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*an exploration of designing
for mixed reality*

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Department of Architecture and Civil Engineering

Supervisor: Jonas Lundberg
Examiner: Kengo Skorick

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Material Turn

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Department of Architecture and Civil Engineering

Master's Programme in Architecture and Planning Beyond Sustainability

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Abstract

Physical spatiality, that once was a key aspect of architecture, will become less relevant in the future. As the virtual working its way into the physical word, the novum that emerges in the interaction between the physical and virtual will forever change the built environment as we experience it today.

This thesis explores this novum by investigating how the virtual information may be implemented in architectural design at an equal level of importance as physical materiality.

The Pixel Library places itself in a future where an undistinguished mixed reality, a hyperreality, has become the new reality. Supporting equipment, i.e. vision enhancers, haptic technology, and auditory receivers etcetera, augment the user's biological senses. An immersive reality where information and data are easier than ever to access, collect, and distribute. The library as one of society's most important public buildings will have to change both its media format and its function to keep up with the rapid technological development.

Departing from an existing building, the Pixel Library is manifested when virtual spaces is anchored to the physical structure. With a series of experiences that augments the contemporary usage of a library, it shifts the perception of how spaces might be designed in the future.

The outcome is an architectural expression and design methodology that challenge the understanding of what it means to design for mixed reality. It also provides an alternative way of perceiving scale and perspective in the contemporary design process.

Student Background

Education

2018–2020   **Chalmers University of Technology**
Master Of Science,
Architecture & Planning
Beyond Sustainability
Gothenburg, Sweden

2012–2016   **Savannah College of Art and Design**
Bachelor of Fine Arts,
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Employment

2020   **Kanozi Arkitekter**
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2016–2018   **BSK Arkitekter**
Stockholm, Sweden

To Titti, for everything.

Table of Content

Reading instructions

Introduction

The thesis is introduced with a general overview of the thesis subject together with definitions of specific terms. Research questions with the purpose, delimitation, and program of the thesis are stated to expose the framework of the thesis.

Background

The background gives a deeper understanding of the forthcoming of the fourth industrial revolution and how it is, and may be, implied in society. Speculative and critical architecture is introduced to give a historical and contemporary picture of how it has been used.

Method

The method chapter introduce the method of the thesis. A loop that includes conventional 3D-modelling and 2D-drawings together with the game world of Minecraft and virtual reality.

Design proposal

The final design of Pixel Library is shown through an online animation and a narrative, which a complemented by conventional architectural drawings and images.

Design development

The thesis went through four different main phases that are explained and shown.

Discussion

A summary of the thesis where thoughts and explorations are concluded.

Design references

Reference projects that has affected the thesis in different ways. Divided into three main themes.

Introduction

As the full effect of the fourth industrial revolution is approaching, the way we understand and interact with reality will forever change. Internet of things (IoT), artificial intelligence (AI), robotics, autonomous vehicles, additive manufacturing, nanotechnology, biotechnology, energy storage, quantum computing, and material science, are just a few fields that will revolutionize every sector across society. A new era of technological breakthroughs builds on and amplify each other across the physical, digital, and biological worlds (Schwab, 2016).

Mixed reality (MR) occurs when the physical and virtual worlds merge to produce new environments, where objects co-exist and interact in real time. It creates an immersive environment supported by equipment that augment the physical senses, such as vision enhancers and haptic sensors. The connection to virtual information in any physical location is nothing new, since the internet and smartphones already provide society with the services. The difference lays in the experience; the interaction between the mentioned worlds.

Moving towards this future, the built environment will not shift focus from the physical artefact but rather include its virtual counterpart. From the application's virtual representation of the physical world on your smartphone screen to be an integrated part of the physical world. As information will be retrievable from any physical location, the built environment has to take a greater responsibility of curating the usage of information to fit and support the end user.

This thesis investigates the twilight between the physical and virtual via the design of a public library. Due to the fact that the public library has been one of the most prominent public institutions for decreasing segregation gaps, improvement of democracy, and the enlightenment of knowledge, society would take a great loss if it cease to exist due to alternate ways of retrieving information. The exploring of how virtual information materializes in the physical world and how that will affect the design and function of a public library will be more important than ever.

Immersive media

Technologies that attempt to create, or imitate the physical world through digital simulation. It is the coming together of technology and reality. Sub-catagories of immersive media are virtual reality, augmented reality, mixed reality,

Virtual reality (VR)

A complete immersion experience that shuts out the physical world. VR-device(s), such as goggles, headphones, and gloves, are placed over body parts to simulate senses, at the same time as they block their physical counterpart.

Augmented reality (AR)

Adding virtual layers to the physical world. Contemporary AR-devices such as tablets and phones add the virtual content to the physical world without it being able to correspond and act together with the physical world.

Mixed reality (MR)

combines VR and AR, which makes it possible to interact both with the physical and virtual world simultaneously. The virtual objects are now able to be anchored to, and alter, the physical world's objects.

Internet of Things (IoT)

Encompasses everything connected to the internet, but it is increasingly being used to define objects that Communicates with each other. Simply, the Internet of Things is made up of devices connected together with the ability to transfer data over a network without requiring human-to-human or human-to-computer interactions. Objects that may be included in IoT-systems include connected security systems, thermostats, cars, electronic appliances, lights, alarm clocks, and speaker systems (Burgess, 2018)

Cyber-Physical Systems (CPS)

Cyber-Physical Systems a combination of computation and physical processes. Embedded computers monitor and control physical processes, usually with feedback loops where the processes affect each other (Lee, 2008).

Artificial intelligence (AI)

A system with an ability to correctly interpret external data, to learn from the data, and to use the developed knowledge to achieve specific goals through flexible adaptation.

Skeuomorphism

The term most often used in user interface design to describe objects that mimic their real-world counterparts in how they appear and/or how the user can interact with them. An example is the recycle bin icon used for deleting files.

How can virtual information be implemented in architectural design at an equal level of importance as physical materiality?

To what degree will the public library change to fulfill the new society's functions and requirements?

How can information, as a building material, articulate design decisions of a public library?

Purpose

This thesis explores how architectural design have to adapt when mixed reality has become an integrated part of society. Particularly how we may understand and shape the built environment and its virtual counterpart simultaneously. By using conventional designing tools together with contemporary practices that rapidly evolve, the articulation of the public space will have to shift from being a static physical artefact to a flexible mixed reality entity.

As society may change, the public institution such as the public library will have to as well. Not only the physical articulation per se, but its spaces will accommodate other activities, functions, and requirements than what we experience today. Achieving a design proposal where physical material and virtual information on an equal level, which forms and develops the building typology of a public library, is the aim of this investigation.

Delimitations

For this thesis to be understood and evaluated within an architectural theoretical framework, there is certain standpoints on how the technological and societal development will occur in the project's speculative future. This is to ensure the objective of the thesis and its evaluation to be assessed on the exploration and conclusions founded within the framework.

This thesis places itself in acknowledgement of the fact that the technological development has given the world's population mixed reality gadgets, which supports the user with mixed reality. As the narrative is of fictional character, it is in this novum the discussion will take place. All new technology brings risks; cyber-security, legislation, living standard, class segregation, and ownerships are only a few concerns that surfaced during the project. As the focus is on the public library, the application of mixed reality, and their immediate context, a deeper discussion and evaluation of rest of society is not included in this thesis.

Why a public library?

As a gateway to knowledge and culture, public libraries play a fundamental role in both today's and future's society. The resources and services the libraries offer do not only give the opportunity to gather and convert information into knowledge, but also shape, create, and distribute new ideas and perspectives that are central to a creative and innovative society.

Due to fact that we have entered the age of information, as the commodity of the future and different way it will be retrieved, the public library will fundamentally change. The informational artefacts of the present, i.e. paper and screens, will slowly be replaced by virtual information placed in mixed reality. The physical need of shelves and stacks will slowly dissolve into a network of clouds.

The public library, as it is growing to be more and more of a public living room, has a prominent part of our cities and democracy. From being a vessel of information, it has transformed into a hub of creation. Libraries all over the world are more and more being used for the opportunity to create. The information the library provides in forms of text are available from home. Meeting rooms, digital fabrication, sound studios, and other creative alternative are being placed where the old iron stacks once held the world's information (Helsinki Central Library Oodi, 2020).

Therefore, the opportunity to design a public library in the future, with the virtual information as a building material, has the potential to be seen as a possible future. As the population often has strong ties with the library, it is also a great building to open up a discussion about.

The Fourth Industrial Revolution

The first industrial revolution used water and steam to power production. The second used electricity to create mass production. The third revolution used electronic and information technology to automate production.

The fourth industrial revolution is building on the third, the digital revolution that has been occurring since the middle of the last century.

The fourth industrial revolution describes the exponential development that will profoundly change the way we live, work, and relate to one another. It is made up of a fusion of technologies that blurs the lines between the physical, virtual, and biological spheres.

Cyber-Physical Systems are integrations of computation and physical processes. Integrated computers and networks watch and control physical processes, commonly with integrated feedback loops where physical processes affect computations and vice versa (Lee, 2008). The usage of integration of physical processes and computing is not a new intervention. "Embedded systems" is a term that describes engineered systems that combine physical processes with computing. Successful functions

such as communication systems, aircraft control systems, automotive electronics, home appliances, weapons systems, games and toys. The embedded systems are in most cases closed "boxes" that do not expose the computing capability to the outside. The transformation that we

As we implement smart technologies in all instances of production, our homes, and cities, the IoT is growing and overlapping previous different markets. The now internet-connected machines will not only be able to gather information, but communicating the results with not only humans but with other connected machines as well.

Artificial intelligence (AI) is already implemented all around us, autonomous vehicles to virtual assistants that translate or invest. Due to the exponential increase in computing power and availability of vast amount of data, impressive progress has been made in recent years in the development of AI. It is now possible for software to discover new drugs to algorithms used to predict our cultural interests. (Schwab, 2016)

Digital fabrication technologies have begun
to interact with the biological world more and
more.Interdisciplinary work between engineers,
designers, and architects with the help of
computational design, additive manufacturing,
material engineering, and synthetic biology find
synergies between microorganisms, our bodies, the
things we consume, and the built environment.

As the previous industrial revolutions, the fourth in
order has the potential to increase the global income
levels and improve life quality for populations
around the world. Up until today, the ones that have
gained the most of the new technology are those
able to afford and access the digital world; it has
given the consumers new products and services that
improve efficiency and pleasure of their personal
lives. Order a cab, book a flight, making a payment,
order food, listen to music, watch a movie, or
playing a game – any of these can now be done
remotely. (Schwab, 2016)

As all these systems start to interact with each
other, our smart device will be part of a smart
environment. It is in this environment where we
now experience a revolution.
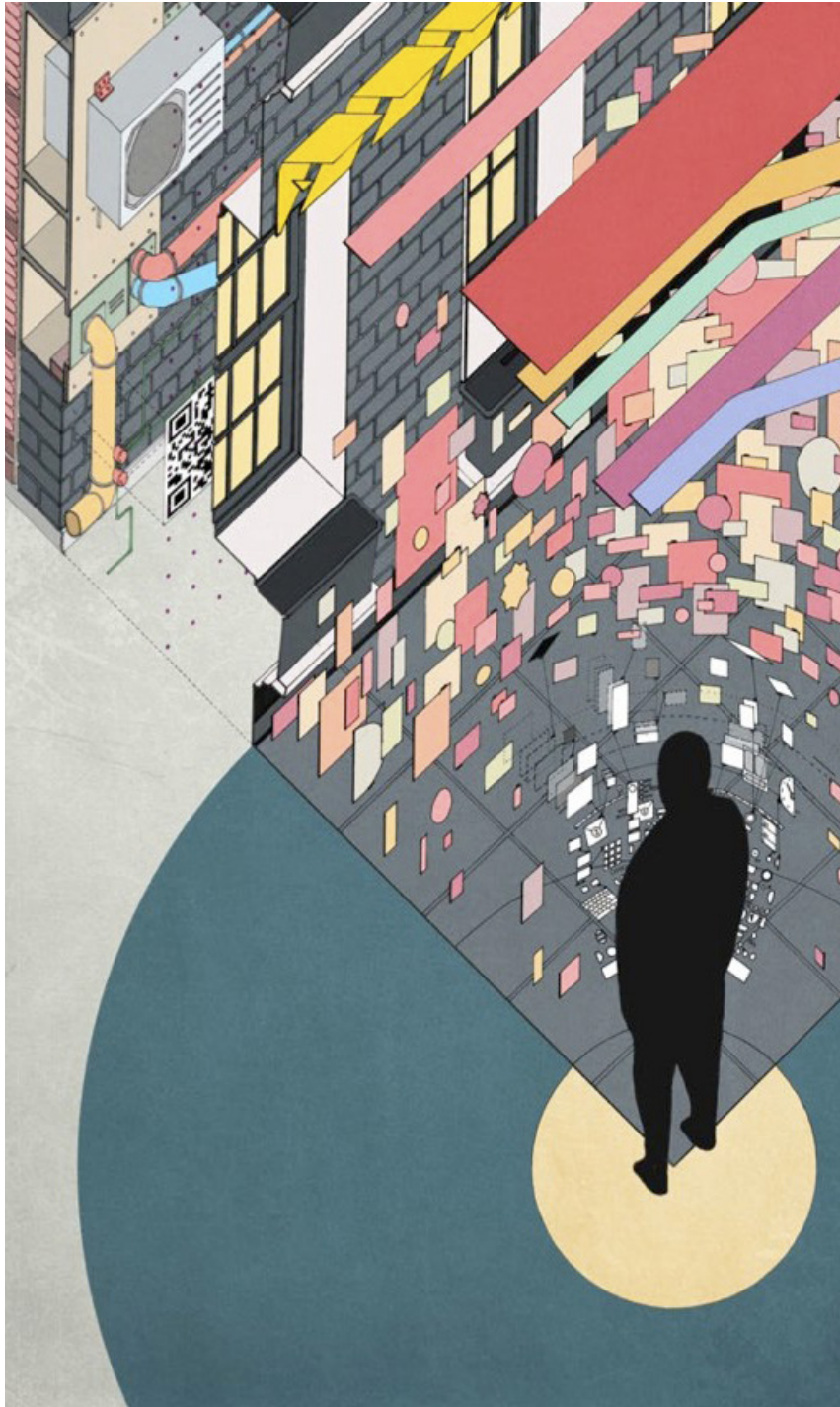
Fig. 01 / Keiichi Matsuda (2010)
Augmented City: Layers/hierarchies

Augmented Architecture

Mapping and alternating the physical environment in a virtual world have architects done since computer-aided-designed (CAD) surfaced in the middle of 1960's. Since then has much happened, architects are no longer undermined by lack of information. Computers are able to handle an increased amount of data due to the fact that computational power and storage has exponentially decreased in cost (Carpo, 2016).

With contemporary technology to collect information of a product, it is now possible to create a real time virtual replica.
Pairing the virtual and the physical worlds allows data to be analyzed and system to be monitored to detect problems before they even occur, develope new opportunities, precent downtime, and even be able to plan for the future with help of simulations (Marr, 2017). As the IoT are developed and sensors are placed over larger areas, digital twin cities are emerging. These cities are able to be used as forums and tools for everything between urban planning to traffic signals. (Chalmers, 2020)

The usage of immersive media in architecture has since its departure been used as a presentational tool rather than a designing tool. The large bulky headset and lower resolution makes it difficult to spend the large amount of time it takes to design. On top of this, 3D-modeling on a 2D surface such as the screen still gives the designer higher efficiency in form of speed and overview of the project. As the development of mixed reality glasses has come to a point where we now starting to see options where they can be implemented in certain parts of the production chains. Microsoft's HoloLens have been used as support in the construction of smaller pavilions, where complex geometric forms can be put together in a more efficient way (Fologram, 2019).

As the technical development proceeds, society are moving closer and closer to a full mixed reality. When the bulky headsets are compressed into contact lenses or regular glasses with high enough fidelity to be worn at all time together with systems that are able to handle the digital twin, we are experience a new dawn of society.

Fig. 02 / Superstudio (1969)
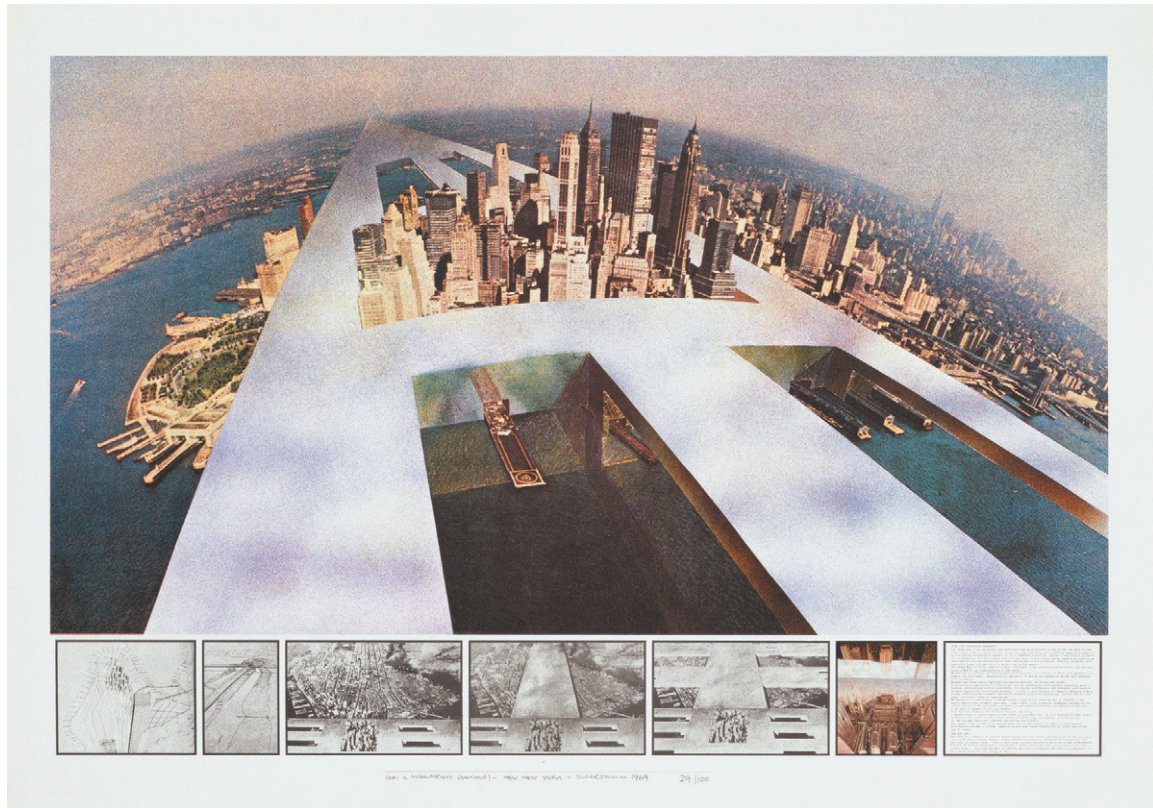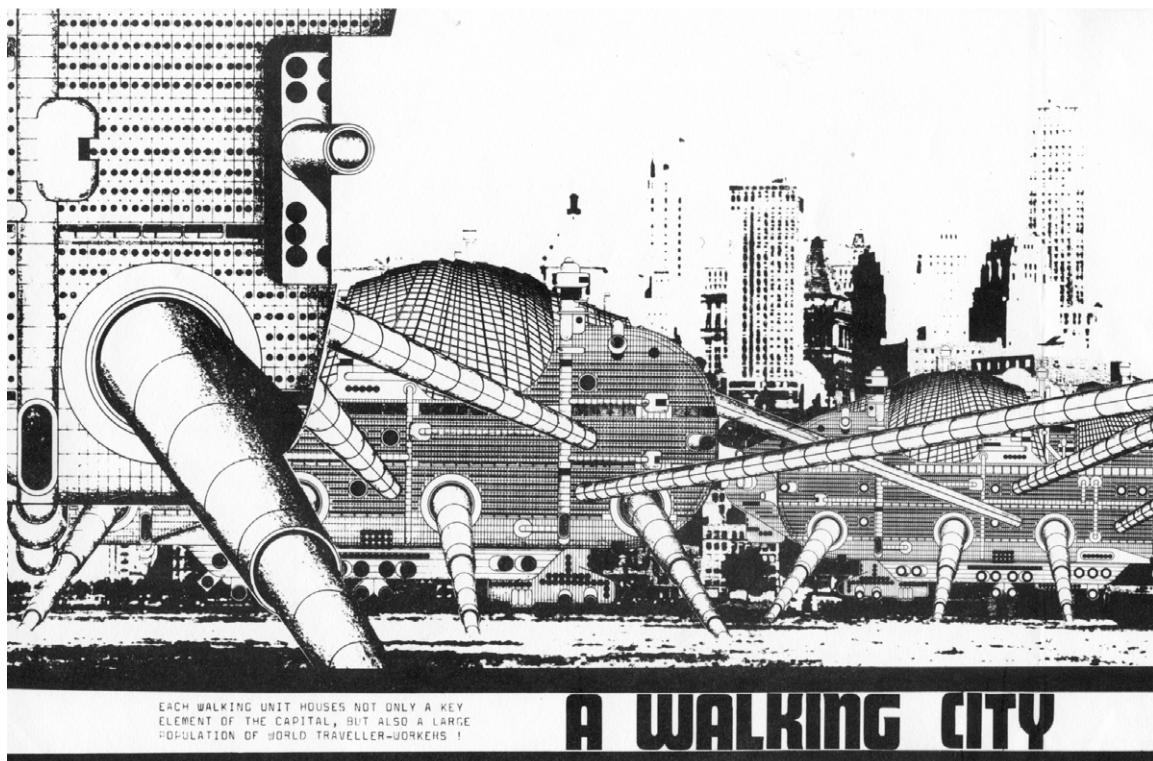*Monumento Continuo, New New York*

Fig. 03 / Ron Herron (1964)
A walking city

Speculative Architecture

Many architects are speculative designers during periods of their careers, it is by many means part of the trade. Runner-up competition entries, clients financial status, or shift in regulations, might force designs to stay on paper.

