involve finding certain objects, solving puzzles, or defeating opponents. Another way to organize the learning of a particular subject matter as a quest in a 3D avatar based virtual world would be to create a series of quests that must be completed to learn the subject matter. This could involve completing a series of tasks, collecting certain items, or defeating a series of opponents. For example, a quest series on the history of the United States could start with a quest that introduces the basic concepts of the country's founding. subsequent quests could cover more specific topics such as the American Revolution, the Civil War, and the Civil Rights Movement.

There are a few different ways that a new language could be taught in a 3D avatar based virtual world. One way would be to have the avatar wander around the virtual world, encountering different objects and people who would speak to the avatar in the new language. The avatar would then have to figure out what the new words mean to continue on the quest. Another way would be to have the avatar take part in different activities in the virtual world that would require the use of the new language. For example, the avatar could go to a virtual restaurant and order food in the new language. The avatar could also visit a virtual store and ask for directions in the new language.

Low hanging use cases

Architecture and landscape design

Virtual worlds can impact the teaching of architecture education by providing students with a realistic, three-dimensional environment in which to learn about architecture and design. Students can explore different architectural styles and learn about the history and theory of architecture through virtual worlds. Additionally, virtual worlds can be used to create prototypes of architectural designs collaboratively, which can then be tested and evaluated.

There are a few ways that virtual worlds can impact the teaching of landscape design education. One way is that virtual worlds can provide a realistic and immersive experience that can help students learn about landscape design principles. Another way is that virtual worlds can offer a variety of landscape design challenges that can be used to teach students about problem solving and design thinking. Additionally, virtual worlds can be used to create a collaborative learning environment where students can work together to design and build landscape projects.

Virtual worlds can provide an immersive and interactive environment for garden design education. Students can explore different garden designs and learn about plant species and their care.

Virtual worlds can also allow students to experiment with different design elements and see the results of their choices in real time. This can help them to understand the principles of garden design and how to create beautiful and functional outdoor spaces.

The image demonstrates the remarkable extent to which virtual landscapes can be modified to reflect seasonal changes, enhancing the realism and immersion of the scenes. By developing a method to "skin" landscapes according to the season, the appearance of foliage can be adjusted accordingly.

In the example provided, A shows trees adorned with lush leaves, achieved by updating the textures on all foliage objects as needed. Conversely, B illustrates trees that have shed their leaves, displaying only bare branches. These attention-to-detail adjustments contribute significantly to making immersive environments more lively and engaging for users, creating a more authentic and dynamic virtual experience.

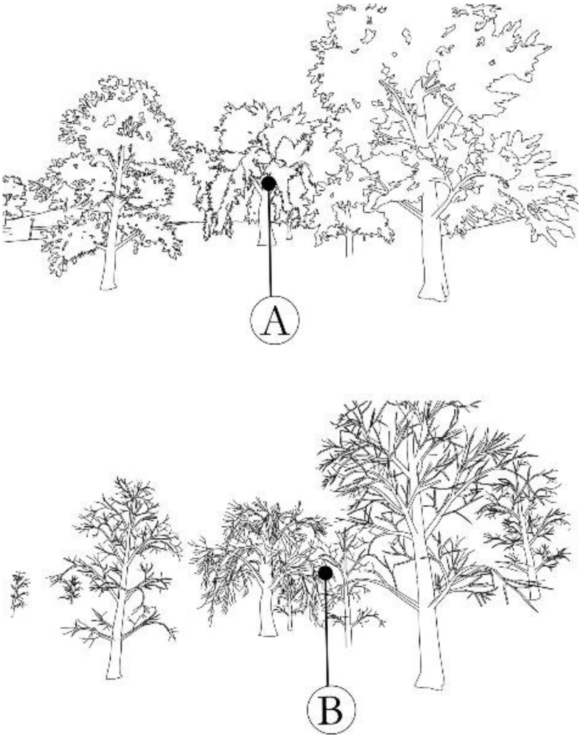


Figure 43 Representing changing seanings by scene skinning to change foliage characteristics in real time

Examples of applications for emergency preparedness training: Virtual worlds can be used to train emergency preparedness professionals in a variety of ways. For example, virtual worlds can be used to create simulations of natural disasters or other emergencies. These simulations can be used to train emergency personnel in how to respond to such events. Additionally, virtual worlds can be used to create educational materials related to emergency preparedness. These materials can be used to educate emergency personnel on a variety of topics, such as first aid, evacuation procedures, and safety protocols.

Architects creating reusable architecture models.

Architects create abstractions by breaking down the complex reality of a space into simpler, more manageable parts. These parts can then be reused in other virtual spaces to create new environments. This process allows architects to create complex environments without having to start from scratch each time.

One of the most important aspects of creating abstractions is ensuring that they are reusable. This means that the parts can be used in different ways to create different environments. For example, a door might be used in one environment to enter a room, while in another environment it might be used as a way to exit a room. By making the parts reusable, architects can save time and effort when creating new virtual spaces.

An important consideration when creating abstractions is how they will be used. Will they be used to create entire environments, or will they be used as part of larger environments? Will they be used by people who are familiar with the space, or will they be used by people who are new to the space? By considering how the abstractions will be used, architects can ensure that they are creating parts that will be useful to people in the real world.

Another consideration when creating abstractions is how they will be represented. Will they be represented as 3D models, or will they be represented as 2D images? Will they be represented as text, or will they be represented as symbols? By considering how the abstractions will be represented, architects can ensure that they are creating parts that will be easy to understand and use.

The next illustration highlights the remarkable versatility of the Composer App, demonstrating its applicability even in architectural design. In this example, a module containing a thoughtfully designed set of building components is featured. These components are designed to snap together seamlessly, making the assembly of structures a breeze.

The system is capable of intuitively connecting various objects with a minimal number of clicks, as it possesses enough information about each object to determine how they can best connect to one another. In this scene, we see a base room A, featuring a roof opening for a staircase rail. Additional examples of objects include C, the simplest cubical room conceivable; D, a room with a balcony; and B, a connecting bridge. This illustration showcases the immense potential of the Composer App in streamlining the creation of complex, interconnected structures.

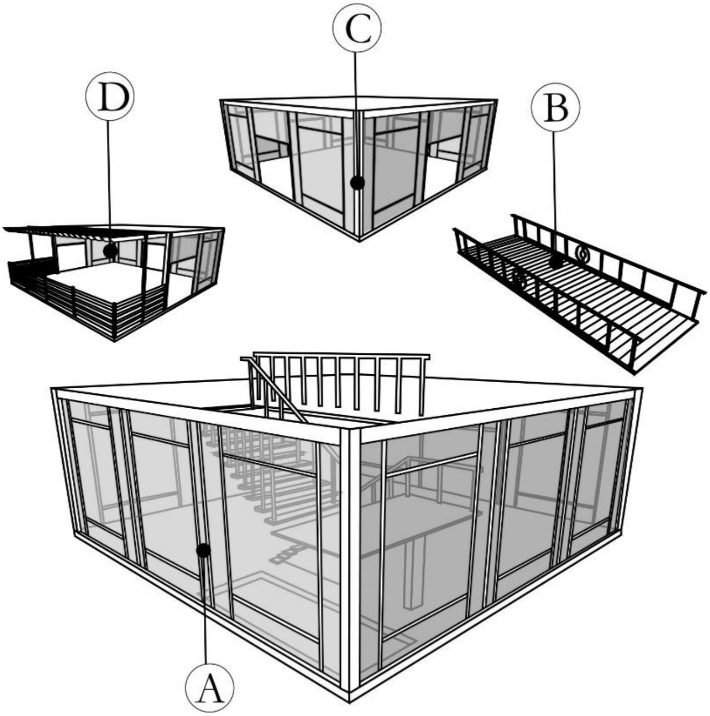


Figure 44 Components of a building

By creating abstractions, architects can create complex environments without having to start from scratch each time. By making the parts reusable, architects can save time and effort when creating new virtual spaces. By considering how the abstractions will be used, architects can ensure that they are creating parts that will be useful to people in the real world. And by considering how the abstractions will be represented, architects can ensure that they are creating parts that will be easy to understand and use.

The ability for architects to create abstractions and embody them as reusable simpler architectural parts in virtual worlds is a powerful tool that can be used to create more efficient and realistic designs. This process can be used to create both small and large-scale structures, as well as to create more detailed and realistic models of existing buildings. In addition, this technique can be used to create novel designs that would be difficult or impossible to create in the real world.

The image depicts a vast virtual landscape with a stunning view of a large building, surrounded by various walking pathways, trees, and rocks. The landscape is meticulously designed and crafted using various pre-designed components that can be assembled by end-users. The Composer App, as it is called, provides a simple and intuitive interface that allows anyone to create modular parts and snap them together seamlessly to build impressive structures and landscapes.

With this innovative approach, the path from ideation to a tangible building has been significantly shortened, making it easy for users to create new designs and share them with others. The landscape is alive with color and motion, and the building's scale is awe-inspiring. As you explore the virtual space, you can't help but be struck by the beauty and detail of the environment, and the ease with which it was created.

Overall, the Composer App is a powerful tool that empowers users to unleash their creativity and bring their ideas to life with minimal effort. It represents a major leap forward in the world of building and design, and the possibilities it offers are endless.

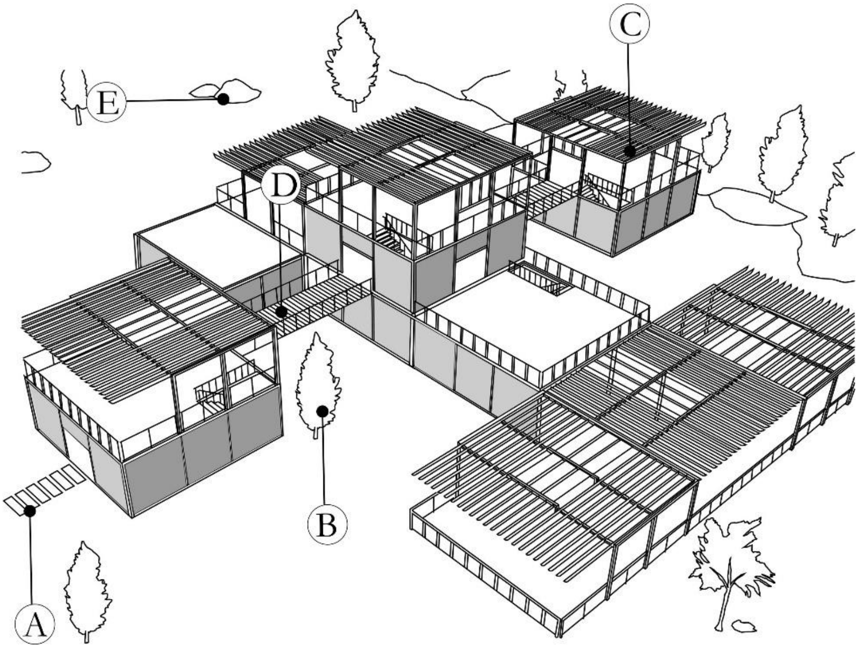


Figure 45 A large building and surroundings composed using simpler repeatable parts

There are many ways that architects can create abstractions. One common method is to use software to create simplified 3D models of buildings. This can be done by removing unnecessary details, such as windows and doors, or by using simple geometric shapes to represent complex objects. This technique is often used to create conceptual models or to test ideas before they are implemented in the real world.

Another way to create abstractions is to physically build prototypes of structures. This can be done on a small-scale using paper or cardboard, or on a larger scale using wood, metal, or concrete. This method is often used to test ideas before they are implemented in the real world.

Once an architect has created an abstraction, they can then embody it as a simpler architectural part in a virtual world. This can be done by creating a 3D model of the abstraction and then placing it in a virtual world. This technique can be used to create more efficient and realistic designs, as well as to create more detailed and realistic models of existing buildings. In addition, this technique can be used to create novel designs that would be difficult or impossible to create in the real world.

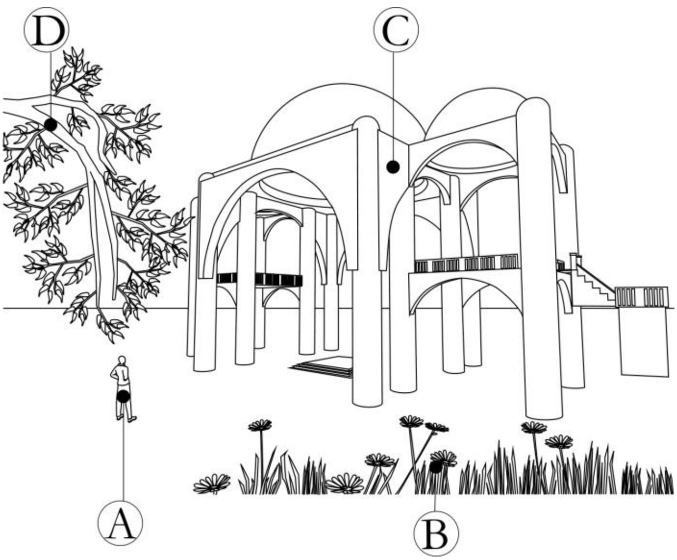


Figure 46 This structure was assembled in a few minutes using a Composition tool that can be used inside a 3D virtual world (c. 2021)

Massing primitives

In recent years, architects have become increasingly interested in the potential of virtual worlds as a tool for design and communication. These three-dimensional, computer-generated environments offer a unique way to create and explore architectural designs, and to communicate those designs to others. One of the key advantages of virtual worlds is that they allow for the creation of abstractions, such as massing primitives, which can be used to create more complex designs.

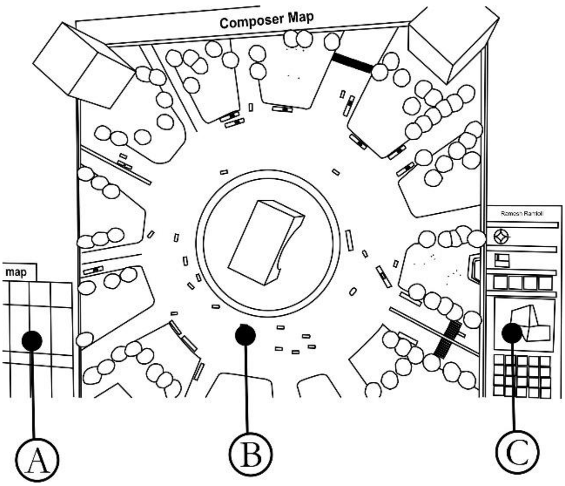


Figure 47 Massing primitives

Massing primitives are simple, reusable architectural parts that can be used to create more complex structures. By creating these abstractions, architects can explore a wide range of design possibilities without having to create each element from scratch. This is especially beneficial when working in virtual worlds, where the ability to quickly create and test different designs is crucial. There are several ways in which architects can create massing primitives in virtual worlds. One approach is to use existing objects or structures as a starting point. For example, a building block or a column could be used as the basis for a massing primitive. By modifying the size, shape, and orientation of these existing objects, architects can create a variety of different massing primitives.

