VIRTUAL REALM

An Exploration of Stimulating Virtual Space

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Architectural Experimentation
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Gothenburg, Sweden, 2024

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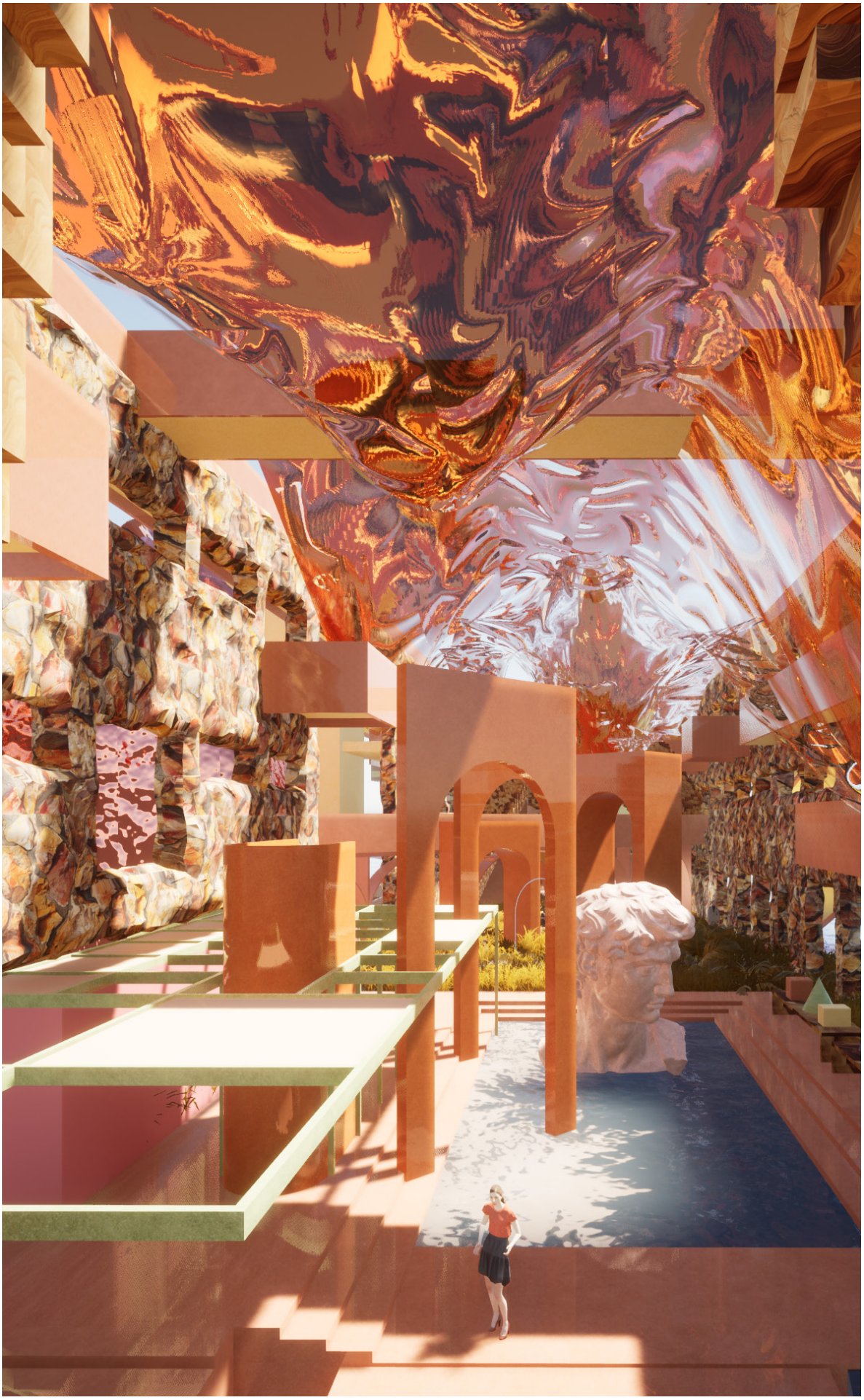


ABSTRACT

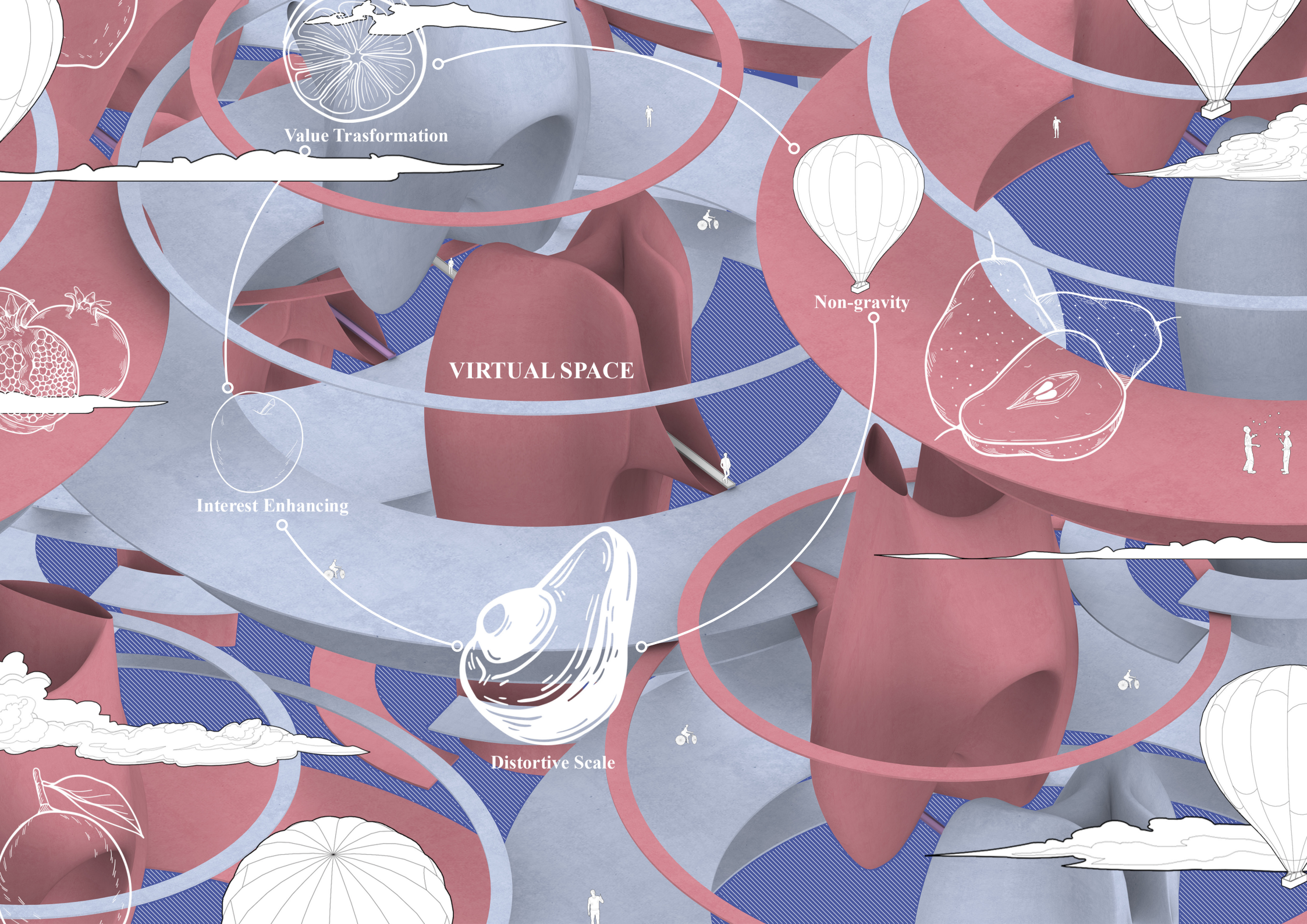
The increasing technological sophistication and widespread availability of digital modeling and visualization tools have led to a growing interest among designers, artists, scientists, and architects in the development and design of virtual places. As Grosz (2001) comments, VR has the potential for a world of unfettered choice. From 'Pygmalion's Spectacle' in the 1930s to the current prominent VR productions such as HTC Vive and Meta Oculus, 'virtual reality' is gradually and quietly changing our way of observing the World.

The virtual space is a secondary creation of the physical space relying on the perception of it, and virtual creation is a way for designers to show and communicate their creativity. Therefore a vessel that combines technological interchangeability with the concepts of social participation and improvisation, the Fun Palace paradigm space, can provide a platform for designer dynamism and creativity (Mathews, 2006) At the same time, virtual environments as a vessel need to be constantly formatted in the base scenario to respond to the multiple creativity of designers, as in the case of the Black Box Theater (Ö zel, 2017)

Based on the inspiration of the Fun Palace and the Black Box Theater, the thesis assumes the author as a social architect and discusses the virtual and reality environments that stimulate visual, auditory, and tactile multi-sensory experiences from the perspective of designers. The case study analysis of virtual architectural design, the literature review of VR interactions, and the virtual environment and creativity provide the theoretical support for developing a collaborative environment for the designers to create a multi-sensory experience that can stimulate the visual, auditory and tactile senses

The Virtual Realm enhances the physical simulation of the environment through ventilation, materials, and tactile senses to fully immerse the user in the experience. The design in the form of a warehouse community facilitates interaction between designers and stimulates reflection on the creation and thinking of virtual places.

Keywords: Virtual Reality, Immersive Multi-sensory, Creativity, physical stimulation, Community


Value Trasformation
Non-gravity
VIRTUAL SPACE
Interest Enhancing
Distortive Scale

INTRODUCTION

The increasing number of Internet communities has posed an opportunity to the traditional urban environment, as the virtual realm of the World Wide Web is becoming influenced by our daily lives. In the traditional city, a body is required to support oneself; in the modern city of the Internet, purely the mind is required to function (Grosz, 2001). Mario Carpo, in 'The End of projective image' (2017), defines VR as an essential medium for the second digital transformation and for the 2D drawing towards stereoscopic representation.

Virtual reality (VR) has the potential to provide users with immersive experiences that simulate real-life circumstances, enabling them to learn knowledge and skills via the performance of simulated activities. VR comes in contrast to the traditional approach of acquiring general data from a deconstructed library of knowledge (D. Kirshner, 1997).

In terms of virtual environments (VE) in the architectural and urban design field, some studies have already started to explore the relationship between human sense and virtual space with the utility of the VR headset. Liu and Kang (2018) applied virtual reality (VR) technology to examine the associations between urban environments and the levels of visual and audio comfort experienced in streets. They achieved this by manipulating the ratio of street width to building height. In the same way, Echevarria Sanchez et al. (2017) developed a VR system that facilitates the evaluation of how visual aspects can reduce the discomfort caused by noise. These physical stimulations of the senses can, to some extent, enhance and increase the value of the virtual space representation. In the context of virtual or augmented architecture, a significant transformation occurs, leading to the emergence of new sets of values. When considering virtual textures that simulate actual materials, it is observed that their essential characteristics are reversed. Specifically, in virtual worlds, the energy and effort required to represent a chair as solid gold is less than that needed to depict a more complex surface, such as a fluffy textile. (Lara, L & Fredrik, H, 2018).The value transformation of virtual products in virtual space brings more creative possibilities, i.e. the designer can ignore the value of the material itself to a certain extent and put more focus on the refinement and creativity of the virtual creation.

The widespread application of the Internet and virtual reality has greatly improved the practicability of the design and creation of virtual architecture. In this regard, the thesis discusses the characteristics of virtual architecture based on the concepts of virtual and reality through a case study of a virtual architecture project: Unlimited Creativity, Community-Centric , Immersive Experience. These characteristics can be used as a design strategy to build virtual scenarios. The Vritual Realm, as a community-based virtual reality experience and creative space prototyped by Fun Palace, incorporates the characteristics of virtual architecture. The physical place of the warehouse is remodeled to bring sensory stimulation to the designers and experiencers.

At the same time, the authors, from the perspective of a social architect, based on the idea of interaction and reaction to the design and creation of virtual environments, regard the place as how to realize the creative communication of meaning by engaging not only with others but also by engaging with the environments in which these interactions take place (Popov, 2015) In this project, the architects programmed all the possible events that could take place in the envisioned place and brought into the spatial design of Virtual Realm through virtual building plaform, providing a diverse arena for the communication and exchange of designers in the virtual environment.

The design of various spatial viewing experiences is created for both the user and the designer, utilizing hallways and window openings. Virtual construction and product overlap on the physical world's architecture enables the experiencer to manipulate the position, scale, and orientation of virtual objects in the space through VR editing tools, and to tailor the materiality of the virtual objects to their personal preferences. The virtual space opens up unlimited creative possibilities for designers.

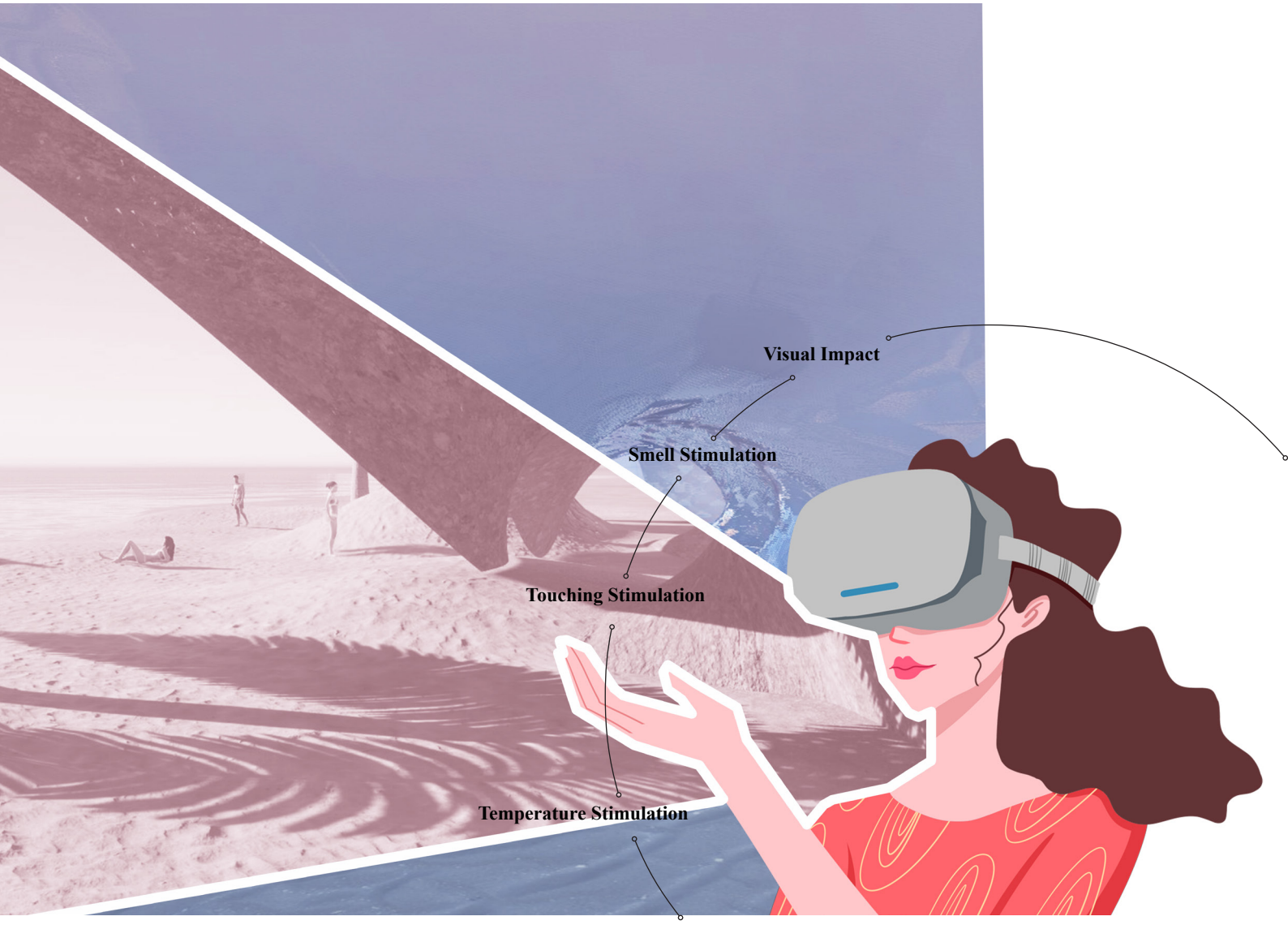


Figure 1, Conception image to illustrate the sense stimulation of the Virtual Environment

GENERAL AIM AND SPECIFIC PURPOSE

The virtual world is based on the real world and it constitutes a radically different environment.
In virtual environments, the properties of architectural spaces and building materials can be modified, e.g., in non-gravity-bound environments, the shape of architectural surfaces can differ from that of the real world; the value of building materials is no longer evaluated in terms of their rareness, but rather in terms of their technical complexity. However, in virtual environments there is often a lack of immersion, thus allowing the experiencer to feel only a faint presence of these characteristics in them. Bringing objects and humans from the physical environment into the virtual media (Millerson, 2012) is what this research hopes to achieve in the design phase of the Master's thesis.

The study, from the perspective of architectural professionals, is aimed at designing a physical space that evokes a multi-sensory experience of sight, sound, and touch, and corresponds to the virtual space on a human scale, enabling the designer and the experiencer to be fully immersed in the virtual space, and to create architectural spaces and material attributes within the virtual environment that are distinct from those of the real world. The site of the project will be located on the northern side of Göta Älv, Magasin 113.

In the structure, Designers are constantly changing virtual materials and shapes, generating encounters and collisions of creative ideas in a common, virtual space with the stimulation of the physical environment as a context, allowing for a gradually expanding range and freedom of thought, thus stimulating the imagination and creativity of designers in the field of virtual space and material design.

RESEARCH QUESTION

Nowadays, as the concept of virtual reality becomes more and more widespread, more and more people start to pay attention to the topics of immersive experience in virtual space, virtual interaction, and virtual space design. Regarding VR and virtual spaces, relevant research has shown that VR is used to create a synthetic avatar (a virtual representation of the user) of the user's experience as if it were his/her own body. In order to realize a synthetic embodiment, a multisensory signal and sensory feedback experienced by the user and a spatial and temporal correspondence between the visual data associated with the avatar are required (Chirico, 2016). How the immersion of the users in the virtual space is enhanced when there are physical signals in the virtual space. And how creativity is stimulated when designers enter such a virtual space as experiencers and interact, communicate, and collaborate on scenarios in virtual environments.

Therefore, in response to the above questions, the thesis addresses the spatial design of virtual reality from the designers' point of view as follows:

Q1: How does the stimulation of the physical space increase the immersion of the user who experiences the virtual space?
Q2: How to inspire designers to be creative in virtual spaces through virtual space design?

Regarding Q1, Experimental aesthetic research tends to inevitably deviate from the real experience because of diminished control over environmental factors, and providing a relatively high degree of ecological validity in virtual environments can enhance the designer's aesthetic perception of the space (Gulhan,2023). Meanwhile, Wideström's opinion notes that individual has the capacity to perceive and engage with their surroundings in both tangible and digital realms using interactive environments that encompass both physical and virtual dimensions. This implies that the individual engages in interactions that involve their physical presence as well as their virtual presence, thereby participating in a combined physical-virtual world through embodied interactions (Wideström, 2020). Also, the studies illustrated in the theory part reply to Q1 that the physical space can enhance the experience of virtual space. Sensory enhancement both visually and aurally creates a more authentic spatial contextual experience, allowing designers to create unique materials and spaces within a specific spatial context.

For Q2, the study is elaborated in the chapter VIRTUAL SPACE DESIGN AND CREATIVITY INSPIRATION of the VIRTUAL REALM project in terms of virtual space and human consciousness, virtual media and cognition, collaboration and cooperation in virtual environments.

METHOD

The Thesis used qualitative approach, applying the research for design methodology by interpreting the three research questions into design strategies and theoretical support through literature review and case study (Wang, 2007) related to Q1 and Q2:

1. VIRTUAL AND REALITY
2. VIRTUAL ARCHITECTURAL DESIGN
3. VIRTUAL REALITY AND HUMAN-COMPUTER INTERACTION
4. VIRTUAL SPACE DESIGN AND CREATIVITY INSPIRATION

The VIRTUAL AND REALITY chapter summarizes the virtual and physical worlds through literature review explaining:

1. Virtual environments (VEs) have unique contributions to architectural design that are reflected in the way they stimulate, communicate, and inspire.
2. Spatial design in virtual environments relies on the human mind and requires designers to have a deep understanding of cognitive psychology and human perception.

3. The immersive nature of virtual reality is comparable to physical presence and enhances the potential for feedback and exploration in architectural design.
4. Virtual reality has transformative potential in architectural design, transcending physical limitations and shaping our perceptions and interactions with the built environment.

The VIRTUAL ARCHITECTURAL DESIGN chapter illustrates the characteristics of the virtual architecture by case study and summarizes them as:

1. Unlimited Creativity
2. Community-Centric
3. Immersive Experience

Three design strategies are proposed for the project Virtual Realm:

1.Collaborative Virtual Experience
2.Nature Hyper-Realistic Simulation
3.Deconstruction and reorganization

Chapter **VIRTUAL REALITY AND HUMAN-COMPUTER INTERACTION** provides a detailed description of the manipulation of VR equipment and multisensory stimulation as a basis for practicing VR use and VR interaction in Virtual Realm.

Chapter **VIRTUAL SPACE DESIGN AND CREATIVITY** explores the three components of human and spatial perception, virtual spatial cognition, and cooperation in virtual environments and get the conclusion that:

There is a connection between human consciousness and spatial experience that allows interior spaces, virtual media, and virtual reality (VR) to influence human perception and creativity.

Spatial perception can influence self-awareness and action, virtual media influences emotional and cognitive processes, and virtual reality enables immersive design experiences that enhance innovation and communication between designers through collaboration.

These four chapters provide the theoretical basis for the space design of Virtual Realm, which is to transform Magasin 113 into a virtual experience space for creation and experience, where some of the human-scale objects in the virtual space will be replicated and built in the physical space. Through corridors and window openings, different spatial viewing experiences are designed for the experience and the designer, while the physical simulation of the environment through ventilation, materials and touch deepens the immersion of the experience. The design of the warehouse community form increases the direct communication between the designers, and provokes thinking about the creation and imagination of the virtual space.