The profession of architects has a long history of unbuilt projects that meant to stay that way. Groups like Archigram, Archizoom, and Superstudio had a bigger say in the 1960's and 1970's than any single built building ever did. They were all involved in an entire cultural shift that moved from thinking of architecture as solely a static building.
By initially aiming at fiction, the desired outcome is not a complete building as a result. Instead of creating only buildings themselves; it is that the context, the cities, and the people, have the same value in the end (Babkin, 2017).

"Unsettle the present" rather than predict the future, the design duo Anthony Dunne and Fiona Raby argue that designers have to realize that they always deal in fiction. The contemporary norm for designers is that they are mostly interested in what can be produced and marketed under existing, or comfortably imagined, future conditions. Designers create things that are "meeting the imaginary needs of imaginary users" and by neglecting this "are expert fictioneers in denial". Speculative design release society out of the imposed and presumed realism of the current neoliberal order: it provides "alternatives that loosen the ties reality has on our ability to dream" (Speculative Everything, 2013)

Architects need to develop to stay relevant. Intervening in systems that influences space, culture, and communities, beyond just shaping the physical environment. It is more than communication, it is suggesting possible uses, interactions and behaviors that are not obvious.

Fig. 04 / Göteborgs Konsthall (2017)
West facade of Magasin 113.

Magasin 113 placed in Gothenburg.
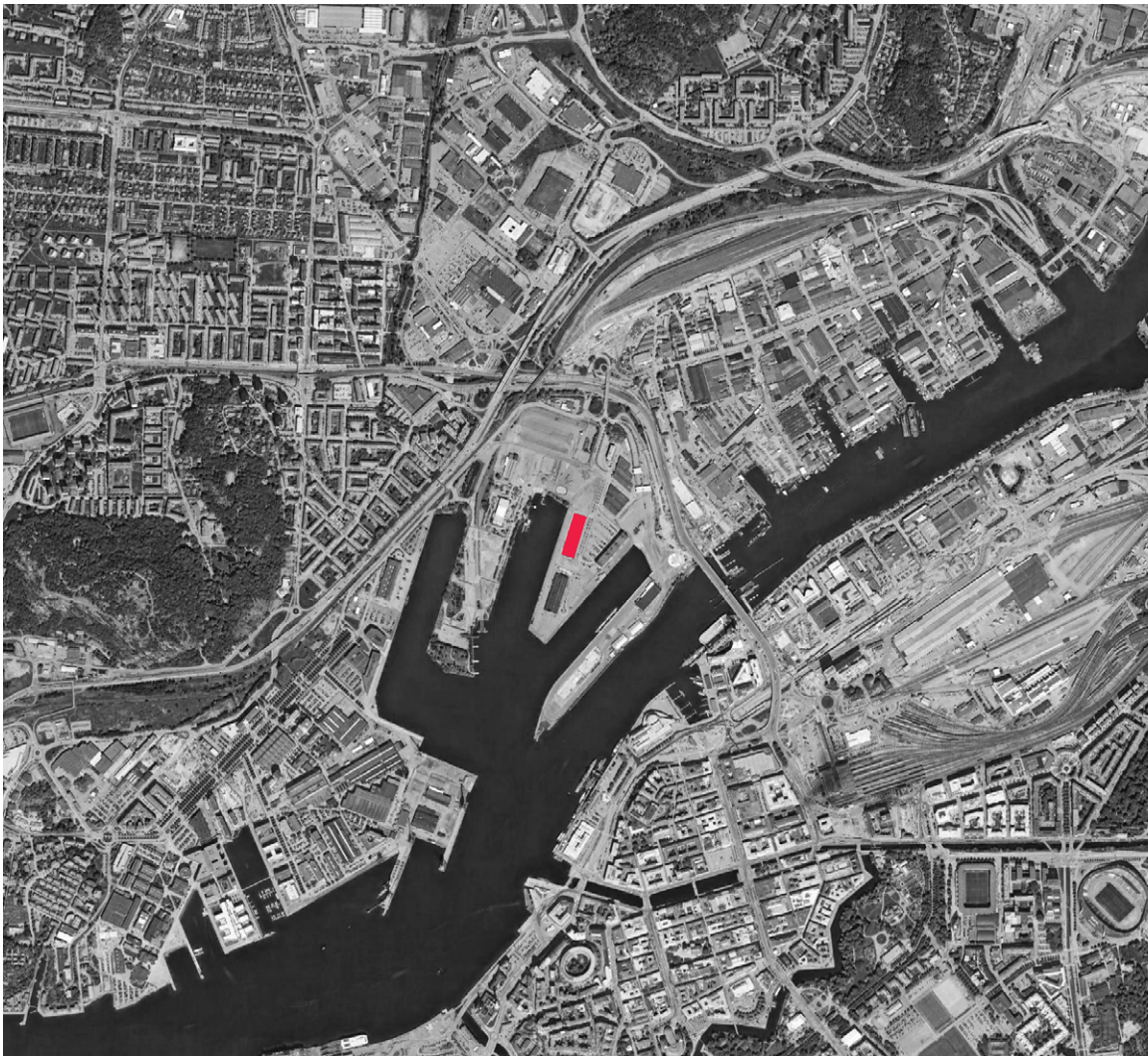
Magasin 113

Placed on the northern side of Göta Älv, the days
with large cargo ships unloading their goods into
large warehouses are over. The structures remain
as a monument of the past. Built rigorously with a
structure of brick and concrete with large balconies
that have seen their initial functions moved
elsewhere, Magasin 113 has since it was built in 1964
(Älvstranden, 2020) been worn down to a shell of its
former glory. The 3000 square meter building has
since the harbor moved closer to the coast facilitated
Göteborgs Konsthall, cafés/bars, and a performance
stage for artists. It is now empty and waiting for a
new function.

Method

The method used for the Pixel Library is unorthodox and playful.

By combining conventional architectural design tools with the gaming world, the project is placed in a loop between the 3D modelling software Rhinoceros 3D and the game Minecraft. By using their different modeling perspectives, Rhinoceros 3D's overview and Minecraft's first-person, operations have been executed in the relevant software.

The existing building was imported into the 3D modelling software where the initial design for the virtual was made. The form was then exported to Tinkercad, Autodesk's online software for 3D printing, where it was converted to a Minecraft schematic-file to be able to be imported into the game. To be places in the game world, it had to be imported with help of an editor, McEdit, where it was be placed on selected coordinates. In Minecraft, the monolith was carved to form spaces of the library in first person perspective in both virtual reality and on a screen. The monolith was then exported back into the 3D modelling software to complete the loop.

Due to the speculative nature of the project, a narrative was used as a tool for both the development of the mixed reality experience but also to validate the design. As the narrative, and later the spaces, are influenced by the fourth industrial revolution historic and contemporary architecture, speculative architecture, and novels of fiction.

The two different parts of the method, the loop and the narrative, has been implemented to create a dialogue of how both the development of design tools and society might occur in the future.

Physical building

3D-modelling

conversion   2D-drawings

placement   Virtual reality

First-person modelling

Design proposal
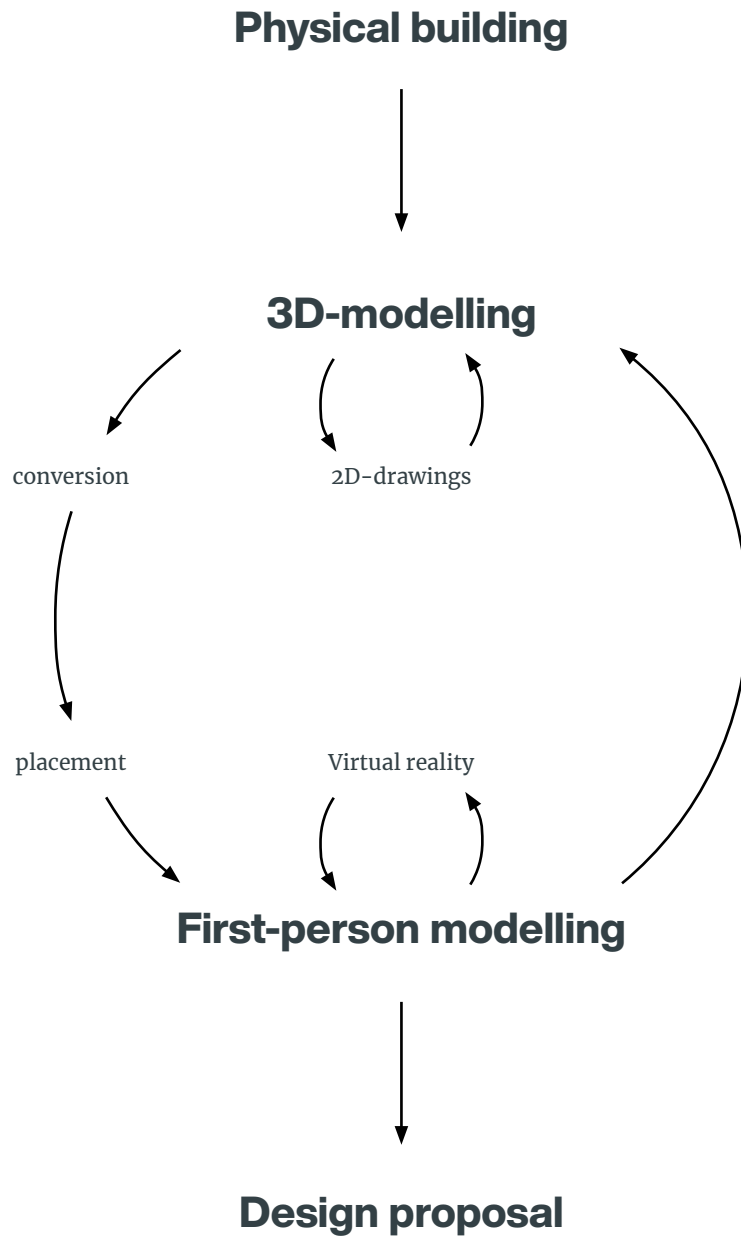
The initial part of design was developed in Rhinoceros 3D. A monolith was formed in relation to the physical building's attributes by using the overview perspective in the software. Size, openings, balconies, and slabs were taken into account. Suitable placements of carving and apertures were marked out to be continued in Minecraft. To make the process run more fluent, the monolith was voxelated to 1x1x1 meter blocks before it was exported.

As the game world of Minecraft is set on a 1x1x1 meter cartesian grid, blocks build up terrain and inheritable spaces. A block can only be placed adjacent to an already placed block, which creates a similar effect as gravity in the physical world. In the default game, players must first "mine", i.e. breaking placed blocks to gather materials, and placing them again wherever they want. However, for this project the creative mode has been used. The mode gives the player an unlimited amount of materials to use. The technique of "mining" works as carving to reveal voxelated spaces, an attribute that followed the project along. As the monolith was imported, the carving of the exterior was in relation

to the already pointed out placements from the 3D-modelling software.

The interior spaces were carved out by the usage of the first-person perspective on both the screen and in virtual reality. By using this perspective, the spaces were experienced while designed in the same way it would be experienced as building a physical structure. Scale, circulation, thresholds, and detailing were visible all the time.

As the narrative required the library to be transformed and moved when the visitor went from space to space, several buildings in Minecraft was connected with support of teleports. The teleports move the player from one coordinate to another by stepping on hidden pressure plates. This made it possible to both altering the scenery without giving anything away before entering the space and having virtual spaces overlap.

In the continuation of the loop, rhinoceros 3D was used to evaluate the relationship between the physical and virtual entities. Being able to guide the carving and relationship between spaces before proceeding into the first-person perspective once again.

In an addition to the game of Minecraft, several plugins have been developed by its players. The plugins that are called "mods" gives the game different attributes and options that does not exist in the regular form of the game. The mods the project mainly has been used are following:

Architecture Craft
Enables the player to customize blocks into a few different geometric forms that follows the default grid. Examples of forms are classical pillars, rounded vaults, and railings.

Carpenter's Block
Enables certain block's default materiality to be changed.

Chisel and Bits
Enables smaller sized blocks, especially in fractions from 1/2 to 1/16 of a meter, to be used inside the game.

McEdit Mod
Enables copy and pasting masses on specified coordinates, changing of original blocks materiality, and adding and subtracting blocks from specified areas.

Design Proposal

Welcome to the Open Seminar

Pixel Library

The Pixel Library resides in an evergreen vegetation that shows no signs of decay. Exotic flowers, animals, and enormous trees that seems not been there yesterday. Placed with a careful precision that feels unnatural.

The city is as busy as usual on the other side of the river, not noisy or disturbing but rather full of life. As the city has transformed from being the static physical cityscape with bulky and loud vehicles to become an interacting and dynamic environment that fulfills the dreams of its inhabitants.

The facade of the large monolith feels cold and rigid to the touch, like solid stone blocks. The large stacked blocks inflict calmness of order and continuation for the visitor. As the carving takes place with exemption of the carved middle spaces between them that are giving an attribute of decay and disorder. As the carvings reaching the ground the entrance to the library reveals itself, welcoming the visitor inside.
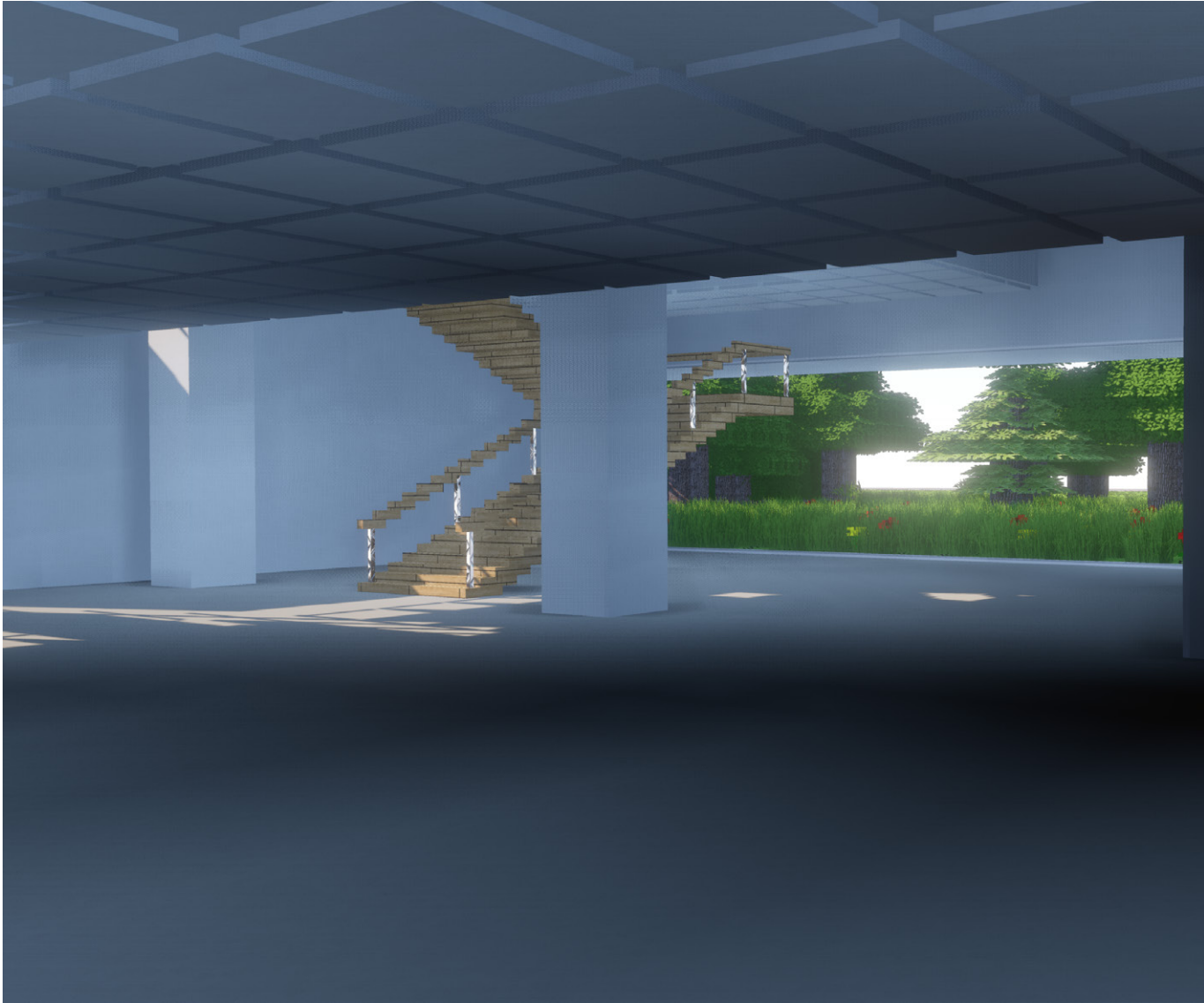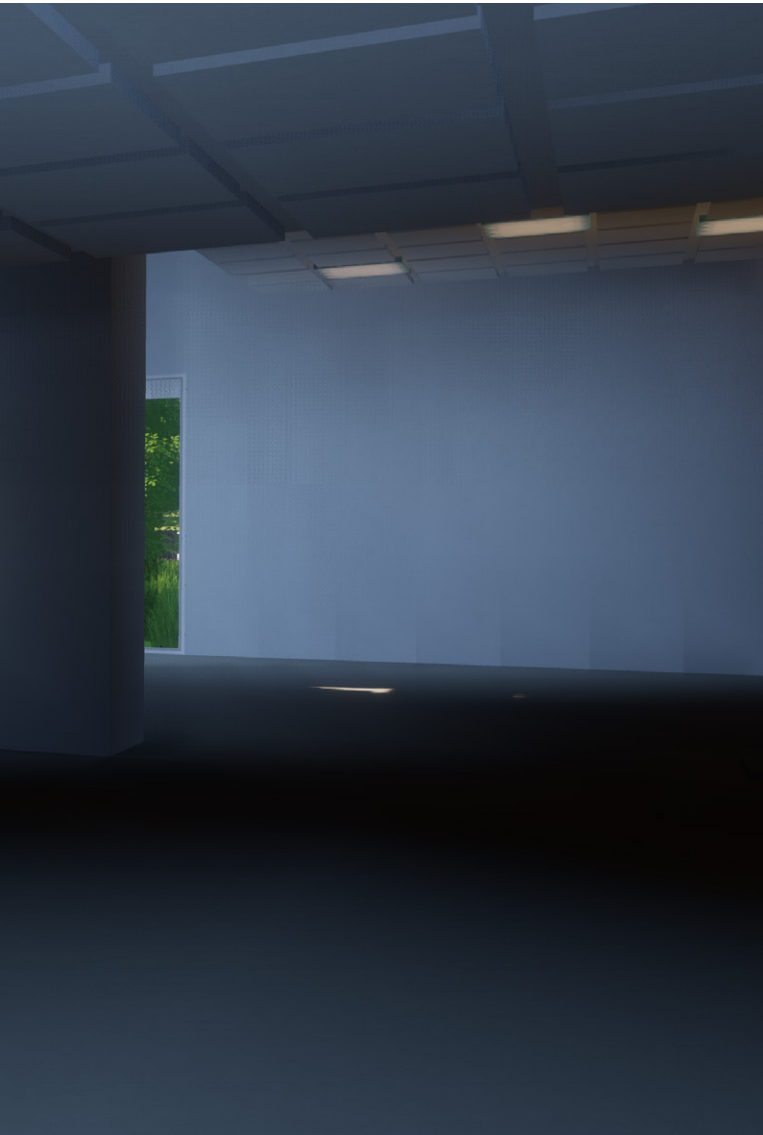
1.
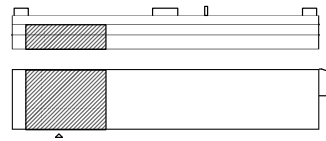
Entering the Pixel Library the visitor faces a commonly known library layout with a skeuomorph method of retrieving information. Books are placed on shelves and tables placed for meetings and studies. Retrieving, reading, and meeting is occurring in the same manner as the 20th century.