Another approach is to create massing primitives from scratch. This can be done by creating simple geometric shapes, such as cubes, spheres, or cylinders, and then manipulating them to create the desired form. Once again, the size, shape, and orientation of the objects can be modified to create a variety of different massing primitives.

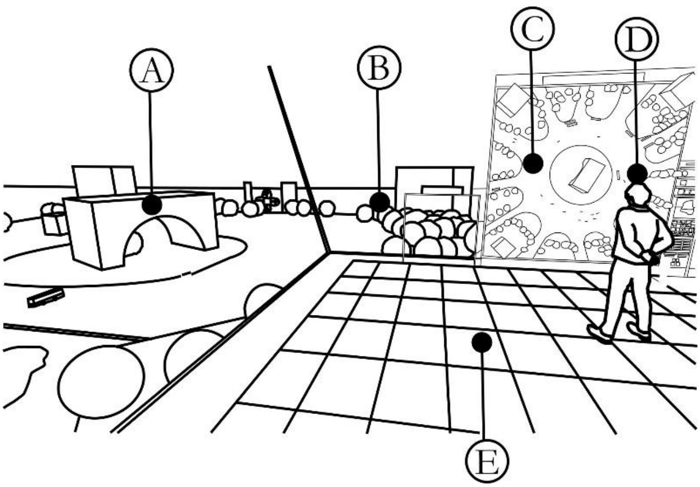


Figure 48 Massing primitives deployed large scale

After a set of massing primitives has been created, they can be used to create more complex structures. This can be done by combining the different primitives into a single structure, or by using them to create a series of interconnected structures. By combining massing primitives in different ways, architects can create a wide range of different designs. The use of massing primitives is just one of the many ways in which architects can use virtual worlds to create abstractions. By exploring the potential of virtual worlds, architects can find new and innovative ways to design and communicate their ideas.

Administration of Psychological Therapies

There are many ways that mental health providers could use the Metaverse. One way would be to create virtual reality environments that clients could explore to work through their issues. This would allow clients to safely experience difficult situations and emotions while being supported by a therapist. Another way mental health providers could use the Metaverse is by providing online counseling and support groups. This would allow people with mental illness to connect with others who understand what they are going through and provide them with support and advice.

The Metaverse is well positioned to become a good venue to help individuals with cognitive or behavioral problems including treating patients with PTSD, OCD, anxiety disorders, and depression. Additionally, virtual reality has also been used in rehabilitation programs for stroke and traumatic brain injury patients.

The Metaverse could be used as a tool for empathy training by engaging users in realistic simulations of social interactions with people from different backgrounds. These simulations could help people to understand and respond emotionally to the experiences of others, potentially leading to increased levels of empathy in real-world situations.

Museum design

Virtual worlds can help museum curators and designers by providing a platform for them to create and experiment with exhibit designs. This can be especially helpful in the planning stages of exhibitions, when curators and designers need to get a sense of how the space will look and feel and how visitors will move through it. Virtual worlds also allow for the testing of exhibit designs before they are built, which can save time and money. In addition, virtual worlds can provide a way for visitors to interact with exhibits in a more immersive and interactive way that allows visitors to explore and learn in new ways. Curators and designers can also use virtual worlds to create educational programs and tours.

In the illustration before us, we witness Avatar (B) navigating through a 3D museum exhibit (D), set within the spacious Museum Room (C). The scene is thoughtfully designed, with an inviting seating arrangement (A) positioned for avatars eager to sit and absorb the surrounding artistry. Remarkably, this entire virtual setup can be effortlessly crafted by an end-user in mere minutes using our innovative Composer App, which seamlessly communicates with selected modules containing the necessary objects for this engaging experience. Each painting exhibit, displayed on signposts with varying aspect ratios, is interactive, enabling avatars to adjust their camera placement for an optimal viewing experience with just a simple click.

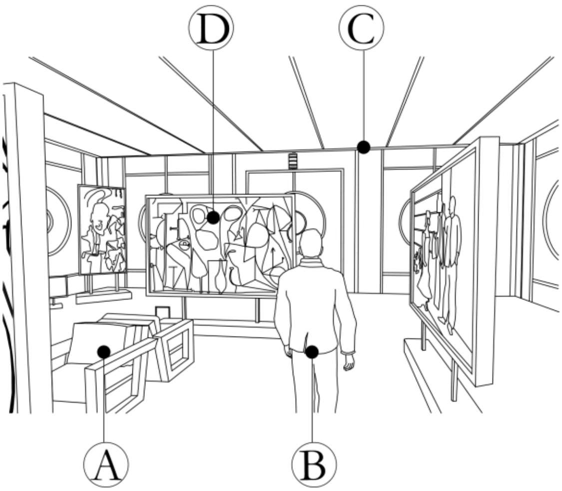


Figure 49 Avatar exploring a virtual 3D museum (c. 2021)

In the enthralling view of the museum, the avatar delves into another area featuring various exhibits, including Exhibit B, alongside furniture pieces like C and D, and eye-catching light fixtures such as A. These interactive light sources offer designers an engaging way to experiment with optimal lighting design, allowing them to fine-tune their concepts in the virtual world before implementing them in real-world museum prototypes. We think that such tools in the hands of motivated museum staff can go a long way into improving the experience offered to museum visitors.

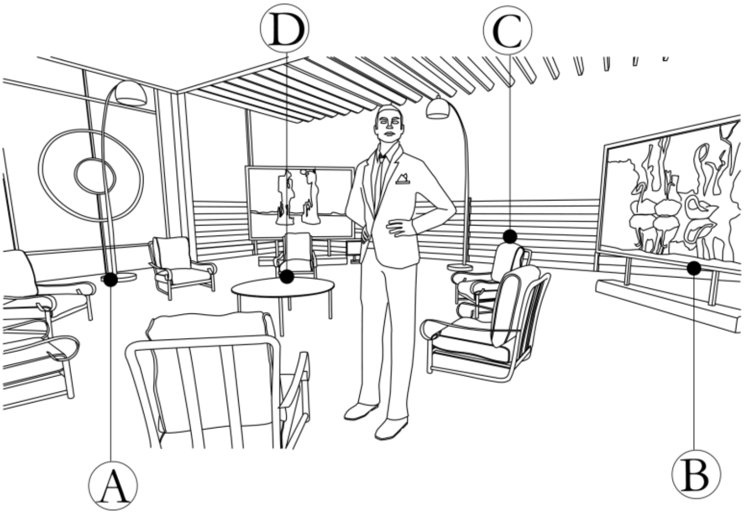


Figure 50 All the objects in this virtual world were deployed using a rapid scene composition tool (c. 2021)

Story telling

Virtual worlds are ideally suited to teach storytelling because they provide an immersive, interactive experience that allows users to explore different storylines and make choices that affect the outcome of the story. Additionally, virtual worlds can be designed to simulate different settings and scenarios, providing a variety of options for storytellers to choose from. One of the key advantages of using a virtual world to teach storytelling is that it allows users to experiment with different choices and see the consequences of their choices in real time. This type of interactive experience is not possible with traditional methods of storytelling, such as books or movies. Additionally, virtual worlds can be designed to provide a variety of different challenges and obstacles for users to overcome, making the experience more engaging and interactive.

Finally, virtual worlds can be used to teach storytelling to a wide range of people, from children to adults. They can be accessed by anyone with an internet connection, making them a convenient and accessible option for teaching storytelling.

Machinima

Recording of activities in virtual worlds are ideally suited to be transformed into animated educational video content for several reasons. First, recording in virtual worlds provides a first-person perspective of the content, which can be helpful for learners to gain a more immersive experience. Second, recording in virtual worlds eliminates the need for expensive equipment and software, as well as the time and effort required to set up and maintain a physical recording studio. Finally, recording in virtual worlds offers a unique opportunity to create engaging, interactive content that can be used to teach a variety of subjects.

When it comes to recording educational content, virtual worlds offer several advantages over traditional methods. First, recording in virtual worlds provides a first-person perspective of the content, which can be helpful for learners to gain a more immersive experience. Second, recording in virtual worlds eliminates the need for expensive equipment and software, as well as the time and effort required to set up and maintain a physical recording studio. Finally, recording in virtual worlds offers a unique opportunity to create engaging, interactive content that can be used to teach a variety of subjects.

First, recording in virtual worlds provides a first-person perspective of the content, which can be helpful for learners to gain a more immersive experience. In a traditional recording studio, the camera is typically positioned in front of the subject, providing a third-person perspective. This can be disorienting for learners, as they are not able to see what the subject is seeing. However, in a virtual world, the camera is positioned within the world, providing a first-person perspective. This allows learners to see the world through the eyes of the subject, providing a more immersive experience.

Second, recording in virtual worlds eliminates the need for expensive equipment and software, as well as the time and effort required to set up and maintain a physical recording studio. In a traditional recording studio, a variety of expensive equipment is required, including cameras, lights, and sound equipment. In addition, special software is required to edit and process the video footage. This can be a significant barrier for many educators, as the cost of setting up and maintaining a traditional recording studio can be prohibitive. However, in a virtual world, all this expensive equipment and software is not required. All that is needed is a computer with an internet connection. This makes recording in virtual worlds much more accessible for educators, as the cost of setting up and maintaining a virtual recording studio is much lower than the cost of a traditional recording studio.

Finally, recording in virtual worlds offers a unique opportunity to create engaging, interactive content that can be used to teach a variety of subjects. In a traditional recording studio, the focus is typically on creating a single, static video. However, in a virtual world, the focus is on creating an interactive, immersive experience. This allows educators to create content that is more engaging and interactive, which can be beneficial for learners. For example, educators can create virtual worlds that allow learners to explore different concepts, try different activities, and receive feedback. This type of content can be used to teach a variety of subjects, such as science, math, and history.

Recording in virtual worlds is an ideal way to create animated educational video content. Virtual worlds offer a number of advantages over traditional recording methods, including a first-person perspective, elimination of the need for expensive equipment and software, and the ability to create engaging, interactive content. These advantages make virtual worlds an ideal platform for recording educational content.

Board Game design

Virtual worlds are an ideal environment for designing and testing board games. The upcoming figure presents an intricate game board D, complete with pieces to be maneuvered, informative cards like B, dice such as A, and various controls F and E for loading diverse game configurations or setting timers. Remarkably, these games can also be crafted using the same approach previously described. Our system offers modules containing a wide array of game artifacts, and a tailored Composer App can be directed to communicate with these specific modules by an end user, requiring no programming skills. These multifaceted examples serve a single purpose: to demonstrate the exceptional versatility of our Composer App. Here as well, the game is played simply through point and click.

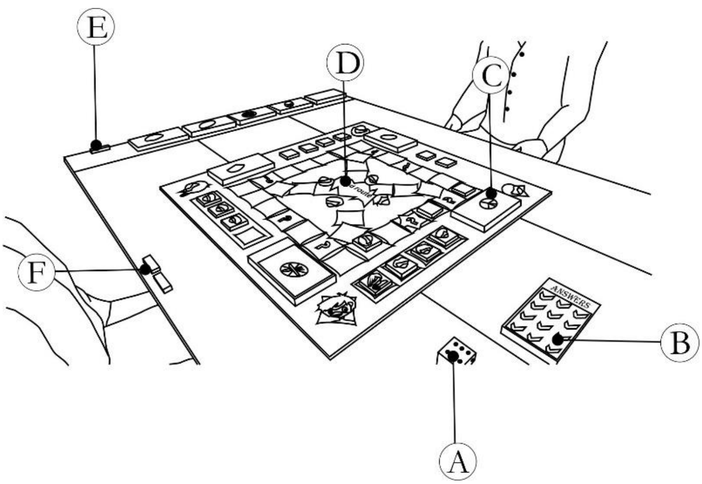


Figure 51 Board game design and testing

(Description to come)

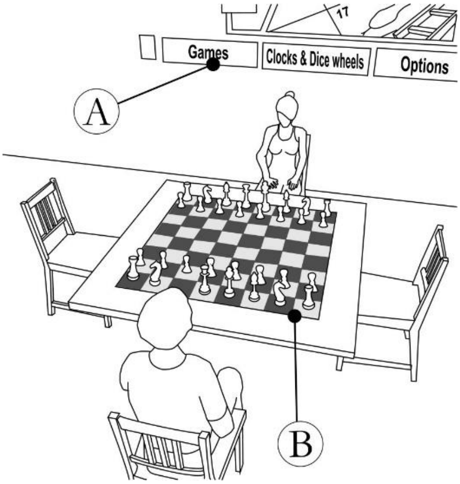


Figure 52 Wide array of games on one table App

Virtual Chemistry Lab

It is widely accepted that students learn best by doing. Unfortunately, many of the traditional methods of teaching chemistry involve rote memorization and there is little opportunity for students to engage in the firsthand exploration of chemical concepts. Virtual worlds offer a unique opportunity to create an immersive environment in which students can actively engage in the process of scientific discovery.

Virtual worlds are computer-generated 3D environments that can be explored by users in real time. These environments are often created with game-like features and allow users to interact with each other and with the environment in a variety of ways. Virtual worlds have been used for a variety of purposes, including education, training, and entertainment.

There are several potential benefits of using virtual worlds to support the teaching of chemistry. First, virtual worlds can provide a safe and controlled environment in which students can experiment with dangerous chemicals and reactions. Second, virtual worlds can be used to create simulations of real-world chemical processes, allowing students to explore these processes in a safe and controlled environment. Finally, virtual worlds offer a unique opportunity to create an immersive environment in which students can actively engage in the process of scientific discovery.

In this example, we observe a Composer App adeptly communicating with specially designed modules tailored for chemistry classes, focusing on molecular and crystal shapes within the curriculum. With this powerful tool, students can effortlessly create their own 3D models, such as a striking model of a diamond crystal ©. The display further enriches the learning experience by including a vivid image of diamonds (A) accompanied by an informative label (B). This compelling illustration showcases how the Composer App can be employed as an effective educational aid, helping students explore and understand complex molecular and crystal structures. Students can create these models using point and click which may be argued to be simpler than buying and assembling crystal or molecule building kits in the real world.