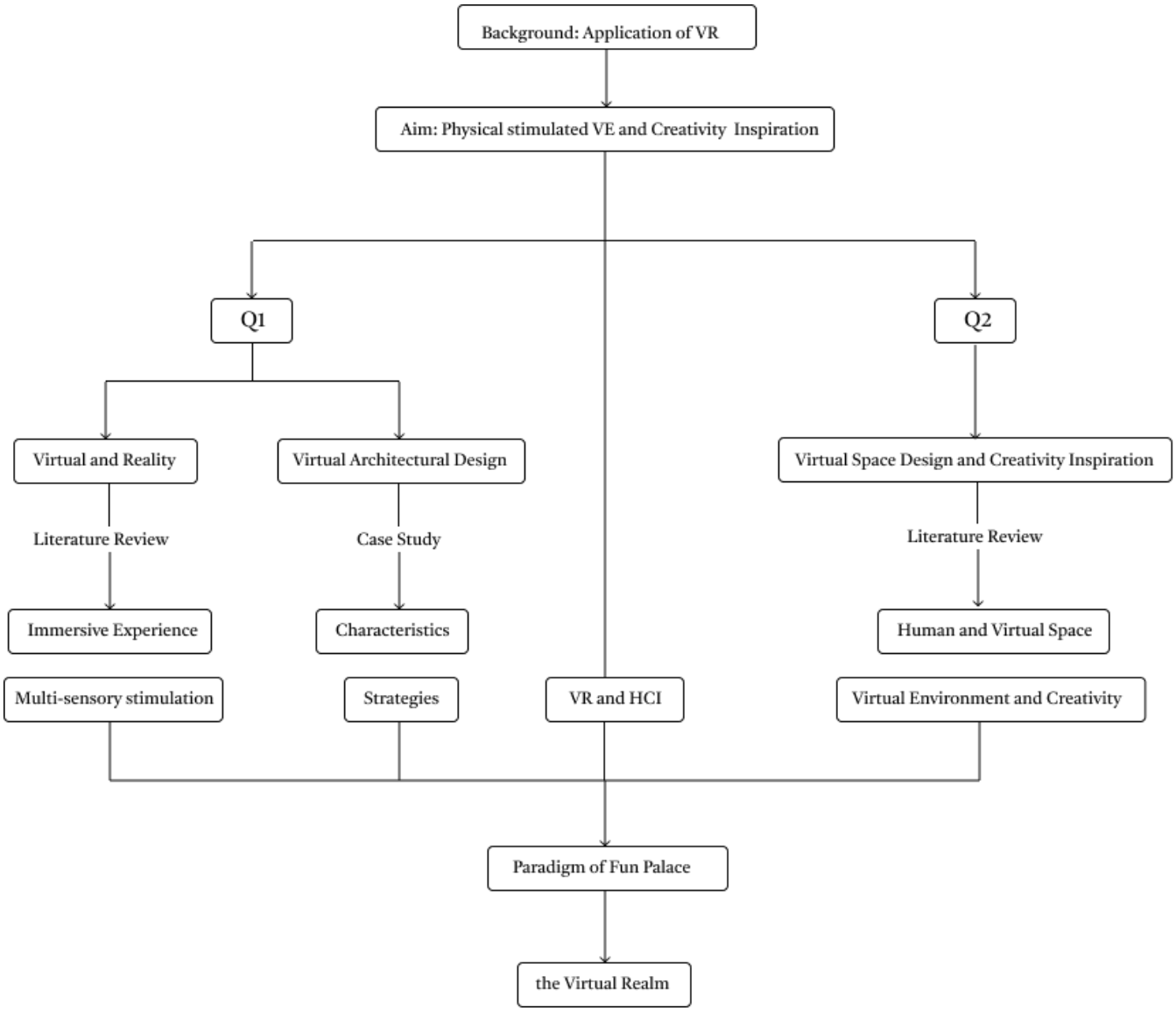


Figure 2, Illustration of the method

BACKGROUND

The emergence of digital communication tools is gradually changing our way of life. Especially for Cyberspace and virtual reality (VR), have a trend to be the most focused topics for igniting the imaginations of individuals and allowing them to engage in entertainment, education, and as well as the fields of design. (Grosz, E, 2001). Nowadays, there are many definitions of virtual reality, all of which overlap to a greater or lesser extent in critical areas. When we use the term "VR", it refers specifically to computer-generated visualization and hardware specifically designed to bring these sights and sounds to us in a fully immersive way in most instances. Elmqaddem (2019) also provides a more specific definition and notes that Virtual reality (VR) is a technological innovation that enables the full immersion of individuals within a simulated environment, which can encompass either an entirely manufactured universe or an accurate replication of the physical world. The experience may also include auditory, cognitive, and occasionally sensations of touch in the virtual environment (VE).

The concept of virtual reality could be dated back to the 19th century. In 1838, Charles Wheatstone conducted a study that indicated the capacity of the brain to synthesize different two-dimensional visual inputs in each eye, resulting in the perception of a three-dimensional object. The act of observing two nearby stereoscopic pictures or photographs with the use of stereoscopic glasses triggers a perceptual experience characterized by an enhanced sense of depth and a stronger feeling of immersion. (Goldsborough, 2007) In 1935, the American science fiction writer Stanley Grauman Weinbaum published Pygmalion's Spectacles, a fiction short novel that conceived the idea of utilizing a pair of spectacles that enable the user to immerse themselves in imaginary worlds by using holograms, smell stimulation, taste perception, and touch. (Weinbaum, 1935)

…a movie that gives one sight and sound. Suppose now I add taste, smell, and even touch, if your interest is taken by the story. Suppose I make it so that you are in the story, you speak to the shadows, and the shadows reply, and instead of being on a screen, the story is all about you, and you are in it. Would that be to make real a dream? …

—— Pygmalion's Spectacles by Stanley Grauman Weinbaum

On a rainy night in high-rise Chicago, Dan Burke stumbles encountered Professor Albert Ludwig and discusses philosophy and human perception, in which the professor argues that the sensations people feel are actually spiritual phenomena-they don't exist in the world, but in our minds. The Pygmalion's Spectacles had the first mention of virtual reality and the discussion by Dan Burke and Professor Albert Ludwig precisely predicted the application of the future VR experience.

The first virtual reality equipment was created in 1968. Ivan Sutherland and his student Bob Sproull developed the earliest virtual reality/augmented reality head-mounted display (known as the Sword of Damocles) connected to a computer. (Boas, Y. A. G. V, 2013).

In 1987, Jaron Lanier, the inventor of the visual programming lab (VPL), proposed the phrase "virtual reality," which subsequently acquired popularity in some areas. The research field has been assigned an official name. Jaron, in collaboration with Tom Zimmerman, contributed to the development of various virtual reality equipment, such as the Dataglove and the EyePhone head-mounted display, through his business VPL research (Lanier, 1992) . The release of affordable and high-performance headsets since 2014 has significantly boosted the availability and popularity of virtual reality among people of all ages. The initial iteration of the Oculus Rift headset, intended for developers, was introduced in 2013. However, it was not until March 2016 that this particular helmet became widely available to the general consumer market (Elmqaddem, 2019) Nowadays, with the emergence of a series of high-resolution and affordable VR products such as the Meta Quest 3 and the HTC Vive, more and more people could have the opportunity to create virtual worlds and experience them in very immersive environments, with a variety of interactive behaviors with the virtual worlds. For designers, the theory and hardware of virtual reality already provide prerequisites for stimulating, communicative, and inspiring design. Because by providing users with intuitive interfaces and interactive feedback systems, architects can engage in iterative design exploration through specific design methodologies, digitally refining design concepts and optimizing design(Chase,2002)

In virtual environments, Users can only interact with the virtual world through external devices, without being able to realistically perceive the properties of objects through physical touch (Witmer, 1998). When users from human-perspectives are situated for spatial design, virtual spaces can be experienced and felt immersive through a range of sensory stimulation, such as smell, taste, and auditory simulation, so that architects can bring their imagination, creativity, and passion for architectural design to life in virtual spaces without constraints and limitations. As mentioned by Lombard (1995), when users are unable to distinguish whether they are in a virtual environment or not, they will respond directly to what they see and hear in the virtual environment as if the content they see and hear actually exists in their viewing environment, rather than responding to it immediately.

The virtual environment, in some ways, can also be seen as a complex Black Box Theater, where each scenario that takes place in the virtual environment becomes an original behavior born in the Box, a space that breaks down the boundaries between the users and becomes a highly interactive staging machine (Hannah, 2003) In virtual environments, the technology, rather than the construction, defines its boundaries. Like the Black Box Theater, the mobile and fixed stage compresses the space for audience and actors into a single room, which can be manipulated by technology to provide any number of spaces. Under the label of "flexibility," virtual spaces are considered infinitely adaptable to meet all the requirements of scenography and spatial design. As such, virtual environments are also considered a form of sustainability, minimizing the initial cost of creating a physical space.

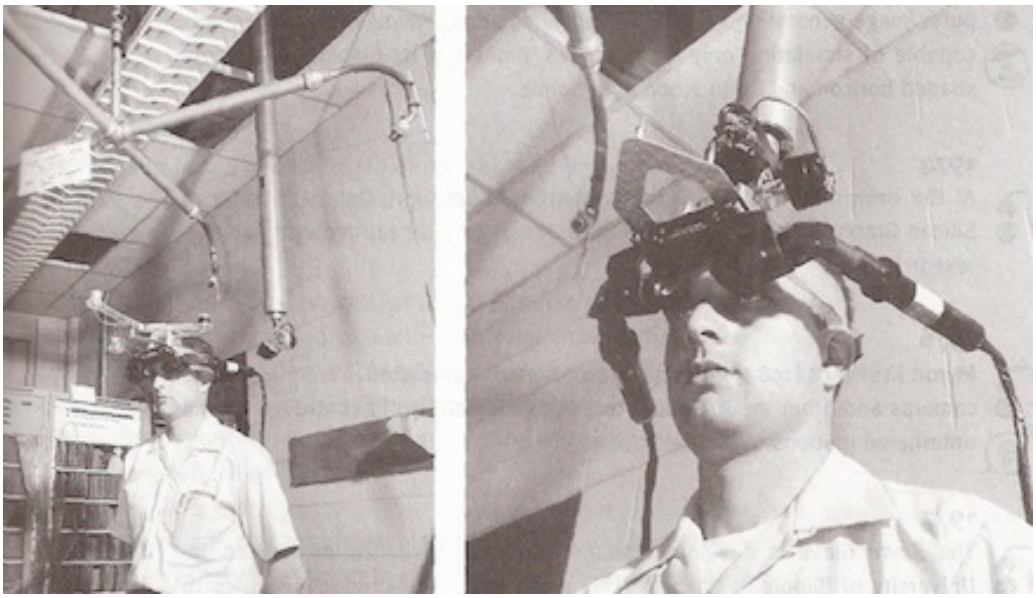


Figure 3, Sword of Damocles, From https://www.vrs.org.uk/virtual-reality/history.html

DELIMITATIONS

The main focus of the Master's Thesis is on the characterization of virtual design elements and the scenario-based interaction of the designer with the virtual environment, and therefore it does not directly address the relationship between building structural joints, building energy consumption, and life-cycle assessment. While these aspects are undoubtedly important in the broader context of building design and sustainability, and are involved in the STIMULATION section of the physical environment, they are not the main focal point of this research. The project is more concerned with the virtual aspect, i.e. the immersion of virtual reality and the virtual interaction stimulating both creativity and imagination. However, in future research, the authors expect that the study of building energy consumption and the psychology of the user can be taken into account in the study of virtual architecture, so as to have a more comprehensive explanation of the design of virtual spaces.

SUSTAINABLE DEVELOPMENT

The study illustrates the relationship between projects and sustainable development in terms of both physical building construction and virtual scenario awareness.

Digital technology is used to minimize reliance on physical building materials in a physically stimulating virtual building context. Virtual models simulate the external surface, structure, and function of physical buildings, enabling architects to visualize and analyze designs in a digital environment. By allowing architects to interactively manipulate design parameters and evaluate design variations, parametric design tools enable architects to digitally optimize designs and reduce their reliance on physical models. (Aish, 2002)

At the same time, relevant studies have shown that virtual scenarios are a primary medium for stimulating awareness in experiencers (Chirico, 2023) Virtual nature can influence socially engaged environmental attitudes and behaviors from an individual's perspective, and virtual reality devices are a particularly effective tool for emotional induction (Chirico, 2016), helping to make individuals more receptive to self-transcendence and a potentially transformative reverence experience (Quesnel, 2018). Therefore the research will incorporate more nature-related scenarios in the design phase of the virtual space to stimulate the designer's sense of reverence for the natural environment from the perspective of the scenario.

VIRTUAL AND REALITY

Virtual worlds have inherent characteristics that make them ideal for an architectural design that emphasizes stimulation, communication, and inspiration. Spatial design in virtual worlds primarily relies on the human mind as the central point. Therefore, the process of creating inside virtual environments (VE) requires designers to possess a comprehensive understanding of the potentialities offered by cognitive psychology and the intricate details of human perception. In the words of Oliver Grau (Oliver, 2004) virtual environments (VE) exhibit an atmosphere of immersion that is not necessarily unique or innovative in the field of digital images. However, what separates them apart is their enhanced capacity for flexibility and interactivity. The A digital image is capable of modification and engagement. The digital image differs fundamentally from a physical image, not only in its intangible characteristics but also in its methods of creation, utilization, and comprehension. Consequently, the digital image has the ability to serve as a platform for engagement, rather than just a medium for observation. Once a virtual space is brought to other human senses, such as smell and touch, those in the virtual environment that has the designer's mind as their content echo the experiencer. In such a scenario, as mentioned in Seamon's (2018) interpretation of Merleau-Ponty's understanding of the Phenomenology of Perception, at every moment, perception is based on the existence of the immediate world as a matter of fact, just as the physical body makes certain that the actions and ways of existing are synchronized with the perceptual realm. The subjective perception of presence occurs when individuals find themselves in a particular location, accompanied by other individuals or things. This sensation involves an understated sense that the current world and the many activities within it share an actual character

Figure 4, Image generated by Midjourney. imaginative future architecture, green landscape, narrow space, sublime feeling, surface of lake, cyberpunkstyle, unreal engine

Not all brain systems differentiate between cognitive and perceptual presence, meaning they do not distinguish between what is considered 'real' and what is considered 'virtual'. This includes the ability to experience the tranquility and serenity of a natural environment through cognition or verbal expression. (Waterworth, 2003). This is an immersive status, which is nicely demonstrated in Space Popular's narration of the exhibition Value in the Virtual, through the example of an ancient tale: The narrative of Pygmalion in Ovid's Metamorphoses talks of a sculptor who, in his attempt of flawlessness, makes a realistic statue that portrays his dream lady. He is fascinated by the sculpture, and it magically comes to life, transforming his beautiful masterpiece into a living person (Lara, L & Fredrik, H, 2018)

While Pygmalion prayed to the goddess Aphrodite to transform stone into a living, breathing form, we turn to science, technology – and design.
——Value-in-the-virtual, Space Popular

Probably each of us, in some way, share a dream: a desire for the unreal made real. The production of a comprehensive illusion in which the artist or programmer generates all stimuli involved in the establishment of 'perceptual presence' indicates a permanent human aspiration.

When the virtual world becomes real to the experience, the value of the virtual space can be communicated to the experience in a holistic way. As mentioned above, the virtual environment's reality is enhanced when combined with the stimulation of the physical environment, and people can provide more realistic and quicker feedback on the values conveyed by the designer of the virtual space. With a virtual reality augmented experience based on physical structures, in the context of the architectural field, a detailed discussion can be initiated about the properties of architectural forms and building materials in virtual space.

The limitations that define our physical environment are not important in the virtual world. In virtual reality, there is no gravity to constrain objects, so even behemoths above the visual can fly as lightly as balloons in the sky. Also in a scene without gravity, the scale of objects can be exaggeratedly enlarged or reduced.

Throughout the migration to the virtual realm, there will be positive as well as negative effects in terms of values, and the introduction of unfamiliar spatial aspects will impact our assessment of our surroundings. In the virtual realm, architecture will possess the capacity to rapidly transform in accordance with our thoughts and will possess the power to mold, enhance, restrict, and manipulate our assessments of worth. The worth of an object in virtual reality is typically determined by its complexity.

Virtual environments will enhance our curiosity and enthusiasm for the physical environment. Virtual worlds rely on our tactile comprehension of the surrounding environment, as they are products of the physical universe. Just as fiction impacts our lives, virtual reality will intensify our curiosity and concern for our physical surroundings.

Figure 5, https://www.john-demaio.com/space/z84i8ow8zxq66ha4o2dj4umwa45fi3

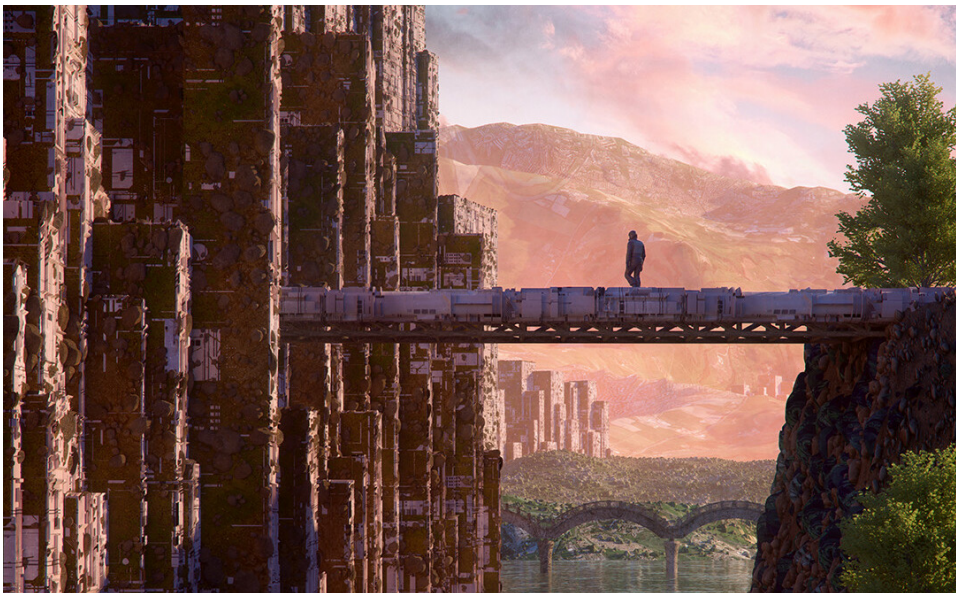


Figure 6, Annibale Siconolfi, From https://www.artstation.com/artwork/GXYAaQ

Figure 7, value-in-the-virtual by Popular space http://www.spacepopular.com/exhibitions/2018---value-in-the-virtual

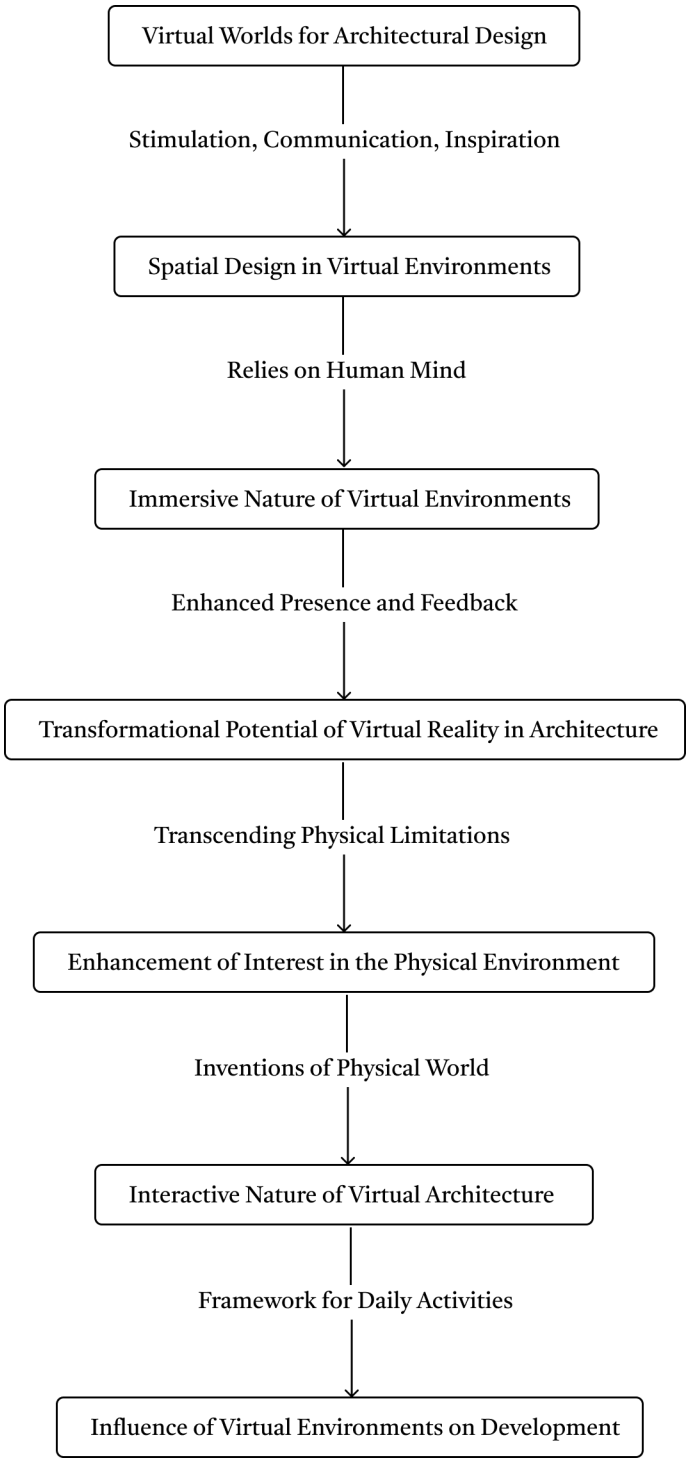


Figure 8, Illustration of the chapter VIRTUAL AND REALITY

The physical architecture is predominantly fixed and thus less significant in our perspective of daily life. Virtual architecture has the capacity to demonstrate the same level of interactivity as human individuals do when conversing with each other. Architecture serves as a framework for the routines and activities of daily life, however, it often maintains a secondary role in shaping our actual lived experiences. As the prevalence of inhabitable virtual worlds increases, it is evident that the surroundings we create will have a reciprocal influence on our own development.

VIRTUAL ARCHITECTURAL DESIGN

A “virtual environment” is a computer-generated, interactive framework that simulates a genuine environment in a way that is indistinguishable from reality to the user. (Stuart, 1996) Users can engage with these systems via a human-computer interface, and the system generates scenarios where users feel as if they are physically present in the environment. This environment can consist of real or virtual agents, objects, and processes. Merrick (2007) explains that virtual architecture design focuses on developing and presenting 3D models that form the foundation of virtual worlds. Virtual Architecture, although derived from physical architecture through the application of 3D infrastructure, is made highly interactive and dynamic by the software employed to construct virtual environments.

Mars House

Mars House serves as an illustration of the virtual architectural design concept. As described by Kolirion (2021), Christine King initiated the design of Mars Home and created visual representations of it using the Unreal Engine in May 2020. Users can navigate the home using VR and AR with the app’s settings. The Mars Home has LED panels around the facade. All furniture is made of tempered glass, cloth, and recyclable materials, and the floor and ceiling feature wonderful colour gradients.

In the interview conducted by Kolata (2022), Kolorion presents an original approach to thinking about architecture through the eyes of MH. This approach emphasises the community aspect over the physical building and its structure. Architecture, functioning as a communal shepherd, must unite the society, a task of heightened significance in the metaverse. The experience is mostly theatrical, requiring collaboration with community members to generate a range of circumstances. The dynamism of the metaverse relies on the active participation of the community. Virtual architectural designs, like Mars House, are representations of the spatial structure of architectural design in a simulated environment that closely resembles the actual world. They also have features that facilitate specific types of online interactions.

Figure 9, Mars House was sold in an NFT auction. https://www.dezeen.com/2021/03/22/mars-house-krista-kim-nft-news/

/IMAGINE: A Journey into The New Virtual

The exhibition, A Journey into The New Virtual, focuses on how video games, artificial intelligence, and futurist projections push the boundaries of design. The curators of the show at the MAK Museum in Vienna claim that the only limit to architecture and design is creativity, rather than technical, material, or budgetary constraints. Visitors are transported to virtual dream worlds where innovative ideas and fictitious architectural scenarios bore no resemblance to the intricacies of the actual world. (Christina, 2023) After studying the descriptions of the many exhibits, two of the pieces are representative of the many virtual works:

Andres Reisinger and Alexis Christodoulou have produced hyper-realistic digital artwork that showcases organic building, a bright pink colour palette, and spectacular natural landscapes. This artwork emerged during the pandemic. These works, typically focused on demonstrating the principles of physics, are strongly influenced by plants and are a response to feelings of isolation. The limitations imposed by physical constraints inspire the mind to imagine extraordinary environments.

The "/imagine", an instruction used by users of the Midjourney artificial intelligence software to generate their own ideal architectural utopias. The software combines a brief textual depiction to generate illustrations with unlimited possibilities and variations.

Design techniques such as visualisations and AI algorithms are becoming more and more common. The emergence of computational technologies has not only revolutionised the design process and concept generation in architecture and design, but has also expanded our awareness of how humans shape, experience, and navigate place, encompassing cultural, social, political, and aesthetic aspects.