An atrium exposes the upstairs for the user, where the most of the room's functions are placed. A wooden stair is bringing the visitor to the second floor.

The exterior's carving has been replaced with transparent glazed aperture, letting the outside to be part of the inside that enriches the space with light and view of the outside.

Mixed reality
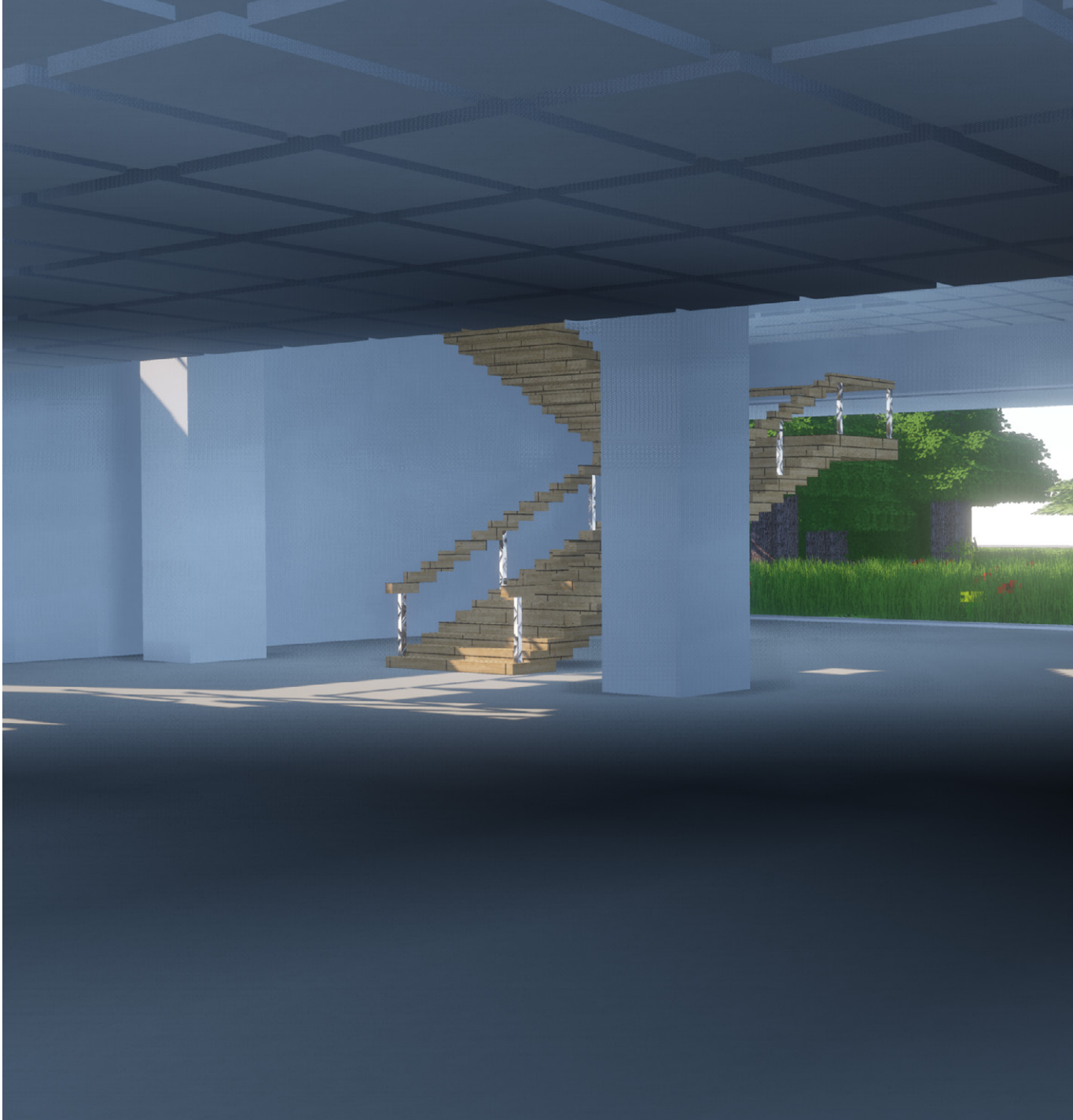
Existing building
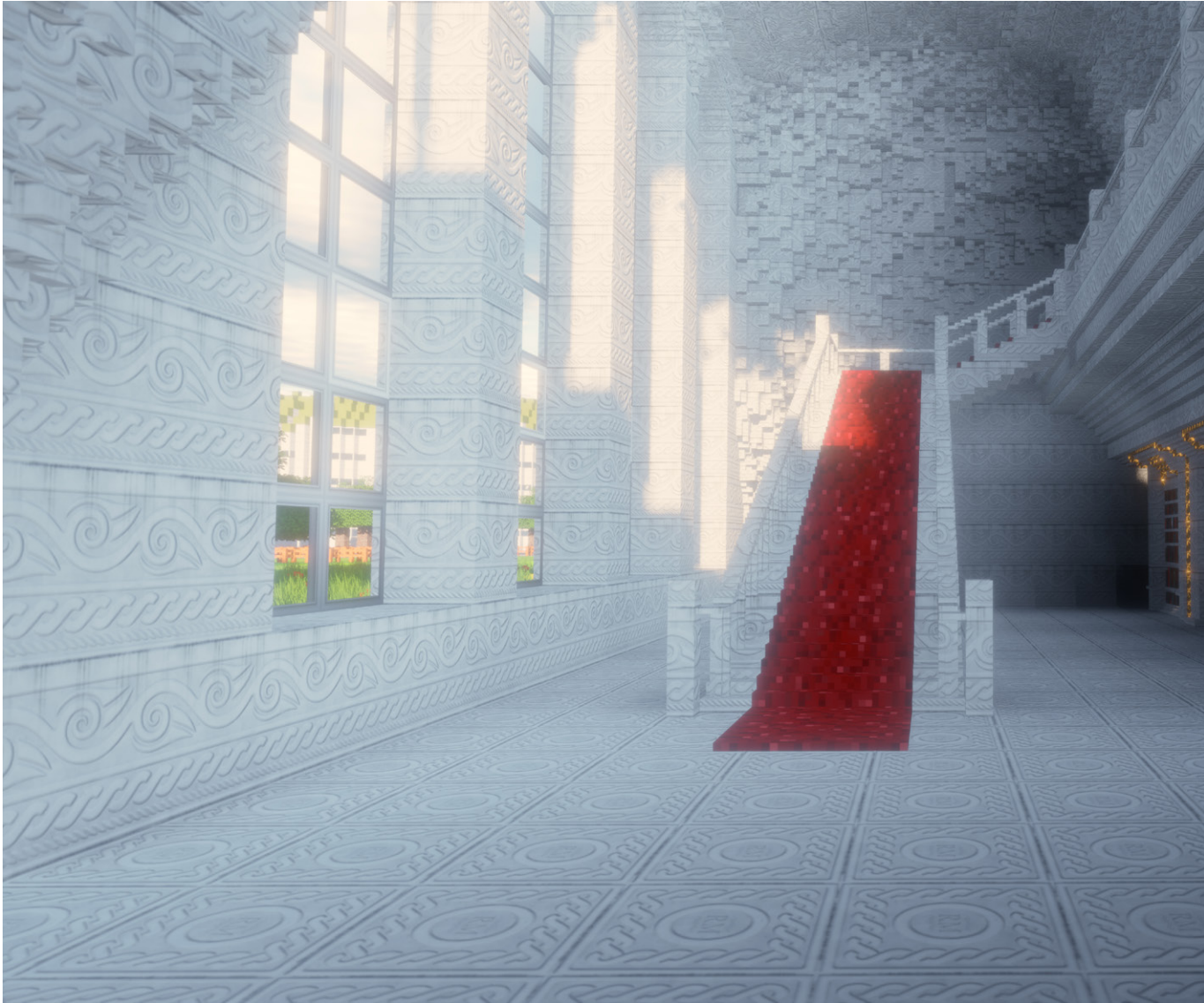
2.
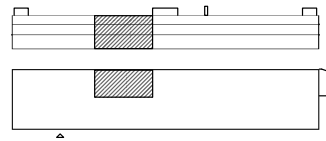
Proceeding further in the library the user is experiencing a shift from being experienced as a common library of the 20th century to a historically carved out library hall. The high windows reaching towards the carved ceiling have no correspondence to the exterior, changing the understanding of the proposed interior/exterior relationship.

The large stone stair is bringing the user from the first floor up to the balconies of the gallery. With the ornamented bookshelves on the hall's side, the skeuomorph method of retrieving information proceeds.

Mixed reality
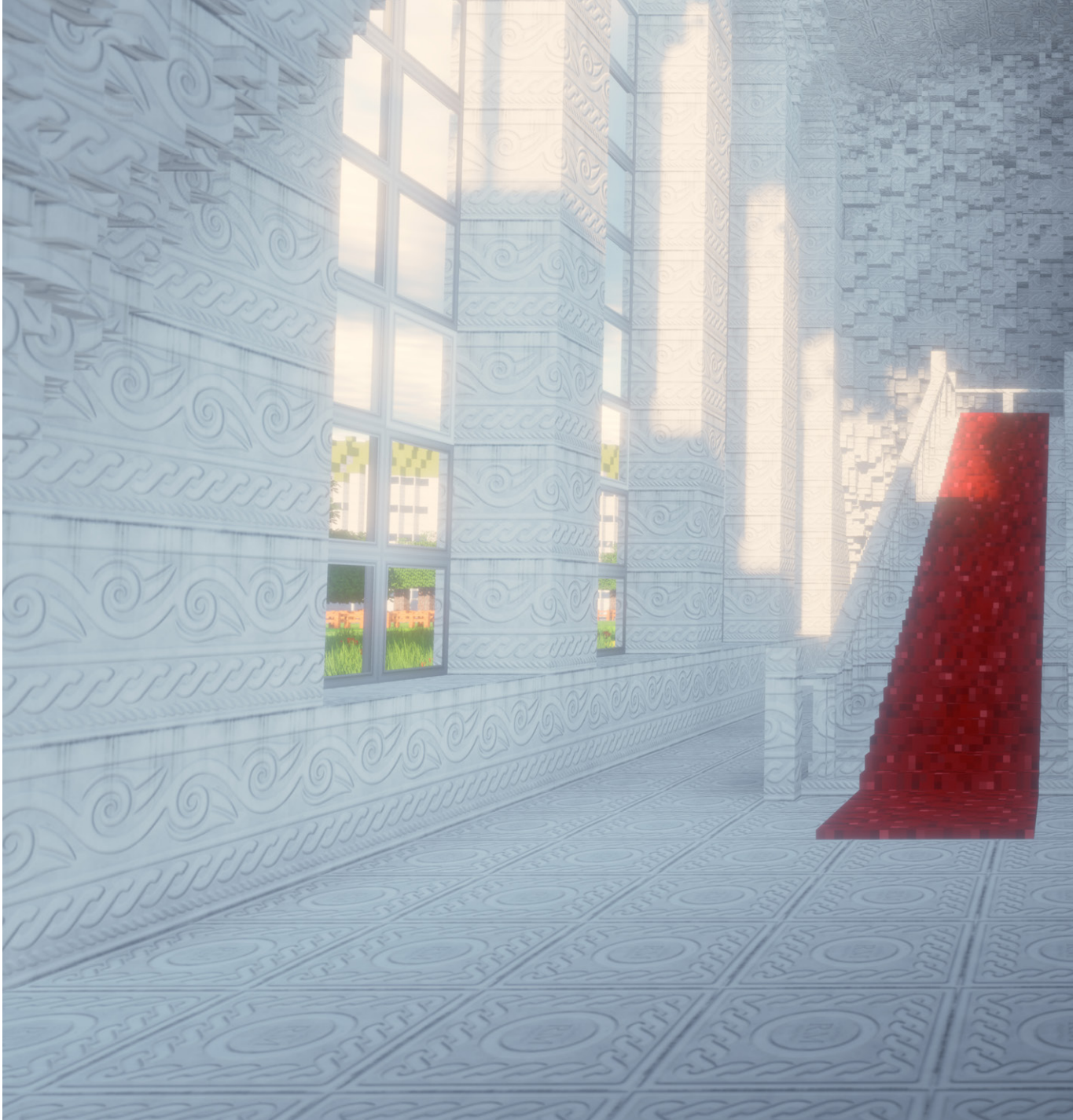
Existing building
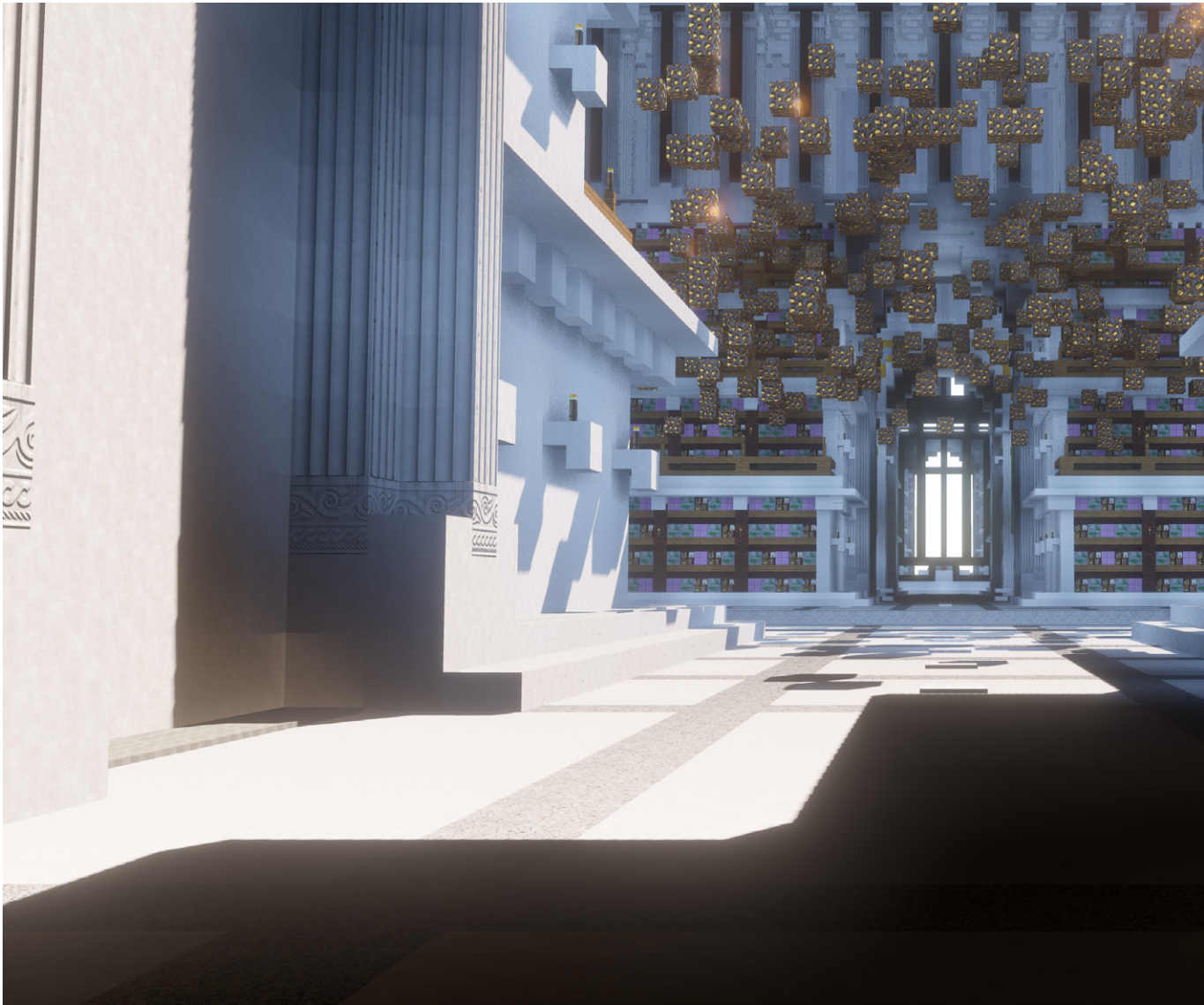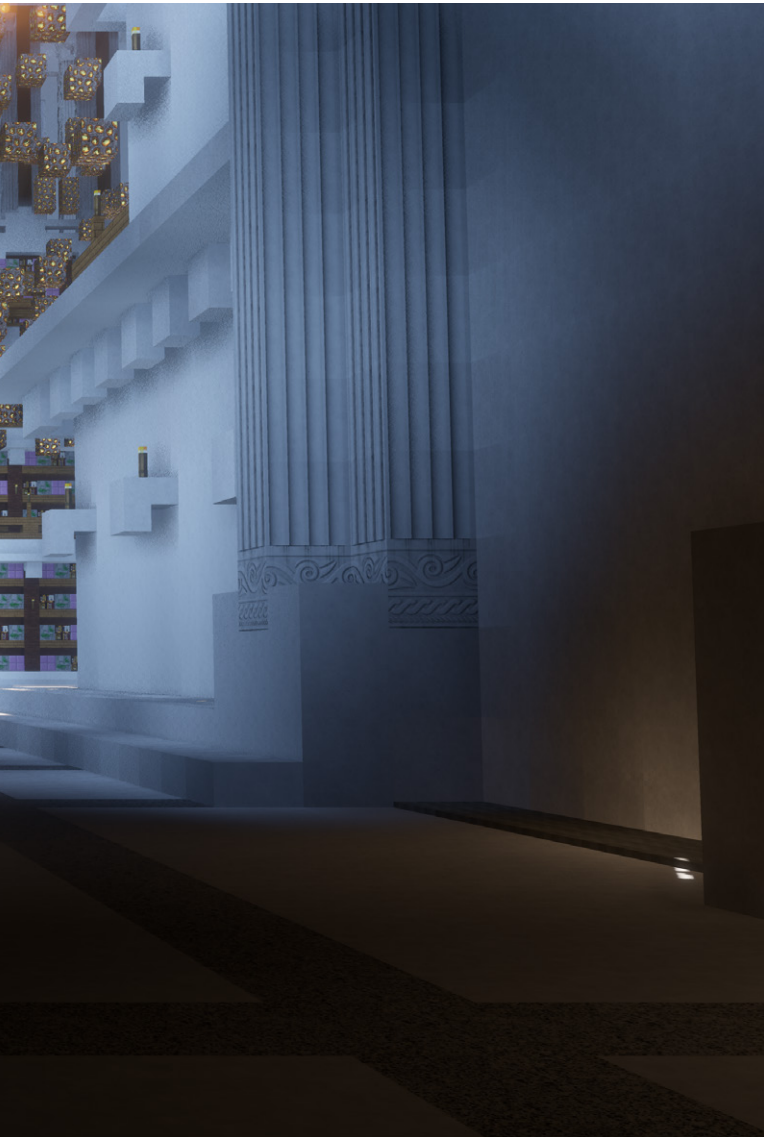
3.
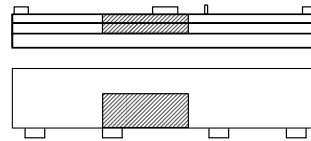
Continuing into the "The uncensored Library", the virtual library made by Journalists without borders. Information is hidden in a virtual gameworld to work around certain countries censorship to promote and service unbiased information and freedom of speech.