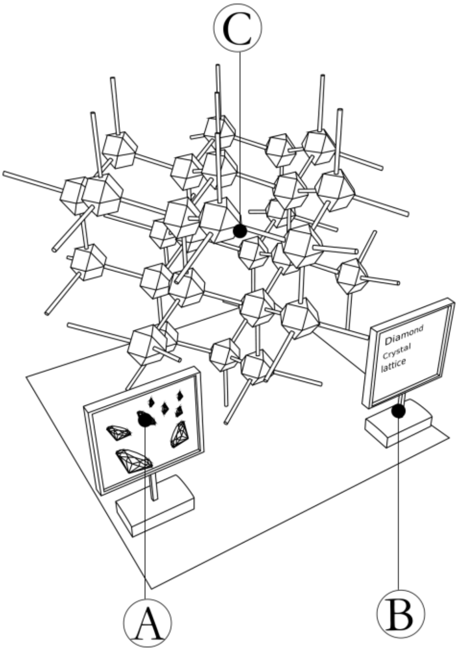


Figure 53 A 3D molecular model of Diamond constructed using the Composition tool (c. 2020)

In the next example, we witness the Composer App skillfully employed to visualize and construct a propane molecule. The exhibit is enhanced by an informative picture (A) and accompanying text (B) to provide a comprehensive understanding of the subject matter. As students engage with the App, they sign in and access a menu, guiding them through the molecule creation process. They may begin with a single carbon atom, positioning it on the composer's base before elevating it using the HUD menu, and gradually attaching bonds and additional atoms as required. This intuitive tool offers a remarkable opportunity for students to visualize molecules and gain insight into their complex construction.

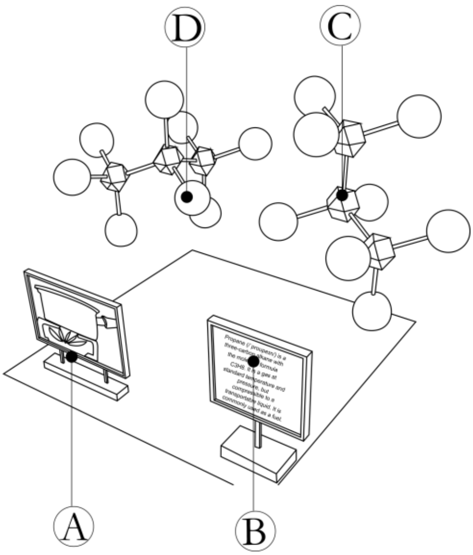


Figure 54 Propane molecules constructed for a class exhibit using the Composition tool

Investigating brainstorming and note taking tools.

There are various techniques that can be used to facilitate brainstorming and note taking. One popular technique is called the "6-3-5" technique. This technique involves having six people sit in a circle and each person taking turns sharing three ideas or solutions to a problem. After each person has shared their three ideas, the group then votes on the best solution. This technique is popular because it allows for a large number of ideas to be generated in a short amount of time. Another popular technique is called the "round robin" technique. This technique involves having a group of people sit in a circle and each person taking turns sharing one idea or solution to a problem. This technique is popular because it allows each person to share their ideas without being interrupted. Finally, the "brainstorming" technique is popular for groups of all sizes. This technique involves having a group of people share their ideas without interruption. This technique is popular because it allows for a large number of ideas to be generated in a short amount of time. There are a variety of techniques that can be used to facilitate brainstorming and note taking. Some of these techniques include using a mind map, brainstorming with a partner, and using prompts.

Mind mapping is a technique that can be used to brainstorm ideas and organize thoughts. This technique involves creating a visual representation of ideas, with each idea represented by a different color or symbol. This can be helpful in brainstorming because it allows for a quick way to organize thoughts and ideas.

Brainstorming with a partner can also be an effective way to generate ideas. This technique allows for two people to share ideas and build off of each other's thoughts. This can be helpful in brainstorming because it allows for a more diverse range of ideas. Finally, prompts can be used to generate ideas. This technique involves coming up with a prompt, such as a question or a prompt, and then brainstorming ideas in response to that prompt. This can be helpful in brainstorming because it can help to focus the mind and come up with ideas that may not have been thought of otherwise. Overall, there are a variety of techniques that can be used to facilitate brainstorming and note taking. Each technique has its own advantages and disadvantages, so it is important to choose the technique that best suits the needs of the situation.

Emergency preparedness training

As we take a moment to reflect on the pioneering work carried out in 2007, we recall the creation of a virtual replica of a hospital. To accomplish this feat, we physically visited the location, filmed the area, and enlisted a team of skilled builders to craft the necessary 3D elements. The process was both time-consuming and labor-intensive. The 360-degree image before us showcases the hospital's exterior (B), the parking lot (C), and the surrounding flora (A), evoking memories of the numerous exercises conducted within this space.

Today, the pipeline for generating such content has undergone a radical transformation, with significant improvements in efficiency. It is now conceivable that similar environments can be constructed using the versatile Composer App approach described earlier, opening up new possibilities for virtual world design and exploration.

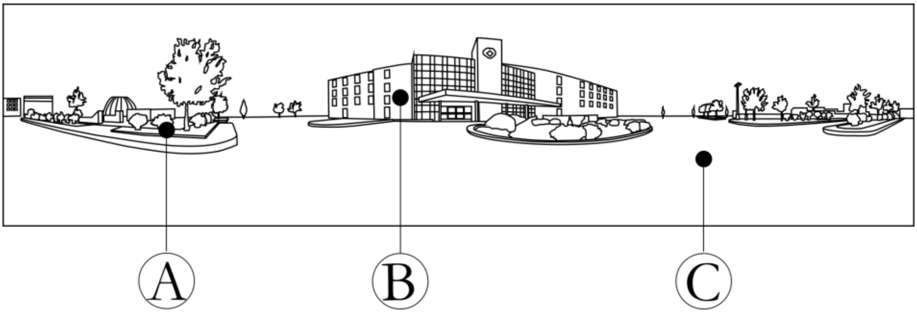


Figure 55 One of the first 3D virtual world replica of a real world hospital, Elks Memorial Hospital, developed from training purposes (c. 2007)

The forthcoming figure presents the welcoming entrance or lobby of the virtual hospital. Key features include the strategically positioned reception desk (B), the main entrance area (C), the conveniently located wheelchairs (D), and the designated space (A) reserved for examination rooms. By participating in exercises within virtual replicas of real-world environments, individuals often find their training experiences to be more meaningful and engaging. This immersive approach to learning facilitates better information retention and fosters a stronger sense of camaraderie among peers as they navigate these shared spaces together.

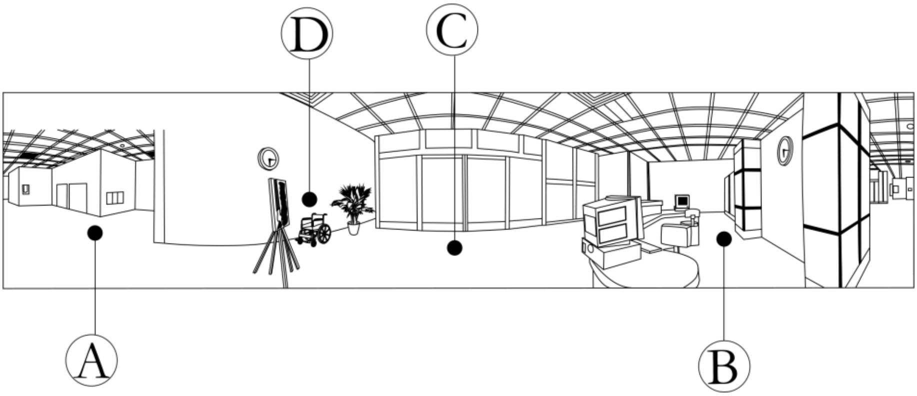


Figure 56 The lobby of the 3D virtual world hospital (c. 2007)

The image illustrates a virtual simulation of a parking lot triage operation, with numerous healthcare providers participating as avatars (B, G). A line of cars (C) forms along the road, progressing toward a series of rapid-deployable tents (E), which feature customizable labels (D). Beside the tents, interactive equipment is available for training staff to experiment with during the exercise. Previously, such a setup necessitated the collaboration of expert 3D modelers and programmers, but now, subject matter experts can create these simulations without any coding expertise. This training has proven invaluable, as this approach was used during the Covid 2020 outbreak when testing and vaccination centers were established in parking lots for the first time.

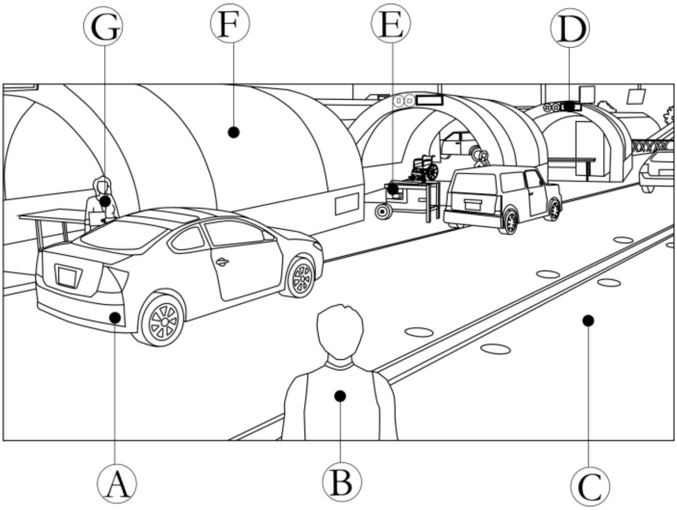


Figure 57 Practicising triage in a parking lot as a virtual exercise for health care staff preparing for a pandemic patient surge (c. 2007).

(Description)

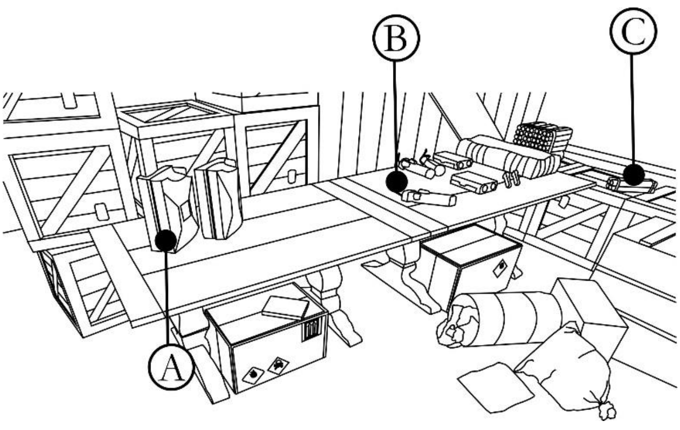


Figure 58 Emergency preparedness hazardous materials prep

(Description)

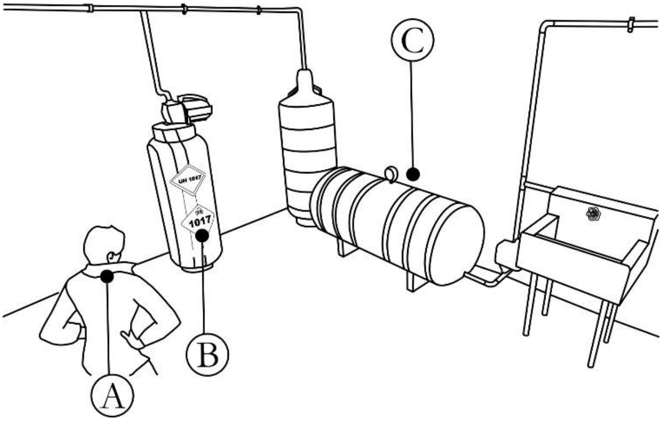


Figure 59 Small chlorination plant with Hazmat placards

Modularizing content

On abstraction design

1. When designing a learning objective, the first step is to identify the level of abstraction that is most appropriate for the learner. There are three levels of abstraction - concrete, representational, and abstract.

2. The concrete level is the most basic level and is appropriate for learners who are just beginning to learn a concept. At this level, learners are introduced to the concept in its most basic form.

3. The representational level is more advanced than the concrete level and is appropriate for learners who have a basic understanding of the concept. At this level, learners are introduced to the concept in a more abstract form.

4. The abstract level is the most advanced level and is appropriate for learners who have a thorough understanding of the concept. At this level, learners are introduced to the concept in its most abstract form.

Content production efficiency

Modularizing content and creating templates makes it easier for educators to share content and collaborate because it allows them to break down the content into manageable pieces that can be easily reused and repurposed. Additionally, templates provide a framework for educators to follow when creating new content, which makes the process of creating and sharing new content much simpler and more streamlined. By modularizing content and creating templates, educators can save time and effort when it comes to creating and sharing new content, which makes collaborating with others much easier.

Main features of a content creation application for educators

A content creation software for virtual worlds would be an amazing tool for educators. It would allow them to create engaging and interactive learning experiences for their students.

Some of the main features of such a software would include:

The ability to create and edit 3D models: This would be a key feature, as it would allow educators to create custom content for their virtual world. They would be able to create 3D models of objects, buildings, and landscapes.

The ability to create and edit animations: This would be another key feature, as it would allow educators to create custom animations for their virtual world. They would be able to create animations of objects, characters, and events.

The ability to create and edit scripts: This would be a vital feature, as it would allow educators to create custom scripts for their virtual world. They would be able to create scripts for character interactions, events, and game mechanics.

The ability to create and edit audio: This would be a valuable feature, as it would allow educators to create custom audio for their virtual world. They would be able to create audio for character dialogue, sound effects, and music.

The ability to create and edit textures: This would be a useful feature, as it would allow educators to create custom textures for their virtual world. They would be able to create textures for objects, buildings, and landscapes. The main features for an education content production tool for educators would be the ability to easily create and manage content, the ability to share content with others, and the ability to track and assess student engagement with the content.

The ability to easily create and manage content would be the most important feature for an education content production tool educators would need to be able to create content quickly and easily, and then easily manage and update that content as needed. The tool would also need to be able to handle a variety of content types, including text, images, video, and audio.

The ability to share content with others would be another important feature for an education content production tool. educators would need to be able to easily share content with colleagues, students, and parents. The tool would need to be able to share content via email, social media, and other platforms.

The ability to track and assess student engagement with the content would be the final important feature for an education content production tool. educators would need to be able to see how students are interacting with the content and be able to assess whether or not the content is effective. The tool would need to be able to track student progress and provide data that educators can use to improve the content.

How to deter educators from linear thinking in virtual worlds?