Figure 10, MAK Exhibition View, 2023, /imagine: A Journey into The New Virtual, Alexis Christodoulou, Quantum Express, 2022 © kunst-dokumentation.com/MAK

Figure 11, Liam Young, Film still from Planet City, 2021 © Liam Young. https://www.mak.at/en/program/exhibitions/imagine

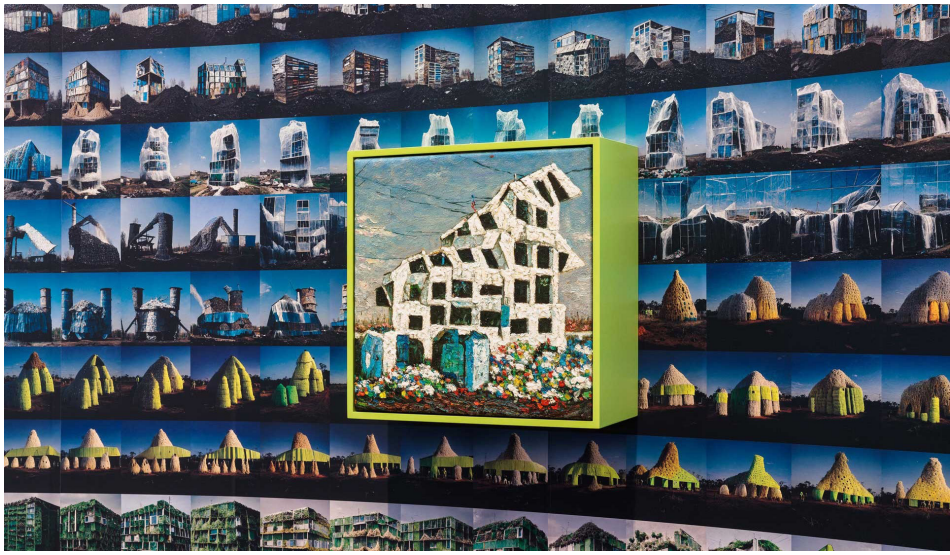


Figure 12, MAK Exhibition View, 2023, /imagine: A Journey into The New Virtual, Leah Wulfman, My Mid Journey Trash Pile, 2022, Installation, Midjourney images, oil paintings © kunst-dokumentation.com/MAK

Metaverse Real Estate Development

In December 2021, The Alexander Team and Everyrealm declared their plan to collaborate on the creation of a remarkable community with unique design elements. The purpose of this collaboration is to enable their clientele, who currently own valued assets in the physical world, to replicate the same degree of collection in the Metaverse (Dima Stouhi, 2022). As Janine Yorio, the CEO of Everyrealm, describes the virtual world has no limitations regarding weather or physics other than the human mind.

Daniel Arsham's 'uchronic'digital artworks, including 'The Ares House', prominently feature architecture and sculpture. The sculpture of Ares in The Row is of immense proportions, to the extent that it may potentially be inhabited. Arsham created five various versions of The Ares House, each featuring a special crystal characteristic: amethyst, quartz, pyrite, and volcanic ash, meant to stimulate thought about the ideas of time and age. (Dima Stouhi, 2022). Regarding the Metaverse, Daniel claims that the architectural designs have the potential to become fantastic places to live in the Metaverse as it expands. Although artwork in the first versions of the room, clients might opt to arrange pieces by other digitally native artists or artists who produce most of their work in the real world. He drew really realistic illustrations of this piece of art, including how it may look, feel, and move through as well as how light would flow through it throughout the day.

Figure 13, Daniel Arsham and Andres Reisinger Among Acclaimed Designers of Newly Launched Metaverse Real Estate Developmen, https://www.archdaily.com/985957/daniel-arsham-and-andres-reisinger-among-acclaimed-designers-of-newly-launched-metaverse-real-estate-development

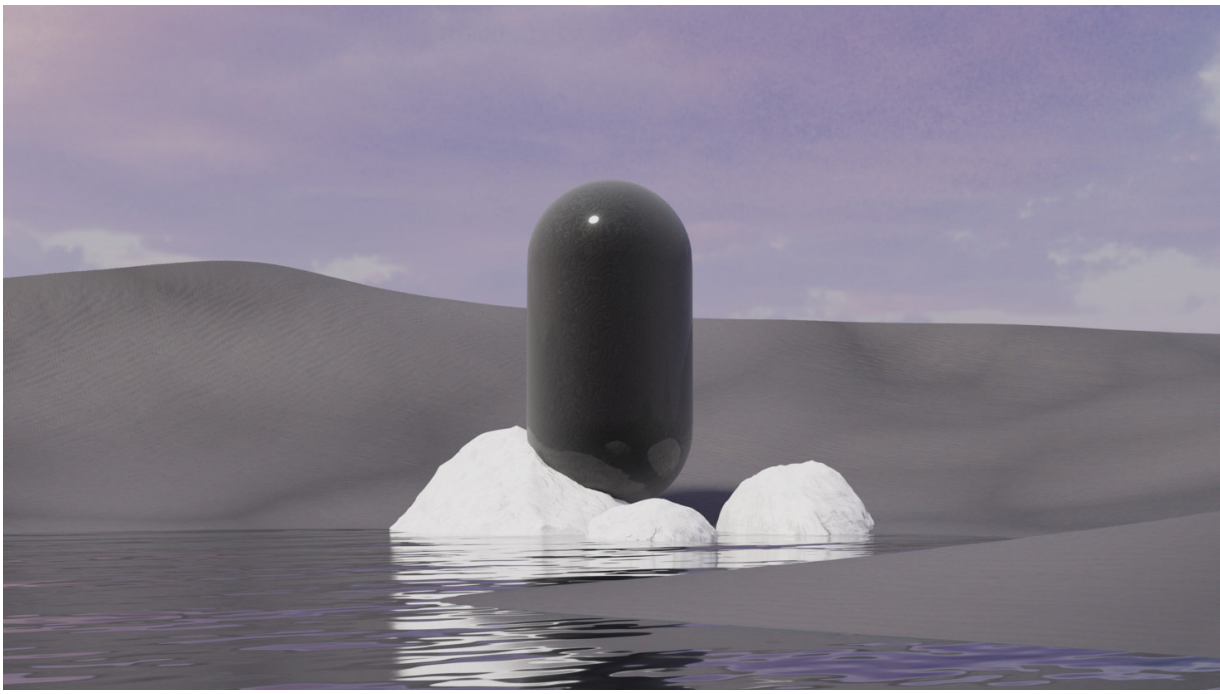


Figure 14, Daniel-Arsham's The Ares House, Image © Daniel Arsham, https://www.archdaily.com/985957/daniel-arsham-and-andres-reisinger-among-acclaimed-designers-of-newly-launched-metaverse-real-estate-development

Other Metaverse Projects

The Mirage, designed by Alexis Christodoulou Studio, is the initial individual floating facility in the metaverse, designed for leisure and spiritual immersion into the digital environment. Each version of the project is based on the contradiction of gravity at different times of the day. It is designed to have a distinct tone that reflects the position of the sun as it hangs overhead.

Andrés Reisinger presented a comprehensive and visually compelling statement on the digital representation of architecture. The project aims to explore the difficulties presented by conventional architecture and its compatibility with the Metaverse. Reisinger's virtual house overcomes spatial limitations and overcomes the problems of insignificance, monotony, existential anxiety, and vacuity by integrating stimulating components like spatial design, atmosphere, and architectural composition.

Hard.Architects' contribution to 'The Row' was driven by an introspective exploration of the need for luxury and the desire for a sense of belonging. The image serves as a critique of the desire for a luxurious and lavish lifestyle, symbolizing the concept of a virtual reality world through the use of a black pearl, which represents both simplicity and elegance.

'Make Room for Us', a design work by Six N. Five, explores the themes of guilt and atonement in response to the damage imposed upon the natural world. The company showcased an architectural system that engages with the natural environment within a fictional ecosystem consisting of cliffs, mountains, and virtual dreamscapes. This was achieved through a narrative approach, where visual conceptions were created utilising flexible designs inspired by cellular organisms.

CHARACTERISTICS OF THE VIRTUAL ARCHITECTURE

The research characterizes the above case features related to virtual architecture, and the keywords in the descriptions are extracted and codified to produce a summary of the features related to virtual architectural design

Virtual architecture design illustrates a combination of community-centric values, limitless creativity, and immersive environments. From Mars House's expression of community life to the Vienna Exhibition's unlimited creative expression, each project challenges physical constraints. Reisinger and Christodoulou's hyper-realistic digital art, combined with AI-generated possibilities, shows this infinite creativity. With its unphysical character, the metaverse provides a canvas for investigation, encouraging emotional connection and mental reflection. Whether overcoming gravity in Mirage or addressing existential questions in Reisinger's declaration, virtual architecture provokes thinking, inspires emotion, and encourages unlimited imagination, eventually changing our sense of space and design.

Figure 15, Alexis Christodoulou's The Mirage. Image © Alexis Christodolou, https://www.archdaily.com/985957/daniel-arsham-and-andres-reisinger-among-acclaimed-designers-of-newly-launched-metaverse-real-estate-development

Figure 16, Hard's The Pearl. Image © Hard, https://www.archdaily.com/985957/daniel-arsham-and-andres-reisinger-among-acclaimed-designers-of-newly-launched-metaverse-real-estate-development

Figure 17, Andrés Reisinger's virtual house. Image © Andres Reisinger & Alba de la Fuente, https://www.archdaily.com/985957/daniel-arsham-and-andres-reisinger-among-acclaimed-designers-of-newly-launched-metaverse-real-estate-development

Figure 18, Six N. Five's Make room for us. Image © Six N. Five, https://www.archdaily.com/985957/daniel-arsham-and-andres-reisinger-among-acclaimed-designers-of-newly-launched-metaverse-real-estate-development

Table 1, Case study of Virtual Architectural Design Projects

Project Name	Description	Key Words
Mars House	1. The community, more than the building and structure itself, is valued. 2. A theatrical experience that must work with community members to create a variety of contexts, and it is the vibrancy of the community that brings the Metaverse to life.	Community，Theatrical Experience
Exhibition in Vienna: design and architecture in virtual reality	1. The only limitation in architecture and design is creativity, not technical, material or budgetary constraints. 2. Innovative ideas and fictional architectural scenarios have no resemblance to the intricate real world.	Creativity，Unlimited
Andres Reisinger and Alexis Christodoulou ，Hyper-realistic digital artwork	1. A response to feelings of loneliness. Physical limitations inspire the imagination of extraordinary environments.	Imagination，Inspiring，Unlimited
/imagine	1. The program incorporates short text descriptions to generate illustrations with unlimited possibilities and variations.	Unlimited Possibilities，AI
The Alexander Team and Everyrealm	1. The Metaverse has no physics, no weather, and no limitations other than human intelligence. 2. Users can duplicate the same level of collection in the Metaverse and use it over time	Unphysical，Unlimited，Duplicated
Daniel Arsham , The Ares House	1. Provokes thoughts on concepts of age and time 2. Collectors will place artwork by other digitally native artists in the space, or by artists who work primarily in the physical world. Very accurate visualization	Thinking, Artwork Visualization
The Mirage, designed by Alexis Christodoulou Studio	1. The paradox of gravity at different times of the day. 2. Designed for relaxation and spiritual immersion in a digital environment	Non-gravity，Immersive
Andrés Reisinger，visual manifesto on the digital form of architecture	1. Spatial constraints are eliminated and problems such as meaninglessness, boredom, existential dread and emptiness are addressed through the incorporation of stimulating elements such as a sense of space, mood and project architecture.	Emotion，Unlimited
Hard.Architects' The Row	1. A reflective exploration of the need for luxury and the desire to belong.	Reflection，Thinking
‘Make Room for Us’ Six N. Five	1. Inspired by cellular organisms, visual concepts were created using flexible design.	Visualization，Inspiring

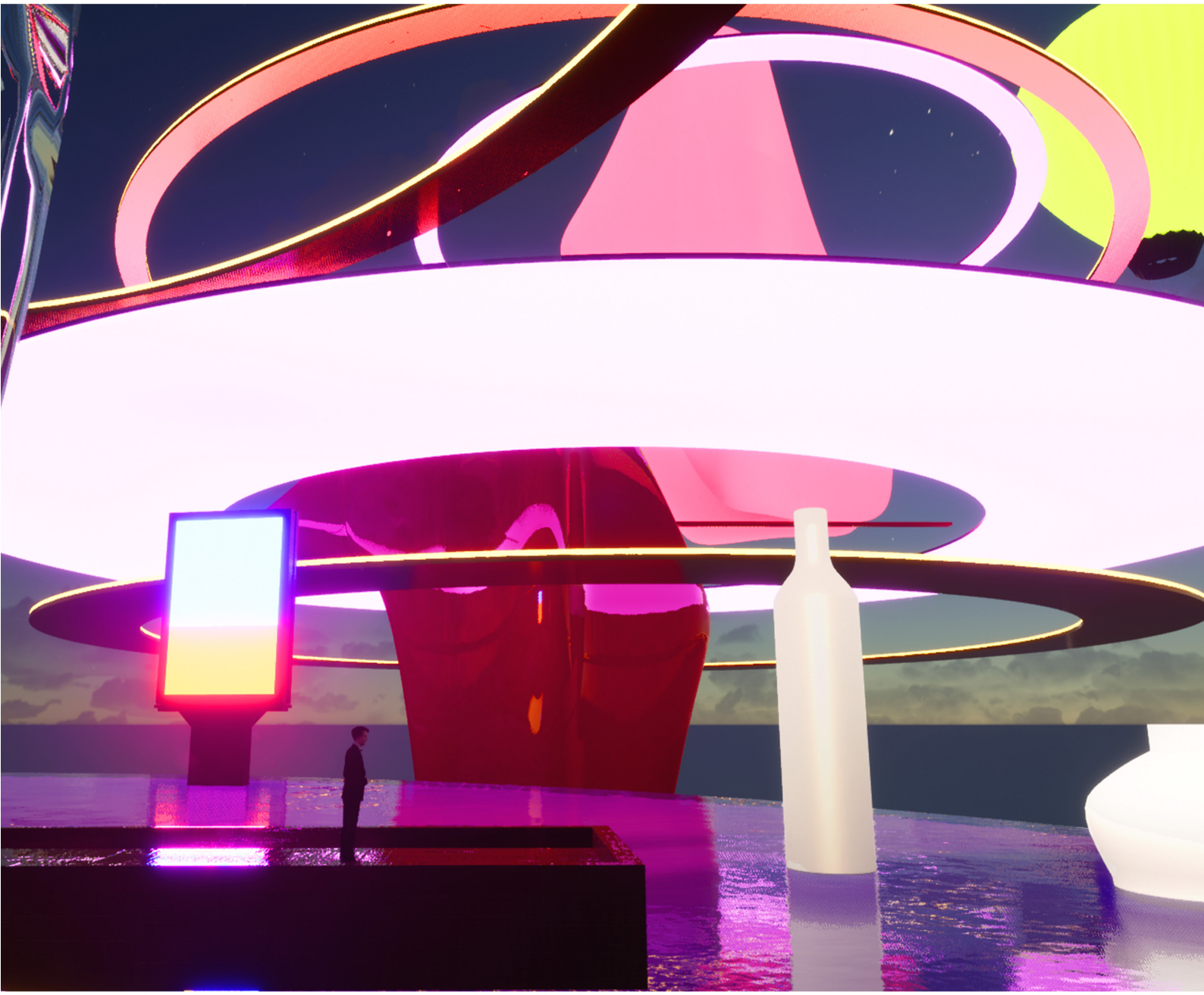


Figure 19, Unreal Engine Senario, By author

Based on the discussion above, the study summarises three characteristics of the virtual architectural design:

1. Unlimited Creativity: Virtual architecture design improves the boundaries of traditional constraints of the design elements which are aligned to the physical world.

2. Community-Centric Platform: Emphasizing community engagement, the virtual architectural design allows designers to communicate with each other in the virtual environment for the sake of inspiration.

3. Immersive Experience: Virtual architecture aims to create immersive experiences that transcend physical limitations through hyper-realistic digital art, non-physical environments, or emotional space.

Based on the three-point summary of the characteristics of virtual architecture, combined with the observation of scenario design in the case
study, the study proposes the following three strategies to be applied to the design of the VIRTUAL REALM project.

Collaborative Virtual Experience
By highlighting the form and aesthetics of the building and symbolizing the function of physical architectural elements, the constructs of the virtual environment allow people to have a visually more realistic spatial experience. Meanwhile, the virtual environment contains a community-centric atmosphere which allows designers to conduct creativity discussions inside the virtual space.

Nature Hyper-Realistic Simulation
Virtual architecture focuses on hyper-realistic possibilities in a non-gravity, non-lighted environment while enhancing the comfort of the visual experience of the virtual environment through natural elements such as rocks and plants.

Deconstruction and reorganization
The composition of the virtual building inherits the real architectural theory and norms and decomposes and reorganizes the realistic architectural elements to form the virtual architectural elements. Virtual design components provide physical feedback to users to enhance the immersion of the virtual environment.

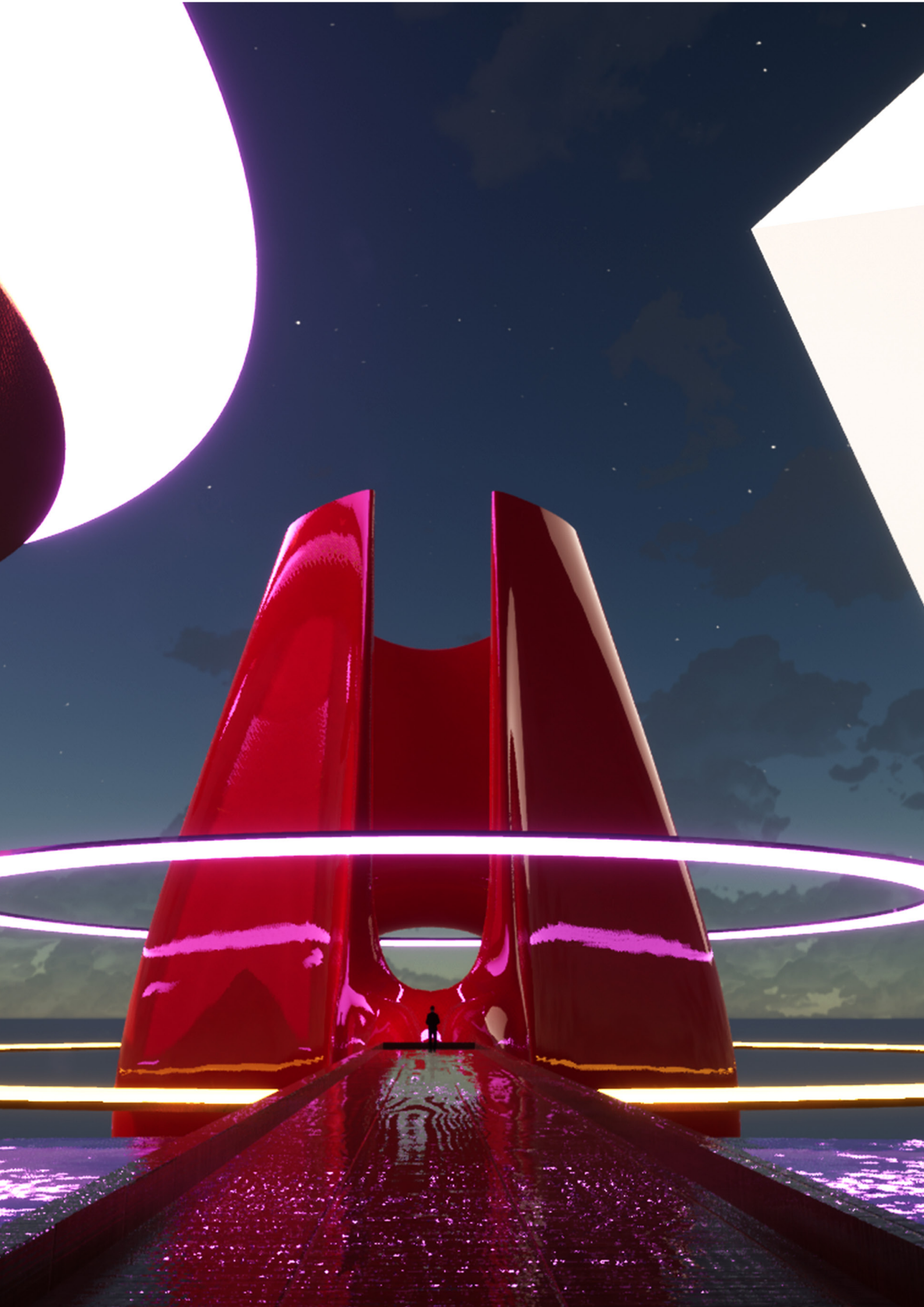
Abbreviate

VE	Virtual Environment
VR	Virtual Reality
MR	Mixed Reality
AR	Augmented Reality
VPL	Visual Program Lab
HCI	Human Computer Interaction

Figure 20, VA Corp. XR Studio Virtual Space, https://designstudiotdl.com/

Figure 21, VA Corp. XR Studio Virtual Space, https://designstudiotdl.com/

Figure 22, VA Corp. XR Studio Virtual Space, https://designstudiotdl.com/



EXPLORATION

EXPLORATION 1

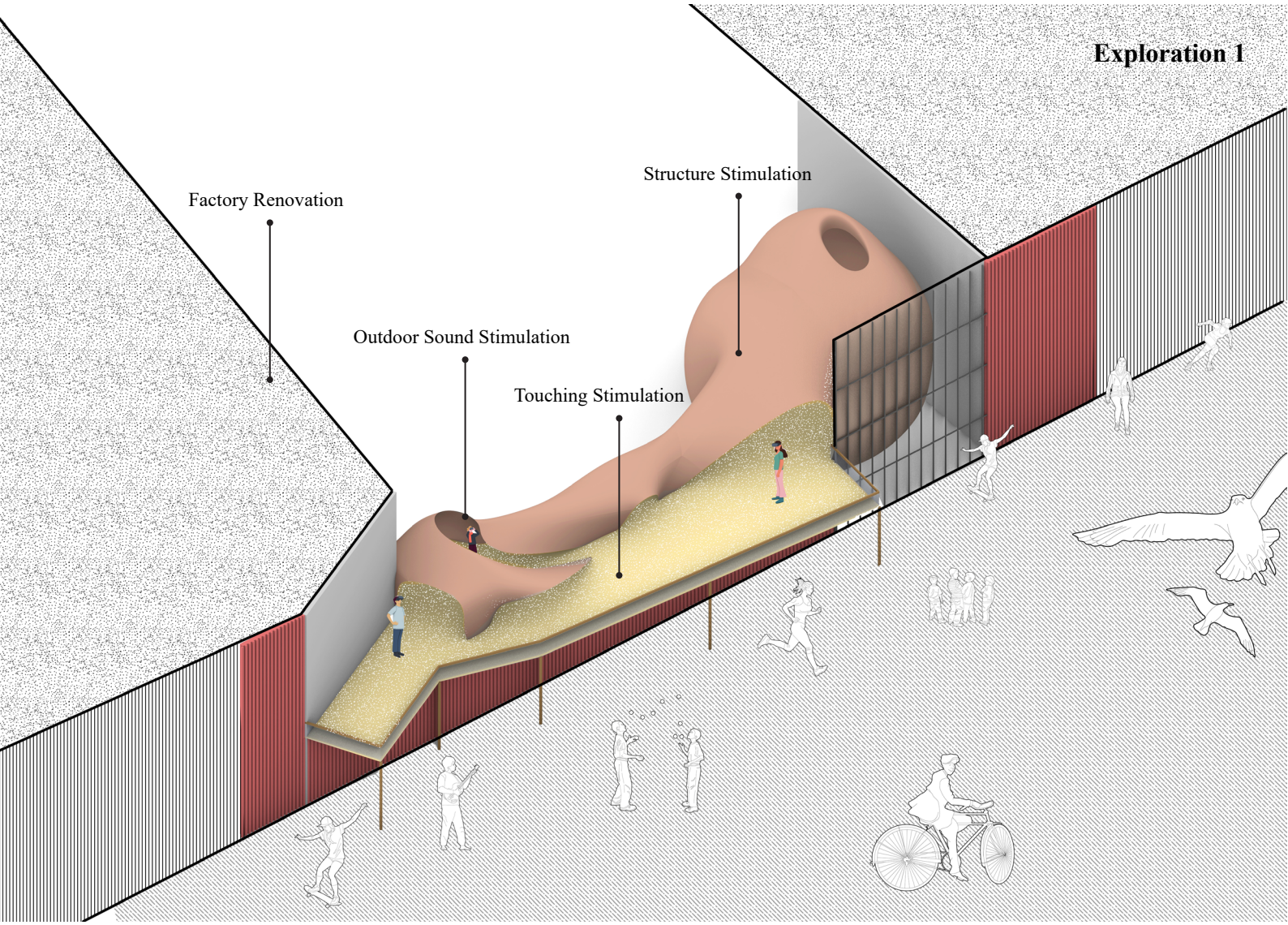


Figure 23, Axonometric graphic of real-world space

Here is an example of the stimulated physical space of the beach. Using the VR glasses could provide uses an immersive experience to travel in the space to turely touch the beach and hear the wave.