As the virtual environment is constrained in a physical space, the scale is set on a 1/10th ratio between the physical and virtual. The user experience movement ten times as much as it does in a regular physical space. The different scale gives the user the ability of using the whole virtual library on a smaller area.

Mixed reality
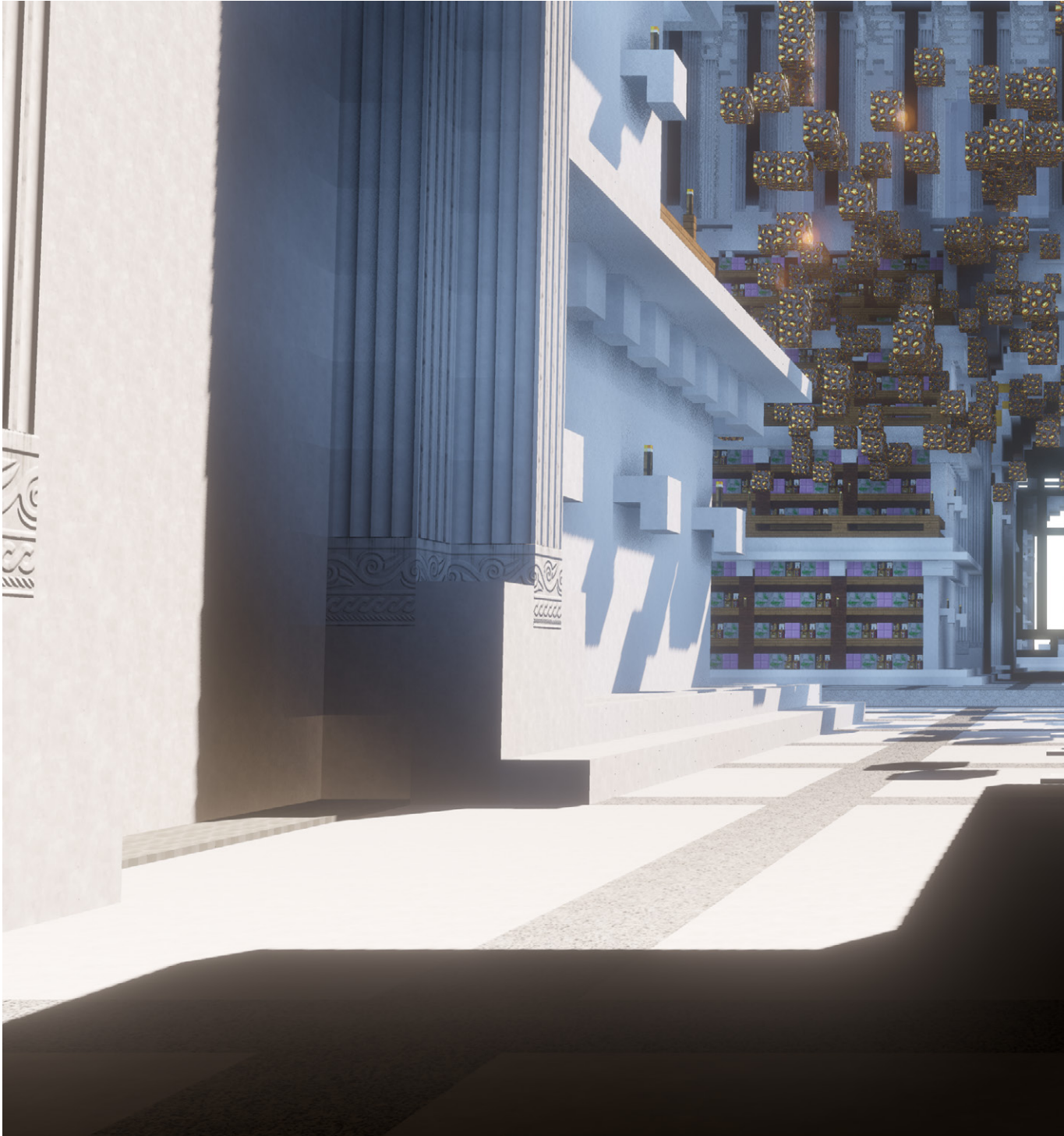
Existing building

4.
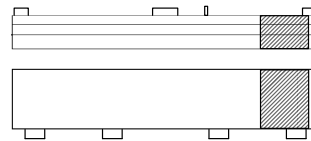
Entering the cave, a hidout inside the building that creates space for recreation, studies, and meetings, which inflicts calmness and atmosphere that seems to be taken from a fairytale.

As the waterfall is falling down from the overarching clouds that forms the ceiling of the space, a little pond has found its purpose as a recreational sanctuary from the otherwise busy citylife.
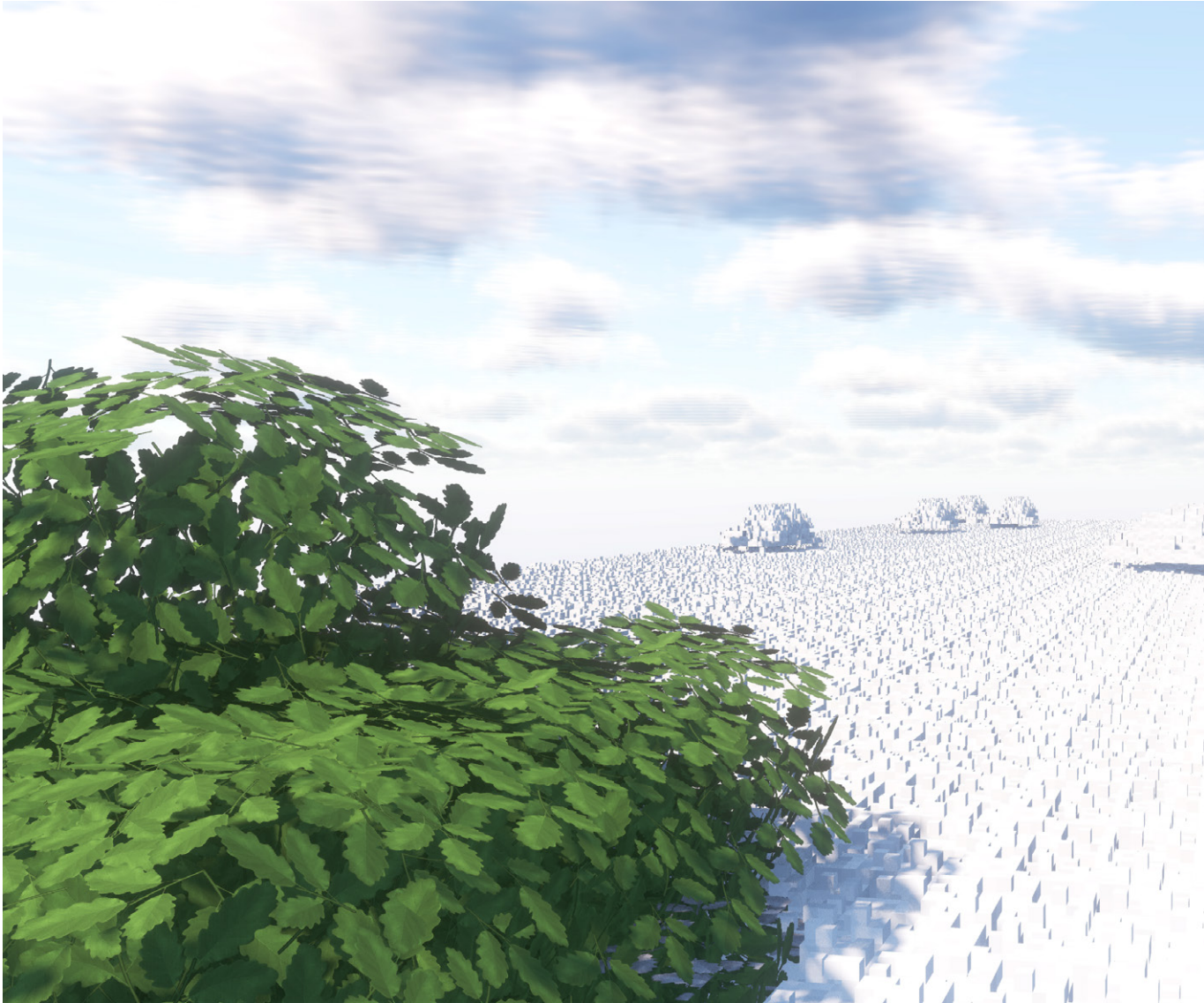
The cave has its usage in contemplation and meditation, being able to close of the rest of the world while still being able to interact with it.

The visitor begins to experience an unexpected reveal of unmatching materiality in certain spaces. The continous materiality is distureb by inflicted elements that seems to be out of place.
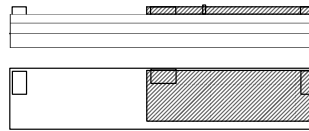
Mixed reality
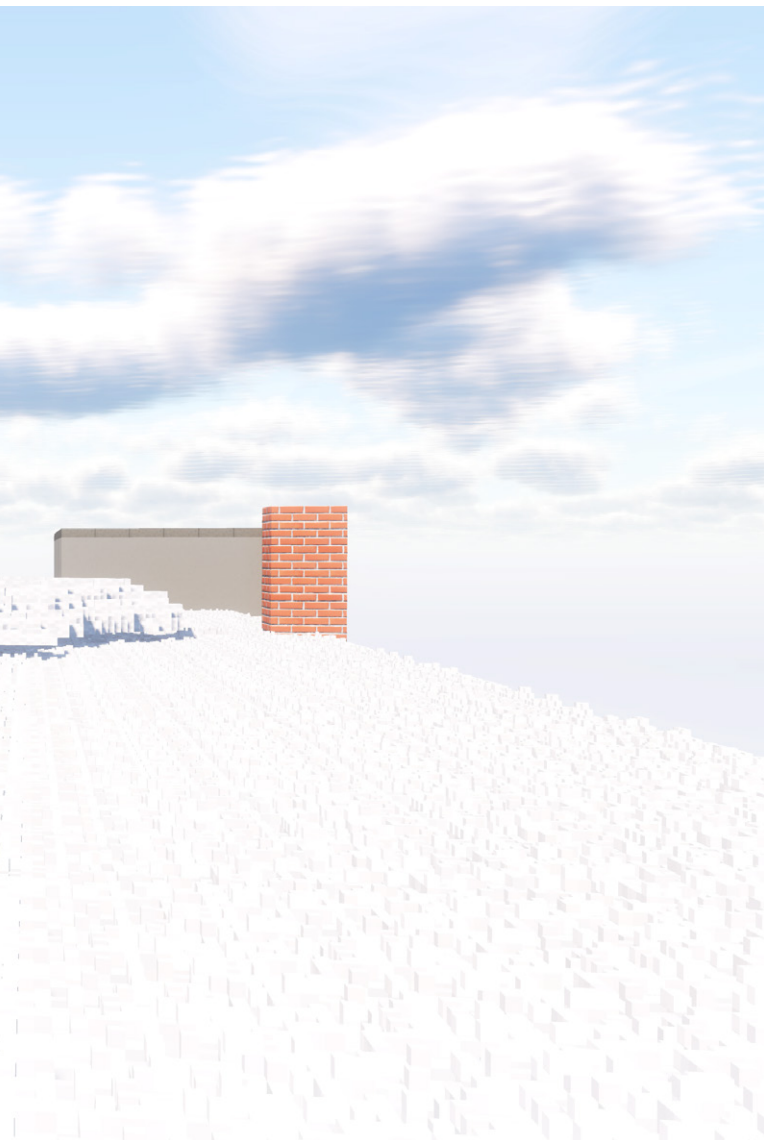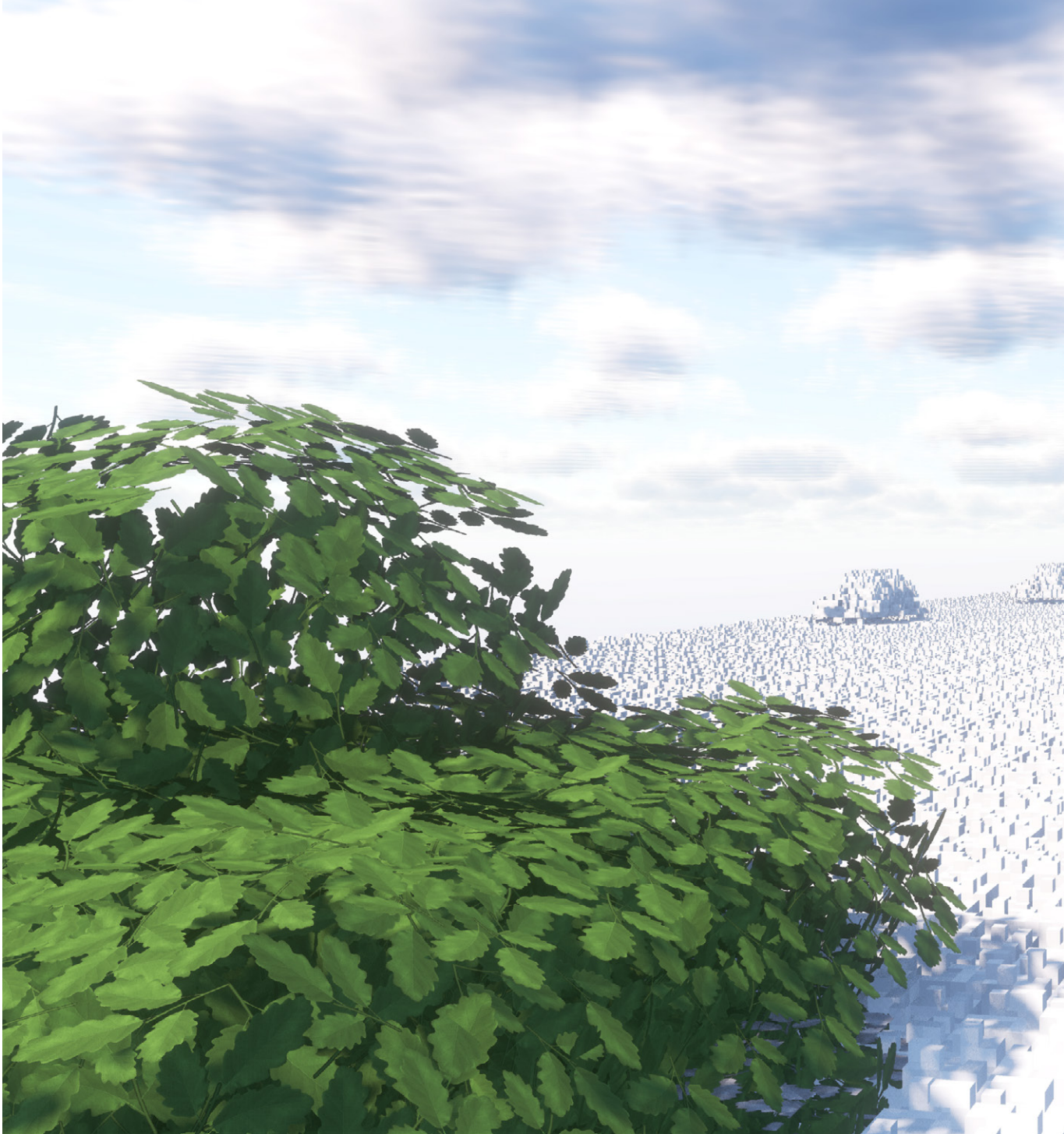
Existing building

5.

Reaching the clouds, the imminent feeling of the wind and curiosity of watching the city go by under a floating platform.
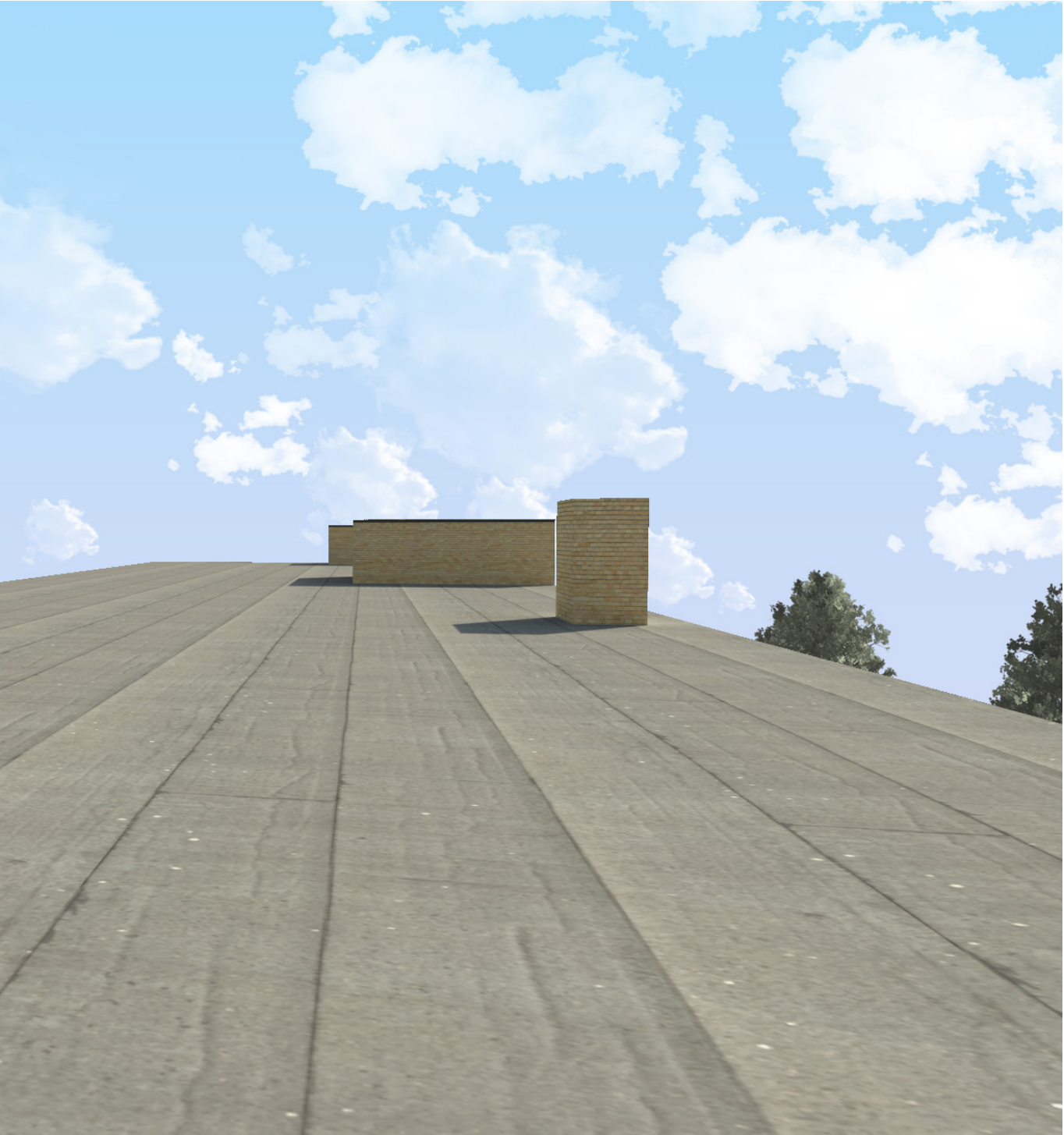
Still connected to the underlaying building with the tree's canopy penetrating the clouds.