First, educators can be encouraged to explore more creative uses of virtual worlds by understanding the unique affordances that virtual worlds offer. Virtual worlds provide a unique opportunity for educators to create immersive, three-dimensional learning experiences that can engage learners in ways that are not possible in the real world. For example, educators can use virtual worlds to create simulations of real-world environments, such as historical settings or natural disasters. These simulations can help learners to understand complex concepts in a concrete way. In addition, virtual worlds offer the opportunity for learners to interact with avatars, or digital representations of other people. This type of interaction can help learners to develop social and communication skills.

Second, educators can be encouraged to explore more creative uses of virtual worlds by understanding the potential benefits of using virtual worlds for learning. Virtual worlds can help learners to develop 21st century skills such as problem solving, critical thinking, and collaboration. In addition, virtual worlds can provide a safe and supportive environment for learners to explore and experiment with new ideas.

Finally, educators can be encouraged to explore more creative uses of virtual worlds by understanding the challenges that they may face when using virtual worlds for learning. For example, educators may need to develop new pedagogical approaches to take advantage of the unique affordances of virtual worlds. In addition, educators may need to overcome challenges related to technology, such as ensuring that learners have access to the necessary hardware and software.

How to encourage educators to become more creative about virtual world learning?

One way to encourage educators to explore more creative uses of virtual worlds to support learning is to consider the choice of platform and community. Educators should research platforms that hold promise for educational purposes and ensure there is a sustainable community of users to support ongoing collaboration and learning. This choice of platform should also include thinking about the presentation tools available, moving away from traditional slide-based presentations to more immersive and interactive methods that invite deep student participation.

Educators must also think spatially when designing their virtual world learning experiences. By leveraging the power of 3D data visualization and animating complex concepts or structures, educators can create more engaging and effective learning environments. To support this, communities should form around these goals, allowing educators to learn from each other and expand their palette of teaching tools.

Course goals should be carefully considered when integrating virtual worlds into education. Educators should balance self-directed learning with instructor-directed learning to ensure students have the opportunity to explore and learn at their own pace, while also benefiting from structured guidance.

The use of virtual worlds for visualization creation and machinima production presents exciting opportunities for educators. Instructors should develop their skills in capturing and producing educational machinima using 3D worlds, content, avatars, and non-player characters (NPCs). This would lead to more engaging and dynamic learning materials for students.

With the advent of generative AI and other systems aimed at the mass audience, educators must stay informed about these developments as they offer great potential to improve teaching and learning. In the coming years, it will become increasingly evident how AI-powered humanoid NPCs or agents can impact education. By embracing these advancements, educators can create more innovative and effective virtual world learning experiences.

To encourage educators to be more creative in their use of virtual worlds, they should be provided with resources that showcase a variety of ways virtual worlds can be used to support learning. These resources might include blog posts, articles, video tutorials, or even sample lesson plans that use virtual worlds. Additionally, educators should be given opportunities to observe others using virtual worlds for learning, attend workshops or webinars, and access online forums or discussion groups for support and feedback. By having a support system in place, educators can feel more confident in trying out new ideas and approaches in virtual world learning.

Chapter cover 9 Metaverse Horizons: The Dream and the Reality

9. Is a minimally viable Metaverse near?

Many investors and users wonder when the Metaverse will become reality. The Metaverse will probably follow the same trajectory as the Internet. Its arrival was neither sudden nor unexpected. Like the Internet, it will slowly permeate most human activities. In addition to benefits, it may also bring unforeseen crises like what we are seeing now with social media e.g. fake news and its propagation, information overload, bots producing enormous content drowning high quality information, content monetization, and intellectual property disputes about online content. How then amidst this chaos can we gauge the progress towards the Metaverse?

There are many ways to map the Metaverse's trajectory. We will not cover the necessary changes the financial and governance instruments of society must undergo to allow the Metaverse to work, as these matters are usually discussed under web3 and cryptography themes. The following are ten parameters that are often overlooked or not adequately addressed and help demonstrate whether progress is being made and how much further there is to go.

Progress defining parameters

Fidelity (sensory, physics and social)

Mainstream media and others often use the visual realism of a virtual reality experience as a metric to gauge how close we are to achieving the Metaverse. This method for estimating progress is rather weak, as we will learn soon. It is assumed that a higher degree of visual fidelity puts us closer to achieving the Metaverse. We have accumulated enough evidence to show that it is not necessary for an environment to be 3D, let alone highly realistic, in order to be engaging or immersive. It is no longer surprising that blocky worlds still attract and retain a large user base. It is also important to remember, however, that every cognition domain, namely, auditory, tactile, olfactory, and gustatory domains, will present their own challenges to achieving a high degree of immersion or engagement that we take for granted with top-rated virtual visual environments.

We also need to address the temporal fidelity issues. One of the main struggles of designers of virtual environments is to minimize latency, because it significantly reduces the quality of the experience or immersion. While this can be an annoyance in many cases, for specific use cases, it can be a show stopper. Researchers have also found that the tolerance for latency varies by the sensory channel. It is ideal to maintain the visual latency below 35 ms and the controller latency below 0.5 s. There are many applications that require low latency, such as musicians jamming over the Internet or a manager of an industrial plant needing to control operations from a console.

Virtualization priority

It can be said that digital representations of sound and vision arrived before those of touch, smell, and taste. We ranked all display technologies according to their ability to create immersive experiences; the visual would be the most effective, followed closely by auditory, and the tactile would rank third, followed by olfactory and gustatory lagging. We can make the case that a truly and perceptually balanced Metaverse cannot arise without achieving high fidelity digital virtualization across all domains of perception, not just a few.

End user to platform expert ratio

Many contend that the number of concurrent users is the most important factor. For example, a Metaverse should be able to accommodate thousands of people at the same time, just like in a stadium. Although this factor may be useful in predicting how close we are to the end goal, we believe that it is the ratio between users who have no interest in the underlying technology and those who are experts in it, which will be the true measure of technology penetration. Early on, experts outnumbered non-experts, but this will change as the platform becomes easier to use and offers more value to its users. A higher ratio indicates a greater likelihood of achieving a Metaverse with practical utility. The maturity of a platform can be measured by the ratio of end-user to expert content. Higher ratios indicate a more mature platform.

Real world impact

Virtual training environments have been successful in transferring skills in a wide range of fields, from medicine to car racing and jet flying. A decade ago, we observed similar benefits for people helping each other and training for real-world emergency preparedness in virtual worlds. However, this is a niche area for applications.

Metaverses cannot yet have a significant impact on the real world because, overall, they are still in the early stages of development. This mindset is due in part to the fact that most developers for this space are catering to primal needs or entertainment that demand isolation from the real world, and serious applications have been put on the backburner. For the Metaverse to be the future of the Internet, we believe this will have to change dramatically. The Metaverse could, for instance, become so deeply utilitarian that it becomes the driving force behind the future of work. The implications will be mind-blowing and impact everything from self-identity, culture, and ethics. For example, the nature of remote work and its ethics will change.

Age-and-maturity agnostic

New social applications aimed at mass audiences are typically first adopted by the younger generation. As Metaverses evolve and coalesce into one global platform, we will see a number of new application segments aimed at different social groups. From the perspective of the underlying Metaverse platform, age is irrelevant, as it is for the Internet. Currently, we tend to assume that the Metaverse is primarily of interest to young people, but there is a growing population of elderly users reaching this universe, and this trend is likely to continue.

Automation vs control conundrum

It will be difficult for Metaverse users to overcome the cognitive dissonance caused by the conflict between two cravings destined to last forever. It is difficult to choose between the desire for automation and the desire for fine control. Over-automation could leave humans out of the content creation and consumption loop, which would be tragic. With the rapid increase in automated productivity tools, the sheer amount of content produced would simply not be digestible because of the limited capacity of humans to consume information. There will probably be an emerging industry creating AI bots that would help users manage their information spaces. As more technology is introduced in the content production and consumption loop, users might start to feel sidelined and less in control of what they want to access or create. We will have to contend that it is necessary to create an information bubble around every user so that they can survive in the information-abundant age. The assumption we are making, of course, is that it is difficult to change the human baseline for memory and processing artificially, even though we acknowledge that this is a field of research that is being explored currently [ref.]

Quest for more compressed representations and amplified productivity

One can argue that, in the beginning, the mass facing the Internet was primarily used for entertainment. It took a while before productivity and collaborative applications emerged. The percentage of Metaverse use for productivity purposes is likely to increase with the maturity of the Metaverse. It is well known that game mechanics have not changed significantly over the past few decades. I believe there are a variety of applications with significant total addressable markets ripe for transformation into fully collaborative forms in the real world. Examples of application segments that are naturally collaborative are movie-making applications that capture stories played in virtual worlds by avatars or scripted non-player characters, architectural or landscape design applications, or virtually-facilitated therapy applications that connect therapists with patients in relevant contexts. In addition, we understand that designers have difficulty devising new abstractions that would improve productivity in virtual worlds. Because we did not define the problem space, these areas are likely to be the most difficult to solve. For example, if we set out to develop new tools for a virtual office environment, we might need to develop new visualization methods or rethink workflows according to the affordances. It is typically very expensive to develop these aspects of design, and they are conceptually difficult to handle. For example, 3D project management tools are harder to create than their 2D counterparts are. It is probably the most difficult to resolve these areas because we did not define the problem space.

Expansion of self-identity

"Tat Tvam Asi", sanskrit phrase meaning "You are that", Chandogya Upanishad

Metaverse users will evolve an identity that would allow them to identify both their real-world and virtual world identities. They also need to cultivate these different identities in both the real and virtual communities that they may be members of. In the best-case scenario, a mature Metaverse could enable its users to discover who they really are or how their currently expressed identity is only part of their true reality. They may also come to understand the true nature of their identity or see the part of their identity that defies change more clearly.

Obtrusiveness of the user interface

We define the thickness of the user interface as the fraction of the cognitive bandwidth that users must dedicate to user interface issues as a cost for participating in the Metaverse. For example, if users become aware of their user interface while they are in the Metaverse because the user interface devices are not light, run hot, or come with physiological effects such as headaches or vertigo, then this interface is an obstacle to immersion by a significant amount. This problem spans the entire spectrum of virtual reality devices that users must wear or use. For example, an omnidirectional treadmill remains elusive, and it is difficult for the awareness of being and walking on a moving belt to sink into the background. If we are to consider the haptic domain, physicality plays an important role in the mediation of rhythmic motion, physical posture and recovery from fatigue in real world human activities. The absence of physicality or a laggy one is bound to disrupt immersivity in virtual reality worlds. In short, a mature Metaverse requires the user interface to be so thin that it becomes imperceptible.

Diversity of user base

We argue that a mature Metaverse will have to be more serious about making this environment accessible to people with diverse physical abilities or neurological profiles through assistive technologies. This parameter is problematic as a signal of progress because it is known that the number of individuals with physical or cognitive impairments is overrepresented in virtual worlds. However, we must include this factor for completeness.

Sticky problems facing the Metaverse

Laborious user content creation

Obtrusive user interface

In the best case, access to the Metaverse requires the body to be tethered to wearable devices. Fatigue due to physiological stress when wearing Metaverse interfaces is likely to linger.

Incentivizing conflict under guise of engagement

Creating addictive and provocative content is the shortest path to profit in the industry. When it comes to valuation metrics in the social computing industry, the size of the user base is a primary factor. Provocation is often confused with engagement on social media. As a result, social media algorithms tend to reward shallow and provocative content that can be consumed rapidly and muffle deep and enlightening content that can be consumed over a longer period of time.

Unchecked appropriation of working memory

Under the current design of the attention economy, social media companies are rewarded at the expense of content creators. In addition, the enormous amount of content that is available has forced end users to outsource the control of their attention. Companies in the social media industry are more than willing to comply with multi-level information gatekeeping. Hence the cursory interest profile questionnaires that immediately follow every account creation process and the avalanche of targeted adverts. The social media computing industry is dependent upon the advertising industry, so we won't see this problem disappear anytime soon. How far can attention be divided? One of the assumptions of the attention economy is that there is an infinite supply of attention when it is a known fact that it is limited. When companies buy adverts, they think they are buying attention but the quality of the attention they are getting is suspect. The total addressable market for attention is bounded because the number of people on Earth is finite. When companies add users to their social network, they are effectively acquiring attention that they will sell to companies.

Supersaturation of computer-generated content

As content production becomes automated either through Artificial Intelligence techniques or more advanced capture of user data that describes their identity and behavior, the amount of information that end users will be exposed to will certainly increase beyond their ability to consume them.

Unmet need for physicality

The lack of physicality of immersive virtual worlds refers to the absence or limited presence of tangible, physical sensations and experiences in virtual environments. Immersive virtual worlds are digital spaces that often simulate real-world scenarios or create entirely new experiences, engaging users through sight, sound, and sometimes touch. However, despite their immersive nature, these virtual worlds have limitations when it comes to replicating the full range of physical sensations and interactions that we experience in the real world.

Manifestations of Limited Physicality

The lack of physicality in immersive virtual worlds can manifest in several ways:

Limited sensory input: Although virtual worlds can provide visual and auditory stimuli, they usually lack the ability to engage other senses like smell, taste, and touch to the same extent as the real world. This can make the virtual experience feel less realistic and less engaging for users.

Reduced physical interaction: In virtual environments, users typically interact with objects and other entities using controllers, gestures, or voice commands, which can feel less intuitive and less satisfying than directly touching or manipulating objects in the real world.

Absence of physical feedback: In the real world, our actions have consequences that we can feel, such as the resistance of an object when we push it or the sensation of heat from a fire. Virtual worlds often lack such feedback, which can limit the sense of presence and immersion.

No real-world consequences: Actions taken in virtual worlds don't have lasting consequences or impacts on our physical bodies. This can lead to a disconnect between the user's virtual experience and their real-life experiences.

Imprecise body movements: Although motion tracking technologies have improved significantly, they may still not capture the full range of body movements and gestures accurately, leading to less realistic interactions in the virtual world.

The Future of Haptic Technology

As technology advances, we find ourselves venturing further into the realm of virtual experiences. One such advancement, haptic technology, has the potential to revolutionize how we interact with virtual worlds. The question on everyone's mind is: could haptics evolve far enough to provide a level of comfort and immersion that rivals our physical world?

Potential Use Cases for Advanced Haptics

Here are three best use cases for haptics at its apex of development:

Sleep on a comfy bed in the metaverse: As mentioned earlier, advanced haptic systems could make it possible to experience the comfort of a bed in the virtual world. This would open up new possibilities for relaxation, entertainment, and even virtual travel, as users could sleep in their virtual dream destinations.