Figure 24, Perspective of the physical and virtual space

Figure 25, Contrast senarios of the exploration 1

EXPLORATION 2

Figure 26, Image generated by Midjourney. Andrei Tarkovsky, Solaris, Futurism, pink style, --ar 3:4 --c 20 --s 250 --v 5.2 --style raw

In the second phase of the exploration, In order to make the virtual scenarios correspond to the spatial and value characteristics of the virtual world in the theoretical part of the project, the project research started with a summary of the adjective vocabulary of the scenarios and the generation of the corresponding conceptual maps, which served as a guide for the modelling of the scenarios.

EXPLORATION 2

Figure 27, Image generated by Midjourney. an open space filled with curved walls and lighting, in the style of photobashing, pensive stillness, mist, redshift, realistic renderings of the human form, sculptural architecture, monolithic structures, imposing monumentality, pink style, monumental scale, passage --ar 3:4 --c 20 --s 250 --v 5.2 --style raw

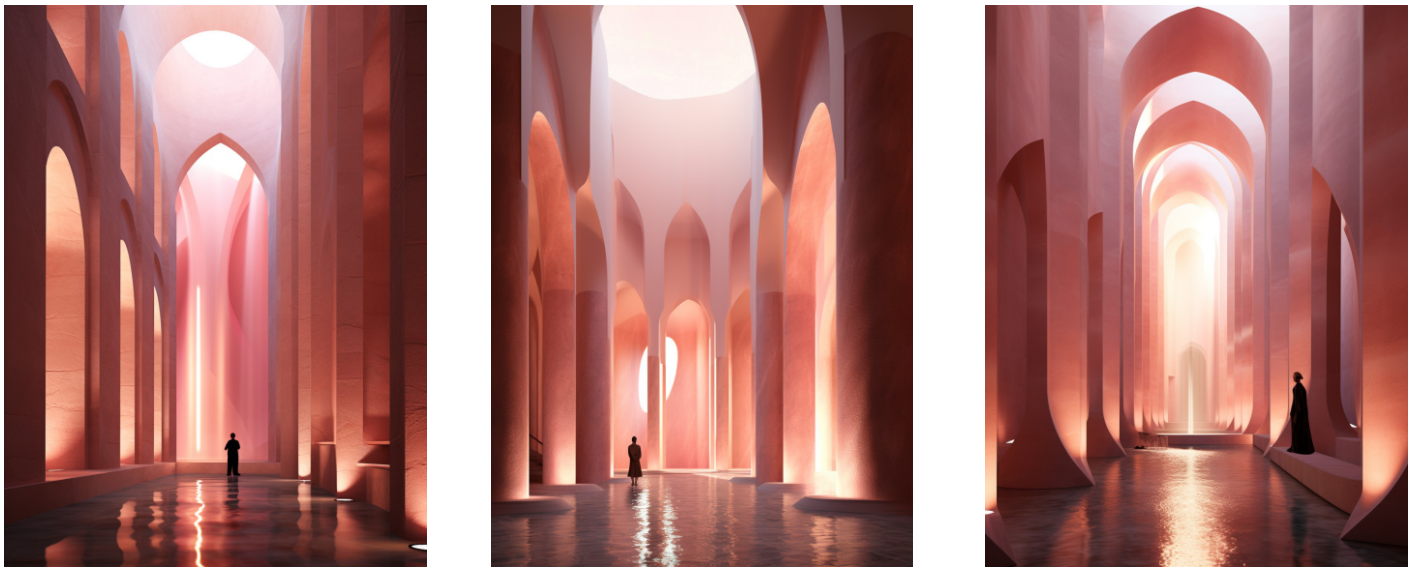


Figure 28, Image generated by Midjourney. 2000s, The Cell, panorama, DVD screengrab, The Holy Mountain, pink style

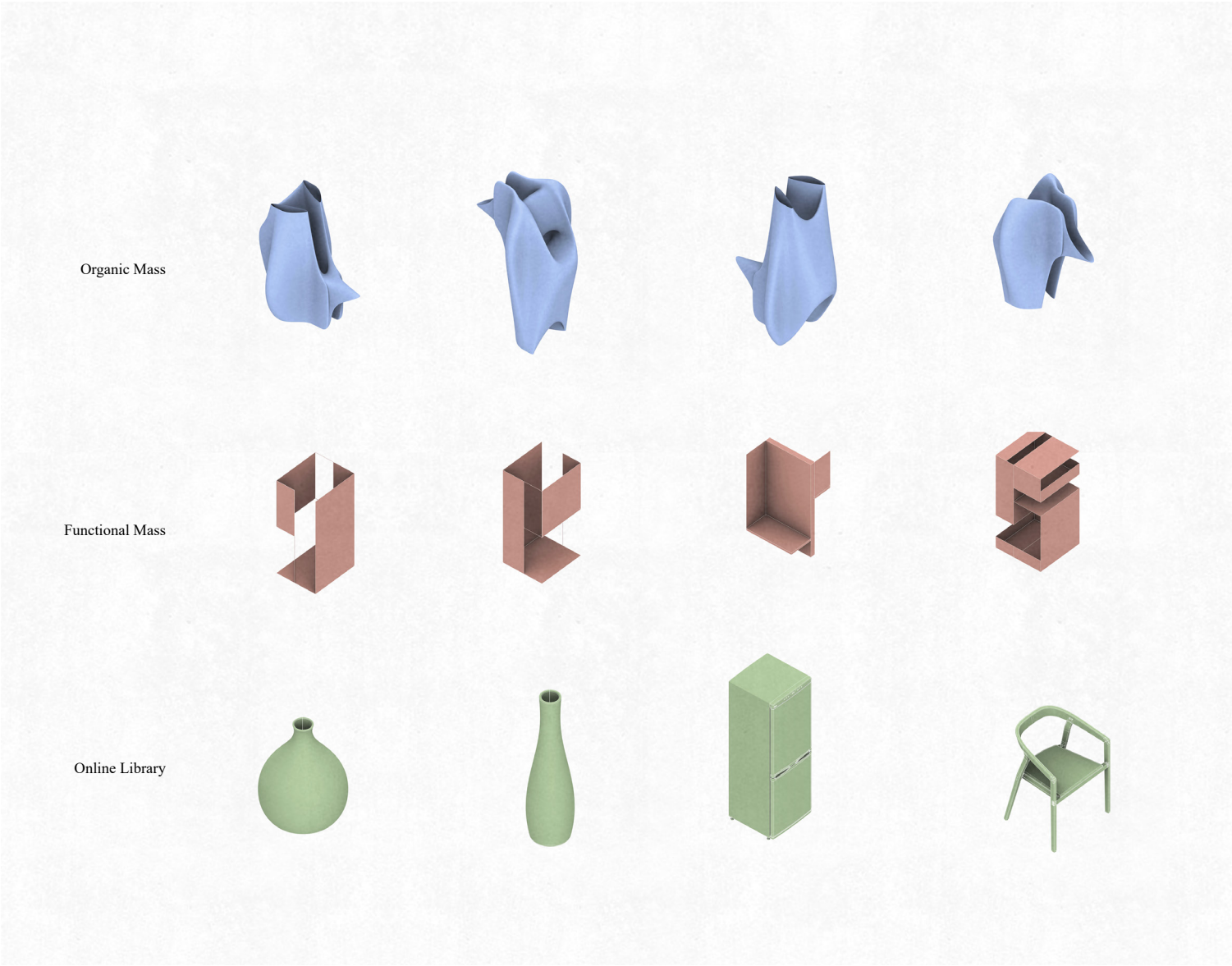


Figure 29, Asset Library

In the second phase of the exploration, the project research discussed how to collect input models for the virtual space. There were three forms of input to the models: organic forms, functional spaces and online libraries. These virtual elements need to be arranged in the virtual space after the input models. Finally the already built models were combined with the spatial carriers of the physical world

EXPLORATION 2

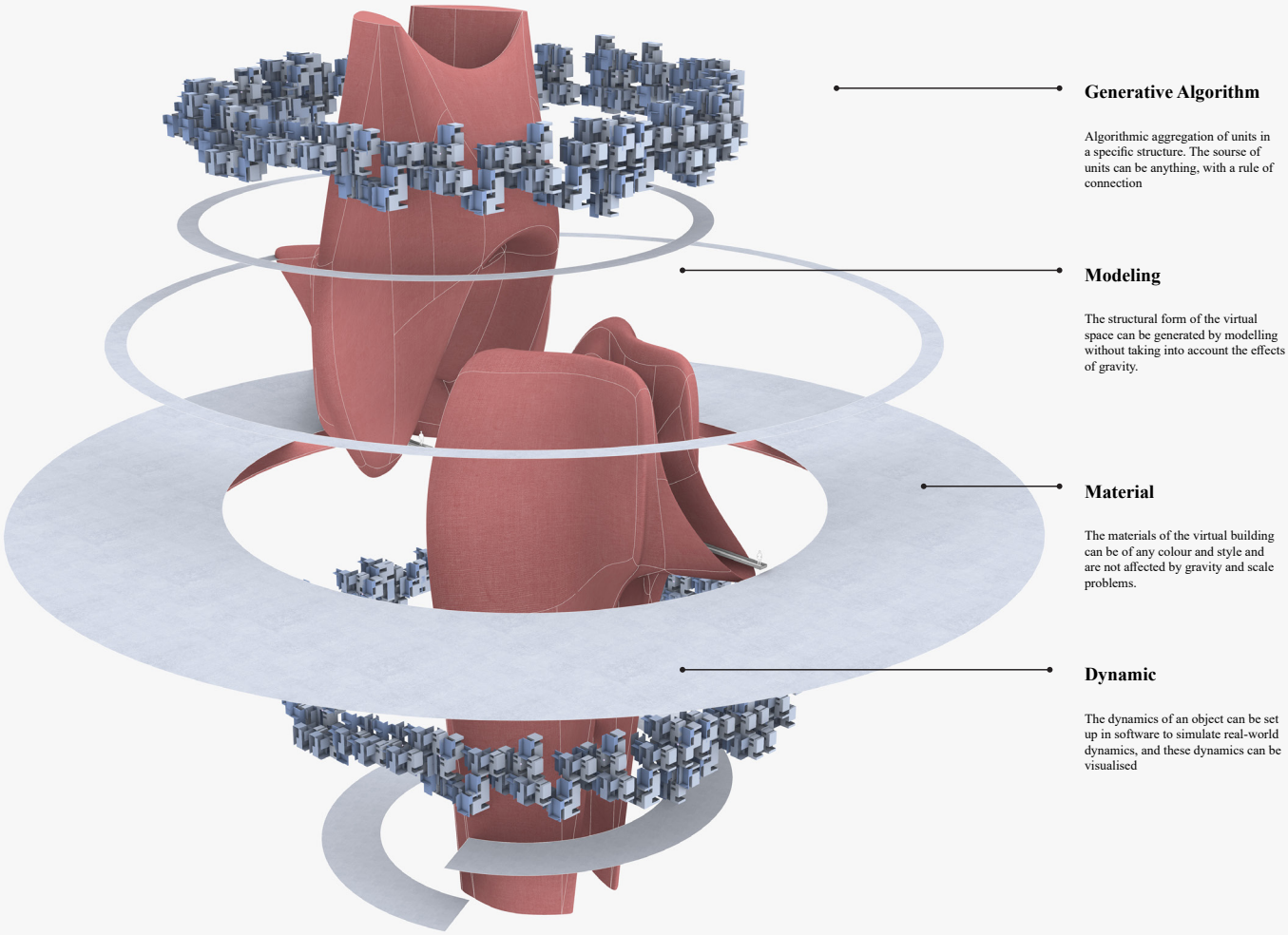


Figure 30, Virtual Structure

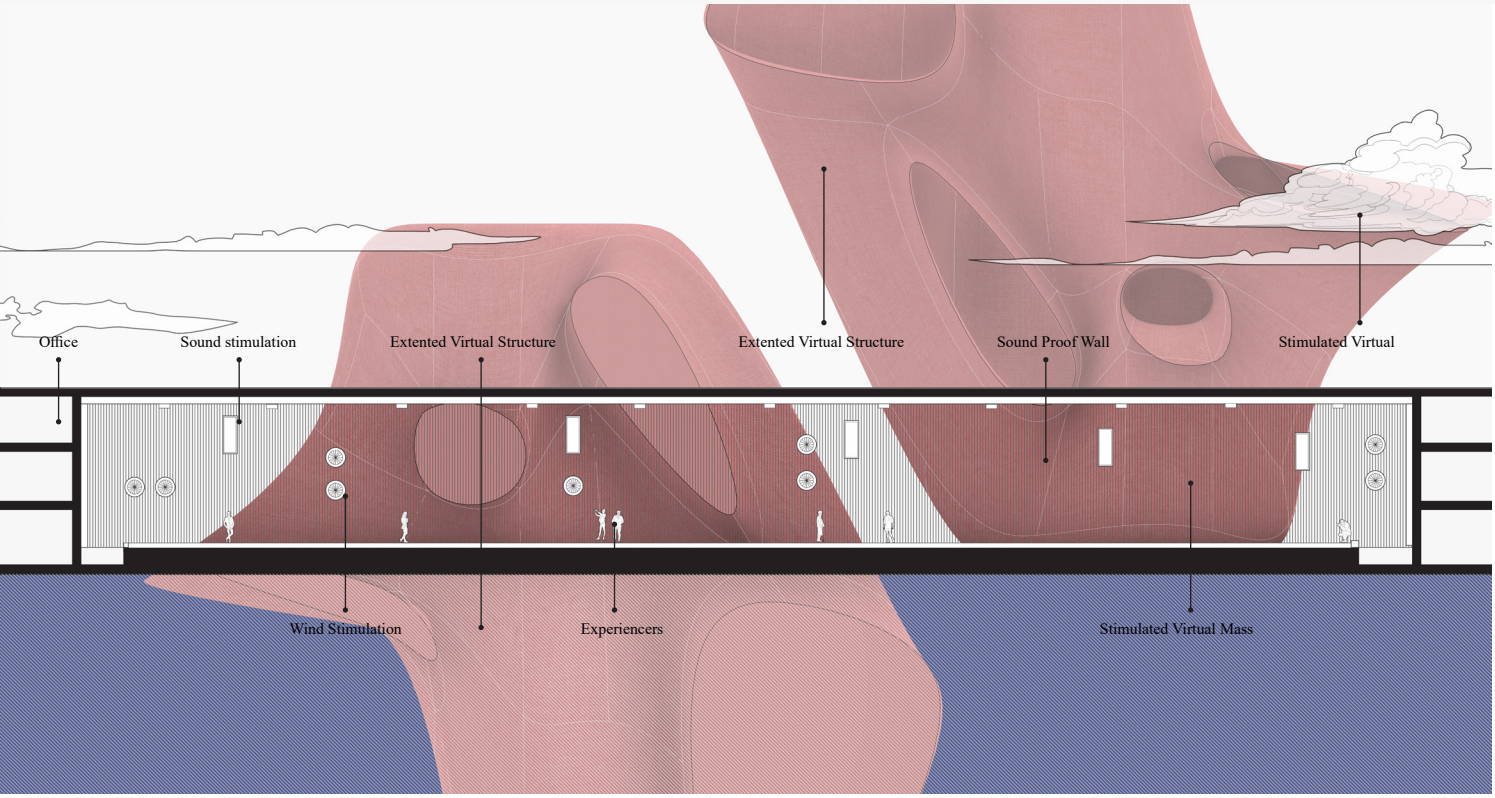


Figure 31, Virtual Extension

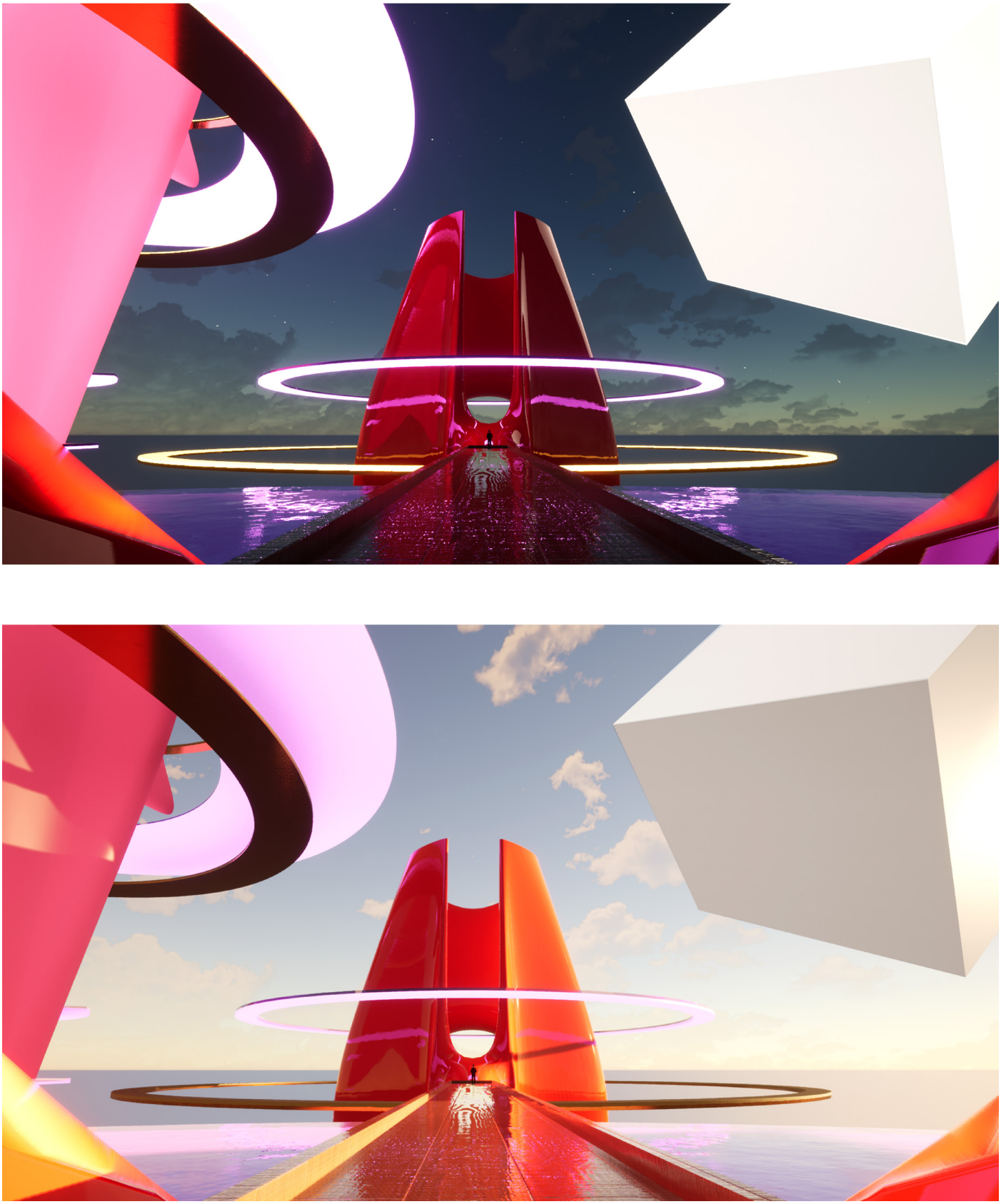
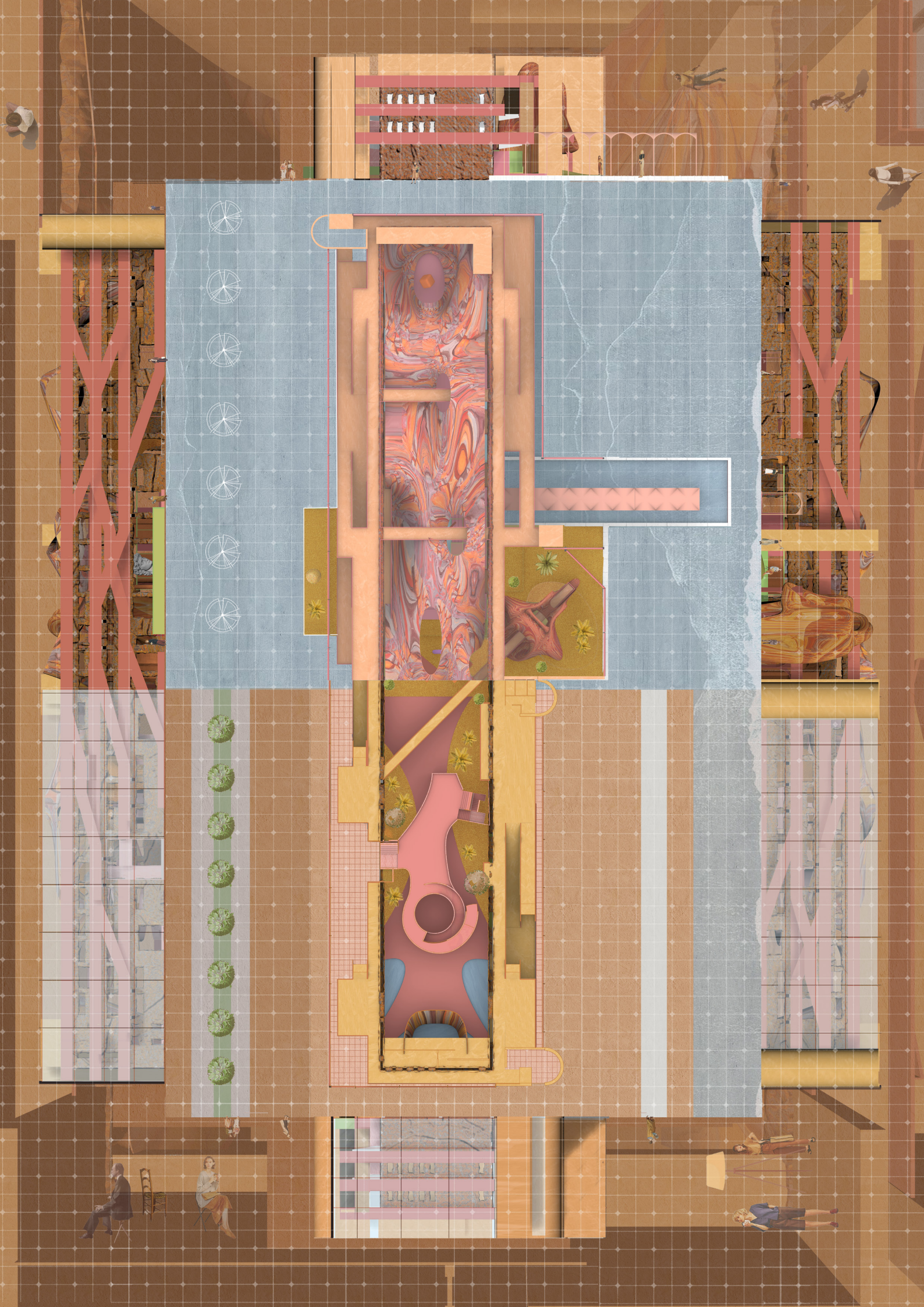


Figure 32, Senario of day and night in virtual space in exploration 2

EXPLORATION 2

Figure 33, perspective in virtual space in exploration 2



VIRTUAL REALM

VIRTUAL REALITY AND HUMAN-COMPUTER INTERACTION

Virtual reality glasses become a main medium for doing thesis research. The study chose VR glasses since they have a significant visual impact on the virtual environment. Berg and Vance (2016) evaluated the effects of employing virtual reality (VR) for design reviews by conducting research with engineers from the manufacturing industry. This study focused on conducting design evaluations using a projection-based virtual reality (VR) environment. The methodology enabled all participants to effectively view and interact with the geometry, precisely expressing its size. The project selected the Meta Quest 3 as the precise edition of the virtual reality spectacles. The Meta Quest 3 is a state-of-the-art autonomous virtual reality (VR) headgear designed to deliver a high-quality and completely immersive virtual experience to viewers. The VR device in issue is a dynamic and self-sufficient device that functions with no personal computer or additional sensors. This feature provides users with the freedom to explore virtual surroundings without the need for physical connections to external devices. The Meta Quest 3 is equipped with a high-resolution display, an ergonomic design, and advanced functionality, making it ideal for various applications like gaming, entertainment, professional, and business use.