The floating cloud-seating gives the impression of weightlessness and comfort, rather than hard benches on the ground.
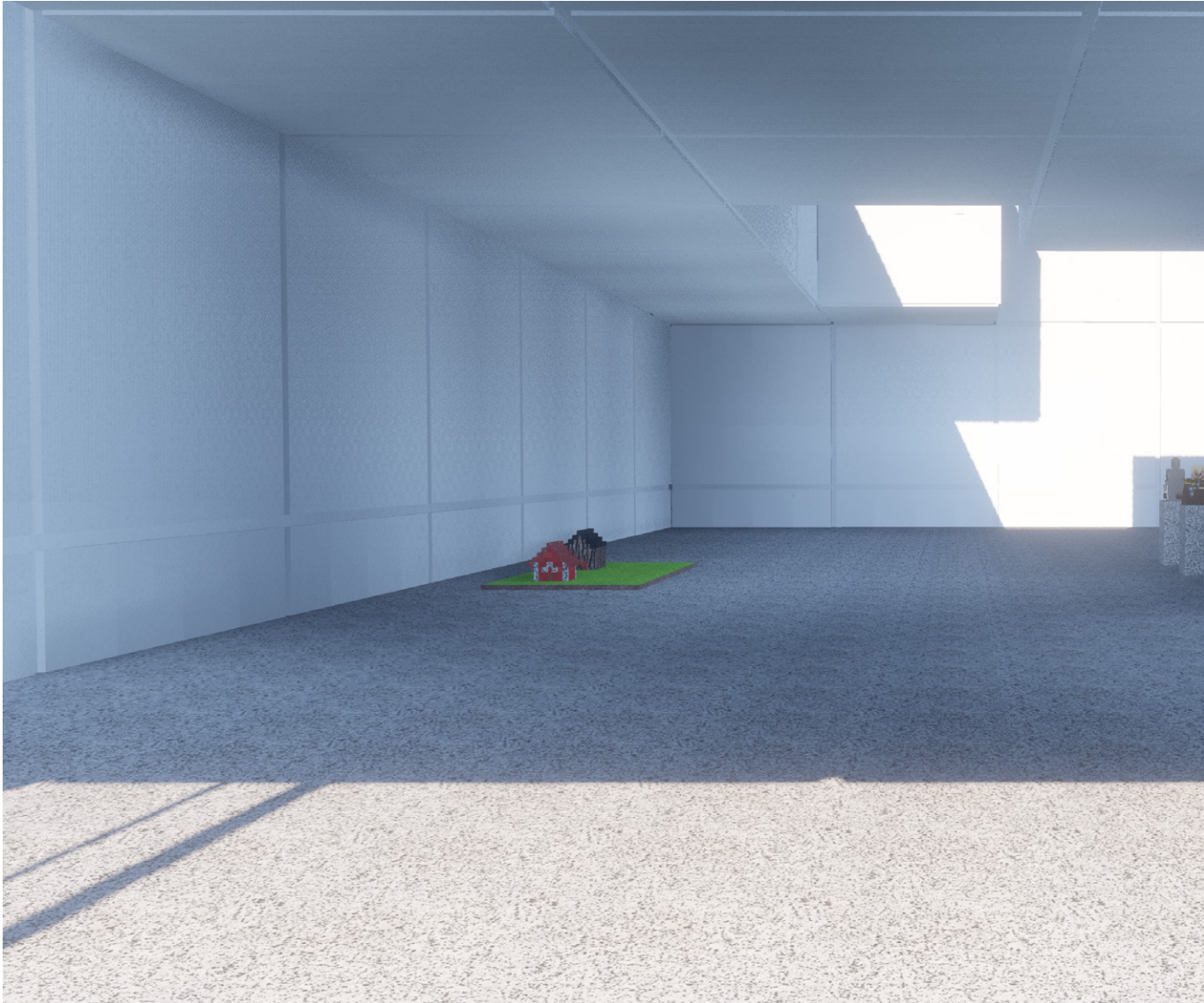
The continuation of disrupting elements are revealed; unexpected and emerging from underneath.
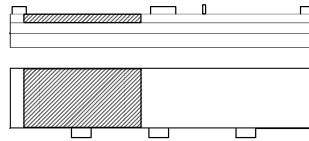
Mixed reality

Existing building

6.

Stepping down to the open gallery, the exterior blocks are stacked to create space for the creatives. The incorporation of physical and virtual craft gives the user the opportunity to use materials and tools that would be difficult to house in a public institution, both for security and economic reasons.

The gallery may be used as a platform to not only create but also expose the visitor to art and design from all over the world. The exhibitions can incorporate a mix of both virtual and physical objects that may be switched and altered at any time. The results from the workshops may be displayed to encourage others to create as well, to improve the knowledge of the mass.
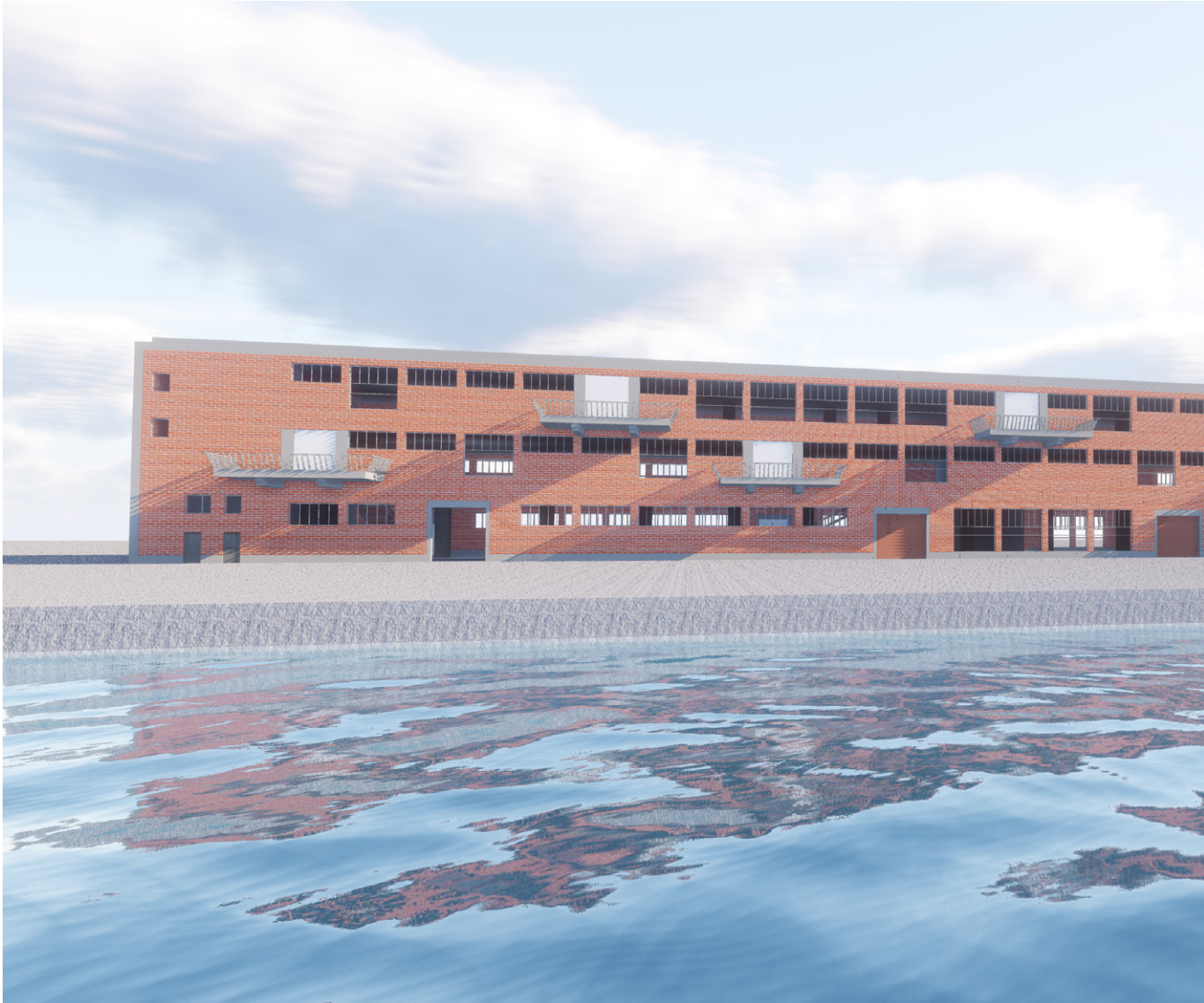
The warehouse has started to be more and more prominent in its relevance to the user, from being single elements to become slab, ceiling, and stairs.
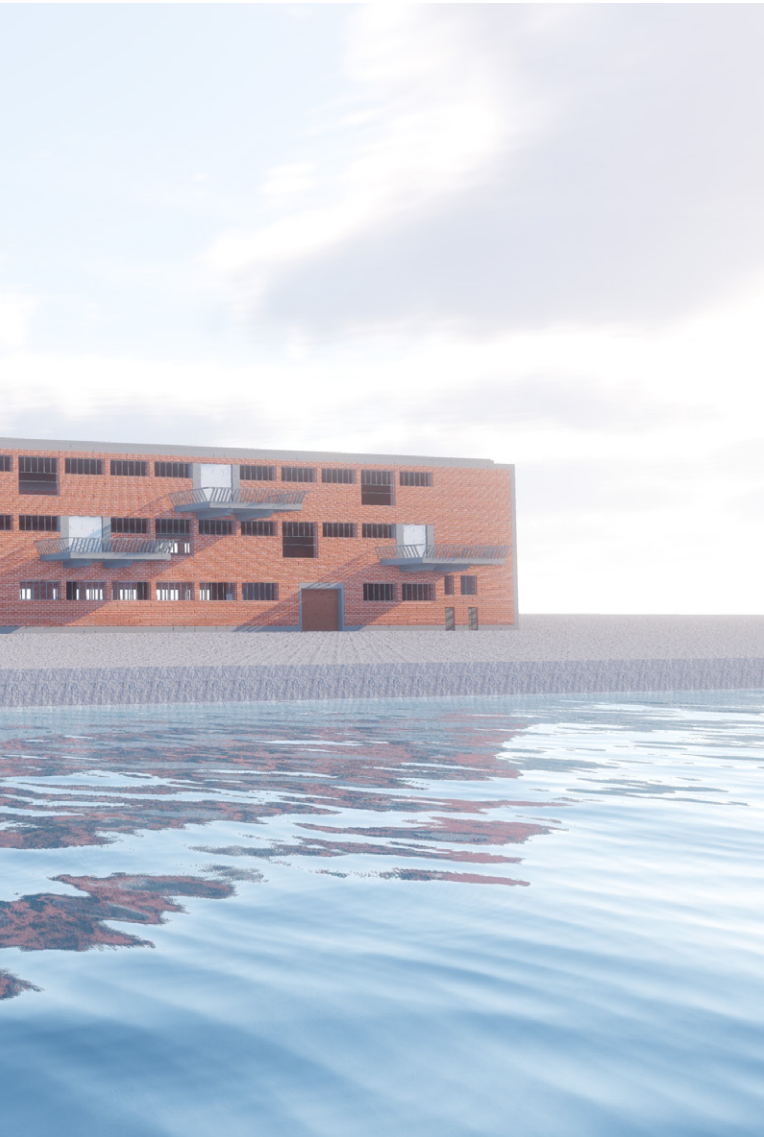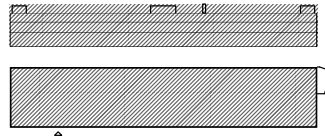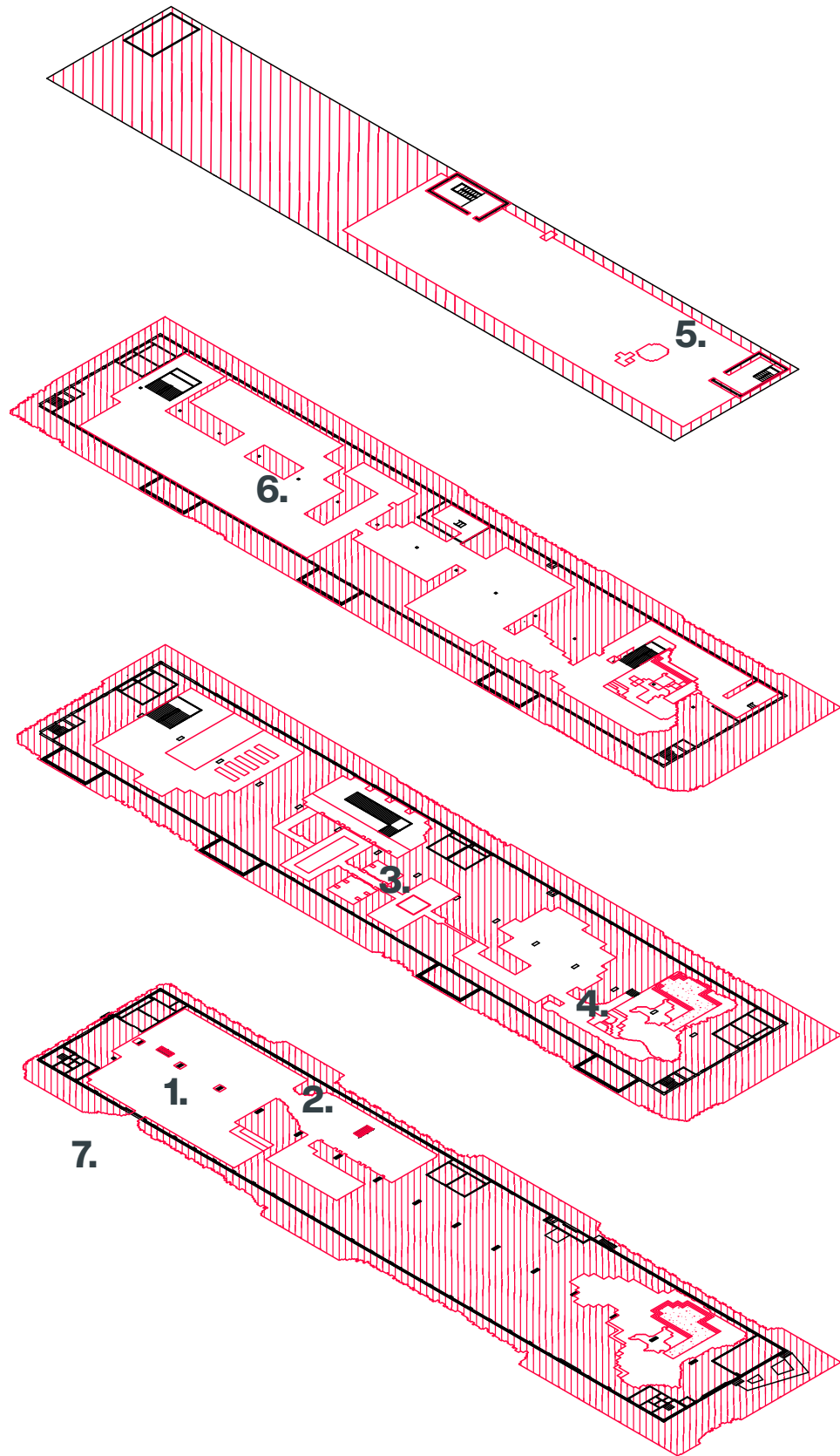
Existing building

Mixed reality
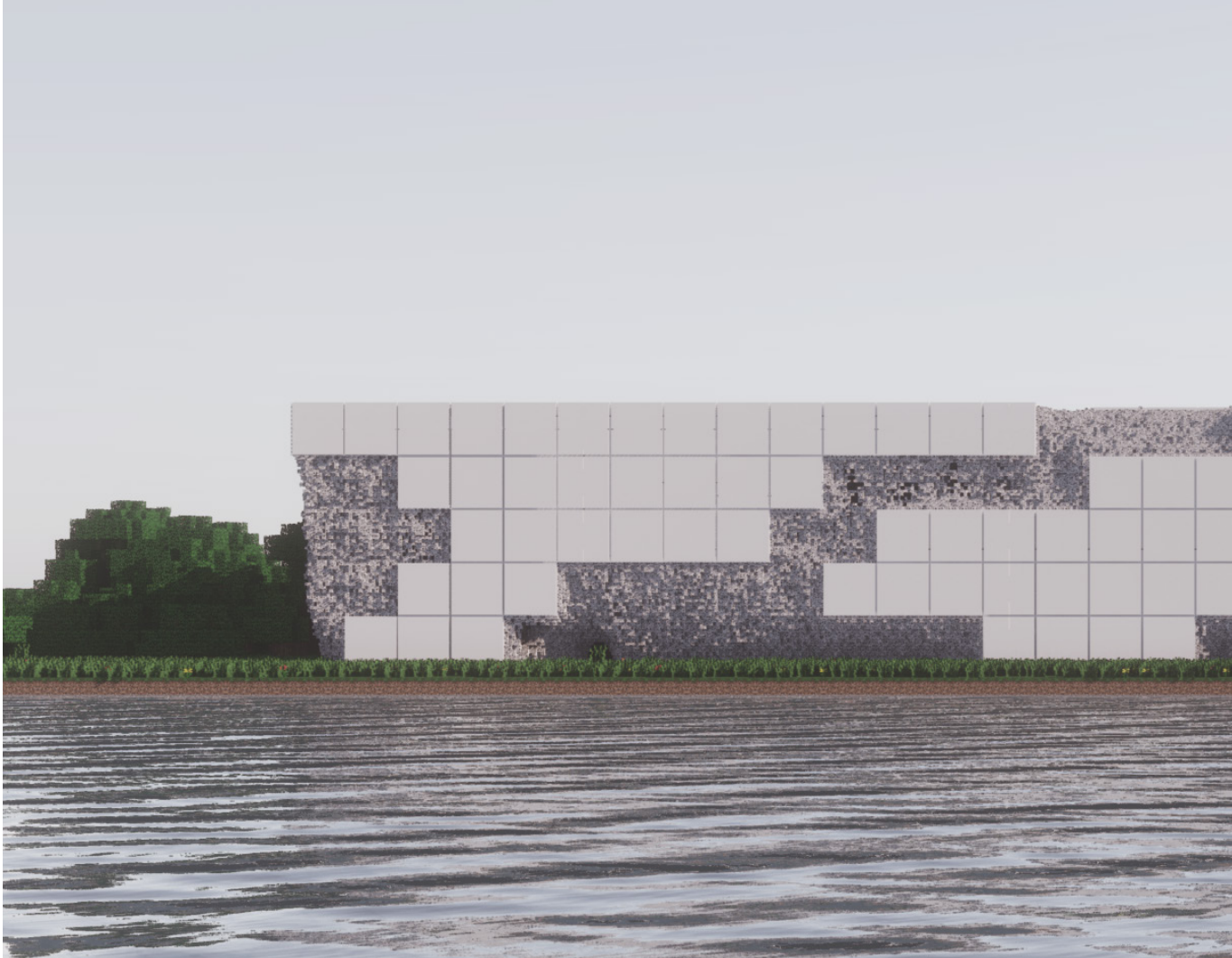
7.

While leaving through the entrance, Magasin 113 has fully revealed itself. There is no more expensive materiality, the functions are gone, and the surrounding environment has shifted from the greenery to a flatland of asphalt.

Pixel Library has turned back to become the solely physical warehouse it has been all along.

5.

6.

3.

4.

1.

2.

7.