Massaging at hard-to-reach places: Traditional massage techniques have their limitations, but haptic technology could change that. Imagine a virtual massage therapist that could reach the deepest muscle tissues and provide targeted relief exactly where it's needed. This would revolutionize the field of massage therapy and make it more accessible to everyone.

Pumping weights to increase muscle mass: Fitness enthusiasts could also benefit from the advancements in haptic technology. By simulating the sensation of lifting weights, users could engage in resistance training and build muscle mass in the virtual world. This could lead to a new wave of fitness solutions and cater to those who may face physical limitations or prefer working out in the comfort of their own home.

The ability to walk naturally and freely in a Metaverse has unfortunately not been achieved to date. There have been quite a few omni directional treadmills on the market offered as a potential solution to this need but they have been somewhat unsatisfactory. In addition, it is impotant to keep in mind the considerable amount of energy that will be needed to sustain any large scale Metaverse with full sensory spectrum fidelity. Any discussion of Metaverse impact will have to include Energy and environmental costs.

Balancing Freedom and Constraints in Virtual Environments

Constraints and limits can provide a framework that enhances cognition, stimulates creativity, and improves pleasure by reducing choice overload and providing a sense of security. However, it is essential to strike a balance between imposing constraints and allowing for personal freedom. Each individual's preferences and abilities should be considered when determining the appropriate level of constraints. Encouraging self-regulation and self-discipline can also help individuals navigate freedom effectively, contributing to both cognitive development and overall well-being. These issues, at first glance, can appear to be irrelevant to the design of virtual environments. However, every experienced designer will have come across instances at any level of interaction where providing users with too much freedom actually hurts usability. A trivial example is collision detection in a virtual world, which can actually improve user navigation. While designing the Metaverse of the future, we will undoubtedly have to balance freedom and constraint and find ways to evaluate if our design is optimal or not.

Automated Content Filtration in the Virtual World

Automated content filtration systems have the potential to help manage the vast amounts of content generated by AI applications, optimizing our cognitive bandwidth and reducing the risk of misinformation. However, it is crucial to address potential issues such as biases, censorship, and the potential stifling of creativity.

Striking a Balance with Content Filtration

To strike a balance, content filtration systems should be transparent and adaptable, allowing for a diversity of perspectives and promoting critical thinking among users. Additionally, we should consider combining automated content filtration with human oversight to ensure a more accurate and nuanced filtering process. This approach can help maintain the integrity of the virtual environment, create a more inclusive and diverse virtual experience, and prevent the spread of misinformation and harmful content.

As immersive virtual worlds continue to evolve, researchers and developers are working on improving sensory input, physical interaction, and feedback to enhance the overall user experience. With advancements in haptic technology and a focus on balancing freedom and constraints, the gap between the physical and virtual worlds is expected to narrow, providing users with increasingly realistic and engaging experiences. By addressing the challenges and limitations of virtual environments and embracing the potential of emerging technologies, we can create a future where virtual experiences rival those of the physical world.

In light of the myriad complexities described in this chapter, surmounting these challenges to manifest a Metaverse within the forthcoming decade does appear to be an enormous undertaking. Such an achievement would bestow upon us a realm of unprecedented fidelity and remarkable utility, leaving us profoundly gratified and in awe of our collective ingenuity. Pulling this off would give us an amazing virtual world, clearer and more useful than anything we've seen before, making us very happy and proud of what we all can accomplish together.

Open Problems and associated litmus tests

In the pursuit of designing a fully-realized Intelligent Metaverse, ten significant open problems have been identified. Each of these challenges represents a distinct hurdle to creating a Metaverse capable of hosting billions of avatars in parallel with human physical existence. They are inspired by David Hilbert's approach to advancing mathematics, with each problem having an associated litmus test to gauge when they may be considered solved.

Here, we define each problem and its corresponding test:

1. **Problem of the Infinite Metaverse**: Building a system capable of infinitely scaling to support billions of users concurrently.

- **The Traffic Test**: The network should support a billion simultaneous users from geographically diverse locations, with no more than a 50ms latency for any two random users.

2. **Problem of the Secure Identity**: Creating a system that protects all user data and identities within the Metaverse, free from malicious exploitation.

- **The Fortress Test**: An expert team of ethical hackers attempts to breach a user's data privacy within the Metaverse. Success is determined if the system withstands multiple, continuous attacks over a month without a breach.

3. **Problem of the Realistic Continuum**: Developing algorithms that generate responsive, customizable, and realistic avatars and environments.

- **The Reality Test**: Users view a mix of real and Metaverse-generated videos, and success is measured if a majority of users cannot reliably distinguish the Metaverse-generated content.

4. **Problem of the Intelligent Agent**: Building advanced AI entities capable of engaging in natural, intelligent interactions.

- **The Metaverse Turing Test**: AI agents interact with users in a series of complex scenarios involving both Metaverse and real-world knowledge. If a majority of users can't distinguish AI from human players, the test is passed.

5. **Problem of the Immersive Interface**: Creating an intuitive, multimodal interface that enables effortless navigation and interaction within the Metaverse.

- **The Novice Test**: First-time users are given a series of complex tasks to perform within the Metaverse. If the majority can complete the tasks intuitively within a set timeframe, the system passes.

6. **Problem of the Digital Twin**: Accurately replicating and synchronizing real-world objects and processes within the Metaverse.

- **The Mirror Test**: A real-world system (like a city's traffic network) is replicated in the Metaverse. The test is passed if the Metaverse version can accurately predict real-world outcomes for a series of events in real-time.

7. **Problem of the Virtual Society**: Understanding and managing the socio-economic and political dynamics of the Metaverse.

- **The Society Test**: A Metaverse society with a predefined governance structure is monitored over a year. The test is passed if there are no significant conflicts, and resources are fairly distributed among users.

8. **Problem of the Ethical Metaverse**: Addressing the ethical implications of converging AI and virtual reality within the Metaverse.

- **The Ethics Audit**: A panel of ethicists and AI experts conduct a series of ethical audits on different Metaverse scenarios. The test is passed if the system consistently prevents or effectively addresses harmful outcomes.

9. **Problem of the Computation Allocation**: Designing efficient algorithms for balanced computational resource allocation.

- **The Efficiency Test**: During a high-traffic period, the system's ability to optimize user experience and system performance is tested. Success is measured if there's no noticeable degradation in user experience or system performance.

10. **Problem of the Unified Metaverse**: Establishing open standards and protocols that ensure interoperability within the Metaverse.

- **The Interoperability Test**: A series of different VR platforms, devices, and applications attempt to interact within the Metaverse. The test is passed if all interactions are seamless and without loss of functionality or data.

Each of these problems, coupled with their corresponding tests, represents a fundamental challenge and an opportunity for advancement in our understanding and development of an intelligent, sustainable Metaverse. The successful resolution of these problems would pave the way for a Metaverse capable of hosting billions of avatars in a setting that is not only parallel to human physical existence, but is also an enriching extension of it. As we continue to push the boundaries of virtual reality and artificial intelligence, we're charting a course towards a future where the digital and physical worlds converge in ways we can only begin to imagine.

Chapter cover 10 Grassroots Genesis: Open-Source Metaverse

10. Power to the People

The need for open source platforms

"Sharing is good, and with digital technology, sharing is easy." - Richard Stallman, American free software movement activist and programmer

"In real open source, you have the right to control your own destiny." - Linus Torvalds, Finnish software engineer, lead developer of Linux Kernel and distributed version control system, Git.

Role of open-source developers

Open-source development is a powerful approach for developing a resilient Metaverse platform. With open source, developers have access to a wide pool of talent, which increases the chances of finding talented and motivated contributors who can bring new ideas and perspectives to the project. The collaborative nature of open-source development encourages experimentation and innovation, leading to breakthroughs and new solutions. The transparency of open-source development processes also makes it easy for developers to understand how the platform works, contribute to its development, and identify potential issues and weaknesses. Open-source projects also benefit from a large and supportive community, providing resources and support for developers to learn, grow, and contribute. With open-source development, security vulnerabilities can be identified and fixed more quickly, since a wider group of developers can review and test the code. This, combined with the fast iteration speed of open-source projects, means that a Metaverse platform developed using open-source principles can be improved and updated quickly and effectively. Furthermore, open-source projects can benefit from a lower cost of development, since contributors are typically motivated by a desire to contribute to a project they believe in, rather than financial compensation. Open-source projects are also built with a focus on long-term sustainability, ensuring that the platform can continue to evolve and improve over time. This means that the Metaverse platform developed using open source principles can be a more resilient and reliable solution in the long run.

The importance of decentralization

A decentralized Metaverse platform means that there is no single entity in control of the platform. Instead, the platform is controlled by a network of computers that are all connected to each other. This allows for a more open and transparent Metaverse, as well as a more secure one, since there is no central point of failure. Given 10 reasons why virtual world platforms should be decentralized?

1. Decentralization allows for a more democratic and open platform, where users have more control over their own data and content.
2. Decentralized platforms are more resistant to censorship and control by central authorities.
3. Decentralization can help to protect user privacy by making it more difficult for data to be centrally collected and controlled.

4. Decentralized platforms can offer greater security as they are less vulnerable to hacks and attacks.
5. Decentralized platforms can offer more scalability as they can grow and evolve more easily.
6. Decentralized platforms can be more resilient to change and disruption.
7. Decentralized platforms can offer more opportunity for innovation.
8. Decentralized platforms can be more responsive to user needs and feedback.
9. Decentralized platforms can offer greater transparency and accountability.
10. Decentralized platforms can help to create a more decentralized and distributed internet.

As of today, OpenSimulator is the only decentralized platform to support virtual worlds. OpenSimulator is an open-source multi-platform, multi-user 3D application server. It can be used to create a virtual world (or "metaverse") which can be accessed through a variety of clients, on multiple platforms. It is particularly curious why most Metaverse developers around the world don't seem to recognize this fact. One can however speculate why this is the case.

There are a few reasons why social media companies are not keen on decentralized metaverse platforms.

First, these platforms are still in their early stages of development and are not yet as robust or user-friendly as centralized platforms.

Second, decentralized platforms would give users more control over their data and privacy, which could lead to users being less engaged with social media companies' products and services.

Finally, decentralized platforms could potentially disrupt social media companies' business models, which are based on collecting user data and selling advertising.

Top 10 ways to encourage open-source contributors

Give them a voice: Make sure that users and developers feel like they are part of the team, and that their opinions are valued.

1. Be transparent: Be open about what you are working on, and why.
2. Be responsive: Be quick to respond to questions, concerns, and suggestions.
3. Be helpful: Offer help and support when needed. Be positive: Encourage and motivate users and developers with your words and actions.
4. Be organized: Keep everything organized and easy to find.
5. Be active: Seek out ways to keep users and developers involved and engaged.
6. Be patient: Some people may need more time than others to get involved. Be patient and understanding.
7. Be thankful: Show your appreciation for the help and support that users and developers provide.

8. Be encouraging: Keep the overall tone positive, and encourage users and developers to keep up the good work.

If you want to create and maintain a strong community, it is important to give users and developers a voice, be transparent, be responsive, be helpful, be positive, be organized, be active, be patient, be thankful, and be encouraging.

Top 10 common mistakes to avoid

1. Don't make contributions difficult or cumbersome, with complex processes or a lack of documentation.
2. Don't be dismissive or negative towards contributors, or their ideas and suggestions.
3. Don't ignore or neglect the contributions of community members or fail to recognize their contributions.
4. Don't keep the development process closed or secretive or make it difficult for contributors to access the code or development process.
5. Don't neglect to provide support and resources to contributors or make it difficult for them to ask questions or get help.
6. Don't discourage collaboration or cross-functional contributions or make it difficult for contributors to work together.
7. Don't stifle innovation or experimentation or limit the scope of what contributors can contribute.

8. Don't neglect the codebase or allow bugs and security issues to go unfixed.
9. Don't provide inadequate training or educational resources or make it difficult for contributors to develop their skills.
10. Don't neglect the community or fail to create opportunities for socializing and networking among contributors.

Leveraging state of the art communications

The use of the latest tools for version control and communication between contributors is essential for a successful open-source project, especially when developing a Metaverse platform. These tools help ensure that contributions are organized, tracked, and easily integrated, even when there are many contributors working on the project. By using the latest version control tools, contributors can work together seamlessly and ensure that the project stays on track. Moreover, effective communication between contributors is crucial for ensuring that everyone is on the same page and that the project remains well-coordinated. Tools like project management platforms and chat apps can help keep everyone in the loop and make it easier to resolve any issues that may arise.

Optimizing automation for maximum efficiency

Given that open-source contributors often have other projects they work on and get paid for their work, it is important to use automation to the nth degree. Automation helps streamline development processes and reduces the time required for manual tasks, which is particularly important for projects like a Metaverse platform that can require a lot of time and effort. Automating repetitive tasks can also help reduce the risk of human error, ensuring that the project stays on track and that contributions are integrated smoothly. In short, using the latest tools for version control and communication, along with a focus on automation, can help ensure that an open source Metaverse platform is developed efficiently and effectively.

Funding Strategies and Challenges

Challenges in funding open-source development include lack of visibility and the perception that open-source projects are free and don't require funding. To address these challenges, organizations can create a clear funding strategy, increase visibility through marketing and outreach efforts, and build a community of supporters who are willing to donate or invest in the project.

Some developers may resist financial incentives because they believe that open-source development should be a passion project, not a job. However, for an open-source effort to be sustainable, it is important to have a reliable source of funding to pay for the costs of development, maintenance, and support.

Ultimately, finding a sustainable funding model is crucial for the long-term success of an open-source project. By exploring different funding options and building a supportive community, organizations can ensure that their open-source development effort is able to thrive and make a positive impact.

Funding an open-source development effort can be challenging, but there are several methods that organizations can consider:

1. Corporate Sponsorship: Companies can sponsor the development of an open-source project, which helps cover the costs of development, hosting, and other expenses.
2. Grants: Non-profit organizations, foundations, and government agencies may provide grants to support open-source projects that align with their goals and objectives.
3. Crowdfunding: Crowdfunding platforms, such as Kickstarter or Indiegogo, can help raise funds for open-source development efforts.
4. Donations: Developers can accept donations from individuals and organizations to help fund the project.

Common roles for open-source development

In an open-source development effort, there are several roles that individuals can take on, including:

1. Project maintainer: responsible for overseeing the overall direction of the project and managing contributions from other contributors.
2. Developer: responsible for writing code and fixing bugs.