During the experimental and exploratory phase, it is necessary to put the model into virtual reality (VR) glasses. To ensure optimal lighting and quality, as well as software compatibility, this project selected Unreal Engine as the main programme for designing the VR virtual space.

In terms of functionalities of VR devices, teleport, which is the most basic way that allows users to move inside the virtual world. Users could use manipulator to precisely move from one point to another. Rotation and short distance moving are aligned with the physical world. Also, users could switch the seasons, months and even clock to obtain different experience inside the VR glass.

Sound effects in VR devices provide the user with a more realistic simulation of the sound environment in virtual space. Audio could and should be a part of the design process from the very beginning, expressing elements of story, characters, or action both independently and in connection to additional features. Each visual element in a game is paired with a corresponding functional sound element. (Summers, 2017). For example, The ‘VR exhibition space’ developed by Abstracta, collaboration with the Stockholm-based architect studio MER, is designed to provide the users a sense of the products as well as an enhanced experience of the soundscape By increasing the interaction between sight and hearing, the client with get a better understanding of the virtual space.

Virtual and Reality

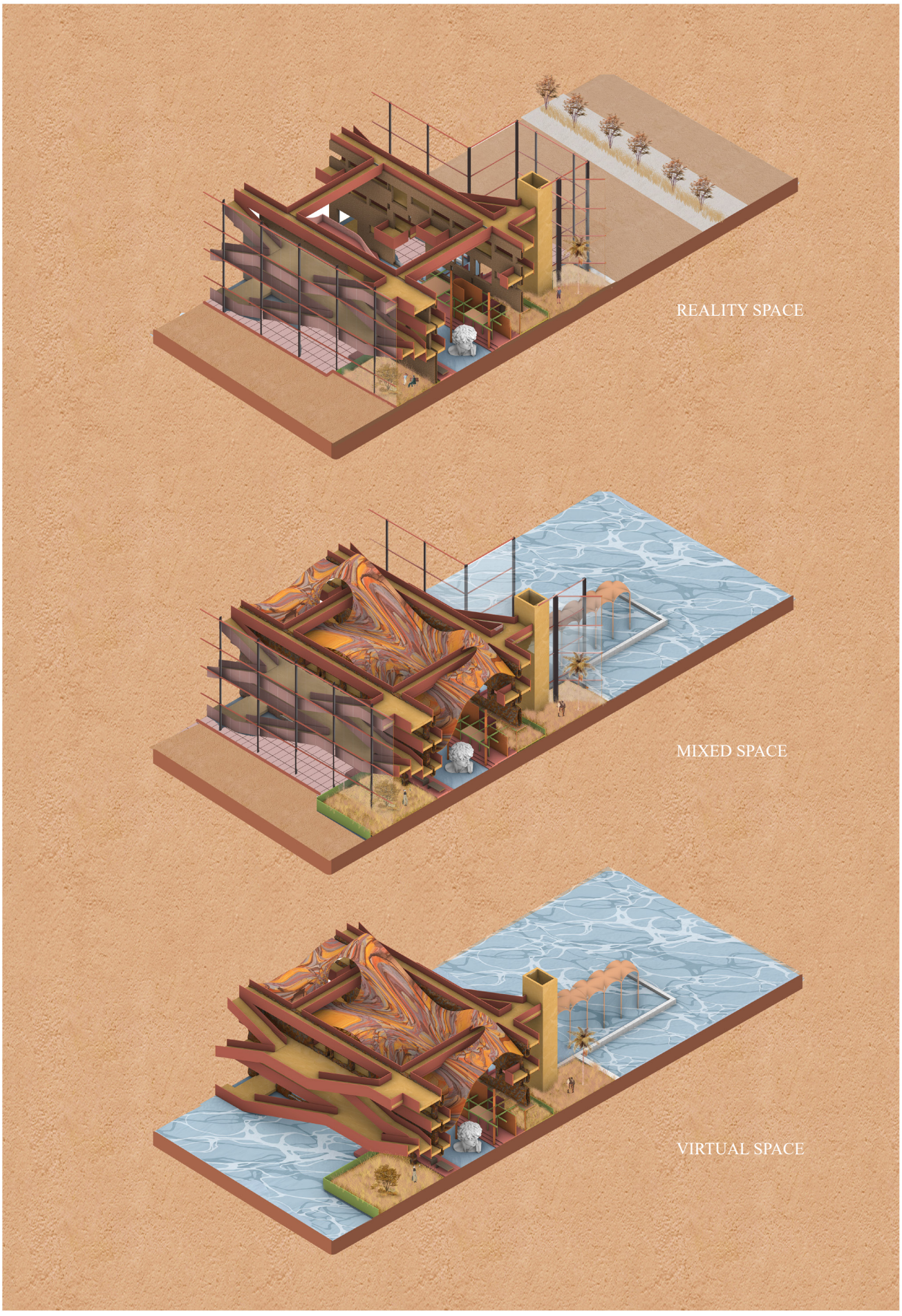


Figure 34, Illustration of Virtual and Reality

The user can interact with objects in the virtual world via VR, which is based on the human-computer interaction between the VR and the player (Mine,1997). while introduced touching guides for object in large-scale virtual environments. Rautaray. (2012) discussed the importance of real-time hand gesture recognition systems for dynamic applications in virtual environments. There is also a Personal-Space Widgets for Object Manipulations for VR users to transform, scale and rotate the virtual objects. (Hsu,2020). Also in the field of space design, there is a way to switch the materials for the virtual object according to the preference of the users.

For virtual environments stimulated by physical environments, physical immersion and realism can be further enhanced by integrating haptic feedback, audio and even smell. This multi-sensory stimulation enhances the user's perception of the virtual design as a physical space that is tangible. The results of the research showed that users could identify themselves with a first-person character in the virtual world based on visual-haptic stimuli. This result correlates with an enhanced sense of touch and depth in the virtual environment. (Serino,2013. Salomon,2017). When the physical sense of touch is synchronized with the visual stimulation of the first-person character's body, extended visual haptics will be delivered to the entire field of virtual space. Through visual haptic touch, both the physical body and the virtual body are perceived in virtual space. (Noel, 2015). The immersive experience of the space, aesthetically conditioned by the virtual built environment, will foster the perception of the surrounding interior as part of the individual's surrounding space, (Pasqualini, 2018).

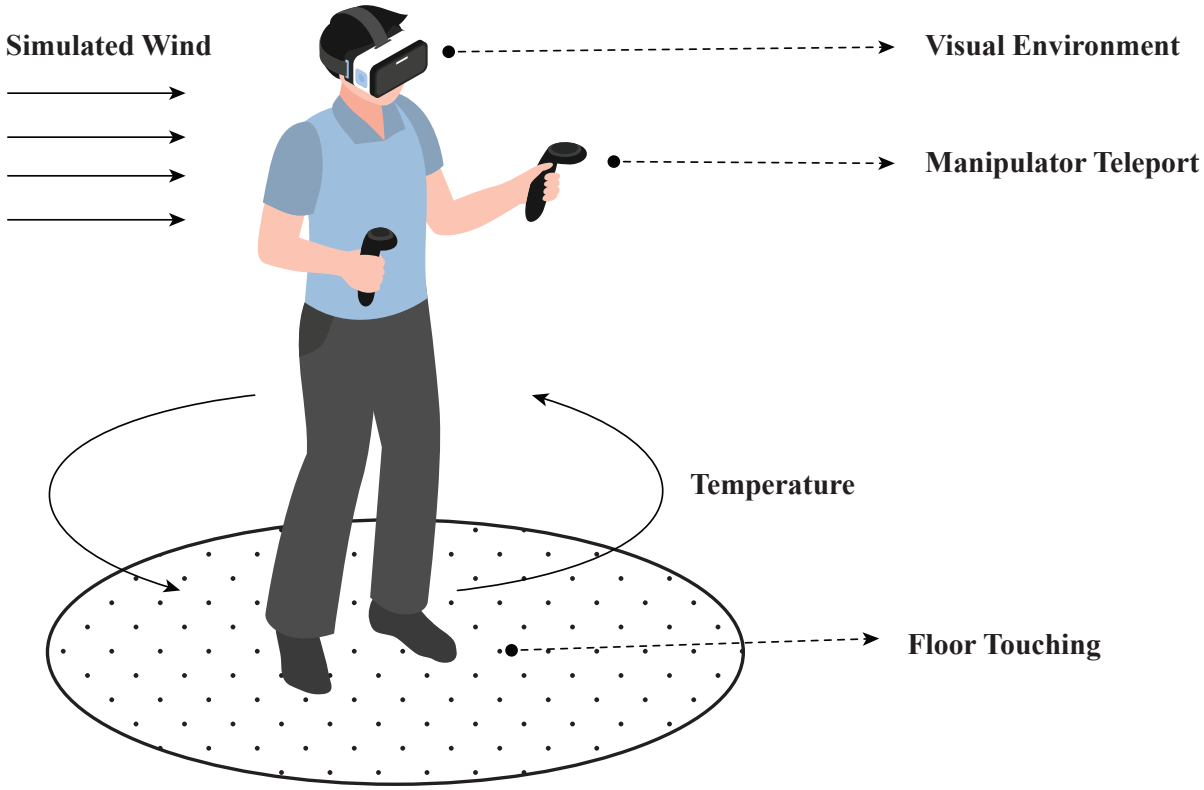
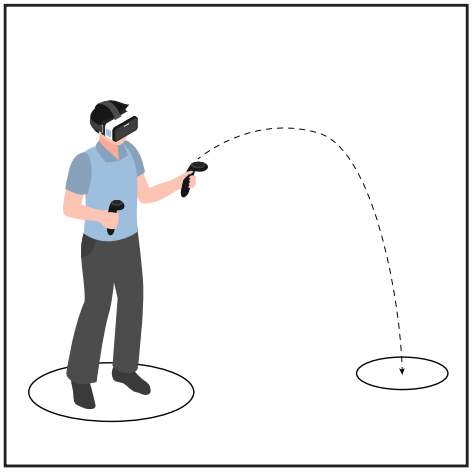


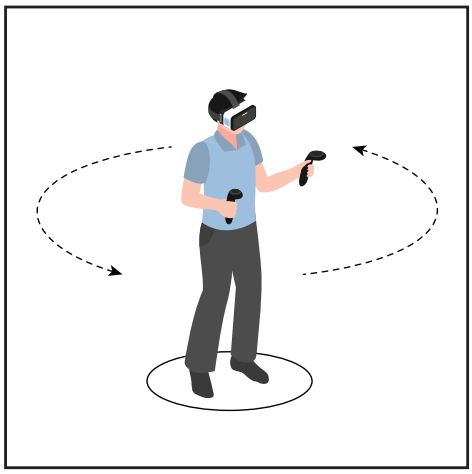
Figure 35, Illustration of Physical Stimulation of Virtual Reality

VR Manipulator

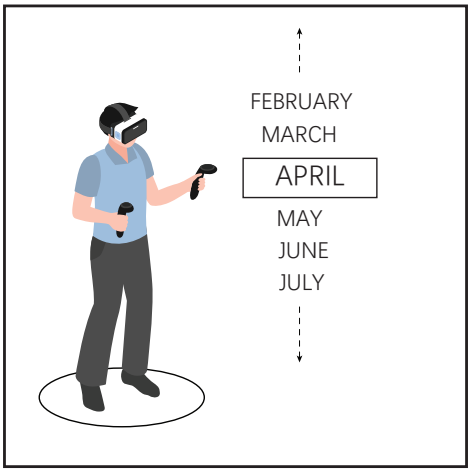


Teleport

Switching Seasons

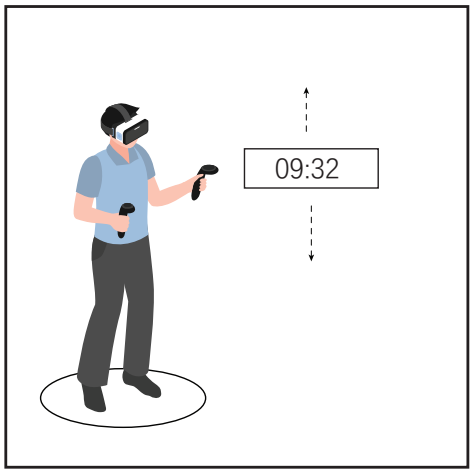


Rotator



Switching Months

Sound Effect



Switching Day Time

Figure 36, Illustration of First-person Controller of Virtual Reality

VR representation

Figure 37, Senario of VR Headset and VR Manipulator 1

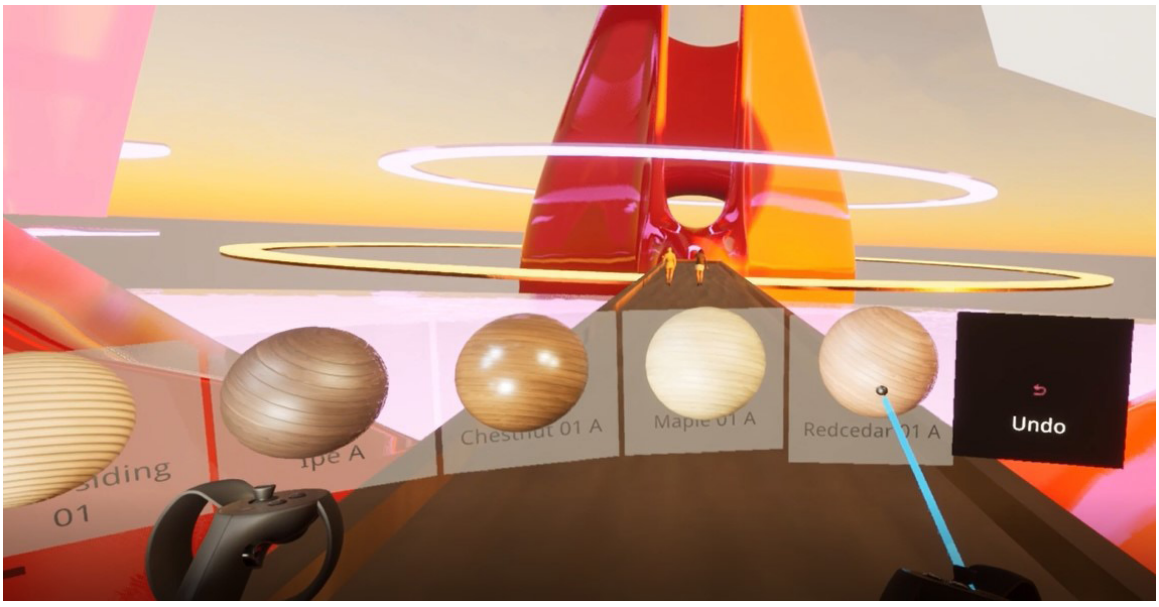


Figure 38, Senario of VR Headset and VR Manipulator 2

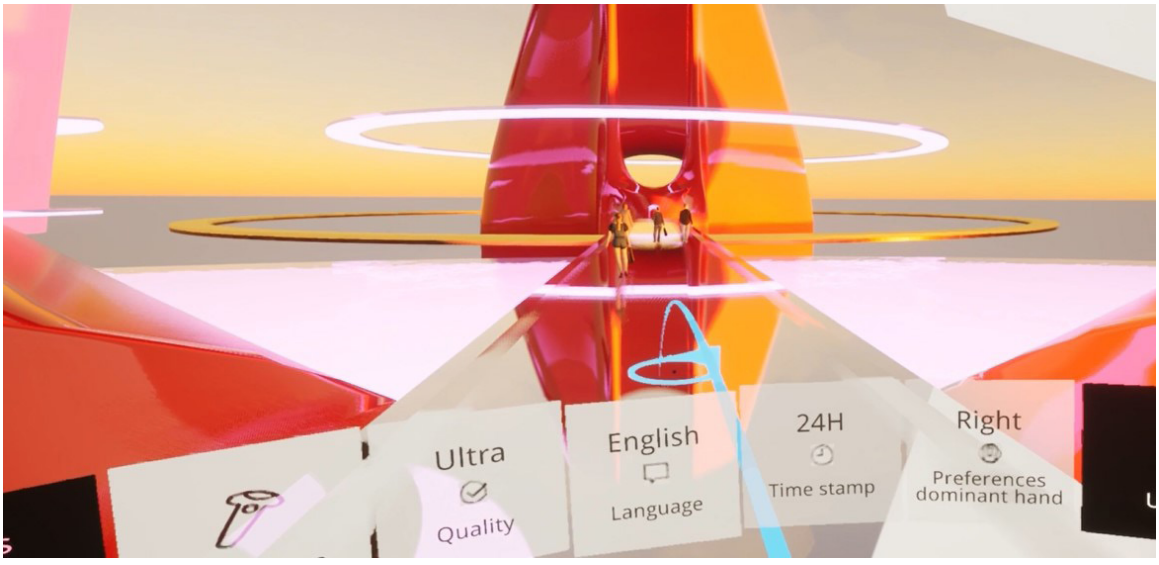
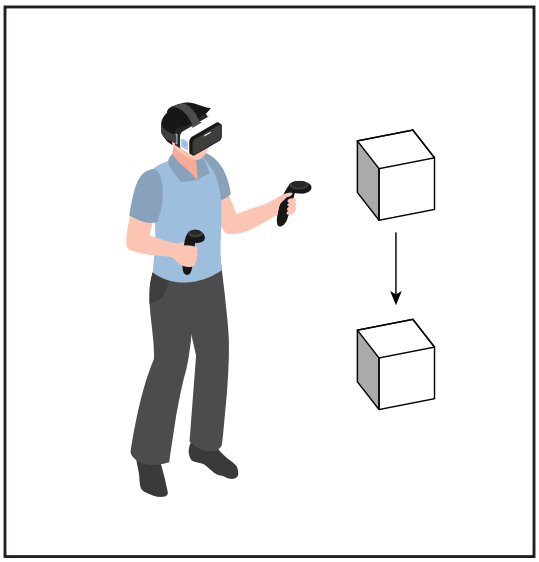
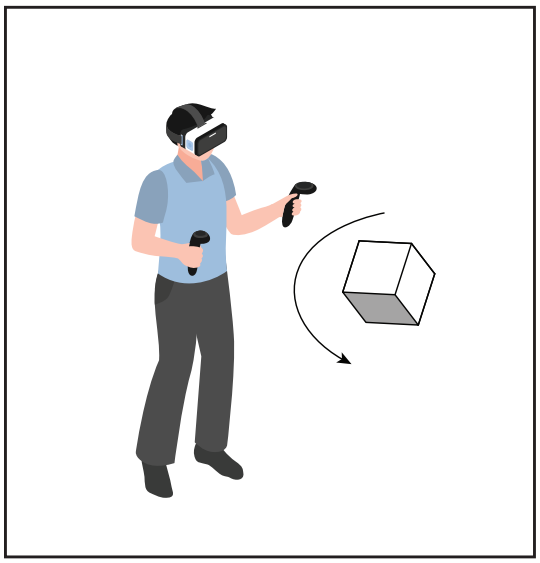


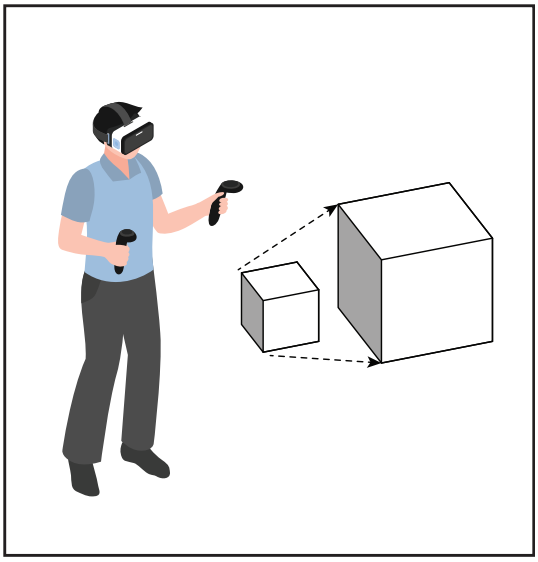
Figure 39, Senario of VR Headset and VR Manipulator 3



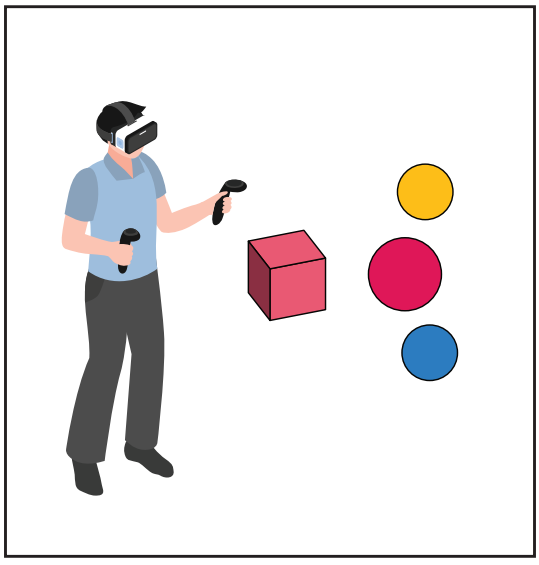
Adjustment of Position



Adjustment of Direction



Adjustment of Scale



Switching Materials

Figure 40, Illustration of Object Editor of Virtual Reality

Virtual Senarios

Figure 41, Senario of Virtual Site 1

Figure 42, Senario of Virtual Site 2

Virtual Senarios

Figure 43, Senario of Virtual Site 3

Figure 44, Senario of Virtual Site 4

Figure 45, Axonometric of Virtual Realm

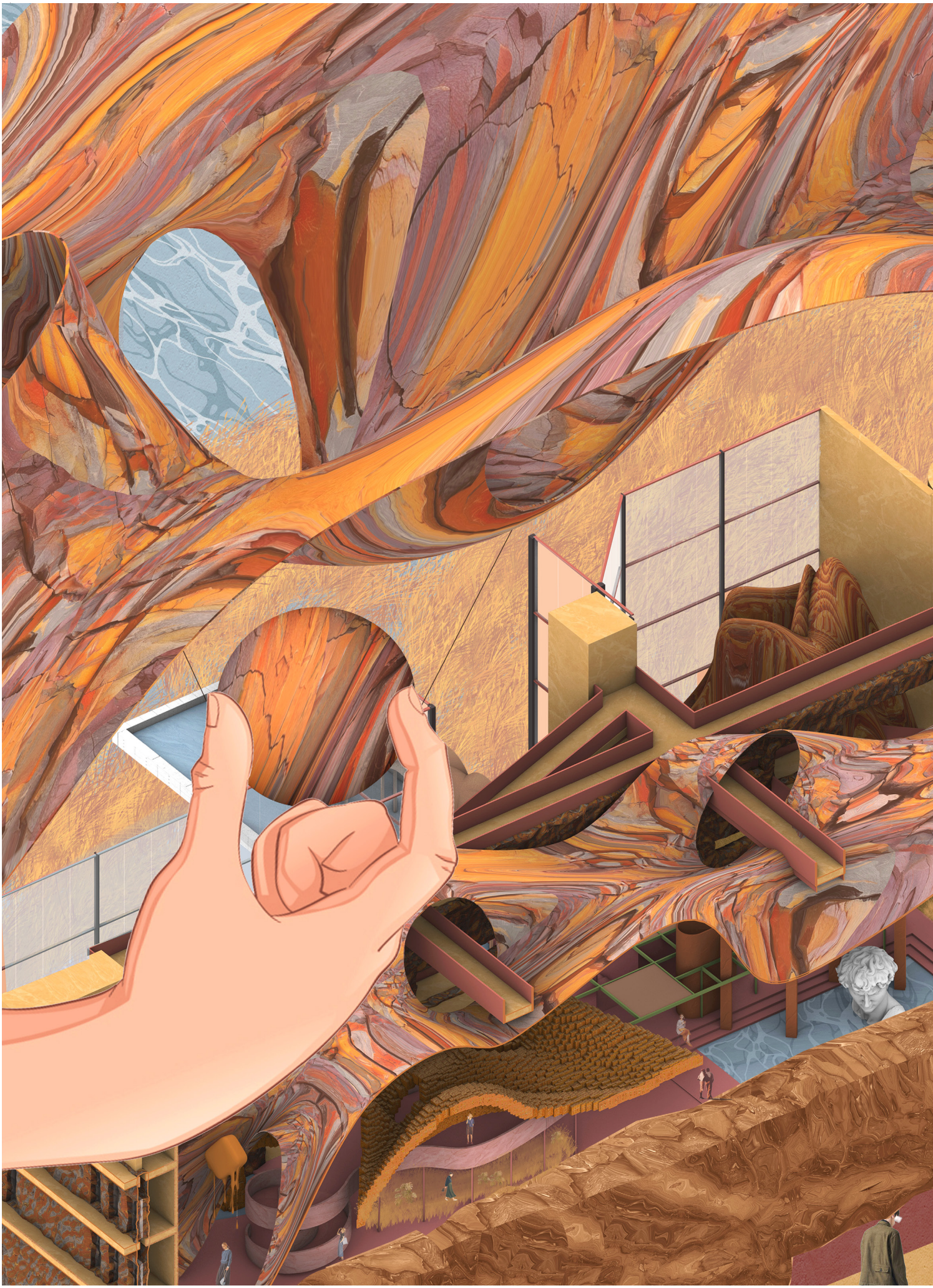


Figure 46, North bank of the Göta Älv

SITE

The scenarios of enormous cargo ships dropping their goods into large warehouses on the northern side of Göta Älv have disappeared. The buildings continue as evidence for history. Constructed with great care and attention to detail using a combination of brick and concrete, Magasin 113, which was completed in 1964 (Älvstranden, 2020), has gradually deteriorated over time, losing its former beauty and functionality as the huge balconies have been repurposed. The relocation of the harbor allowed the opening of Gothenburg Art Hall, cafés/bars, and a performance stage for artists in a 3000 square meters structure near the seaside. The object is currently devoid of any characteristics and is in a state of waiting for a new purpose or role.