West facade
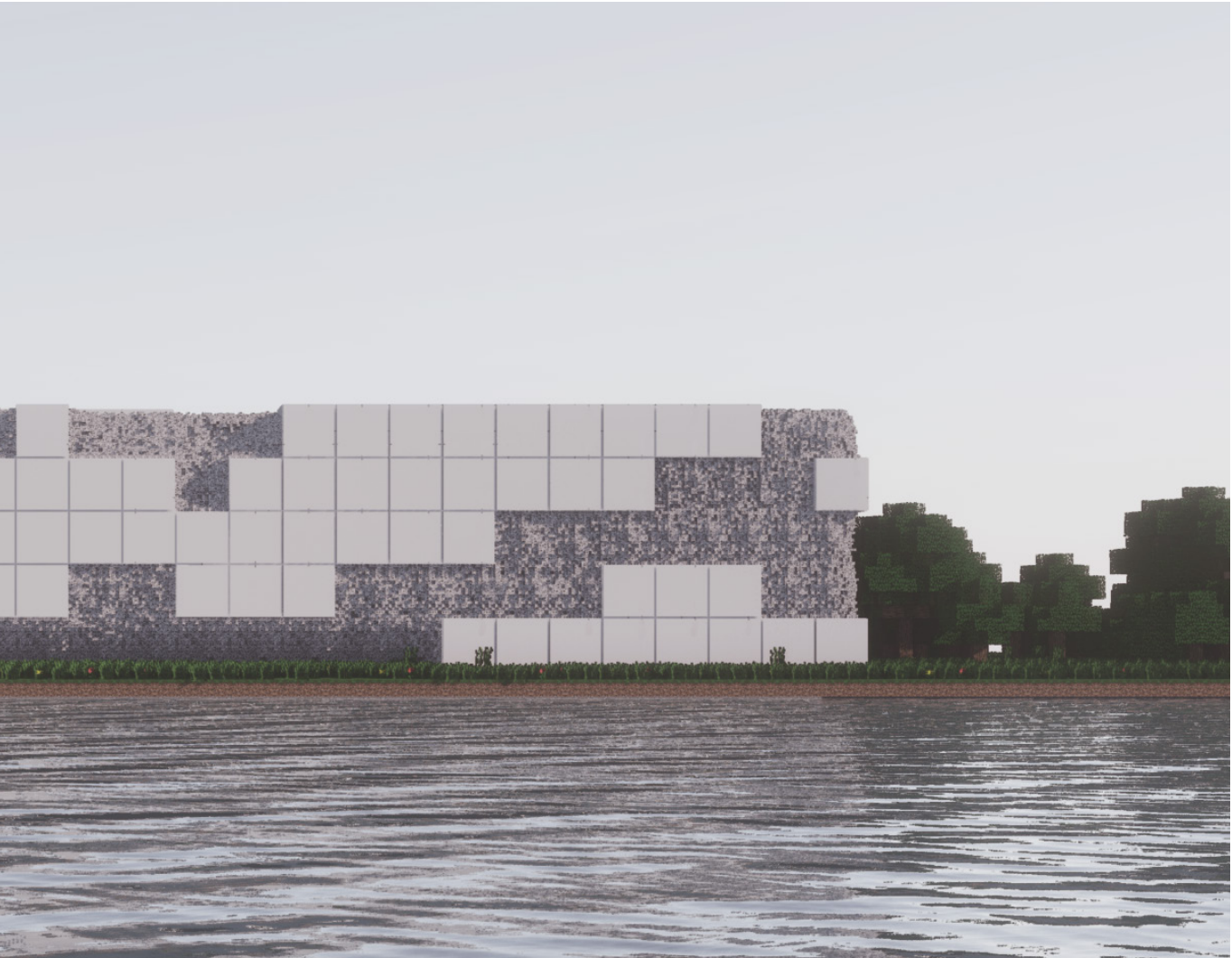
Perspective section

North Elevation – scale 1:400

Floor 01 – scale 1:600 ⏱

Floor 02 – scale 1:600 ◷

Floor 03 – scale 1:600 ☉

Roof – scale 1:600 ⏱

Design development
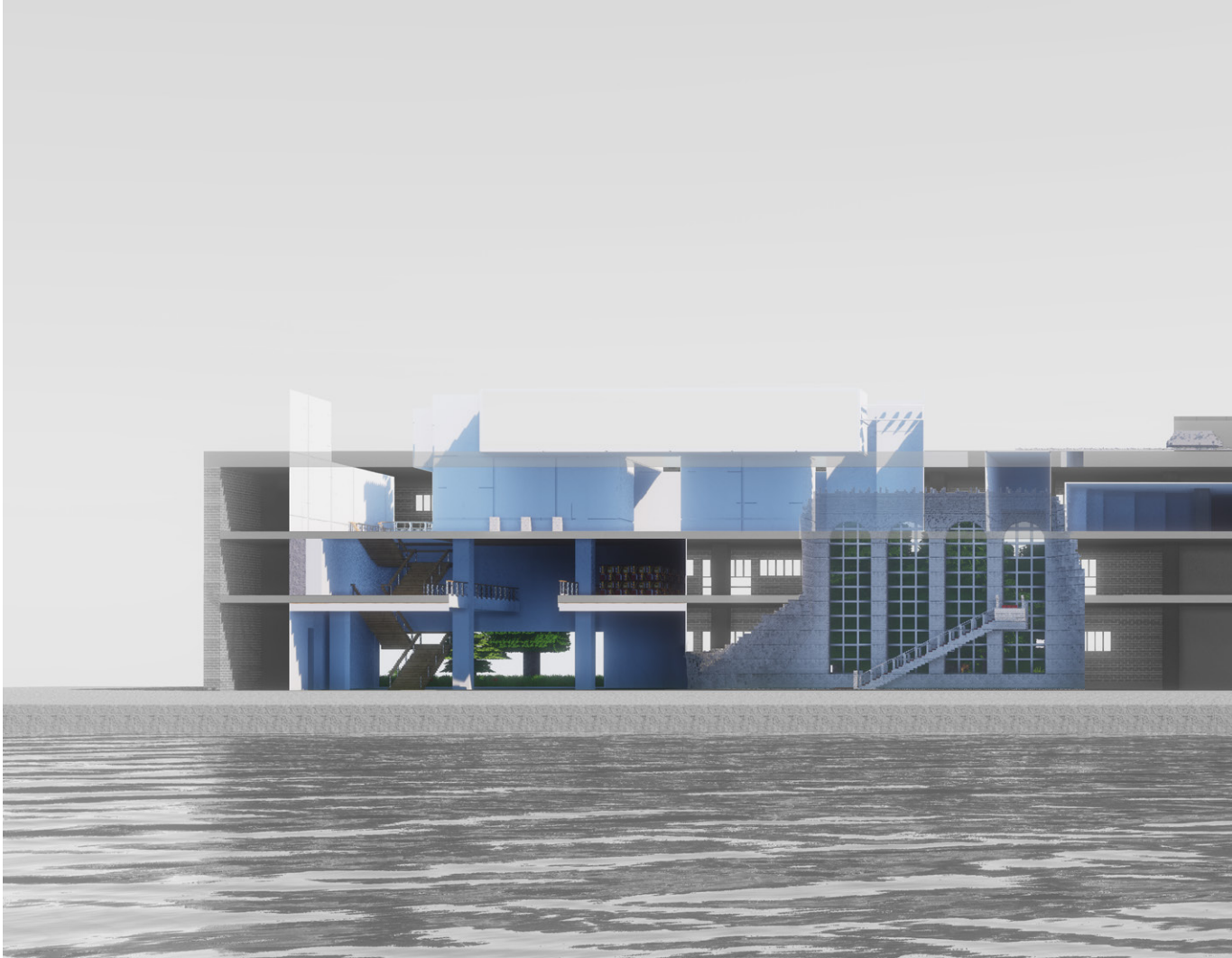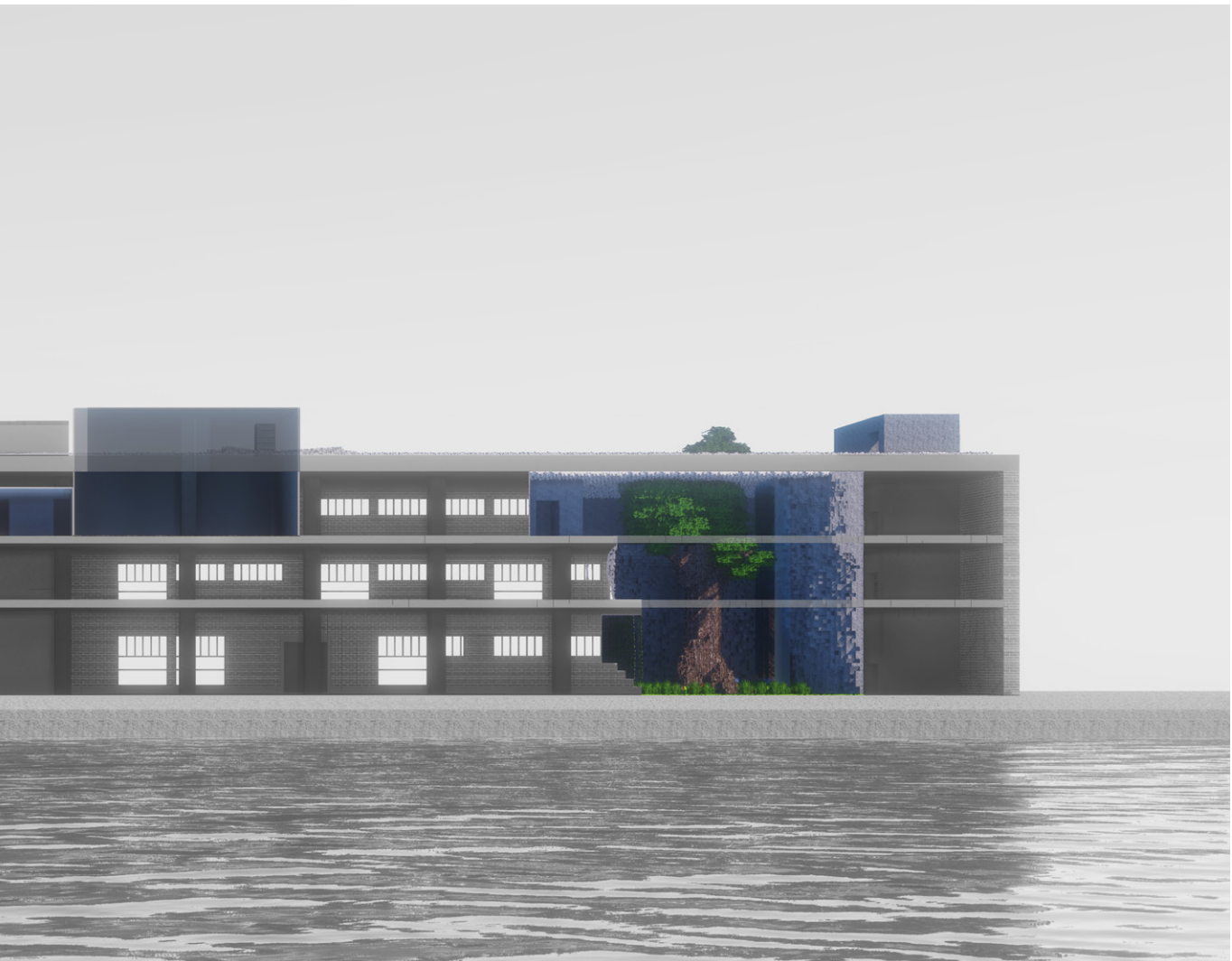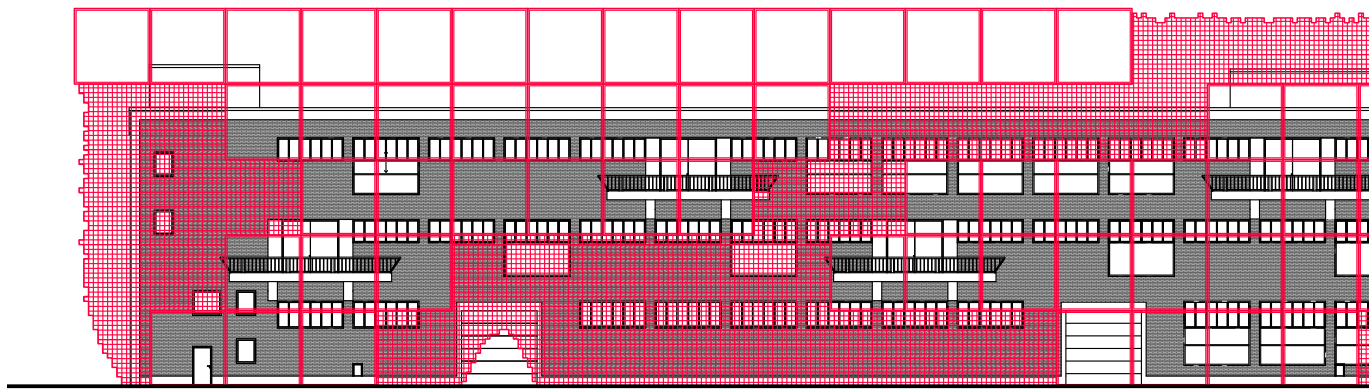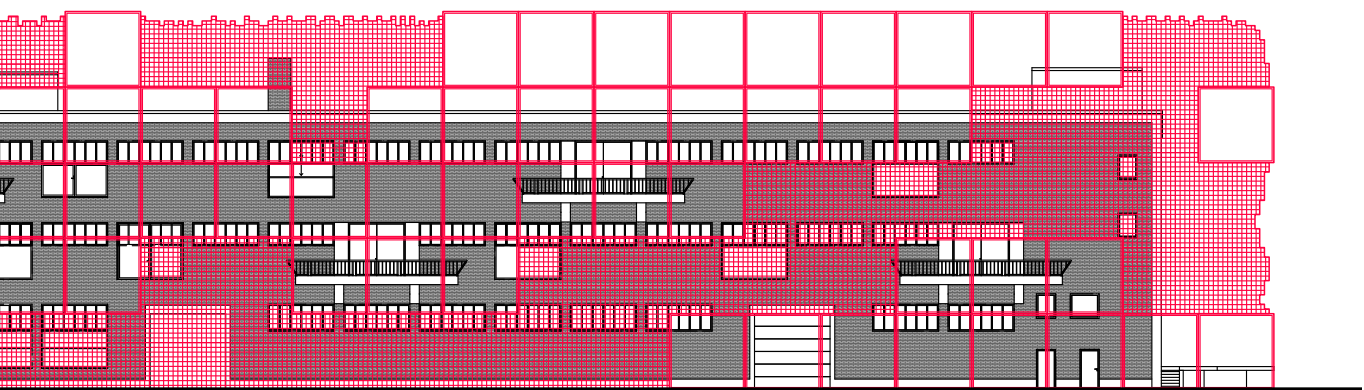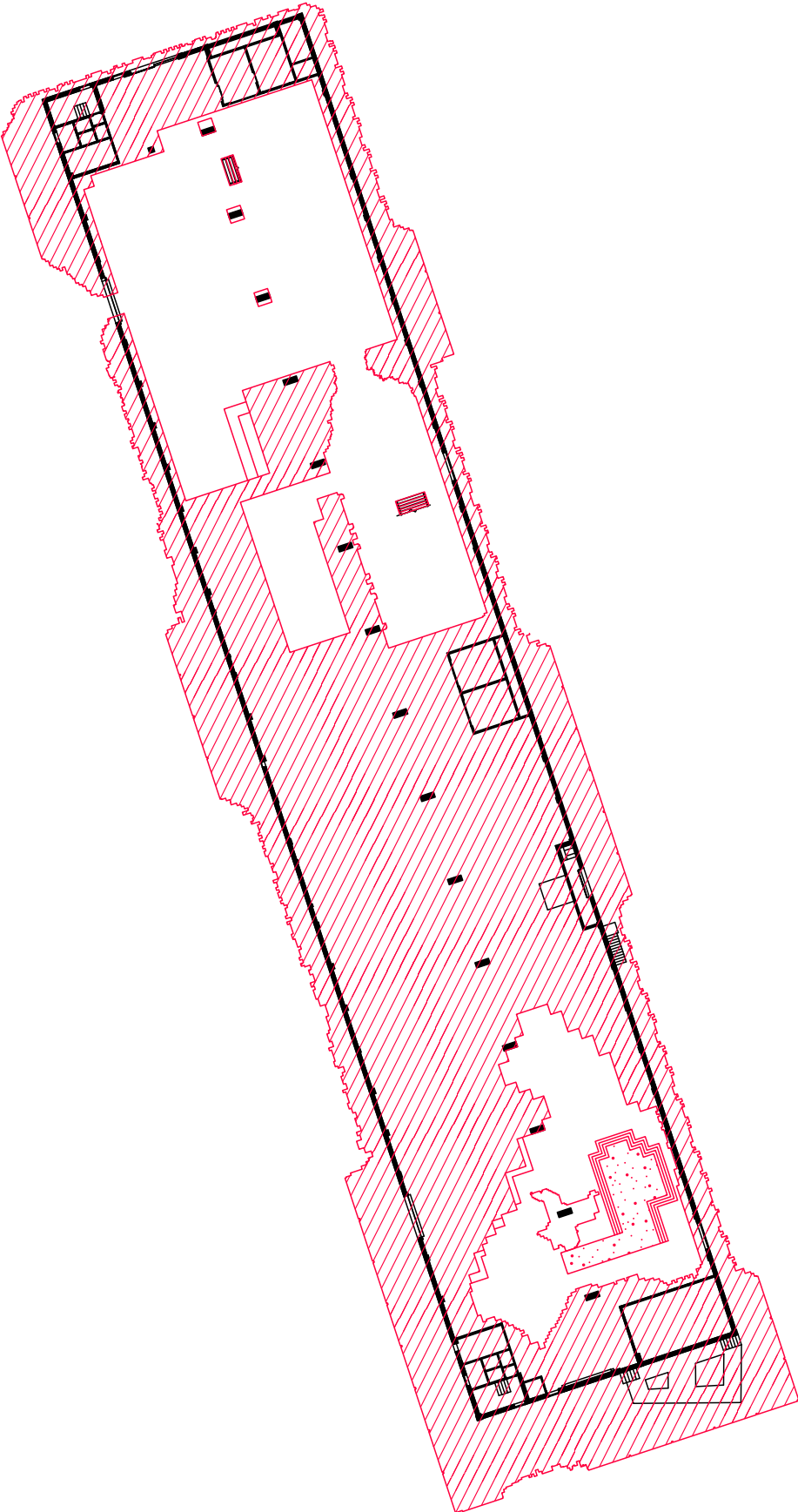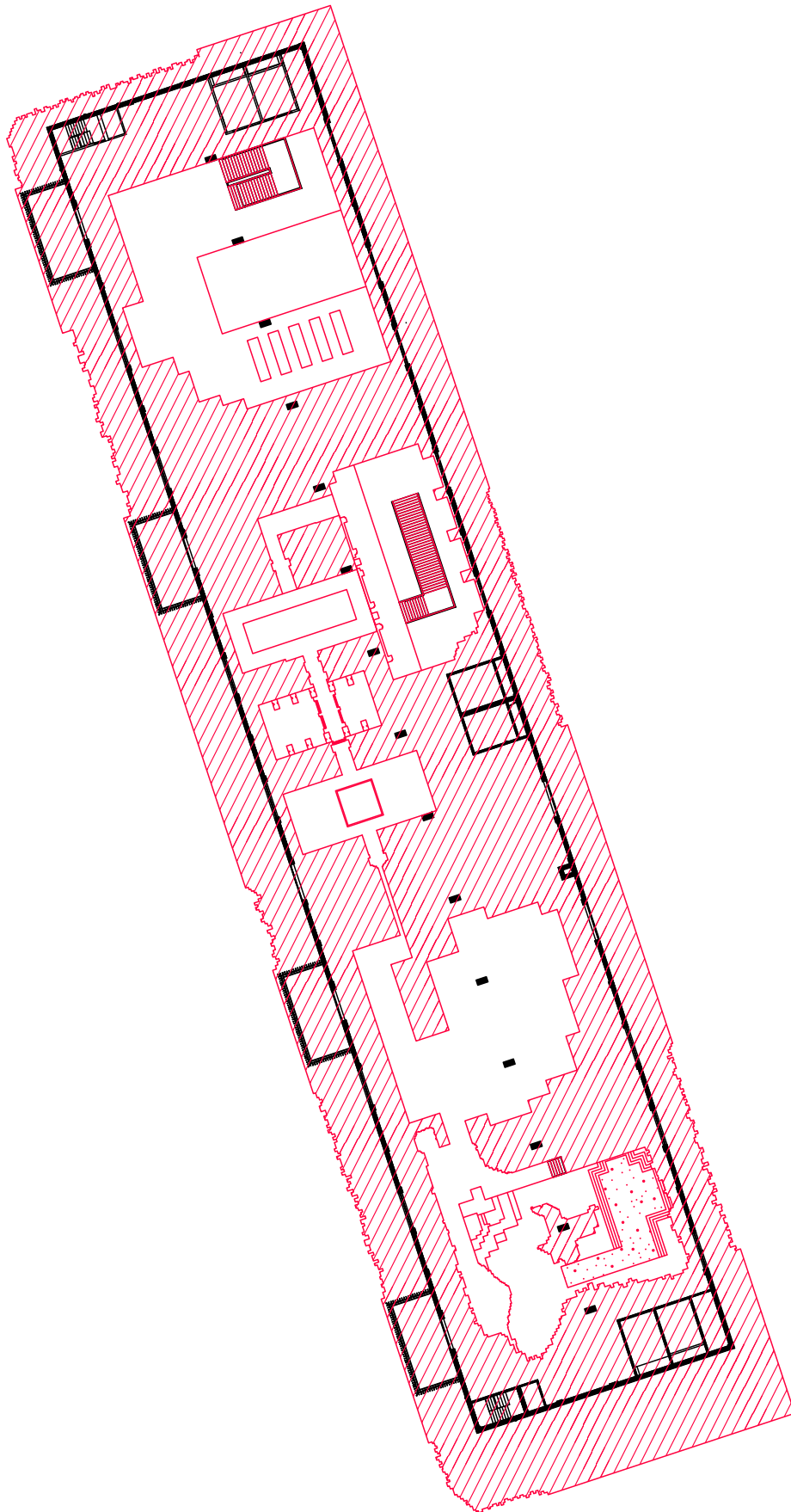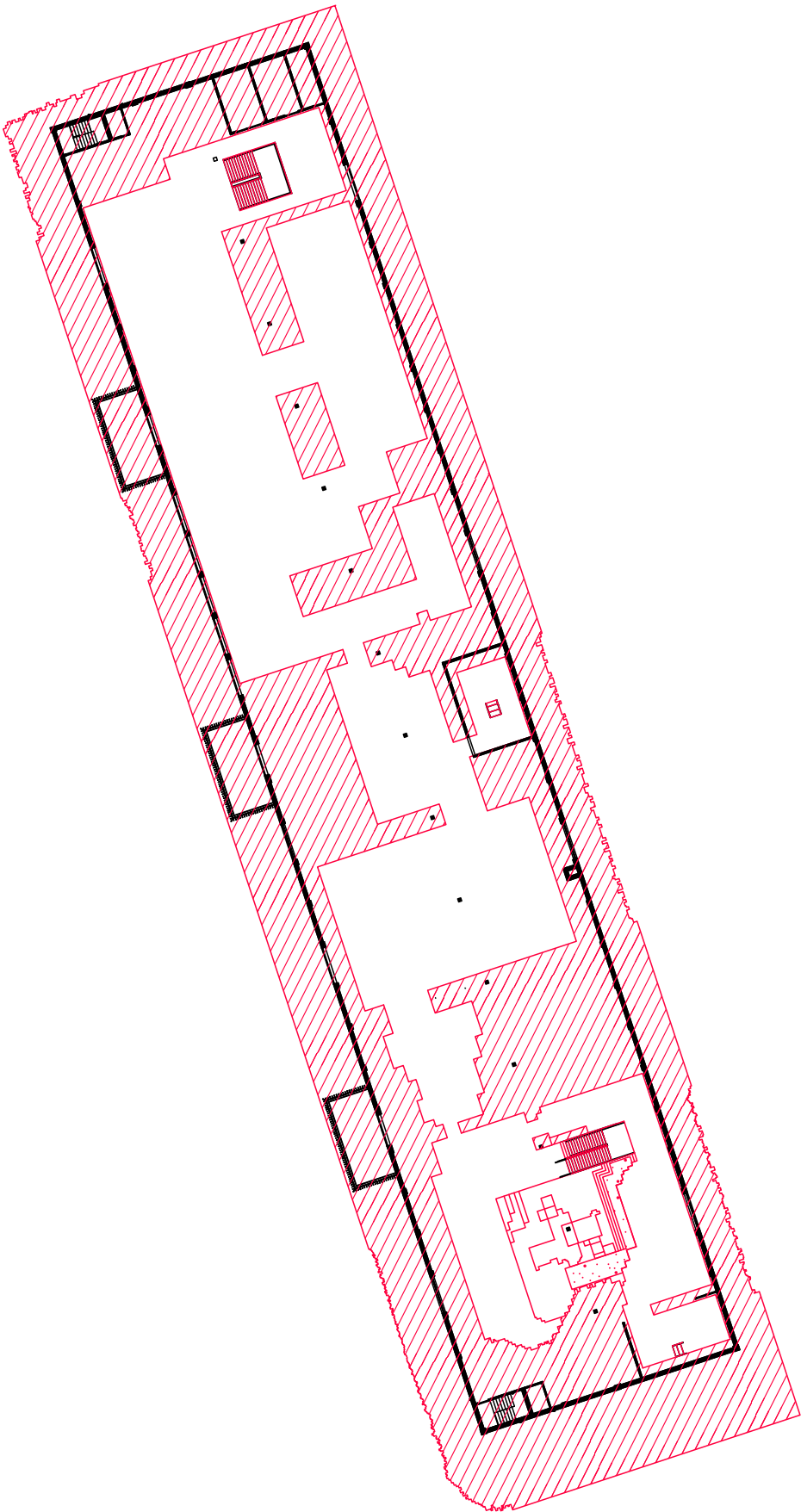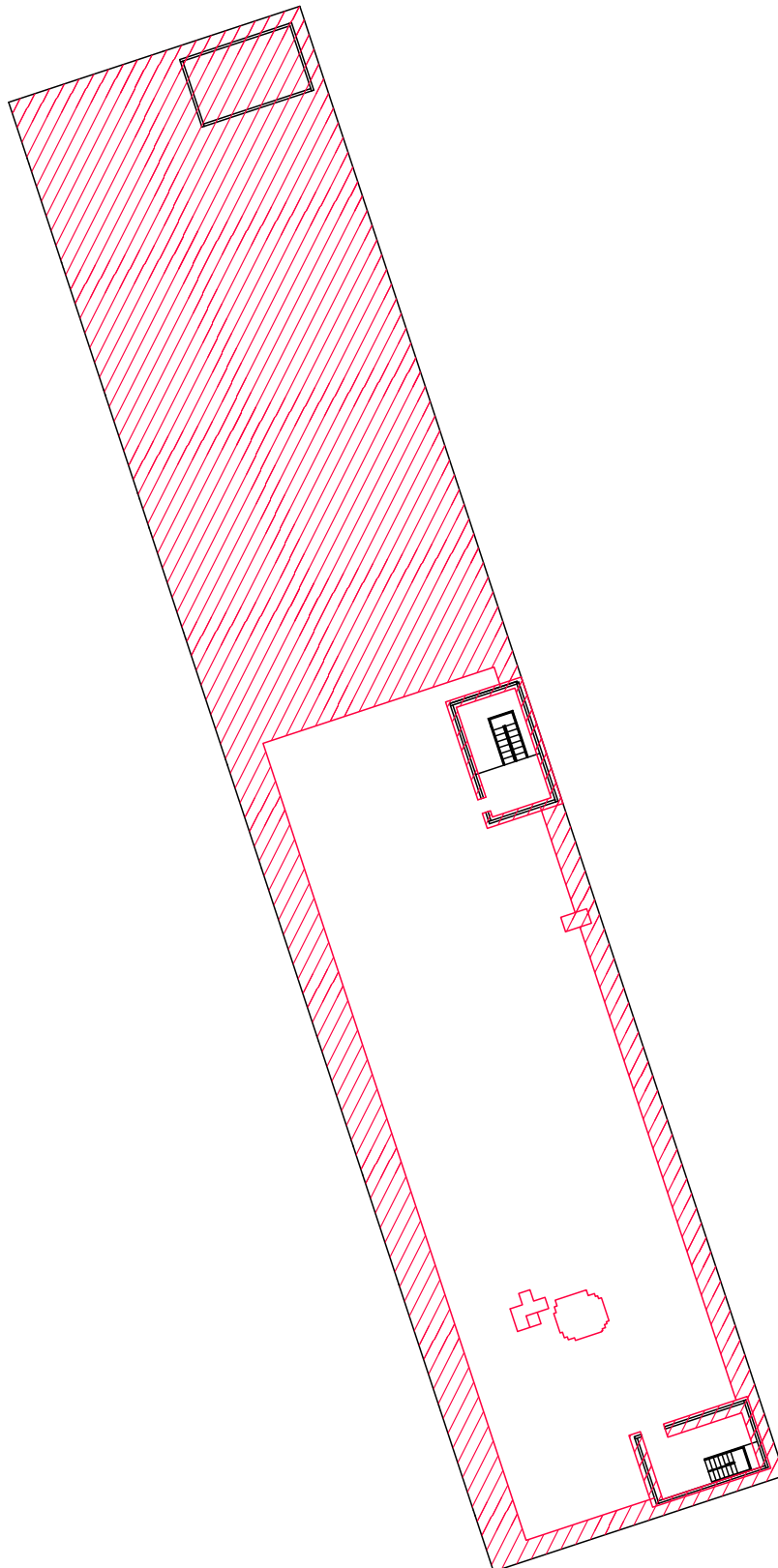
As the progress of the thesis has proceed, different iterations of the design have mainly been made during four different phases.