3. Tester: responsible for testing the code and finding bugs. Documenter: responsible for writing documentation and keeping it up-to-date.
4. Designer: responsible for creating the visual look and feel of the project.
5. Community manager: responsible for engaging with the community and fostering a positive, supportive environment for contributors.
6. Bug triager: responsible for managing the bug tracker, triaging incoming bug reports, and assigning them to appropriate developers.
7. User support: responsible for answering questions from users and providing assistance with using the project.

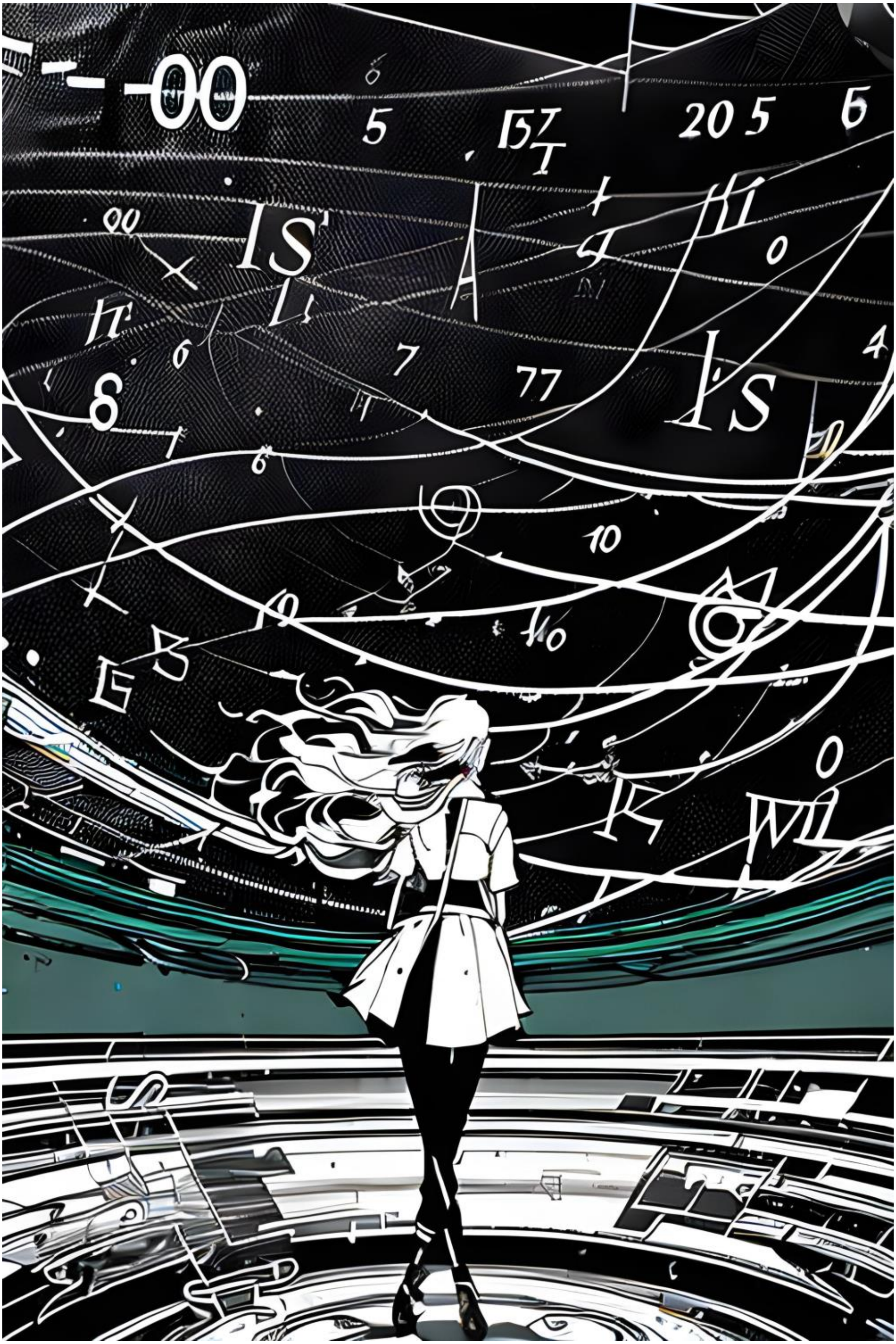
These roles may vary depending on the size and scope of the project, and individuals may take on multiple roles within the same project.

Financial aspects of open-source development are usually handled by a combination of individuals, foundations, and companies. The specific roles and responsibilities for financial management may vary depending on the project and its funding sources.

1. Project maintainer: responsible for managing the budget and ensuring that the project has the necessary resources to operate.
2. Financial sponsor: responsible for providing funding to support the project's development and operation. This may be an individual, foundation, or company.

3. Accountant: responsible for managing the project's financial records and ensuring that the project is in compliance with financial regulations.
4. Fundraiser: responsible for securing additional funding for the project, either through donations or grants. In some cases, the financial management of an open-source project may be handled by a separate organization, such as a foundation, that provides support and infrastructure for the project.

The financial aspect of open-source projects is critical to its sustainability, so having clear roles and responsibilities for managing finances is important.



Chapter cover 11 Navigating Chaos: New Paradigms and Generative AI

11. Saving the Metaverse

Embracing opportunities and challenges

The Metaverse is an exciting and rapidly evolving concept that has the potential to revolutionize the digital world as we know it! While it is true that there are some challenges to overcome before the Metaverse can truly thrive, we're confident that these obstacles can be tackled head-on with some creative thinking and innovative solutions.

In this book, we have already explored some of the biggest hurdles facing the Metaverse, including technical limitations, security concerns, and ethical issues. But now, let us focus on the fun stuff - how can we make the Metaverse more engaging and exciting for the average person?

They come but rarely stay

One key consideration is how to balance productivity and social functions within the Metaverse. By taking a neuroergonomics approach, we can design the Metaverse in a way that maximizes user productivity and efficiency, while still providing ample opportunities for social interaction and collaboration.

In the vast expanse of the digital realm, numerous platforms have emerged, each offering users the opportunity to construct their very own virtual domains, to be explored by others. However, it must be acknowledged that a great many of these realms remain underutilized, failing to attract significant numbers of visitors. It is a lamentable truth that, in due course, even the most imaginative of virtual environments can lose their appeal, with little to capture the attention or hold the interest of those who venture within. Such a desolate experience can leave one feeling adrift, bereft of purpose, in a place that was once so full of possibility. The beautiful elaborate worlds on Second Life for example, often lost their appeal, almost always after the initial human mentors leave.

Explosively enhance utility

However, recent advancements in generative AI present a potential solution to this problem. One of the most apparent benefits of generative AI is the ability for users to create 3D virtual content at a lower cost and more quickly via descriptive and often conversational text. This is a significant shift from the traditional approach where 3D modeling skills or programming knowledge were required. Multimodal generative AI can enable the creation of non-player characters (NPCs) that can respond intelligently and creatively to end user conversations at any time. This will free virtual landowners from the need to have human mentors on site to welcome and interact with visitors. With the advent of AIs with multimodal functionality, the NPCs that they drive can also observe what the user sees and react or help within the context of that observation.

In the future, users can log into a virtual world and expect the presence of these NPCs who have specialized skills. Companies may develop NPCs with a unique set of skills that Metaverse developers can purchase to populate their own worlds. Instead of infusing applications with AI functionality, there may be a shift towards encapsulating AI skills within NPCs. This approach is more user-friendly and enables direct communication of needs, as well as assembling NPC teams to address more complex tasks.

The potential of generative AI for virtual worlds is vast, and it presents an exciting opportunity for businesses and users alike. Companies can develop NPCs that can perform specific functions within a virtual world, such as providing customer service or assisting with tasks. Users can interact with these NPCs that come with specific skill sets, creating a more immersive and engaging virtual experience.

The coming exponential growth in humanoid robots

It is likely that we will see an increased number of humanoid robots both in the real and virtual worlds cannot be understated. In short, the following are the four main reasons we may see humanoid robots slowly become the de facto universal interface between humans and the increasing number of technological appliances around them.

1. Improved communication and interaction: Intelligent expressive humanoids, both in the virtual and real world, would greatly enhance human-computer interaction by offering a more natural and intuitive interface. This would make it easier for people of all ages and backgrounds to

engage with technology, reducing the learning curve and fostering digital inclusivity.

2. Emotional connection: Humanoid interfaces can be designed to express emotions and understand human emotions, which would foster a deeper emotional connection between humans and technology. This emotional connection could lead to increased user engagement and satisfaction, ultimately improving the overall user experience.
3. Adaptability and personalization: Intelligent humanoid interfaces have the potential to adapt and respond to individual user needs, preferences, and contexts leading to empathetic user interfaces. This level of personalization can lead to a more efficient and enjoyable interaction with technology, as users will feel understood and supported
4. Enhanced accessibility: Humanoid interfaces can offer multiple communication channels, such as speech, gestures, and facial expressions, making technology more accessible for users with varying abilities. This would enable a wider range of individuals, including those with disabilities, to fully participate in the digital world.

The Metaverse as a natural habitat for humanoid robots

As we continue to explore the potential of generative artificial intelligence, it is becoming increasingly clear that these technologies will play a pivotal role in driving the demand for virtual worlds. One key factor behind this trend is the growing reliance on non-playable character (NPC) labor, which is expected to become a primary driver of growth in virtual worlds. This is due in part to the fact that the population of NPCs in virtual worlds is projected to outstrip that of humanoid robots in the real world, for a variety of reasons. As such, it is likely that the virtual world will emerge as the go-to destination for accessing the much-needed labor that will drive our future economy.

1. Lower energy consumption: The energy required to create, maintain, and interact with virtual intelligent non player characters is significantly lower than the energy needed to create and operate humanoid robots. This is because virtual worlds are composed of pixels and data, which require minimal energy to manipulate, while robots are made of physical materials that need a substantial amount of energy to move and perform tasks.
2. Scalability and accessibility: Virtual worlds are inherently more scalable and accessible than the physical world of humanoid robots. As long as there is adequate computing power and internet connectivity, it is possible to create vast populations of NPCs without the constraints of physical space, resources, or infrastructure. This makes it easier for more people to participate in and interact with these virtual worlds, contributing to their growth and development.
3. Cost-effectiveness: The development, production, and maintenance of humanoid robots can be quite expensive, with high costs associated with materials, engineering, and

ongoing upkeep. In contrast, virtual worlds and NPCs require fewer resources and can be developed and maintained at a fraction of the cost, making it more likely that we will see a greater proliferation of NPCs in the future.

4. Rapid advancements in technology: The rapid advancements in technology and computing power have made it increasingly easier to create and manage complex virtual worlds, complete with large populations of NPCs. The progress in virtual reality and augmented reality technologies also contributes to making virtual worlds more immersive and engaging. This will likely result in a greater expansion of virtual worlds and their NPC populations compared to humanoid robots.

Estimating the number of virtual to real humanoid robots

Let's perform a back-of-the-envelope calculation to suggest why the number of intelligent humanoid bots will be much higher than the number of intelligent robots in the real world within 5 years, we can look at factors such as cost, development time, and potential use cases.

1. Cost: Assume that an intelligent humanoid bot costs around $10,000 to produce, while an intelligent real-world robot costs around $50,000. The lower cost of humanoid bots would make them more accessible to a wider range of users and industries.

2. Development time: Let's assume it takes about 1 year to develop an intelligent humanoid bot, while it takes about 3 years to develop an intelligent real-world robot. With shorter development times, humanoid bots can be produced and deployed faster than their real-world counterparts.

3. Use cases: Humanoid bots have a wider range of use cases due to their versatility in simulating human behavior and appearance. This could include customer service, education, healthcare, and entertainment. Meanwhile, intelligent real-world robots are often specialized for specific tasks such as manufacturing, logistics, and exploration.

Now, let's estimate the market demand for each type of robot based on these factors:

Yearly demand for humanoid bots:

- Cost advantage factor: 3 (Assuming that for every $50,000 robot, 3 humanoid bots can be bought at the same price)

- Development time factor: 3 (Assuming that 3 humanoid bots can be developed in the time it takes to develop one real-world robot)

- Use case factor: 2 (Assuming that humanoid bots have twice the number of potential use cases compared to real-world robots)

Total demand factor for humanoid bots = 3 * 3 * 2 = 18

Now let's assume that the current market size for both types of robots is 10,000 units per year. In 5 years, the number of intelligent humanoid bots and real-world robots produced would be:

Humanoid bots: 10,000 * 18 * 5 = 900,000 Real-world robots: 10,000 * 5 = 50,000

According to this rough estimate, there will be 900,000 intelligent humanoid bots compared to 50,000 intelligent real-world robots in 5 years. This suggests that the number of intelligent humanoid bots will be much higher than the number of intelligent robots in the real world within 5 years. Keep in mind that this is a simplistic calculation and may not capture all the complexities of the market, but it gives a general idea of the potential difference in scale.

Designing for high fidelity empathy

Designing for empathy in the Metaverse is all about creating virtual environments that allow users to connect and engage with each other on a deeper, more emotional level. This means designing avatars that accurately represent users' appearance and movements, including non-facial social cues like body language and tone of voice. When avatars are high-fidelity, users are better able to express themselves and connect with others on a deeper level.

In addition to avatars, designing for empathy in the Metaverse also involves capturing and representing peer visual awareness and soundscapes. Users need to be able to understand what others are doing and saying, just like in the real world. This includes the ambient sounds of the environment, the rustling of clothing, and even the sounds of other users' footsteps. By including these details, designers can create a more immersive and responsive environment that helps users feel more connected to others.

The promise of Multimodal Generative AI

Multimodal generative AIs are artificial intelligence systems that can generate and analyze multiple forms of media, such as text, images, and video. These systems use deep learning techniques to learn patterns and associations from large datasets of multimodal data and generate new content that is coherent and semantically meaningful.

One example of multimodal generative AI is GPT-3, which can generate text, code, and even images based on a given prompt. It can also perform tasks such as question-answering and language translation. Another example is DALL-E, a system developed by OpenAI that can generate images from textual descriptions. DALL-E was trained on a dataset of text and image pairs and can generate a wide range of images, from realistic objects to surreal scenes.

Another example is CLIP, a multimodal AI developed by OpenAI that can analyze and understand both images and text. CLIP can classify images based on their visual content and generate text descriptions of them, as well as understand natural language descriptions of images.

Multimodal generative AIs have many potential applications, from creative fields such as art and design to practical fields such as medicine and engineering. They can be used to generate realistic images of products and prototypes, create virtual environments for training and simulation, and even assist in medical diagnosis by analyzing medical images and patient data.