PARADIGM OF FUN PALACE AND VIRTUAL REALM

The Fun Palace wasn’t about technology. It was about people. —— Cederic Price

The 'Fun Palace' emerged from the social and cultural environment of Great Britain in the early 1960s. It was conceived as a structure that would offer a diverse range of amusement to the general public, with its design and organization being influenced and modified by the collective desires of the people. (Anstey, 2007)

Thus, the main purpose of Fun Palace is to meet the constantly changing needs and desires of individuals, therefore, rather than to host pre-packaged exhibitions and events for the wider public. (Mathews, 2006) In Price's own words, the Fun Palace complex itself has no clear spatial divisions, and people can choose their own routes and activity engagement. Although the overall frame structure does not change, the total volume changes when in use, so even regular users can see the changing scenario.(Forty, 2000). Price is eager to find possibilities for studying individual outcomes, examining methods in which spare time can be utilized not just for pleasure and recreation, but also for personal intellectual education, and the learning of new abilities for the modern reorganized economy. (Mathews, 2007b) He envisions a million user activities and possible behavioral patterns, and makes lists of the relevant ones. Rather than a traditional diagram of architectural space, Fun Palace in his plan is closer to what we understand as a computer program.(Mathews, 2007a)For the Fun Palace's architectural form, Price gathered all the event spaces under one roof, dividing the different interior and exterior spaces between the two levels of the open steel structure. Over time, these spaces can be replaced, depending on the specific functions and needs that are expected to change over the life of the building. So, to borrow Mathews' words, the Fun Palace reflects a significant change in modern architecture, turning from a Platonic belief in unchanging ideals, abstract space, and purity, towards a Heraclitean perspective that regards the world as always changing. (Mathews, 2006)

Similar to Fun Palace, Virtual Realm functions as a container for virtual settings, resembling a purely theatrical stage where cultural elements are combined. It allows individuals to encounter the elevation and alteration of theatre, not as spectators, but as participants. (Mathews, 2006) For the designers of Fun Palace, or the Virtual Realm that followed its paradigm, the role of the architect may have extended far beyond simply translating a proposal into a design, but rather creating with the aim of realizing a specific societal need (Popov, 2015) Price's concern as an architect was to find a pragmatic way to that incorporates changing social events into architecture as improvisation, and he believes that the best solution to his clients' problems is not architecture, but social design. He envisioned restructuring the client's organization, introducing changes in society and social conditions, and solving socio-spatial problems through social action rather than new architecture. (Mathews, 2007b), Thus, a designer operating within the same paradigm might likewise be seen as an architect involved in social design. An individual with a background in architecture who has broadened their professional knowledge by studying subjects such as the humanities, social sciences, and organizational design.

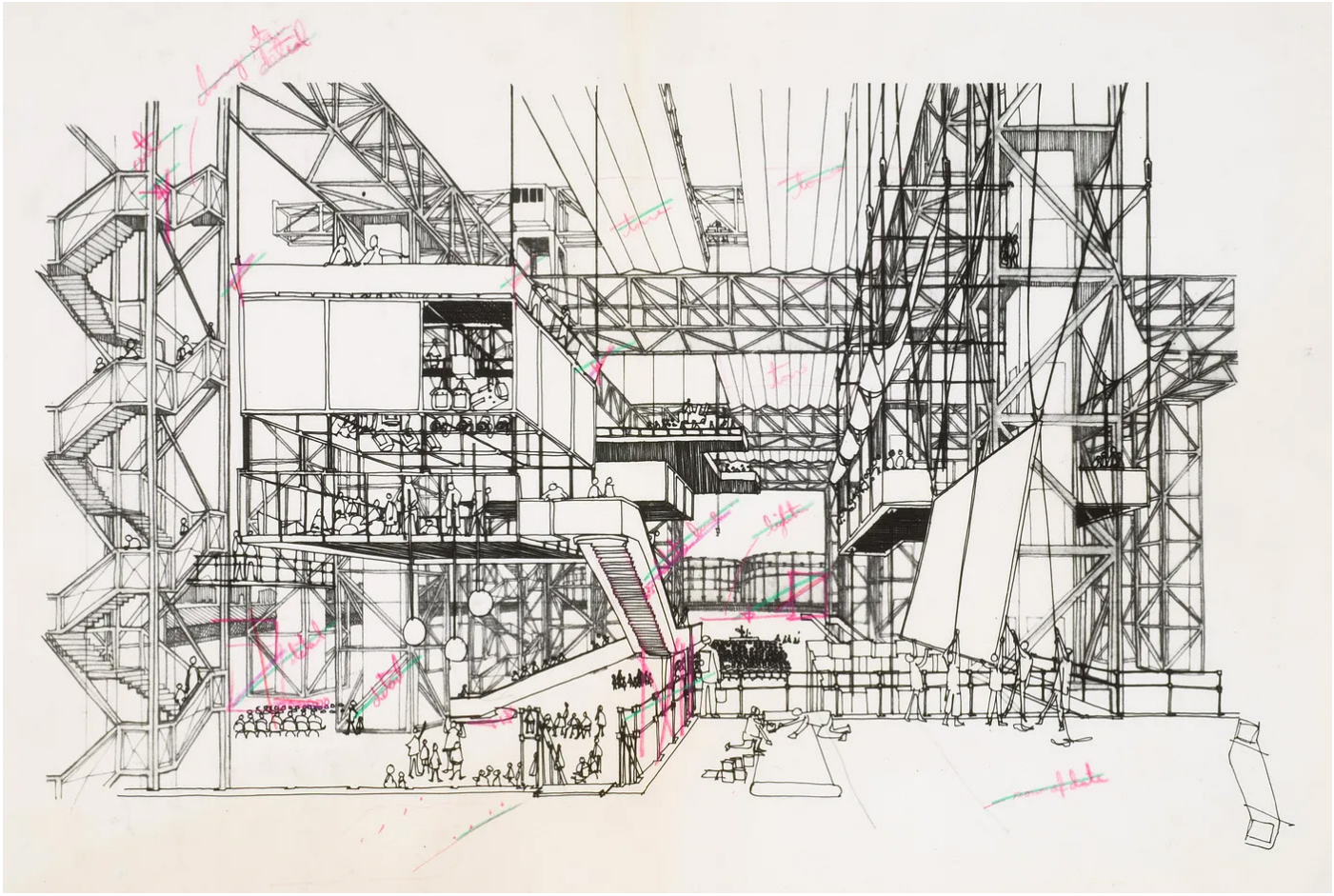


Figure 47, Perspective drawing of Cedric Prices “Fun Palace.” University Of Brighton. 2014. Exemplary Project — Cedric Price. [ONLINE] Available at:https://folio.brighton.ac.uk/user/km226/exemplary-project-cedric-price. [Accessed 5 August 2016].

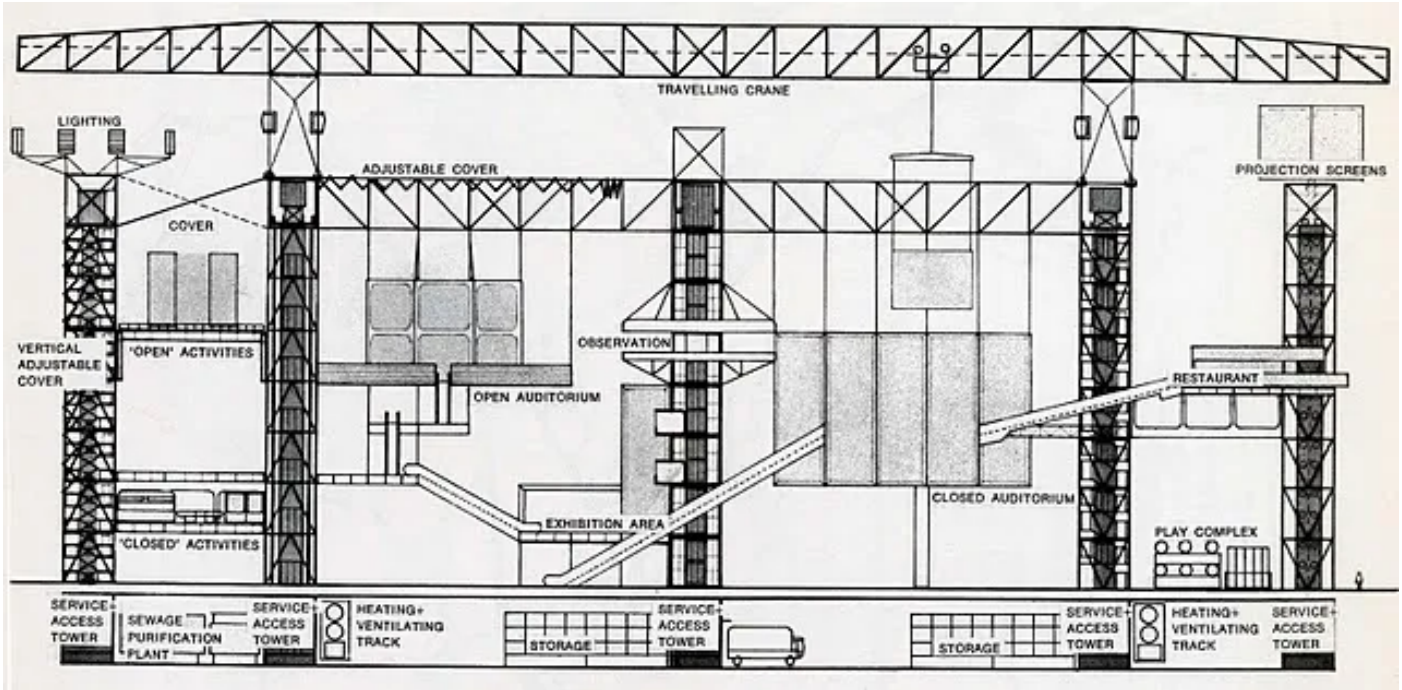


Figure 48, Elevation Drawing of Cedric Prices “Fun Palace.” University Of Brighton. 2014. Exemplary Project — Cedric Price. [ONLINE] Available at:https://folio.brighton.ac.uk/user/km226/exemplary-project-cedric-price. [Accessed 5 August 2016].

DESIGN PROCESS

The project Virtual Realm is a warehouse renovation Magasin 113, located on the Magasin 113, northern side of Göta Älv can be used as a platform for both creativity and experience. The research removes the original column grid during the renovation process, preserves the facade and platform of the warehouse, connects the platforms through a corridor, and adds a glass facade as a new enclosure to the periphery of the original facade.

Virtual Realm organizes the space into a virtual creation area and a hybrid observation area. The interior of the original Warehouse is a pure virtual creation area, where the removal of column grids and floor slabs ensures a large enough space for VR experience to be freely accessible to VR users to create their own creative designs in a virtual environment based on the physical simulation of the building on the ground floor. Based on the virtual construction platform, the project placed two virtual sculptures consisting of thousands of virtual bricks in the building. Users can edit the virtual sculptures in the virtual space by modifying each square's, or the material information or positional shape of the squares in the area. A rotating staircase and raised platforms provide the designers, as sculptors, with an up-close and personal sculpting experience that encourages a creative experience and collaborative design, while also allowing the designers to actively change the virtual structure and have a more first-person view of the overall virtual space. The exterior corridors and platforms of the original Warehouse form a hybrid observation area, where both VR glasses wearers and real observers without VR glasses can observe the creative scene in the virtual creation area in real time from platforms at all perspectives.

At the same time, observers in reality can also observe the virtual environment through cell phones or glass screens set up on the interior platforms and window openings in the original warehouse, and can style transfer the scenes in real time through Midjourney on the device terminal, creating and experiencing their own scenarios. The project envisions that the internal platforms, the window openings and the glass of the external glass curtain wall have LED projection functions, which can project the real-time scenarios happening in the virtual scenario into the real scenario.

The glass facade on the exterior of the project mainly serves the function of maintaining the indoor temperature and enhancing the indoor signal, providing a constant temperature for the multi-sensory simulation of the virtual space inside, as well as different wind speeds and air flows, which allow the creators to create and communicate in an intensely immersive virtual environment.

Figure 49, Mass Analysis

VIRTUAL SPACE DESIGN AND CREATIVITY INSPIRATION

Space is the container for people's lives, and according to statistics, most people spend 86.7% of their time living in indoor spaces (Klepeis, 2001), so a long-term indoor life also allows people's consciousness to gradually establish a closer connection with the sense of space. William James has proposed that a ‘primitive sense of space’ - described as a true ‘sense of volume’ - establishes the basis for a sense of self that is based on a sense of space. The foundation of self-consciousness, based on the unity and continuity of the physical self, serves as the context for human behavior (James, 1890/1950), and from the human perspective, human embodied or abstract actions and mental representations in space enhance the sense of relating to the spatial environment (Alberti, 1450/1988), and spatial sense and human consciousness are mutually reinforcing relationship. As Harry Francis Mallgrave says, the user of an architectural space is not an individual who exists independently of the spatial object, but rather a subject who is experience-driven in the space, and with the deepening integration of the Internet, digital devices, and virtual concepts into everyday life spaces, to a certain extent the space is becoming a vehicle that carries both the user and the virtual media.

Virtual media itself can also have an impact on the user’s emotions and consciousness, multimedia studies of learning have shown that embedding emotional stimuli, such as patterns or shapes, into virtual spaces can stimulate positive emotions in users (Um, 2012), and that virtual assets such as patterns or shapes can have the same impact on human consciousness as properties in the physical world, when observers are asked to evaluate a piece of artwork, they tend to assign and update a set of values to the artwork. The assigned values can be related to any potential aspect of the artwork, such as beauty, compositional properties, or value (Mallon, 2014) Updating the values of an artwork is also an update of experience and intuition, and according to Hakak, creativity is a new combination of experience and intuition. It can be argued that expanding the inventory of experience can gradually help the novel combination of experience and intuition. To support and facilitate this expansion, experiencing virtual spaces with unconventional features is an interesting case. (Hakak, 2012) In this context, Hakak also mentioned in his study that extensive experience gained in unconventional virtual spaces can be positively correlated with creative performance (enhanced interactivity, lateral thinking, idea generation, and cognitive processes that support creativity (retrieving unconventional knowledge, recruiting ideas from unrestricted virtual spaces to realize them).

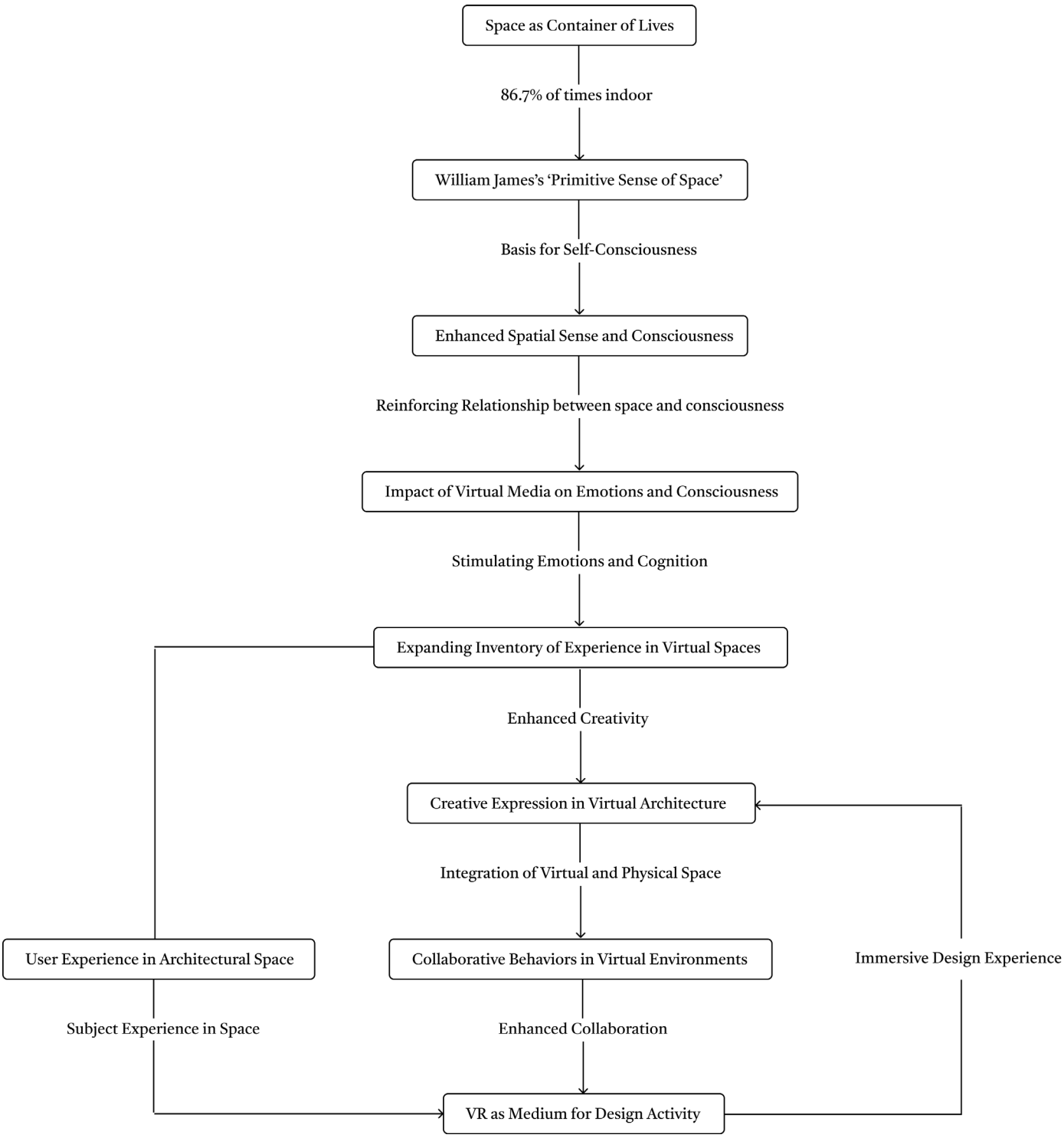


Figure 50, Illustration of Virtual Space Design and Creativity Inspiration

In the VIRTUAL REALM project, we assume that designers, as subjects who are users of the space, when the shape to be constructed in the design activity does not exist before it is constructed, designers invent the media necessary to achieve their goals based on their intuition and experience, just as improvisers ‘pretend’ to use certain props Like improvisers 'pretending' to use a prop to re-imagine unfolding events (Ackermann, 2004), using their imagination to project themselves into a particular scene (sayeki, 1989) while at the same time balancing the states of being in and out of the situation (Kegan, 1982) can help the designer to establish a connection with the object of the design. VR as a spatial medium can be used to manipulate the ‘world of cognitive presence’ by providing the user with different perceptual cues, switching between the "God's perspective" and the ‘first-person perspective’, and inviting the user to construct a specific representation of the situation (Colombetti, 2008). It also enables designers to create virtual assets in virtual spaces that users can explore and interact with as if they were physically present in the design space, (Rehnberg, 2018) This direct experience of virtual design enhances user engagement and promotes more accurate feedback (Pasqualini, 2018). Ackermann compares design in VR to improvisational theater, where the designer plays the role of writer, choreographer, and actor at the same time, staging and surviving on a large stage in virtual space. As the designer interprets the virtual space in VR, it is as if the puppeteer is attached to his string puppets; the puppeteer expresses his thoughts and consciousness through the puppets, while the designers are constantly switching their identities back and forth between ’God's point of view’ and ‘first-person point of view’.between ‘God's perspective’ and "first person's perspective".