Phase 1:
The first iteration was focusing on the development of the method's workflow, limitations, and contextual utilization. The main aspect of the design was Voxelization and Carving. Using the grid of Minecraft, 1x1x1 meter, and the site's inherited properties as a driver for the design. The process in the 3D-modelling software was more of the overviewing, the larger chunks of blocks that was placed and carved. In the first-person perspective in VR had scale, thresholds, and interactions more of a prominent part of the design.

Phase 2:
The second phase emphasized on the difference between the physical and virtual buildings. The monolith was divided into two different entities, the physical was a modular building with large atriums with open circulation while the virtual was a white canvas where the population could alter its appearance. In this phase the narrative began to have a larger part to play in the development of the project.

Phase 3:
The third iteration found itself in the hyperreal, the combination of the physical and virtual that is undistinguished. The narrative progressed to be more about the experience of the environments than previous iteration. In the merged spaces, functions were designed to alter our perception of what a library is, has been and will develop into. From large ornamented galleries to the relaxing properties of nature, the library

Phase 4:
In the fourth phase, the project moves from skeppsbron to the final proposal's site of frihamnen. Using an old warehouse as the physical structure, the project developed to be about how the connection of the physical and virtual will create a hyperreality. The phase progressed into the final design proposal.

Phase 1

As Gothenburg's population is supposed to increase from 2019's 571 868 to 736 000 (+28.7%) until the year of 2040 (Göteborg stad, 2017), similar development needs to occur to our public institutions.

Awarded architectural critic Mark Isitt argues in his article "The city library will age quickly" (author's translation) that Gothenburg's current city library does not have the capacity of maintaining the populations needs. Similar nearby cities, i.e. Aarhus and Copenhagen, have recently built public libraries that are able to cover the future's demands. Not only that the Danish libraries outnumber Gothenburg's public library in area, Aarhus's 30 000m2 & Copenhagen's 40 000m2 to Gothenburg's 13 200m2, they have also used their public buildings to activate the waterfronts. Building a new public library by the river in Gothenburg, would according to Isitt "emphazise Gothenburg's transformation from dockyard-city to knowledge-city".

Skeppsbron will work as middle ground between the expansion of Hisingen/Norra Älvstranden, the development of Masthuggskajen, and the densification of the centralstation/Hisingsbron area.

Using the detial plan that has been developed as a foundation for the proposal, an additional platform has been placed to facilitate the library. The monolith's scale was compatible to the nearby built environments heights and formed to be an integrated part of the cityscape.

The monolith was voxelated in four different scales, 8x8x8, 4x4x4, 2x2x2, and 1x1x1 to due to the cartesian grid to give it more definitions in the carvings.

The carvings were placed to create a pathway towards the river from pedestrian walkway that reaches all the way up the hill. The southern corner was carved in to be open up the space in front of the building to the adjacent water park and at the same time decrease the heat gain into the building.

Fig. XX
Siteplan of the proposal
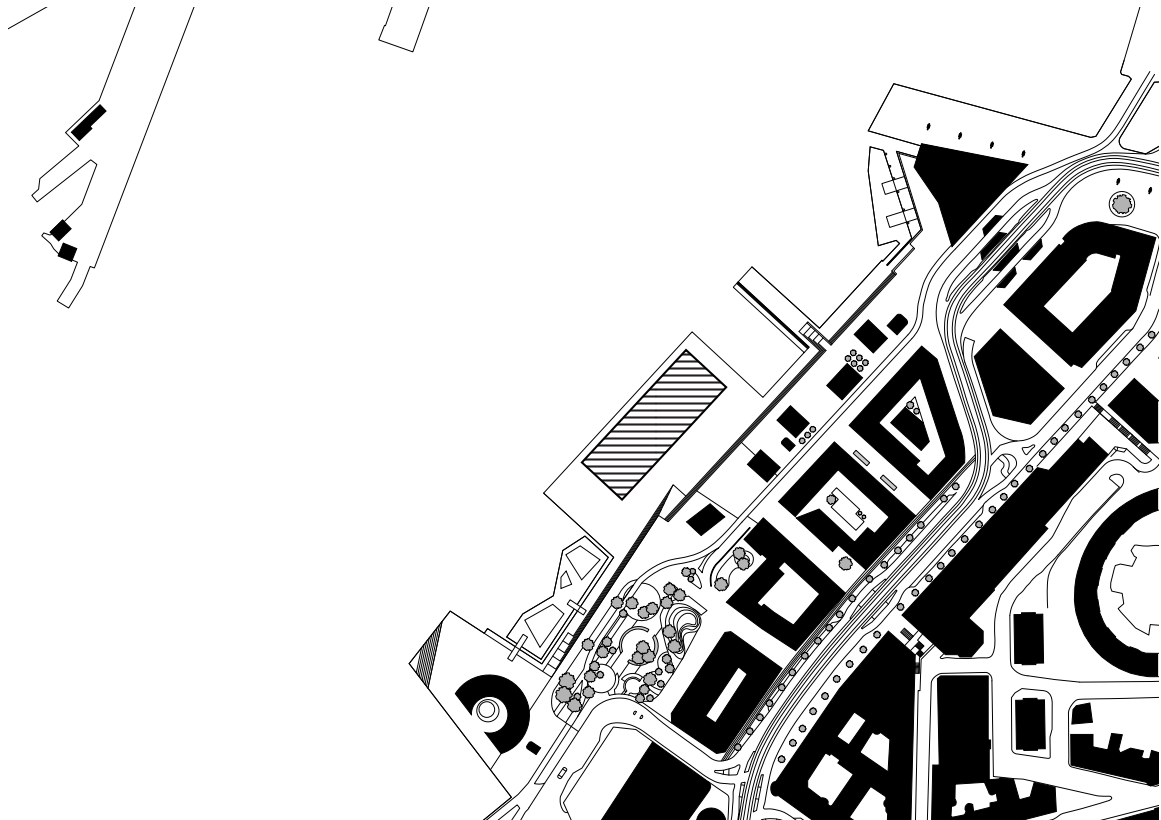
Fig. XX

Voxelization of the monolith.

Fig. XX

View of the monolith in Minecraft.

Phase 2

Immersive technology is used by society to augment the physical environment. The augmentation supports not only its user with everyday tasks as the smart phone do today, but also brings in the city's digital counterpart into the physical world. The virtual city is alternated in real time both of its inhabitants and the extensive systems of IoT.
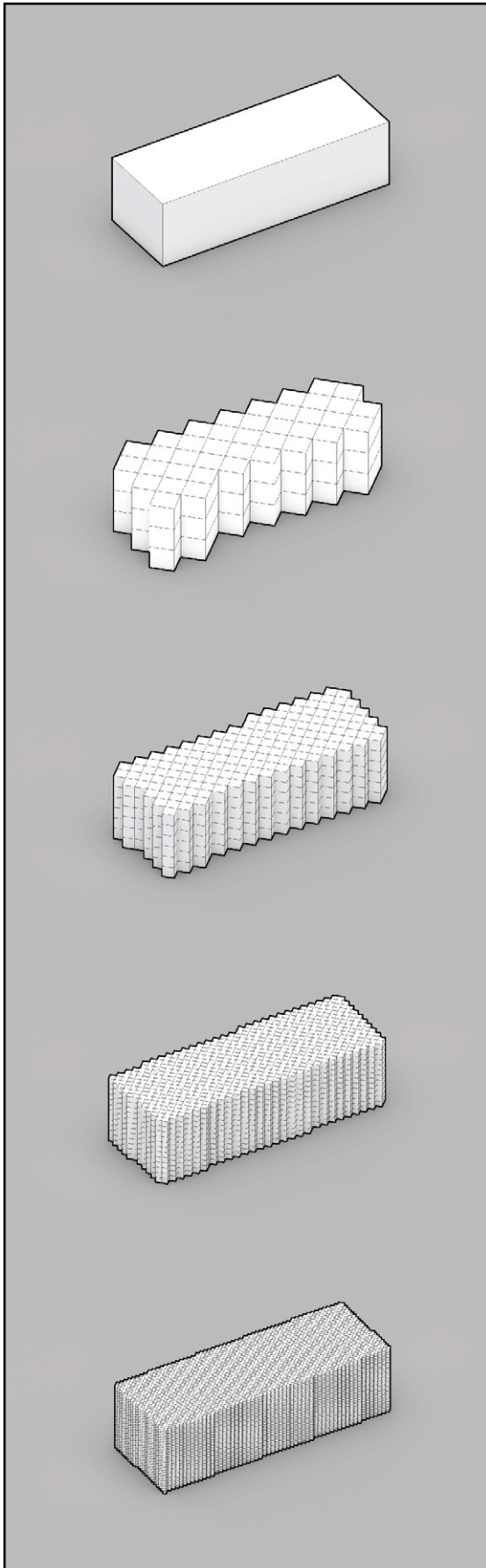
When the city's two counterparts merged, the physical and virtual equivalents, the rise of a new era emerged. Born from individualism and grown in to the collective, the city has been relieved from its previous state of centralized management. Wikipedia, Uber, and Airbnb have changed the way society are looking at knowledge and services. Our built environment is next, it is now articulated by the commons. As other services have a framework made by professionals, or dedicated hobbyists, the physical framework is designed and constructed by people with expertise. The virtual layer is freely changed for the aesthetic taste and functionality that fit the users.

The books are gone, replaced by their virtual counterpart. Now retrievable from any physical, or virtual, location by anyone with a "library card". The library has changed form from stacks of information to spaces for knowledge. From retrieving to creation, from Information to knowledge.

The physical building is simply stacked modular units that is used all over the city. The atriums are formed to have increase the daylight and circulation of the interior.

The program of the library implements that the physical meetings between humans have not decreased, the inhabitants of the city are more prominent to meet in person than over virtual reality.