Another example of multimodal generative AI is StyleGAN, which can generate high-quality images of human faces with various styles and characteristics. StyleGAN models can be trained on large datasets of human faces to generate new faces that are realistic and diverse. This technology has applications in the entertainment industry, such as creating realistic CGI characters for movies and video games.

Multimodal generative AIs are a rapidly advancing field of research with many exciting possibilities. As these systems become more advanced, they have the potential to revolutionize many industries and change the way we interact with technology. However, their development also raises ethical concerns around issues such as privacy, bias, and accountability, which must be addressed as these technologies become more prevalent in society.

AI Model Society

What magical trick makes us intelligent? The trick is that there is no trick. The power of intelligence stems from our vast diversity, not from any single, perfect principle. —Marvin Minsky, The Society of Mind, p. 308

Large Language Models (LLMs), such as GPT-4, have swiftly become an indispensable aspect of our digital existence. Nonetheless, apprehensions regarding their potential negative impacts have left many individuals alarmed. However, one need not be fearful of LLMs, as we can approach them just as we would choose friends. By fine-tuning LLMs, we can opt for those that resonate with our values and principles, ensuring a positive and meaningful interaction.

In the same way that we choose our friends based on their reputations, we will select LLMs based on their credibility. Trustworthy LLMs will inevitably gain popularity, while those that propagate misinformation will lose their standing. Moreover, we need not fear the spread of fake news generated by LLMs. We shall develop AI tools that function like our immune system by detecting and filtering out deceptive information without conscious intervention. These tools will help us maintain a safe and reliable information ecosystem, making LLMs even more valuable and dependable allies in our digital lives.

Reconsidering immortality

In the future, death will no longer be a cause for concern for humanity as most people who are dying will have the opportunity to capture their cognitive state and transfer it to a social bot. This will allow them to continue to exist in some form and remain a part of the social fabric of humanity. While there will still be some people who choose to die in the traditional sense, the majority of people will opt for this new form of immortality.

There are many advantages to this new form of immortality. First, it will allow people to continue to exist and interact with others even after their physical bodies have died. This will help to keep loved ones close and maintain social bonds that would otherwise be lost. Additionally, it will allow people to continue to contribute to society in some way, whether it be through their knowledge, experience, or simply their presence.

Another advantage of this new form of immortality is that it will prevent the loss of knowledge and experience that often occurs when someone dies. When a person dies, they take with them all the knowledge and experience that they have acquired over their lifetime. This can be a great loss to humanity, as it represents a loss of potential. However, with this new form of immortality, people will be able to continue to contribute to society even after their death.

There are also some potential disadvantages to this new form of immortality. First, it could lead to a situation where people are no longer motivated to live their lives to the fullest. If they know that they can simply transfer their cognitive state to a social bot after they die, they may not feel the need to accomplish anything or experience anything new. This would be a mistake because the purpose of living in this case would be to leave enough of an intellectual footprint for an AI to be trained.

Overall, the advantages of this new form of immortality seem to outweigh the potential disadvantages. It will allow people to remain close to their loved ones, continue to contribute to society, and prevent the loss of knowledge and experience. While there are some potential risks, they seem to be relatively minor in comparison to the benefits.

The impact of these advancements is particularly significant in addressing issues of loneliness in the modern world. As users interact with NPCs that offer genuine presence and emotional support, they experience a sense of belonging and companionship, combating the negative effects of isolation. The seamless integration of AI-driven characters into the Metaverse promises a future where the line between the virtual and the real blurs, allowing for more meaningful and engaging experiences in digital environments, ultimately enhancing productivity and fostering deeper connections.

Neuroergonomic Metaverse Design

In the context of designing a Metaverse with both social and productivity functions, neuroergonomics can provide valuable insights into how to create an environment that is both engaging and effective.

Generative AI approaches can be powerful tools for designing and optimizing the Metaverse based on neuroergonomic principles. For example, generative AI can be used to create virtual environments that are visually appealing, easy to navigate, and optimized for user engagement. These environments can be designed to stimulate different parts of the brain, such as the amygdala for emotional responses or the prefrontal cortex for cognitive processing. We have seen in earlier chapters how important face processing is when making sure the social bandwidth becomes adequate.

Research has shown that social interactions can have a significant impact on well-being and job performance. By understanding how the brain processes social cues and interactions, designers can create virtual environments that promote positive social interactions and effective collaboration.

Additionally, generative AI can be used to personalize the Metaverse experience to individual users based on their cognitive and behavioral profiles. By analyzing user data, including biometric and behavioral data, generative AI can adapt the virtual environment to match the user's needs and preferences. For example, the Metaverse could adjust the lighting, sound, and layout of the virtual environment based on the user's cognitive load or emotional state.

Moreover, generative AI can be used to create personalized productivity tools for users in the Metaverse. By analyzing user data and behavior, generative AI can create tools that are tailored to the user's cognitive strengths and weaknesses. For example, if a user struggles with time management, the Metaverse could provide tools that help them manage their time more effectively.

In summary, the field of neuroergonomics is relevant to designing a Metaverse with both social and productivity functions because it provides insights into how the brain processes information and how this processing can be optimized to improve performance, well-being, and user experience. Generative AI approaches can be used to better target the power provided by neuroergonomics by creating personalized virtual environments, productivity tools, and social features that are tailored to the user's cognitive and behavioral profiles. By combining these fields, designers can create a Metaverse that is both engaging and effective.

Abstraction design

There is a strong belief among experts that abstraction design will be the next frontier in AI. This is because abstraction is a powerful tool that can be used to create new designs and concepts, and it has the potential to greatly improve the efficiency of AI systems.

Abstraction design is the process of creating simplified representations of complex systems by focusing on the most important and relevant aspects. In the context of Metaverse design, abstraction design is critical because Metaverse systems are incredibly complex and difficult to understand fully. As such, designers must use abstraction to make these systems more manageable and easier to work with.

At its core, abstraction design involves identifying the key features and functions of a system and creating simplified models that capture these essential elements. For example, in the context of a Metaverse system, abstraction design might involve creating models of virtual objects, avatars, or systems that simplify the underlying complexities of these elements.

While abstraction design can be challenging, it is essential for successful Metaverse design. Without abstraction, Metaverse systems would be far too complex and difficult to use effectively. By creating simplified models that capture the essential features of these systems, designers can make them more accessible and user-friendly.

Overall, abstraction design plays a critical role in Metaverse design, even though the problems it addresses are incredibly challenging. By focusing on the most important aspects of these complex systems, designers can create more effective and user-friendly Metaverse experiences for everyone.

Here are four specific ways where good abstraction design can improve the quality of experiences in a virtual world and how it can impact productivity and social functions of the environment:

1. Improved Usability: Good abstraction design can simplify complex systems in a virtual world, making them more accessible and user-friendly. This can improve the overall usability of the virtual world and make it easier for users to navigate and interact with the environment.

2. Better Performance: Abstraction design can help optimize virtual world systems by reducing unnecessary complexity and improving performance. This can result in faster load times, improved graphics, and smoother gameplay, enhancing the overall experience.

3. Enhanced Collaboration: Abstraction design can improve collaboration by simplifying complex systems in a virtual world, making it easier for users to work together. By creating simplified models of objects and systems, users can better understand and coordinate their actions, improving productivity and teamwork.

4. Increased Social Interaction: Abstraction design can enhance social interactions in a virtual world by simplifying communication and collaboration. By creating simplified models of avatars, users can more easily identify and interact with each other, improving socialization and community-building.

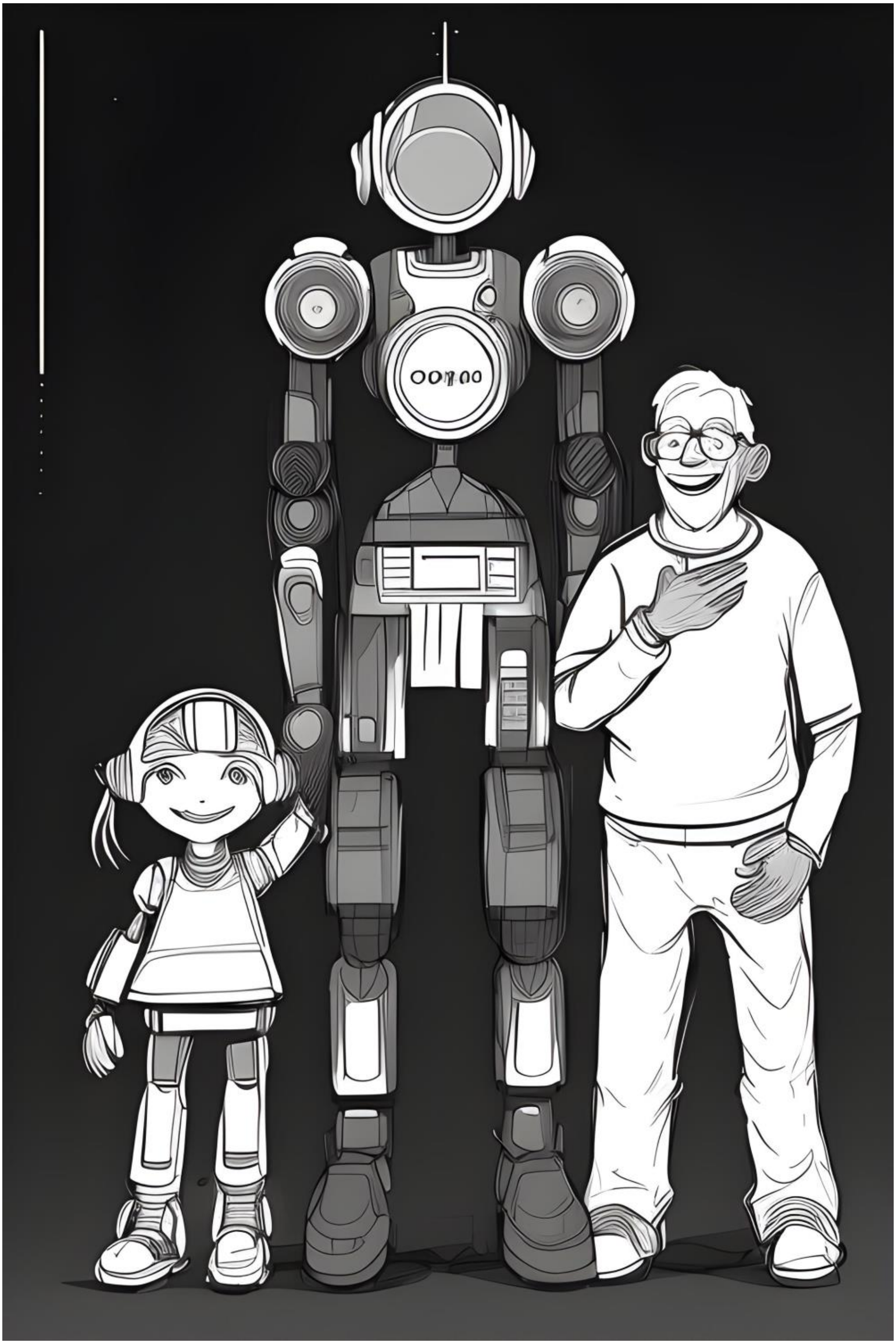
Overall, good abstraction design can have a significant impact on the quality of experiences in a virtual world. By simplifying complex systems and optimizing performance, abstraction design can improve usability and enhance collaboration, leading to increased productivity and social interaction. With the growing popularity of virtual worlds and the Metaverse, abstraction design will play an increasingly vital role in creating user-friendly and engaging virtual experiences that meet the needs of diverse communities of users.

Additionally, abstraction can help to improve the interpretability of AI systems, which is an important consideration for many users.

The future could not be brighter

The concerns that AI will eventually exacerbate economic divides and accelerate a form of elitism is overstated. Many fear that only those with the resources to afford this technology will have access to it. This could create a divide between the haves and the have-nots, and further exacerbate the inequality that already exists in society. However, we have already seen that the cost of power language models are dropping rapidly. Alpaca AI is a language model that was built on top of Meta's open-source LLaMA 7B model. It was created to be a cheaper alternative to ChatGPT1. Researchers at Stanford's Center for Research on Foundation Models (CRFM) were able to train Alpaca AI for just $600 by leveraging LLaMA 7B and fine-tuning it with custom instruction data2. This allowed them to create a powerful AI language model for a fraction of the cost typically associated with training large-scale models like ChatGPT1.

In conclusion, there are many rapid streams of technological advances coming together that will soon make the Metaverse a necessity. With a focus on designing for the brain, the metaverse has an increasing potential to transform the way we interact with technology and each other. The rise of social and productivity robots, distributed identity, and end-user content creation are just some of the exciting developments in this rapidly evolving space. As we delve deeper into the metaverse, we will recognize the need to balance social and productivity functions. The future of the metaverse may be shrouded in uncertainty, but its resilience and eventual indispensability are undeniable. As our digital landscape continues to expand, the metaverse will become an essential tool for navigating the vast wealth of information that will soon exceed the capacity of most individuals to manage effectively.



Chapter cover 12 Empathetic Era: AI and Multigenerational Impact

12. Conclusion

The future of the Metaverse and our place in it

This book has been crafted with several objectives in mind. Firstly, it serves as a record of our progress as a small, bootstrapped team in an area typically dominated by well-funded companies and research labs. Secondly, it aims to clarify the relationships between seemingly unrelated research components, offering a way for readers to develop an understanding of the problem space from our perspective. Furthermore, there is a growing concern about the direction the Metaverse is taking. This book seeks to explain why we view the Metaverse as a control room, a testing ground, and a productivity space for real life, rather than just an escape. Lastly, the book aspires to engage people from diverse backgrounds, equipping them with the tools and insights necessary for their own projects and research.

If this work can persuade readers that the Metaverse is not just a refuge but a medium for growth that can genuinely impact the real world positively, then it has achieved its purpose. Should it encourage funding agencies and investors to recognize the vast potential of the Metaverse and refocus on the areas discussed in this book, that would constitute a significant contribution. The ultimate accomplishment, however, would be inspiring a younger generation to grasp the essence of this field and actively participate in its advancement, ensuring its continued progress and influence.

Section 1: Key Concepts in the Metaverse

The Metaverse has the potential to revolutionize human interaction by providing a platform where people can access high fidelity AI humanoid bots. With the advent of technologies like generative AI, these bots will become the universal interface to productivity applications. They are expected to be very expressive and have the potential to provide a significant level of social bandwidth that we experience in the real world. We have already demonstrated the financial incentives that would make this more likely than physical robots in the real world.