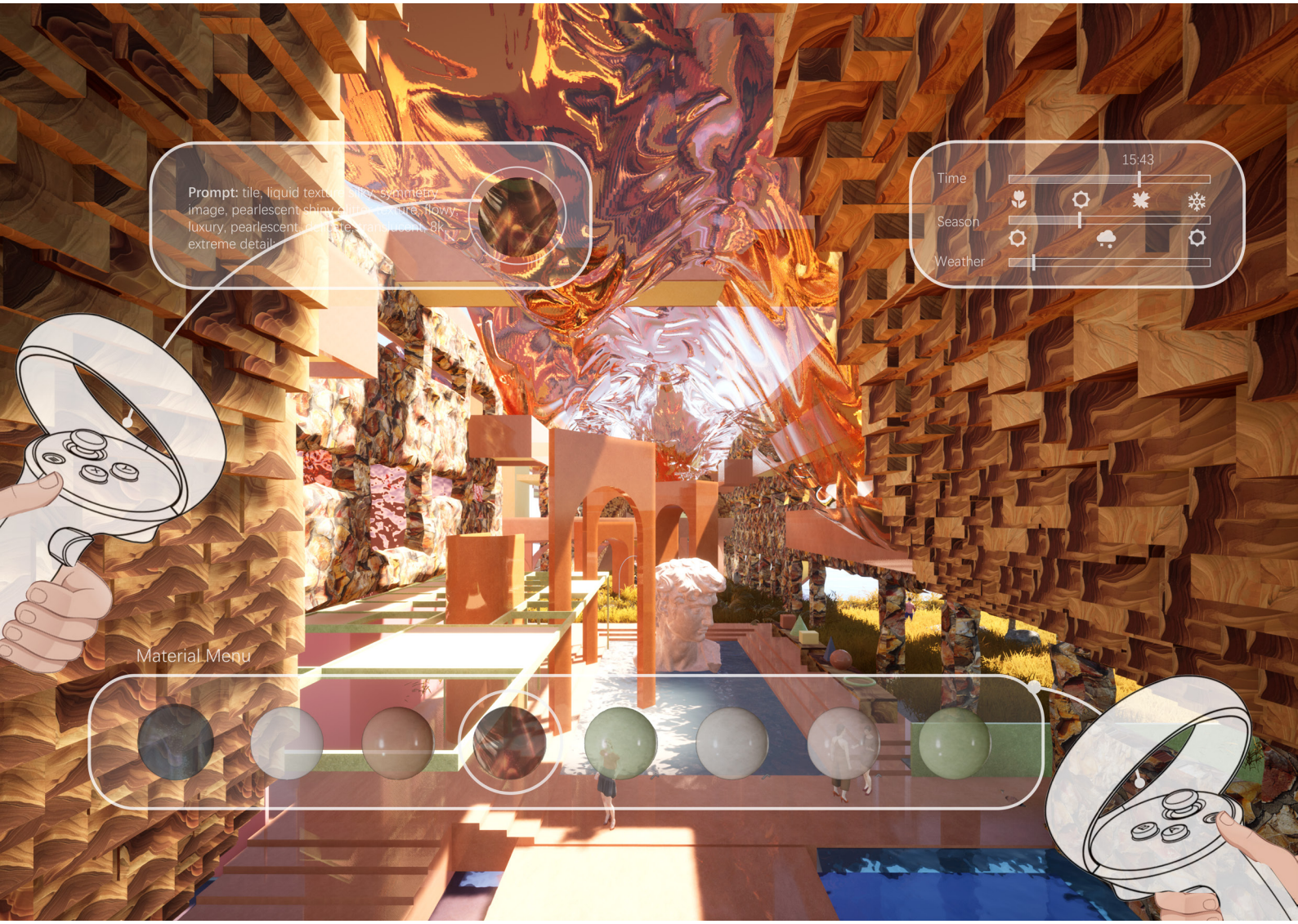


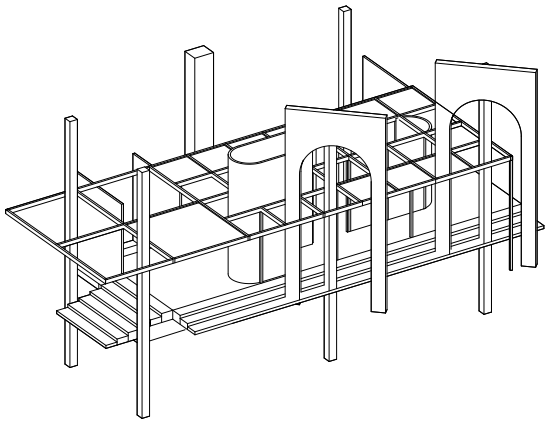
Figure 51, Virtual and Reality Senario inside the Virtual Realm

Figure 52, Illustration of the Virtual Realm with site

On the one hand, they are the experiencers of space, and on the other hand, they are the 'giant puppeteers' who manipulate the puppets. In the role of the 'puppeteer', the virtual environment (VE), as another mode of interpreting virtual space, can help the designer to separate the self from the sense of time, materiality, and physical limitations of the real world, thus enabling the designer to embody and expand a new mode of creativity (Hakak, 2012), while at the same time, it can be used as a tool for the designer to create a new kind of work. (Hakak, 2012) At the same time, VEs are accessible to a wide community of users and can enhance communication, collaboration, understanding, and knowledge sharing among participants. For virtual environments, many studies related to the design process have focused on the collaborative behaviors that occur in virtual environments, for example, Roupé et al. developed a virtual collaborative design environment to explore the collaborative behaviors of designers in a virtual collaborative environment and explored the experiences and perceptions of participants on the collaborative design process through directly documented observations and semi-structured interviews (Roupé, 2020). Leon et al. created a pre-BIM procedure for the conceptual design phase, aimed at cognitive design research in collaborative virtual environments. The procedure encompasses various scenarios, such as setting up teams, brief introductions, project requirements discussions, solution synthesis and brainstorming, solution evaluation, reaching agreement, and final solution development. (Leon, 2020). The designers work collaboratively to communicate and discuss the process of bringing different values to the virtual space of the same physical space context, and these values to a certain extent strengthen the designers' creative intuition and experience of making virtual design works and stimulate the creativity of the virtual space.

Figure 53, senarios of the Virtual Realm

Figure 54, senarios of the Virtual Realm



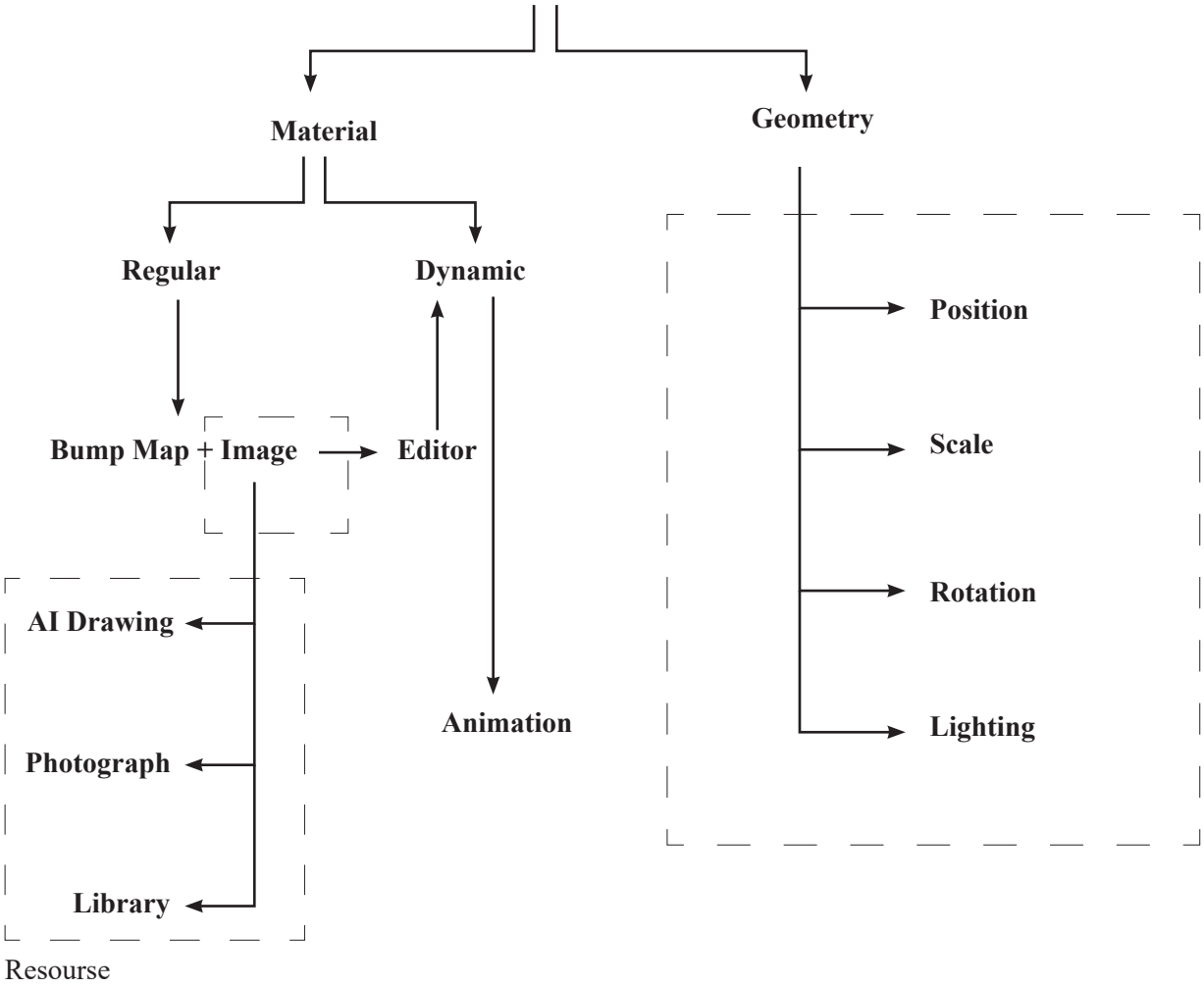


Figure 55, Illustration of the Virtual Building Platform

VIRTUAL BUILDING PLATFORM

In the context of specific physical spatial stimuli providing a sense of immersion in a strong sense, the study proposes a virtual construction platform and experiments in Virtual Realm. Through the human-computer interaction capabilities of VR and Ai-assisted virtual material production, designers can collaborate on spatial creations in the same virtual environment.

Regarding the composing of the virtual space, it is mainly based on the methodology of VIRTUAL REALITY AND HUMAN-COMPUTER INTERACTION. Through VR's external devices, users can change the position, material, and shape of the objects in the virtual space, as well as adjust the light and weather of the virtual environment through VR. Also by compiling a virtual object in space, it is possible to make that virtual object move along a specific track in space by itself.

For the generation of virtual textures, in addition to those already in the program, designers can refine their designs by using the material textures generated by MidJourney, which has been incorporated into the platform and employs artificial intelligence to generate textures, allowing the user to create their own textures by texting in the prompts related to the material or by uploading a photo and editing it according to the textual prompts.

Using the same prompt, four different textures can be generated, while these four different textures can be refined and iterated to generate more material textures. In addition, the project tries to blend these textures with each other in virtual space, so that when several people present the original image and input the different texts at the same time, the texture can be blended and make the user's experience more involved.

In Virtual Realm, the virtual construction platform focuses on rocks and fluids. In the general context of a virtual island, designers can create supernatural virtual scenes with fluid and rock-related prompt words.

Figure 56, Illustration of the Virtual Building Process

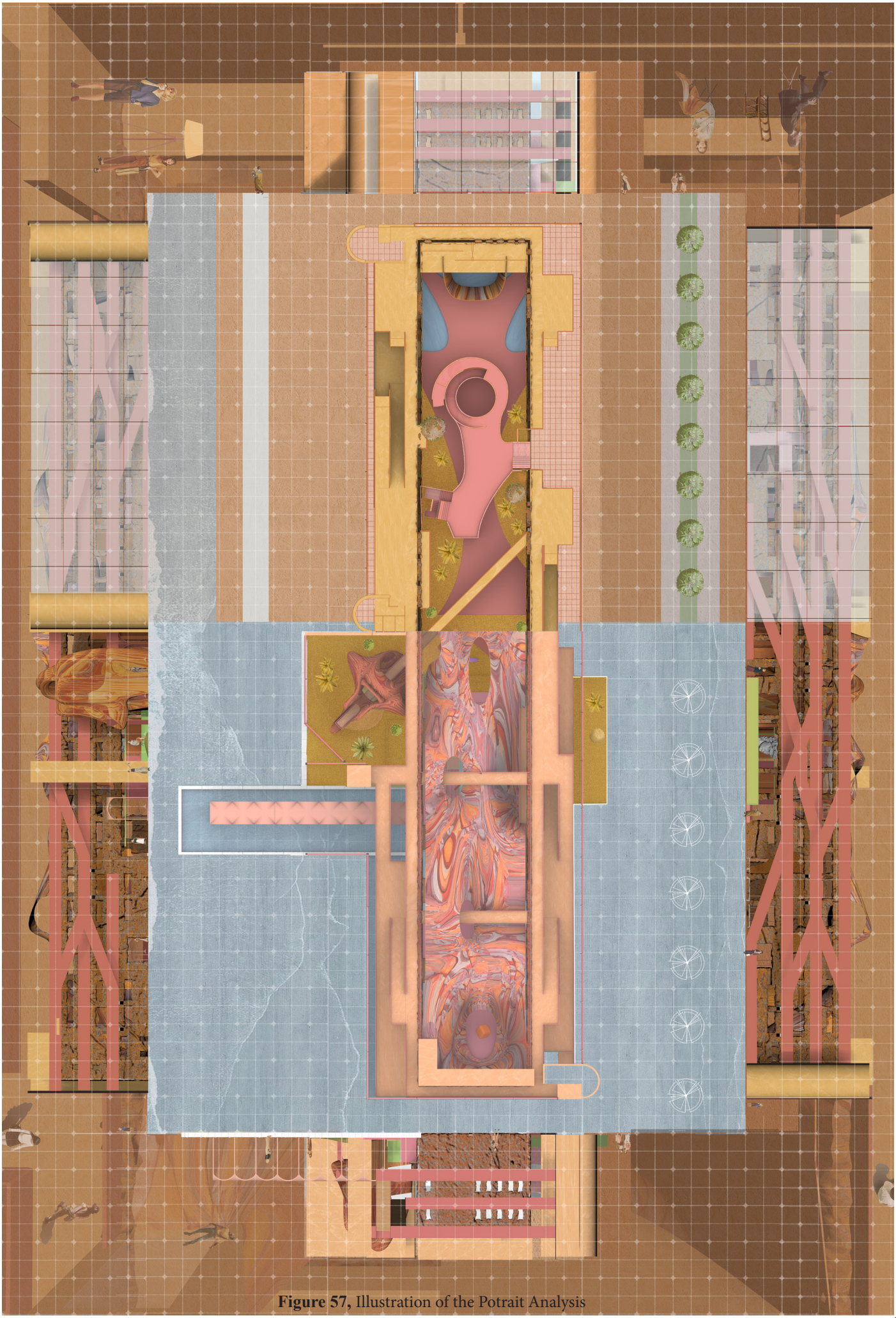


Figure 57, Illustration of the Potrait Analysis

According to Fun Palace's paradigm, scenes in the Virtual Realm can be switched according to the user's preferences, and users can authorize each other to enter each other's stages.

Through the VR system, the user can experience the physical scene on a real-world basis. The following six images show the comparison between the virtual and real worlds.

Figure 58, Perspective of various setting by various users

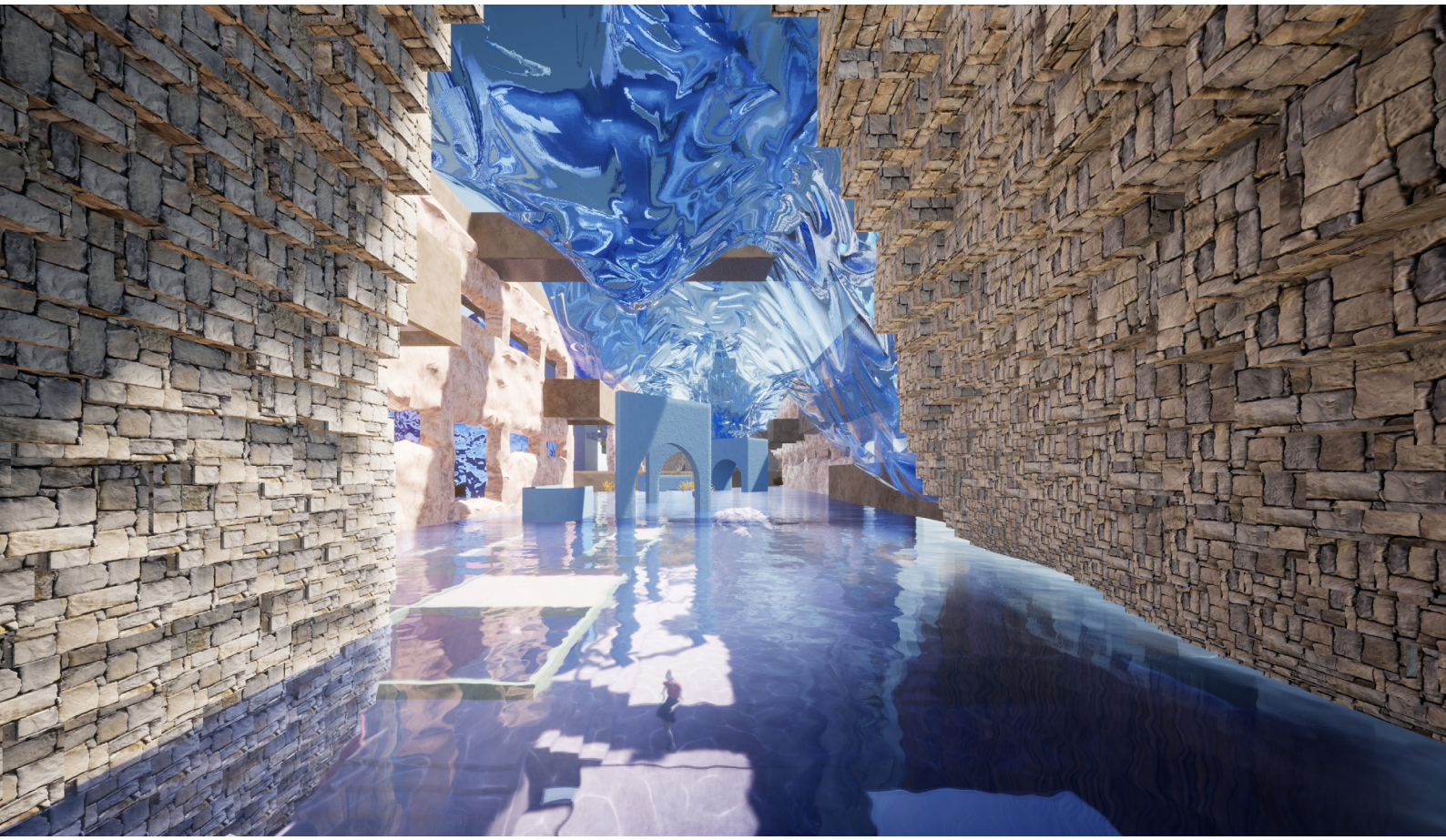


Figure 59, Perspective of various setting by various users

Figure 60, Contrast Perspective Between Virtual and Real 1

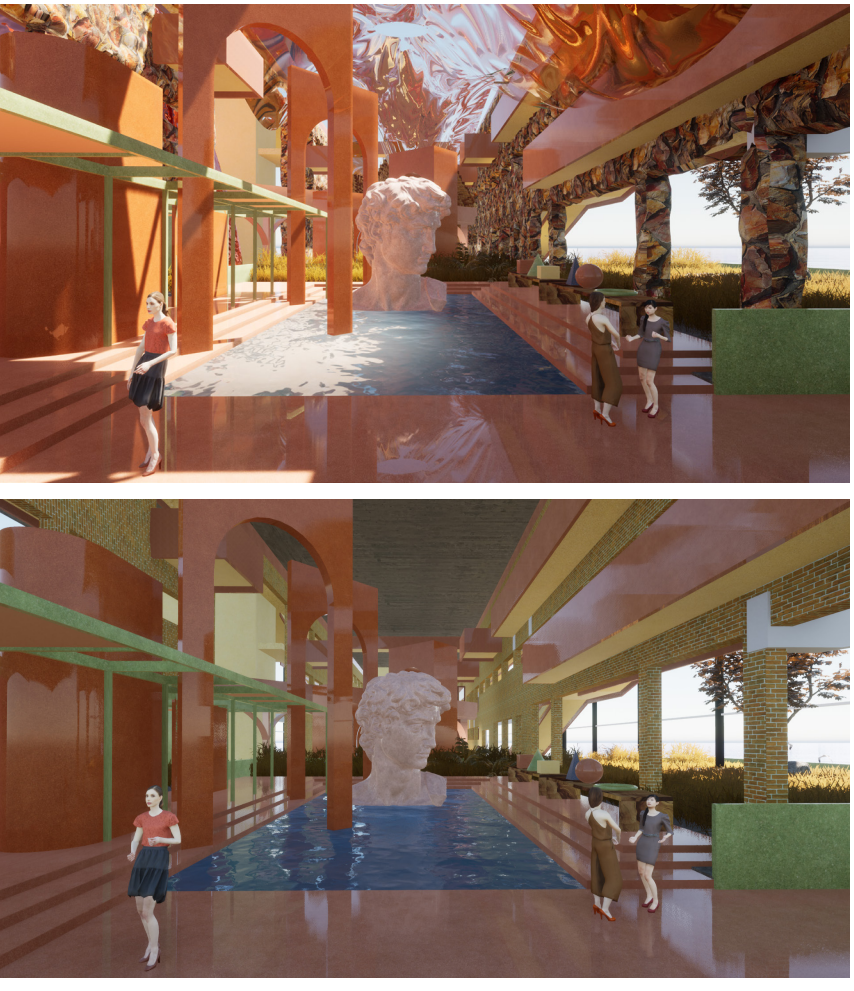


Figure 61, Contrast Perspective Between Virtual and Real 2

Figure 62, Contrast Perspective Between Virtual and Real 3

Figure 63, Contrast Perspective Between Virtual and Real 4

Figure 64, Various Senarios in same user perspective 1

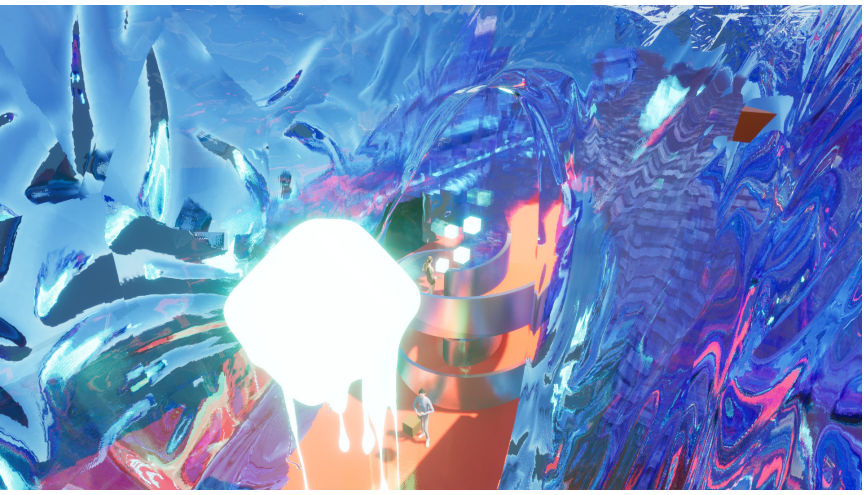


Figure 65, Various Senarios in same user perspective 2

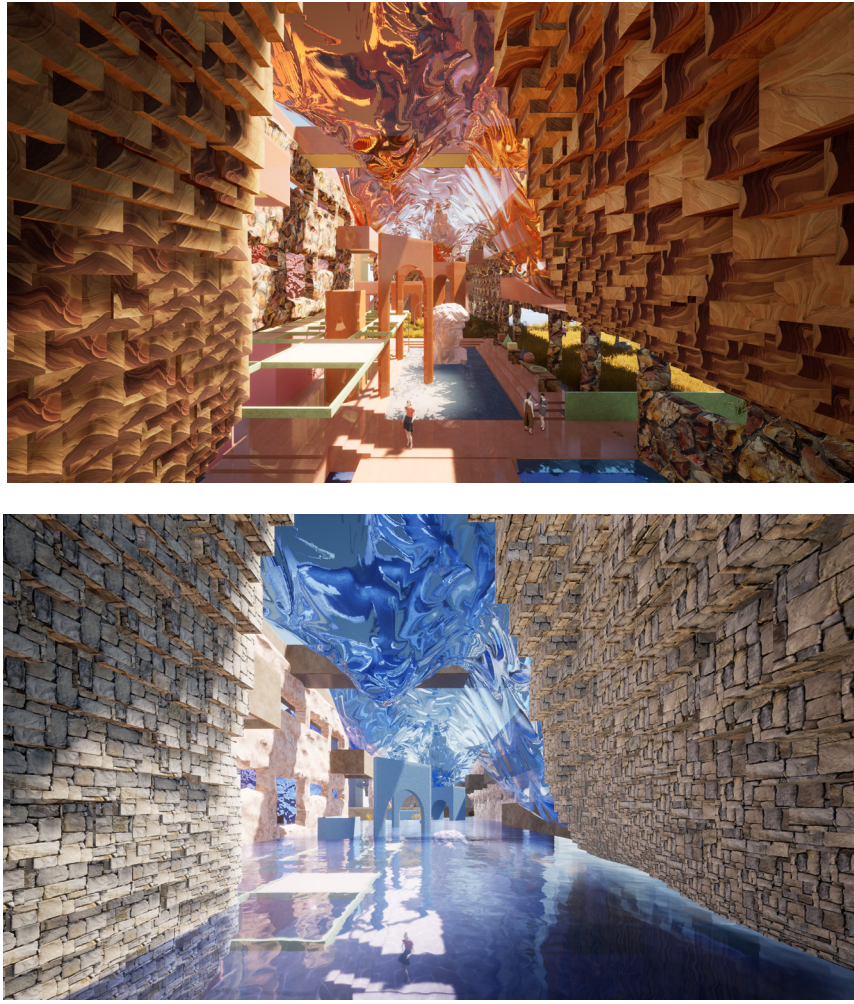


Figure 66, Various Senarios in same user perspective 3

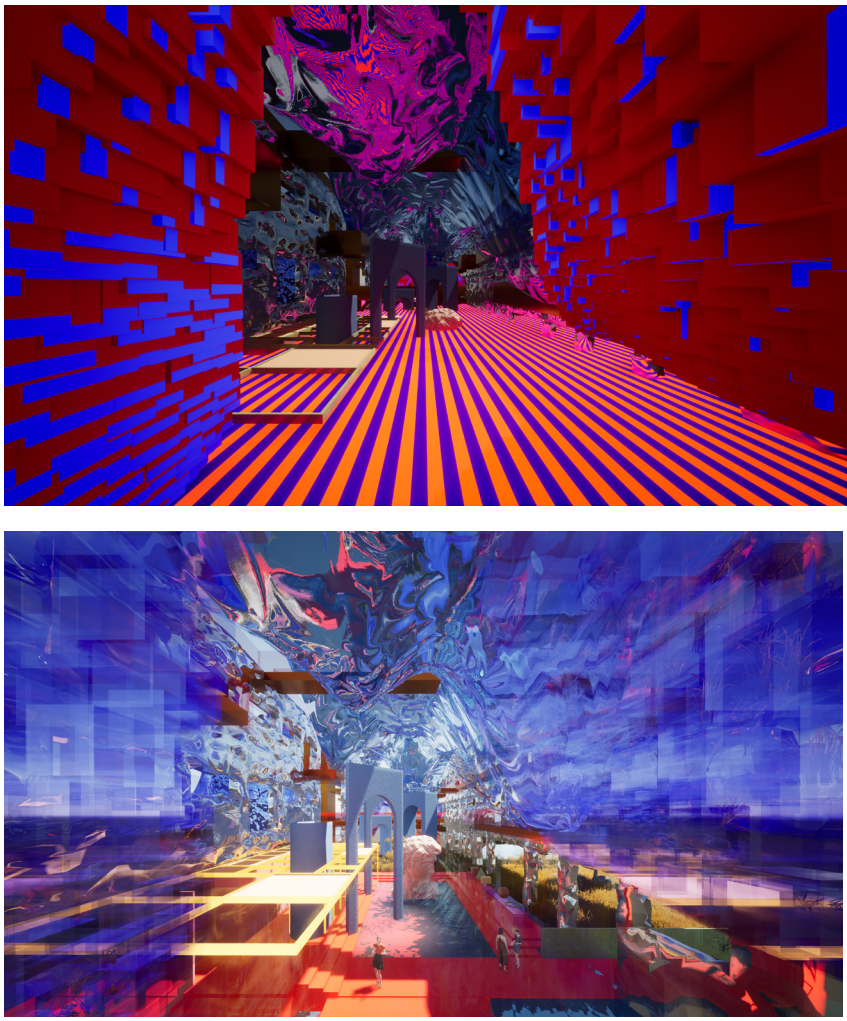


Figure 67, Various Senarios in same user perspective 4

Figure 68, AR Representation of the Virtual Realm

REPRESENTATION

The final presentation will be delivered using a combination of virtual reality (VR) and augmented reality (AR) simultaneously. To differentiate between AR and VR, it is crucial first to clarify the concept of mixed reality (MR). Mixed Reality is a term that refers to the range of reality experiences that lie between pure reality, where the viewer sees only the natural environment without any computer-generated items, and virtual reality when the entire environment is computer-generated. (Milgram, 1994), Augmented Reality (AR) is a cutting-edge visualization technology that enables the incorporation of virtual information, such as 3D models, photos, animations, and music, above the real world. This enhances the user's access to additional information. (Milgram, 1994), This technology enhances the user's environment by providing them with a wealth of information without the need to immerse them in a fully virtual world (Cheng, 2017).