WORKING		EXHIBITION	
MEETING		MAKER SPACE	
MEETING			MAKER SPACE
LOUNGE			CHILDREN
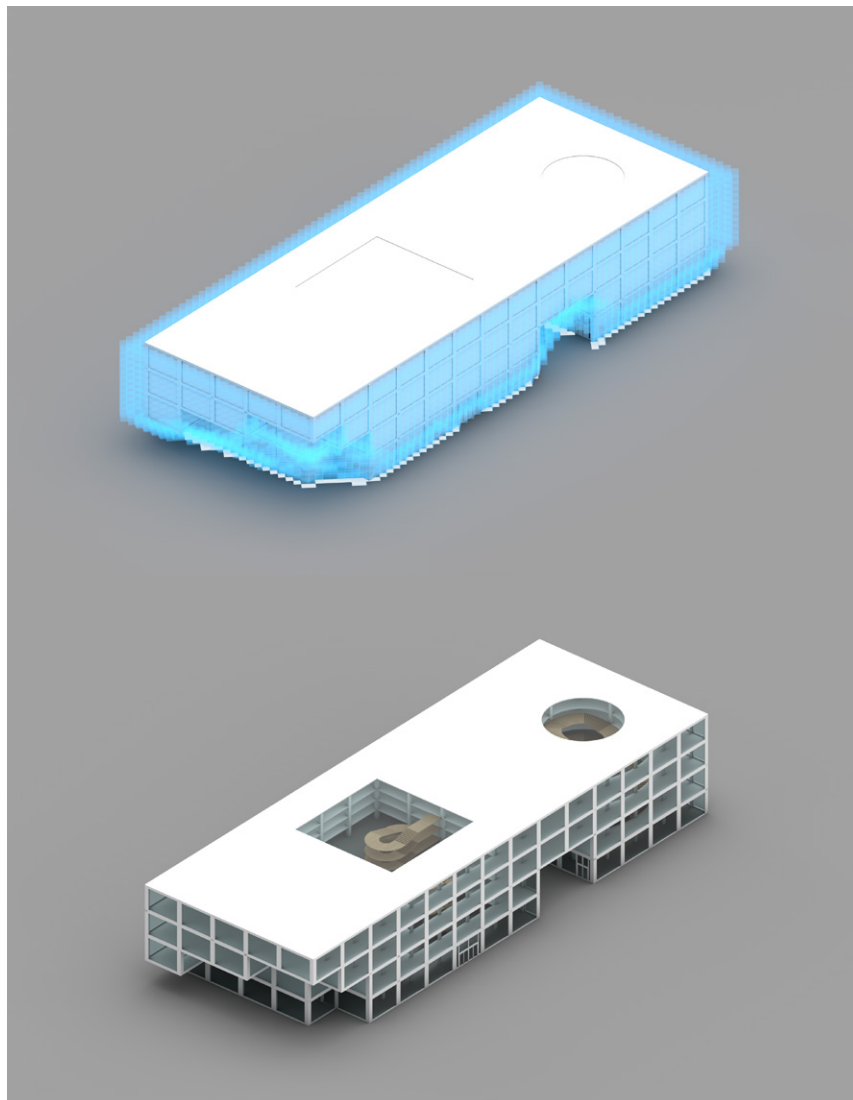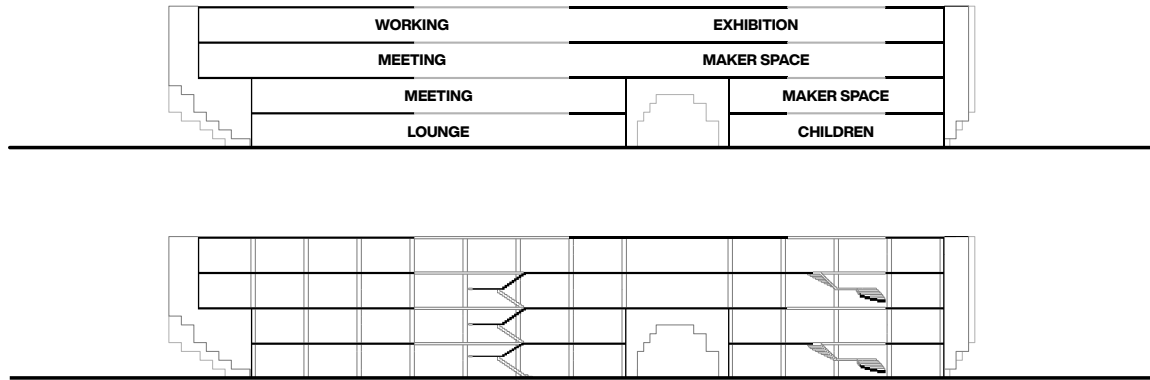
Phase 3

To distinguish what is physical and virtual is impossible, the hyperreal has been formed to give the visitor the experience of a dynamic and flexible environment.

The monolith has been opened up on the ground floor to connect to the street and surrounding activities. Keeping its voxelated state, the monolith is carved in underneath to prevent the facade to feel massive. With the glazed smaller blocks closer to the ground, the larger massive blocks get a feeling of weightlessness.

The interior has been formed to facilitate the functions by dividing the northern and southern parts by the degree of formality. The northern part has a natural experience where the visitor might contemplate and/or have informal meetings, where the southern has with its skeuomorph historical library a more formal setting.
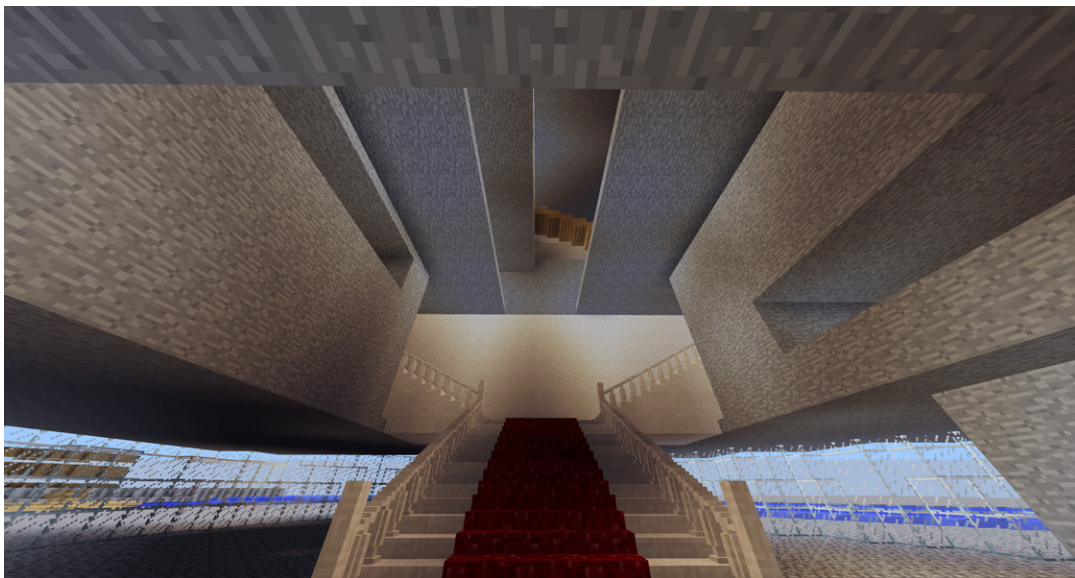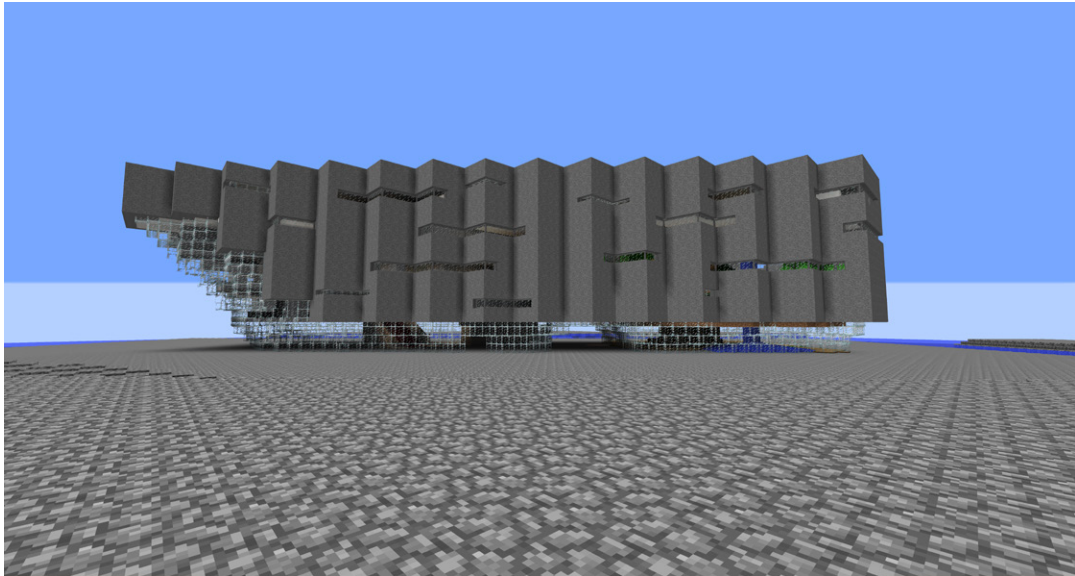
Phase 4

Magasin 113, an old warehouse in frihamnen, Gothenburg, is transformed into a hyper-real library, rather than being restored. An approach of how society will deal with sustainable aspects of the current building stock when our environments develop faster and faster.

 Virtual materiality has been anchored to the physical structure to become a mixed reality. A monolith is placed over the existing building. The overlaid monolith is divided into 4x4x4 blocks that covers the warehouse's attributes and inflict physicality to the virtual materiality. The monolith is then carved to articulate the library, create an entrance, and to open up for interior views.

The narrative progressed as the previous with an experience-based library. The interior environments are developed to change the visitor's perception of time and space when visiting the library. Using different levels of intensity of the virtual in the balance of mixed reality.
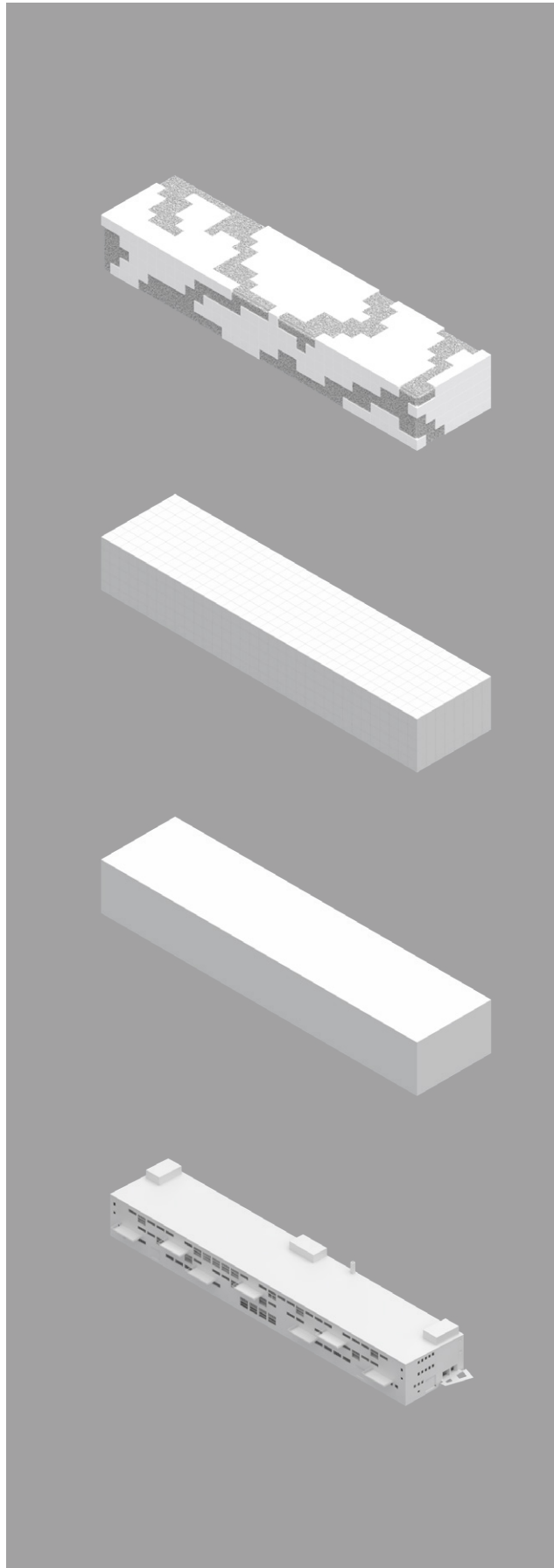
Reference Projects

The usage of references to build a framework was pivotal to the thesis. The utilization of the references has not only been to set limitations and discourse, but also to continue to feed the investigation of the speculative scenario.

Speculative architecture:

Used to understand and develop the narrative of the project and how architects in the past has been using other media, especially writing, to accompany drawings and images. The speculative projects are often radical, which has influenced the project to push the boundaries.

Critical design:

The mixed reality will create new opportunities for society but also responsibilities. The critical design projects are looking at different scenarios of how society might develop and how the architectural environment with it. This has influenced the project to be more of how the built environment will be transformed when the virtual moves into the physical world.

Virtual/mixed reality design:

Using virtual reality and game world for the representation and presentation of an idea and/or information has encouraged the thesis to not only remain a as a physical library. The mixed reality implementation has the potential to relocate, expose, and/or hide elements for the user to increase the experience and usability of the library.

Speculative architecture
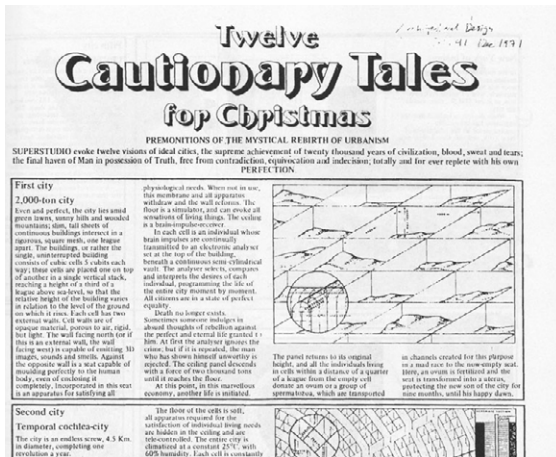
Fig. 05 / Gian P. Frassinelli (1971)
First city – 2,000 ton City

Twelve Cautionary Tales for Christmas
Superstudio – 1971

Superstudio wrote about twelve visions of cities. With precise writing, the group envisioned a final haven of man in possssion of truth. The short stories define schematic design proposals that are radical and very defined in their execution.
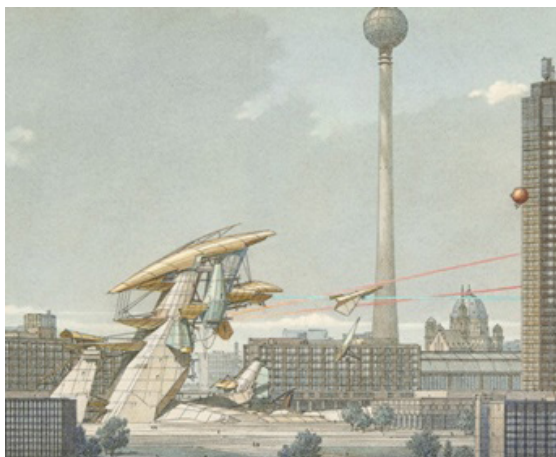
Fig. 06 / Lebbeus Woods (1988)
Illustration of Underground Berlin

UNDERGROUND BERLIN
Lebbeus Woods – 1988

Woods with his elaborate drawings, wrote a story synopsis for a hollywood move. Using a very detailed narrative with architectural sketches that gave life to the extrapolated futuristic setting.

The project tells a story about Cold War Berlin, where an underground city of sheltering chambers and walkways is built as a continuous tunnel tide together with a system of coils, wires, and ladders. Breaching the border between East and West, suddenly emerging from the ground. This monstrous machine for living launches emissaries of destruction on what Woods shows as the peculiarly bleak and forbidding cityscape of the masonry city.

Critical design

Fig. 07 / Inferstudio (2017)
Frame from the short film

Through Leviathan's Eyes'
Inferstudio – 2017

This short film is an optimistic and speculative project where society forms the city collaboratory unconsciously. The film is a non-narrative tour of the everchanging city where Leviathan, an AI, collects and transforms reality for its inhabitants.

Fig. 08 / Keiichi Matsuda (2015)
Frame from the concept film

Hyper-Reality
Keiichi Matsuda – 2015

A concept film that presents a hyperreal future, where the virtual has moved into the physical world. The new mixed reality has become an integrated part of society and its pale without it. Hyper-Reality explores the exciting functionality and its dangerous side effects in this new medium.
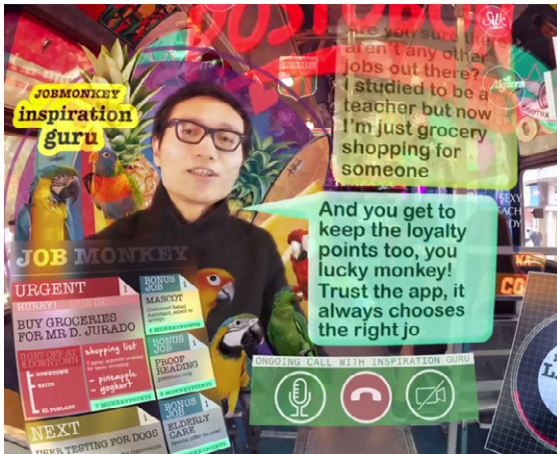
Virtual/mixed reality design

Fig. 09 / Reporters without borders (2020)
The Uncensored Library

The Uncensored Library
Reporters Without Borders – 2020

Part of the world is living in societies where information is controlled and censored. Young people are forced to grow up in closed systems without unbiased information and news.

Reporters Without Borders (RSF) has found a loophole by designing a world in Minecraft to be able to reach the closed off world. By integrating information in blocks in the library is it possible to go around the current censorships in many countries.

Fig. 10 / Space Popular (2018)
Part of the installation at ArkDes

Value in the Virtual
Space Popular – 2018

A exhibition at Arkdes, Stockholm, that envision the potential of spatial design in and for virtual environments.

Taking the form of two simultaneously active environments, one physical and one virtual, in one room. The static physical environment comes to life with the support of a VR-headset. Defragmented familized elements and artefacts from Stockholm dissolve, mutate, distort, and replicate to envision a possible future where the material's value has shifted.

Discussion

This thesis's main theme has been about exploring the connection between the physical and virtual in a hyperreal scenario. It presents a fictional setting where the public library has become less of the retrieval of information, but rather a dynamic living room that may be experienced and used by different user groups in many ways.

The fourth industrial revolution will change the lives for many, especially for consumers in the developed countries. We have already seen the large impact of how the internet have revolutionized our society. A full implementation of IoT with supporting infrastructure has the potential to take it a step further, the question is if we are ready for it.

As the exploration progressed several aspects of the future emerged that could not fit in the frame of the thesis; cyber security, access to the equipment, censorship, surveillance, and ownership of data are only a few subjects that are threatening to only take a glance at. All of them deserves a thesis themselves to understand the seriousness and challenges of our near future.

As the typology of the library will follow the path of information, it will be as much of a challenge. The Library's core functions as an information sharing platform might disappear, due to the aspects of the easiness of sharing content over the internet. We are already experiencing a transformation of the public library, stacks of books are replaced by 3D printers and sewing machines to fulfill the creative needs of the population (Helsinki Central Library Oodi, 2020). As experiences are growing more and more important for the population, the Pixel library has been designed to give the visitors more than a regular building. The mixed reality will have the ability to give people more, without the expense of higher building cost or wasteful area efficiency.

Working in another perspective than the conventional architectural techniques of 2D drawings and 3D modelling, the first-person perspective has given the project an interesting angle of how spaces can be designed at the same view as it is experienced. The three different perspectives have different attributes and relevance in the design process. Keeping in mind that different tools and perspective have superior and inferior qualities during that process.

Keeping the loop during the process enforced the momentum of using the different perspective throughout the process. As the precision and speed of the 2D drawings, the overview of spaces in 3D models, and scale and experience of the first person all contributed to the design of the project, it is important to keep in mind that taken one out of the equation would have changed the outcome drastically. The first-person perspective's lack of speed and overall orientation between elements and spaces makes the technique difficult to compete with the other two previously mentioned perspectives when it comes to contemporary professional design.

Minecraft as a tool for architectural design might preferably be used for larger scale urban design with several users simultaneously to get the most out of it. The games low fidelity due to its large blocks works better when it comes to larger developments and can be run by minimum amount of computational power. As the world may be used by a large number of users simultaneously, the planning is not done by a single hand but rather be a collaboration between many.

Several countries has released their maps in the game world format, the Swedish government released whole Sweden in 2015 for everyone to use (Lantmäteriet, n.d). Due to its low learning curve and its ability to be easily shared over the internet, the game world has been used by municipalities to invite its population to be part of the city planning (Sundbybergs stad, 2019).

The balance of physical materiality and virtual information in mixed reality is crucial to be able to design in/for a future of mixed reality. The hyperreality is based on that the user experience the environment while not able to determine the border between them. By using an existing building as a foundation to the physical and the library as the virtual frame for functions, the Pixel Library's narrative was bound to explore the novum that emerge when they collide. The gradually revealing

of the virtual throughout the building gives the user the understanding of the connection between the two entities.

This thesis was executed during the outbreak of the Covid-19 pandemic, which has given new perspective on how society cope with technology when it is forced to be more remote. It has challenged us to use the internet to connect to others on a whole new level than before. Companies have their employees at home, families and friends socialize over video conversations, and large institution such as schools are fully virtual. This might be the turning point of how the norm will be in the future when it comes to interactions and how we are looking at relationship between the physical and virtual.

The Pixel Library is a concept of how society will cope with the change when mixed reality will be a part of our daily lives. A great institute that has the prominent task of being a service to everyone, for everyone. The flexibility that the mixed reality provides will be able to cope with the rapidly developing society we are taken part of, which is not the case with a fully physical building.

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