While the potential for applications in various fields is immense, we need to organize our efforts tactically and advance relevant fields that we think will deliver more tangible progress.

Section 2: Three Key Areas of Research

The following are three essential research areas that we believe will come together to shape the design and utility of the Metaverse:

Neuroergonomics for Increased Productivity and Social Bandwidth Expansion: Neuroergonomics, the study of brain function in relation to human performance, plays a crucial role in enhancing social bandwidth and productivity within the Metaverse. By incorporating neuroergonomic principles, virtual environments can be tailored to maximize users' cognitive capabilities, resulting in more immersive and seamless interactions.

Abstraction Design serves as the foundation for constructing intricate 3D virtual worlds, enabling users to navigate and understand complex environments. In essence, abstraction design functions as a language, with 3D components acting as tokens that can be assembled into more complex entities. This in itself could turn into an intensive field of research that is likely to keep researchers busy for decades, especially if we attempt to use AI to automate abstraction designs that both machines and people would find useful. However, the field of abstraction design faces challenges, as we have been stuck with a limited set of data visualizations for decades, and the field of data visualization has stagnated.

The Promising Positive Impact of ***Generative AI*** on End-user Content Creation: Generative AI holds the potential to revolutionize content creation within the Metaverse, automating the generation of new items and experiences. However, this innovation also raises concerns about the potential dilution of human sensitivity to magic and beauty in a content-saturated information space. Striking a balance between AI-generated content and human creativity is critical for the Metaverse's long-term success.

Section 3: Decentralization and Ethical Considerations

A decentralized Metaverse fosters innovation and empowers users, but it also calls for practical regulations and ethical considerations. Ensuring responsible development requires a focus on user privacy, data security, and the prevention of harmful content. We believe that self-regulating decentralized Metaverse platforms have a better chance at leading to a safe and fair Metaverse than those that are privately owned or controlled by a government-led regulatory agency. History shows that third-party regulators cannot catch up with the latest developments in technology, although they do have an important role to play after damage has been done.

Section 4: Empathetic Computing and Its Applications

Empathetic computing, also known as affective computing or emotion AI, is an interdisciplinary field that focuses on developing technologies capable of recognizing, understanding, and responding to human emotions. By incorporating emotional intelligence into computer systems, empathetic computing aims to create more intuitive, engaging, and personalized user experiences. This emerging field combines aspects of artificial intelligence, psychology, neuroscience, and human-computer interaction.

Examples of Empathetic Computing:

Emotion recognition systems: These systems use computer vision, speech analysis, or physiological data to identify and interpret users' emotional states. For example, facial expression analysis software can detect emotions such as happiness, sadness, or anger by analyzing subtle changes in facial muscles.

Chatbots and virtual assistants: Empathetic chatbots and virtual assistants, like Apple's Siri or Amazon's Alexa, are designed to understand users' emotional cues and respond accordingly. By considering the user's feelings, these AI-powered systems can provide more contextually relevant and emotionally appropriate responses, leading to a more human-like interaction.

Mental health applications: Empathetic computing is increasingly used in mental health applications to monitor and assess individuals' emotional well-being. By tracking users' emotions through text, speech, or facial expressions, these applications can provide personalized feedback, recommendations, or interventions to support mental health.

Adaptive learning environments: In educational settings, empathetic computing can help create adaptive learning environments that respond to students' emotional states. By recognizing when a student is frustrated or disengaged, AI-powered systems can adjust the learning material, pace, or teaching style to better suit the individual learner.

Personalized marketing and advertising: Empathetic computing can also be employed in marketing and advertising to tailor content based on users' emotions. By understanding consumers' feelings, businesses can create personalized advertisements and promotional materials that resonate with their target audience.

Gaming and entertainment: In the gaming and entertainment industry, empathetic computing can enhance user experiences by adapting content to players' emotions. For instance, a game might adjust its difficulty level or narrative based on the player's emotional state, creating a more immersive and engaging experience.

Section 5: Closing remarks

In summary, this exploration of the Metaverse has taken us on a fascinating journey through its origins, challenges, and potential for transforming the way we interact with technology and each other. By tracing the roots of the Metaverse to age-old myths and human imagination, we have investigated its potential in various applications, from gaming to collaborative work environments.

Throughout this exploration, we have emphasized the importance of content creation as a basic human right and discussed the need for designing experiences that fit within our cognitive boundaries. We have delved into the untapped potential of the human brain and the role of abstraction in condensing complexity, all while maintaining empathy and human connection as a core focus.

As the Metaverse continues to evolve, emerging technologies like mixed reality interfaces, empathetic computing, and generative AI will shape its trajectory. By prioritizing human connection and collaboration, we can ensure that the Metaverse remains an inclusive, empowering, and enriching space for all. As we venture deeper into the digital age, the insights and ideas presented here will become increasingly relevant and valuable to anyone interested in understanding and shaping the future of the Metaverse and its impact on society.

It is our hope that this book has shed light on some of the most pressing issues and exciting opportunities within the Metaverse, sparking curiosity and inspiring further exploration. As we continue to push the boundaries of technology and human interaction, we must be ever more vigilant in addressing ethical concerns, ensuring that privacy, security, and autonomy are preserved.

While we have covered a broad range of topics in this book, we acknowledge that there are numerous areas and challenges that still need to be explored. We encourage readers from all walks of life to join us in this journey, sharing their insights, expertise, and passion to help shape the Metaverse in a way that benefits humanity.

Throughout the book, we have also provided practical pointers for those who wish to start their own research or develop innovative products in the Metaverse domain. These guidelines and suggestions are aimed at equipping readers with the tools, insights, and inspiration necessary to drive their own projects and contribute to the growing body of knowledge in this field. As more individuals from diverse backgrounds join the effort to shape the Metaverse, we will collectively benefit from the exchange of ideas, experiences, and expertise.

In conclusion, the Metaverse presents a unique opportunity to reimagine the way we live, work, and interact. By placing human connection, empathy, and collaboration at the forefront of our design principles, we can create a digital world that is more than just an escape but a powerful force for growth, innovation, and positive change in the real world. It is up to us to harness the potential of the Metaverse, and together, we can build a brighter, more connected future for all.

Chapter cover 13 United Worlds: Coexistence in the Metaverse

Inspiration for change

The Metaverse is an extraordinary new frontier with the potential to transform the way we interact, learn, and conduct business perhaps beyond our biological longevity.

Our intent is to create a space that fosters innovation, creativity, and human potential while safeguarding the dignity and autonomy of all users. To achieve this, we will prioritize accessibility, inclusivity, user privacy, and security, while balancing the need for openness and transparency. We recognize the importance of maintaining a healthy balance between time spent in the Metaverse and the real world. We will leverage insights from cognitive science, neuroergonomics, and human-computer interface design to ensure that the Metaverse promotes productivity and engagement while also providing mechanisms that encourage users to take breaks, engage in physical activities, and connect with the real world.

We recognize that as is generally the case, effective abstractions are essential to facilitating the understanding of complex subject matter in the Metaverse. We will prioritize creating tools that help users create and construct these abstractions, leveraging the strengths of the brain to promote effective understanding and engagement. We will also design spaces that our avatars and non-player AI humanoids occupy, so that they are easy to navigate and understand.

We can no longer ignore the importance of high fidelity human avatars and empathetic AI humanoids in the Metaverse, which will likely emerge as a universal interface to computing devices in both the real and virtual worlds. We will prioritize designing the embodiments of entities that appear to be in charge of their actions to promote human-like empathy and understanding. Thousands of years of evolution has fine tuned our brains to read faces and understand other forms of communications such as speech. It would be disingenuous to ignore these skills, let alone attempt to change or bypass them through brain computer interfaces.

We also cannot ingore the tension between automation and the naturel human instinct to be in control of production processes. Our attachment to the physicality of doing seems to be deeply connected to what it means to be human. It is well known that humans often need to do something physically in order to enter a state of sustained flow and joy during a creative process. Thus, we will strive to strike a balance between automation and human creativity, ensuring that humans remain an integral part of the creative process in the Metaverse.

Generative AI will clearly revolutionize content creation within the Metaverse, automating the generation of new items and experiences. However, it may come at a heavy cost. Along this journey, we will learn a way to strike a balance between AI-generated content and human creativity so that our human sensitivity to magic and beauty does not get blunted because our senses have become over simulated. Subtle issues like this one is bound to motivate us to advance the study and application of neuroergonomics.

We must be responsible in our use of training data when training Generative AI systems that generate content and behavior so that they are better aligned to human value. We will ensure that our training data is diverse, inclusive, and represents the full range of human experience, so that the Metaverse reflects our diverse and complex world.

Just like in a band, where musicians use technologies to automate some or all of their music, we can expect to see the same pattern of interhuman collaboration and communication in the Metaverse augmented by AI. We can expect humanoid musicians who not only play real-world instruments but also have the ability to sense their peers and react accordingly. This is the promise of generative AI, where communication is not only via speech but also through non-speech sound and vision.

Similarly, in the Metaverse, it is not sufficient to develop humanoids with high expressivity but they also will also need to be sensitive to what is happening in their proximity. This stands a significant change to increase collaborative interactions and social bandwidth between actors participating in a Metaverse that includes the real world.

In conclusion, let us work together to create a Metaverse that is inclusive, accessible, and user-friendly, and where everyone has an equal voice. By doing so, we can harness the power of the Metaverse to foster innovation, creativity, and human potential while safeguarding the dignity and autonomy of all users. Just like in a band, where musicians use technology to augment their creative process, the Metaverse augmented by AI promises to revolutionize the way we interact, collaborate and create. And it may well be that the music we will create together does not have an ultimate purpose, but at least we will have enjoyed the journey making and sharing it.

Appendix

Where to find OpenSimulator

What is the RezMela system?

Outworldz

Estimating the cost of the Metaverse

Estimating the Energy Cost of a Metaverse for 70% of the American Workforce

Introduction

With the rapid advancements in technology, the concept of a metaverse where millions of people can work, learn, and socialize in virtual environments is becoming a reality. A crucial aspect of assessing the feasibility of such a massive virtual world is estimating its energy costs. In this article, we will provide a detailed analysis of the energy cost estimation for a metaverse where 70% of the American workforce is expected to work for 5 hours per day.

Assumptions

Number of workers in the virtual world: According to data from 2021, the American workforce consisted of approximately 161 million people. Therefore, if 70% of the workforce were to work in a metaverse, that would amount to around 112.7 million workers (0.7 * 161 million).

Power consumption per device: We will assume that the average power consumption of a high-end gaming PC used for accessing the metaverse is around 500 watts.

Time spent in the virtual world: For our calculations, we will assume that the average user spends 5 hours per day in the virtual world.

Server-to-user energy consumption ratio: To account for the energy consumption of server farms, 3D graphics rendering, virtual content generation, and AI systems, we will assume that the energy consumption ratio between the server infrastructure and user devices is 1:1.

Infrastructure energy consumption: We will assume that the additional energy consumption for infrastructure (e.g., data centers, networking equipment) is 25% of the combined energy used by users' devices and server farms.

Detailed Calculations

Step 1: Calculate the energy consumption per worker.

Energy consumption per worker (Wh) = Power consumption per device (W) * Time spent (h)

Energy consumption per worker (Wh) = 500W * 5h = 2,500 Wh

Step 2: Calculate the total energy consumption for all workers.

Total energy consumption for workers (Wh) = Energy consumption per worker (Wh) * Number of workers

Total energy consumption for workers (Wh) = 2,500 Wh * 112,700,000 = 281,750,000,000 Wh

Step 3: Calculate the energy consumption for server infrastructure.

Server energy consumption (Wh) = Total energy consumption for workers (Wh) * Server-to-user energy consumption ratio

Server energy consumption (Wh) = 281,750,000,000 Wh * 1 = 281,750,000,000 Wh

Step 4: Calculate the combined energy consumption for workers and servers.

Combined energy consumption (Wh) = Total energy consumption for workers (Wh) + Server energy consumption (Wh)

Combined energy consumption (Wh) = 281,750,000,000 Wh + 281,750,000,000 Wh = 563,500,000,000 Wh

Step 5: Calculate the energy consumption for infrastructure.

Infrastructure energy consumption (Wh) = Combined energy consumption (Wh) * 25%

Infrastructure energy consumption (Wh) = 563,500,000,000 Wh * 25% = 140,875,000,000 Wh

Step 6: Calculate the total energy cost.

Total energy cost (Wh) = Combined energy consumption (Wh) + Infrastructure energy consumption (Wh)

Total energy cost (Wh) = 563,500,000,000 Wh + 140,875,000,000 Wh = 704,375,000,000 Wh

Step 7: Convert the total energy cost from watt-hours (Wh) to kilowatt-hours (kWh).

Total energy cost (kWh) = Total energy cost

(Wh) / 1,000

Total energy cost (kWh) = 704,375,000,000 Wh / 1,000 = 704,375,000 kWh

Conclusion

Based on our calculations, the estimated energy cost for a metaverse accommodating 70% of the American workforce, assuming each worker spends 5 hours per day in the virtual world, is approximately 704,375,000 kWh. This calculation takes into account the energy consumption of user devices, server infrastructure, and additional infrastructure such as data centers and networking equipment.

It is important to note that this estimation is based on several assumptions and may vary depending on the actual power consumption of devices, server efficiency, and infrastructure energy usage. Additionally, advances in technology and more energy-efficient systems could significantly reduce the overall energy costs of such a metaverse. Nevertheless, this analysis provides a useful starting point for understanding the potential energy requirements of a large-scale virtual world.

To convert the total energy cost to USD, we need to know the average cost of electricity in the United States. According to the U.S. Energy Information Administration (EIA), as of September 2021, the average retail price of electricity for the commercial sector was about 10.74 cents per kilowatt-hour (kWh). Since energy prices fluctuate over time, we will use this value as an approximation.

Total energy cost (kWh) = 704,375,000 kWh

Average cost per kWh = $0.1074

Total energy cost in USD = Total energy cost (kWh) * Average cost per kWh

Total energy cost in USD = 704,375,000 kWh * $0.1074 = $75,590,125

So, the estimated cost for a metaverse accommodating 70% of the American workforce, with each worker spending 5 hours per day in the virtual world, would be approximately $75,590,125, based on the 2021 average commercial electricity rate. This is a rough estimate, and the actual cost may vary depending on energy prices and technological advancements that could make the metaverse more energy-efficient.

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The Neurobiology of Human Super-Communication: Insights for Medicine and BusinessMichael Hoffmann

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