AR offers a distinct advantage in presentations by allowing users to view reality while adding layers of information to their real-world environment. In contrast to VR devices, which only provide a virtual scene for one person, AR enables multiple individuals to view a virtual model in the field at a significantly lower cost. This is highly advantageous for field users. Considering these advantages, AR technology has significant potential to integrate with VR technology in order to facilitate communication between remote users and local users.

Figure 69, Cocept diagram of the Virtual Realm

DISCUSSION

In the context of the increasingly developed programs and platforms for virtual creativity, designers are gradually transferring their attention from the physical to the virtual. Virtual space also provides an open platform for designers to display their creativity to the public. In this regard, the thesis primarily focuses on three main points: physical stimulation, virtual space, and design.

The thesis begins with the relationship between the virtual and the real to explain that the multi-sensory stimulation of the physical world can enhance the immersion of the virtual space. Then, through a case study of virtual architecture design, it is concluded that virtual space has three characteristics: Unlimited Creativity, Community, and Immersive Experience, and three design strategies are proposed. The project tested the multi-sensory stimulation and virtual space design strategies in the virtual project in the exploration phase. Based on the architectural conceptual model obtained in the exploration phase, the project was developed and applied to the Virtual Realm project.

The inspiration of the Virtual Realm derives from the prardigm of Fun Palace by Cederic Price and the Black Box Theater. The design process of the Virtual Realm project is an exploration of VR human-computer interaction and the creative stimulation of virtual environments. In the design stage, I used Unreal Engine and Twinmotion software to connect to the VR device Meta Quest 3, and tested and concluded that the user can move flexibly in the virtual space, change the position, material, and shape of the objects in the virtual space, as well as adjust the light and weather of the virtual environment through VR. Based on VR's human-computer interaction, the Virtual Realm project proposes a virtual construction platform, i.e., in the context of a specific physical space stimulating a strong sense of immersion, through the human-computer interaction function of VR and the Ai-assisted virtual material production, designers can collaborate on space design in the same virtual environment. As for the creative stimulation of virtual space, the study also illustrates through the method of literature review in relation to the Virtual Realm project that the virtual environment affects the user's consciousness, and the creativity of the designers is stimulated in the process of exploring the spatial characteristics and collaborative work and communication in the virtual environment.

The thesis, in which VR software experiments and architectural space design were conducted in parallel, generated many new ideas and conclusions as it progressed, and in the process of culling and simplifying the project and textual information focused on physical stimulation, virtual space, and design, which means that there are many virtual space design-related research This implies that there are many possibilities for research related to virtual space design. At the same time, the study focuses on the design of virtual space, and the physical space is only used as an aid to physical stimulation, so there is a lack of consideration of the physical space in terms of building structure, building energy consumption, and building life cycle assessment. However, back to the discussion of virtual space design, it provides a platform for designers to stimulate and present their creativity, and the main purpose of this thesis is to offer designers with creative methods and ideas of space design in virtual space, and to stimulate them to create more imaginative works in the field they are passionate about.

ACKNOWLEDGEMENT

First and foremost, I would like to express my deep and sincere gratitude to my supervisor Jonas Lundberg for his generous guidance in project and academic research. His suggestions and guidance throughout the whole master's thesis have helped me to become more open-minded and creative. Also, I really appreciate the guidance from Erica Hörteborn regarding my thesis project which made my thesis more convincing and detailed. I would also like to emphasize my appreciation to the lecture guest, teachers, and students who have advised me on my dissertation. I sincerely wish them all the best in their academic journey!

I am very grateful to my family and friends. They have given me selfless support making me more confident in my period of thesis and exhibition. I sincerely hope they are healthy and happiness and have a better future!

Also, I would like to thank everyone in Chalmers. The university has given me a favorable learning atmosphere and a fascinating academic life. The kind and well-mannered relationship between teachers and classmates made me feel the warmth of a foreign country.

Last but not the least, I would like to express the special gratitude to myself. It's my efforts that have honored me with more people's recognition and given me more courage to face the wide world and my future life straightforwardly!

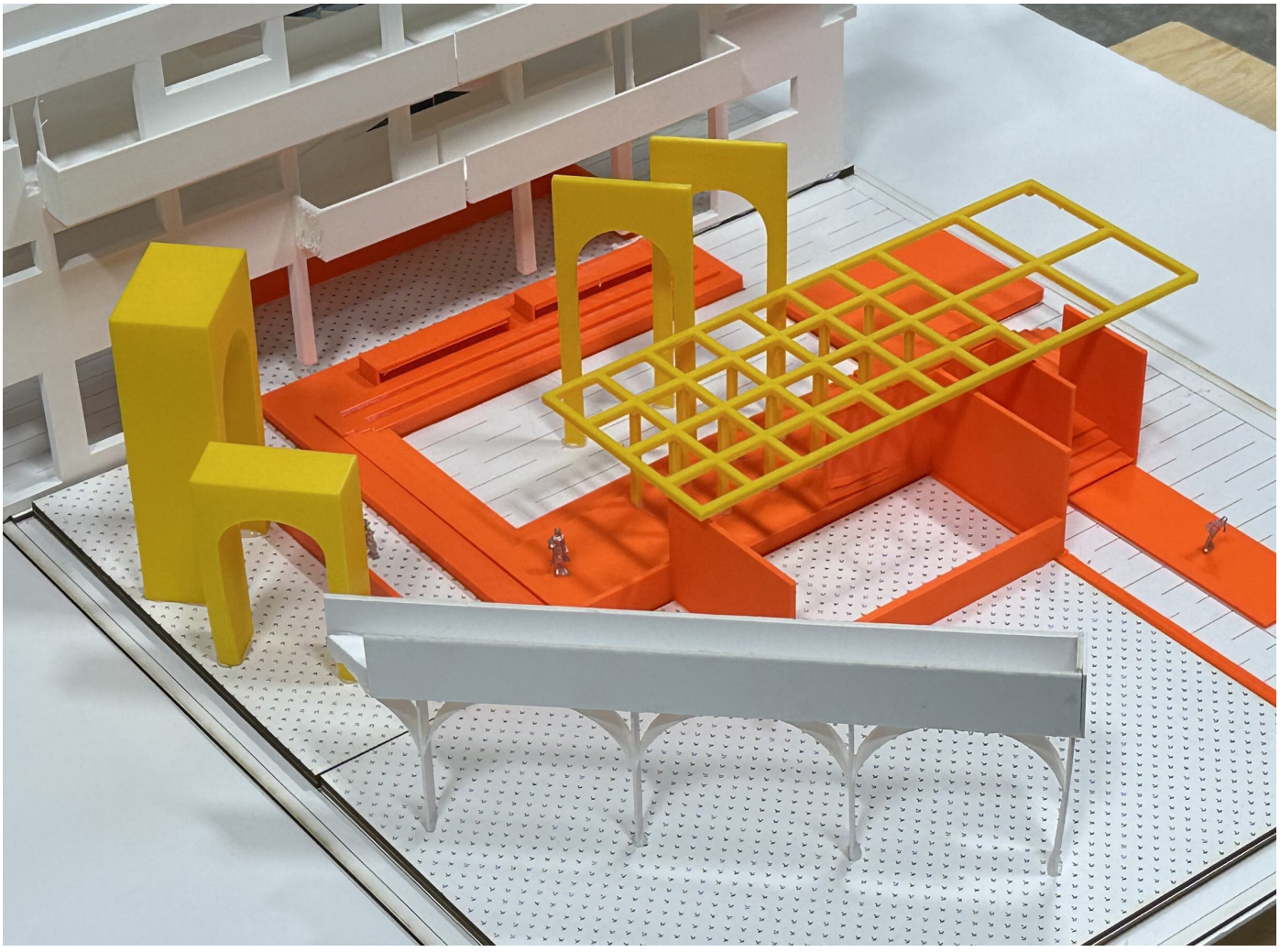


Figure 70, Physical Model of the Virtual Realm

BIBLIOGRAPHY

1. Ackermann, E. K. (2004). Constructing knowledge and transforming the world. *A learning zone of one's own: Sharing representations and flow in collaborative learning environments*, 1, 15-37.
2. Alberti, L. B. (1450/1988). *De re Aedificatoria*, trans. J. Rykwert, R. Tavernor and N. Leach. Cambridge, MA: The MIT Press.
3. Aish, R., & Woodbury, R. (2005, August). Multi-level interaction in parametric design. In *International symposium on smart graphics* (pp. 151-162). Berlin, Heidelberg: Springer Berlin Heidelberg.
4. Anstey, T. (2007). Where is the Project? Cedric Price on Architectural Action. In *Critical Architecture* (pp. 240-244). Routledge.
5. Boas, Y. A. G. V. (2013, August). Overview of virtual reality technologies. In *Interactive Multimedia Conference* (Vol. 2013). sn.
6. Carpo, M. (2017). *The second digital turn: design beyond intelligence.* MIT press.
7. Chase, S. C. (2002). A model for user interaction in grammar-based design systems. *Automation in construction,* 11(2), 161-172.
8. Cheng, J.C., Chen, K. and Chen, W. (2017), "*Comparison of marker-based AR and marker-less AR: a case study on indoor decoration system", Lean and Computing in Construction Congress (LC3): Proceedings of the Joint Conference on Computing in Construction (JC3)*, pp. 483-490. Cheng et al. 2017
9. Chirico, A., Pizzolante, M., Borghesi, F., Bartolotta, S., Sarcinella, E. D., Cipresso, P., & Gaggioli, A. (2023). "Standing Up for Earth Rights": Awe-Inspiring Virtual Nature for Promoting Pro-Environmental Behaviors. *Cyberpsychology, Behavior, and Social Networking*, 26(4), 300-308.
10. Chirico, A., Yaden, D. B., Riva, G., & Gaggioli, A. (2016). The potential of virtual reality for the investigation of awe. *Frontiers in psychology*, 7, 223153.
11. Christina Petridou (2023), *Architectural utopias and fictional scenarios take over MAK exhibition in Vienna*. https://www.designboom.com/art/hyperrealistic-new-virtual-journey-mak-exhibition-vienna
12. Colombetti, G., and Thompson, E. (2008). "The feeling body: towards an enactive approach to emotion," *in Body in Mind, Mind in Body: Developmental Perspectives on Embodiment and consciousness*, eds W. Overton, U. Mueller, and J. Newman (Mahwah, NJ: Lawrence Erlbaum), 45–68.
13. D. Kirshner, J.A. Whitson. *Situated cognition: social, semiotic, and psychological perspectives.* L. Erlbaum, 1997.
14. Dima Stouhi (2022). *Daniel Arsham and Andrés Reisinger Among Acclaimed Designers of Newly-Launched Metaverse Real Estate Development.* https://www.archdaily.com/985957/daniel-arsham-and-andres-reisinger-among-acclaimed-designers-of-newly-launched-metaverse-real-estate-development
15. Elmqaddem, N. (2019). Augmented reality and virtual reality in education. Myth or reality?. *International journal of emerging technologies in learning*, 14(3).
16. F. Liu, J. Kang, Relationship between street scale and subjective assessment of audio-visual environment comfort based on 3D virtual reality and dual-channel acoustic tests, *Building and Environment*. 129 (2018) 35–45, https://doi.org/10.1016/j. buildenv.2017.11.040.
17. Forty, A., & Forty, A. (2000). *Words and buildings: A vocabulary of modern architecture* (Vol. 268). London: Thames & Hudson.
18. G.M. Echevarria Sanchez, T. Van Renterghem, K. Sun, B. De Coensel, D. Botteldooren, Using Virtual Reality for assessing the role of noise in the audiovisual design of an urban public space, *Landscape Urban Plann.* 167 (2017) 98–107,https://doi.org/10.1016/j.landurbplan.2017.05.018.
19. Goldsborough, Gordon. "Victorian virtual reality." *Manitoba History* 54 (2007): 30-39.
20. Grau, O. (2004). *Virtual Art: from illusion to immersion*. MIT Press.
21. Grosz, E. (2001). *Architecture from the outside: Essays on virtual and real space.* MIT Press.

22. Gulhan, D., Durant, S., & Zanker, J. M. (2023). Aesthetic judgments of 3D arts in virtual reality and online settings. *Virtual Reality*, 27(2), 573-589.
23. Grosz, E. (2001). *Architecture from the outside: Essays on virtual and real space.* MIT Press.
24. Hakak, A. M., Biloria, N., & Rahimi, M. R. (2012). Implementing unconventional virtual environments for enhancing creativity in architecture pedagogy. I*nternational Journal of Virtual and Personal Learning Environments* (IJVPLE), 3(4), 41-52.
25. Hsu, T. W., Tsai, M. H., Babu, S. V., Hsu, P. H., Chang, H. M., Lin, W. C., & Chuang, J. H. (2020, March). Design and initial evaluation of a VR based immersive and interactive architectural design discussion system. In 2020 *IEEE Conference on Virtual Reality and 3D User Interfaces (VR)* (pp. 363-371). IEEE.
26. James, W. (1890/1950). *The Principles of Psychology*, Vol. 2. New York, NY: Dover Publications.
27. Kegan, R. (1982). *The Evolving Self. Cambridge*, MA: Harvard University Press.
28. Klepeis, N. E., Nelson, W. C., Ott, W. R., Robinson, J. P., Tsang, A. M., Switzer, P., ... & Engelmann, W. H. (2001). The National Human Activity Pattern Survey (NHAPS): a resource for assessing exposure to environmental pollutants. *Journal of exposure science & environmental epidemiology*, 11(3), 231-252.
29. Kolirin,L. (2021). World's first digital NFT house sells for $500,000, https://edition.cnn. com/style/amp/digital-nft-mars-housescli-intl/index.html .
30. Kolata,S. (2022) .The Crypto-Future of Architecture: an Interview with Krista Kim, https:// www.archdaily.com/author/sara-kolata.
31. Lanier, J. (1992). Virtual reality: The promise of the future. *Interactive Learning International*, 8(4), 275-279.
32. Lara, L & Fredrik, H (2018). Value in the virtual. From http://www.spacepopular.com/exhibtions/2018---value-in-the-virtual
33. Leon, M., Laing, R., Malins, J., & Salman, H. (2015). Making collaboration work: application of a conceptual design stages protocol for pre-BIM stages. *WIT Trans. Built Environ*, 149, 205-216.
34. Lombard, M. (1995). Direct responses to people on the screen: Television and personal space. *Communication research*, 22(3), 288-324.
35. L.P. Berg, J.M. Vance, An Industry Case Study: Investigating Early Design Decision Making in Virtual Reality, J. Comput. Inf. Sci. Eng. 17 (2016) 011001, https:// doi.org/10.1115/1.4034267.
36. Maher, M. L., Rosenman,M. & Merrick,K. (2007) . Agents for multidisciplinary design in virtual worlds. *Artificial Intelligence for Engineering Design, Analysis and Manufacturing*, 21, 267–277.
37. Mallgrave, H. F. (2010). *The architect's brain: Neuroscience, creativity, and architecture*. John Wiley & Sons.
38. Mathews, S. (2006). The Fun Palace as virtual architecture: Cedric Price and the practices of indeterminacy. *Journal of Architectural Education*, 59(3), 39-48.
39. Mathews, Stanley. "Cedric Price as Anti-Architect." In *Architecture and Authorship*. Ed. Tim Anstey, Katja Grillner and Rolf Hughes. London: Black Dog Publishing, 2007b. 142-147. Print.
40. Mathews, Stanley. From Agit-Prop to Free Space: The Architecture of Cedric Price. London: Black Dog Publishing, 2007a. Print.
41. Milgram, P., & Kishino, F. (1994). A taxonomy of mixed reality visual displays. *IEICE TRANSACTIONS on Information and Systems*, 77(12), 1321-1329.
42. Millerson, G., & Owens, J. (2012). *Television production*. Routledge.
43. Mine, M. R., Brooks Jr, F. P., & Sequin, C. H. (1997, August). Moving objects in space: exploiting proprioception in virtual-environment interaction. In *Proceedings of the 24th annual conference on Computer graphics and interactive techniques* (pp. 19-26).
44. Noel, J. P., Pfeiffer, C., Blanke, O., and Serino, A. (2015). Peripersonal space as the space of the bodily self. *Cognition* 144, 49–57. doi: 10.1016/j.cognition.2015.07.012
45. Pasqualini, I., Blefari, M. L., Tadi, T., Serino, A., & Blanke, O. (2018). The architectonic experience of body and space in augmented interiors. *Frontiers in psychology*, 9, 257251.
46. Quesnel, D., & Riecke, B. E. (2018). Are you awed yet? How virtual reality gives us awe and goose bumps. *Frontiers in psychology*, 9, 403078.

47. Rehnberg, A. (2018). Virtual prototyping of physical space-The value of presence, place and direct communication in prototyping.
48. Roupé, M., Johansson, M., Maftei, L., Lundstedt, R., & Viklund-Tallgren, M. (2020). Virtual collaborative design environment: supporting seamless integration of multitouch table and immersive VR. *Journal of Construction Engineering and Management*, 146(12), 04020132.
49. Salomon, R., Noel, J. P., Łukowska, M., Faivre, N., Metzinger, T., Serino, A., et al. (2017). Unconscious integration of multisensory bodily inputs in the peripersonal space shapes bodily self-consciousness. *Cognition* 166, 174–183. doi: 10.1016/j.cognition.2017.05.028
50. Sayeki, Y.(1989) Anthropomorhic Epistemology. Unpublished Paper. Laboratory of Comparative Human Cognition. University of California. San Diego
51. Seamon, D. (2018). Merleau-Ponty, lived body, and place: Toward a phenomenology of human situatedness. *Situatedness and Place: Multidisciplinary Perspectives on the Spatio-temporal Contingency of Human Life*, 41-66.
52. Serino, A., Alsmith, A., Costantini, M., Mandrigin, A., Tajadura-Jimenez, A., and Lopez, C. (2013). Bodily ownership and self-location: components of bodily self-consciousness. *Conscious. Cogn*. 22, 1239–1252. doi: 10.1016/j.concog.2013.08.013
53. Stuart, R.,1996, The design of virtual environments, McGraw-Hill, New York.Schnabel, Marc Aurel. "Architectural Design In Virtual Environments." Published PhD Dissertation, Universi¬ty of Hongkong (2004).
54. Summers, C., & Jesse, M. (2017, March). Creating immersive and aesthetic auditory spaces in virtual reality. In 2017 *IEEE 3rd VR workshop on sonic interactions for virtual environments (SIVE)* (pp. 1-6). IEEE.
55. Um, E., Plass, J. L., Hayward, E. O., & Homer, B. D. (2012). Emotional design in multimedia learning. *Journal of educational psychology*, 104(2), 485.
56. Wang, David. "Diagramming design research." *Journal of Interior Design* 33.1 (2007): 33-43.
57. Waterworth, J. A., & Waterworth, E. (2003). The core of presence: Presence as perceptual illusion. *Presence connect*, 3(3), 1-11.
58. Weinbaum, S. G. (1935). *Pygmalion's spectacles*. Simon and Schuster.
59. Wideström, J. (2020). *A Seeing Place–Connecting Physical and Virtual Spaces*. Chalmers Tekniska Hogskola (Sweden).
60. Witmer, B. G., & Singer, M. J. (1998). Measuring presence in virtual environments: A presence questionnaire. *Presence*, 7(3), 225-240.
61. Älvstranden utveckling. (n.d.). Kajskjul 113. Retrieved from http://alvstranden.com/PROPERTY_LANDING/kajskjul-113/
62. Özel, M. K. (2017). Performativity of Theatre Architecture. Online *Journal of Art & Design*, 5(3).

REFERENCE IMAGES

Figure 1, Conception image to illustrate the sense stimulation of the Virtual Environment
Figure 2, Illustration of the method
Figure 3, Sword of Damocles, From https://www.vrs.org.uk/virtual-reality/history.html
Figure 4, Image generated by Midjourney. imaginative future architecture, green landscape, narrow space, sublime feeling, surface of lake, cyberpunkstyle, unreal engine
Figure 5, https://www.john-demaio.com/space/z84i8ow8zxq66ha4o2dj4umwa45fi3
Figure 6, Annibale Siconolfi, From https://www.artstation.com/artwork/GXYAaQ
Figure 7, value-in-the-virtual by Popular space http://www.spacepopular.com/exhibitions/2018---value-in-the-virtual
Figure 8, Illustration of the chapter VIRTUAL AND REALITY
Figure 9, Mars House was sold in an NFT auction. https://www.dezeen.com/2021/03/22/mars-house-krista-kim-nft-news/
Figure 10, MAK Exhibition View, 2023, /imagine: A Journey into The New Virtual, Alexis Christodoulou, Quantum Express, 2022 © kunst-dokumentation.com/MAK