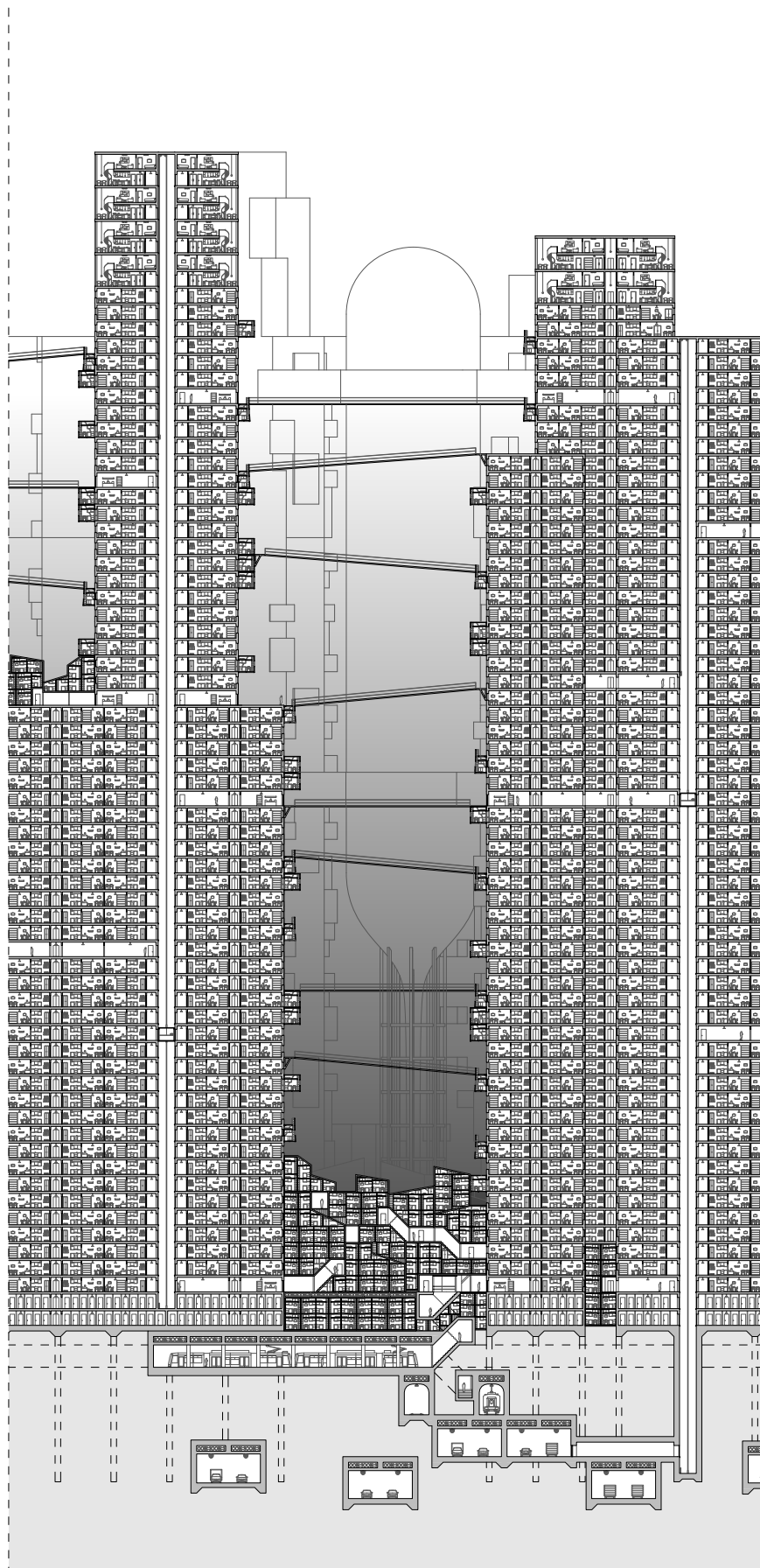


Beyond Density - Exploring Urban Limits Through Digital Space



Frej Einarsson



Course: AAHM01: Degree Project in Architecture

Year: 2025

Title: Beyond Density - Exploring Urban Limits Through Digital Space

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Abstract

What happens when you take a normal city and try to cram more people into it, without expanding the surface on which it can grow? Maybe you end up with something like Manhattan or Tokyo, with skyscrapers standing side by side and large roads cutting in-between them. Now we try to fit some more people in. Then you might get something similar to Hong Kong, more compact, more layered and with even less space between the skyscrapers. Let's try to push some more people in. Now we are getting to the levels of Kowloon Walled City, the densest settlement in recorded history. Buildings are now fully merged, creating one big structure where no light reaches the street level. We have reached the most extreme example of what hyperdensity has ever been on this planet. But what if it went even further? Then we can only guess what it might turn into.

This project explores what such a city could look like, through interactive digital tools such as Unreal Engine. It also explores what these tools can offer when working with complex, three-dimensional spaces, where interactivity becomes a necessity for understanding them.

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Introduction

When I started this project I was relatively new to interactive digital tools. I had done a course the semester before working in Unreal Engine and was amazed by the possibilities of it. In particular I was interested in the visual and exploratory side of the tool. How it could be used to perceive and explore space, and what it could do for architecture that other tools couldn't. I had also found a subject that suited this type of exploration very well: hyperdensity. When studying cities that weren't only horizontally dense, but also vertically, I often found that the existing maps were insufficient. These cities had such a three-dimensional complexity that a plan or a section were not enough to understand them, you needed another medium for that.

I thought the best way to understand their space (other than visiting them in person) was to digitally map them. When using tools like Unreal Engine you would also be able to interact with them, walk around in them and perceive them in a much more complex way. You get a feel for how light falls, how spaces relate, what atmosphere they have, etc.

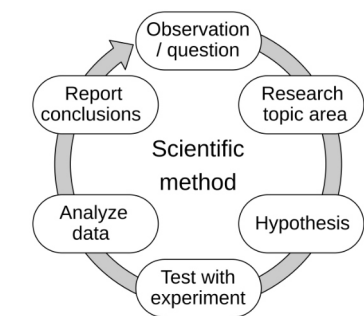
But you don't need an architect to map out an existing city, and there's not really any creativity in it either. To broaden the field of research I decided to also look at how this hyperdensity might manifest on a much larger and denser scale than anything existing today. I did this by creating my own city, which would densify in phases, showing the process of going from a normal city to hyperdensity. In this way you could also see how the complexity exponentially increases with the density of a city, becoming increasingly harder to map and understand.

The result is a project that shows the reader a speculative view of what hyperdensity could look like, through a digital environment showing aspects of it that more traditional tools cannot.

Background

Scientific and artistic research

Scientific research follows a very clear structure and methodology. You are faced with a question or observation, you research existing knowledge on the subject and then formulate a hypothesis, you collect data and then you draw a conclusion from the results of said data. Emphasis is being put on that the results should be reproducible by other independent sources. The aim is to answer your question or confirm your observation and produce objective knowledge that can be verified by, and built upon by others (Britannica 2025).



The Scientific Method (Efbrazil 2021)

In contrast to this, artistic research takes another approach to generating knowledge. With artistic research the creative process itself is the way to explore and generate new knowledge. Rather than seeking objective truths the aim is to produce knowledge via subjective experiences, interpretation and expression. While the research may involve questions these aren't necessarily expected to be answered, but rather the exploration of them is meant to give insight and new perspectives to what the answer might be (Vetenskapsrådet 2017)(Royal Academy of Art n.d.).

In the context of architecture, artistic research allows for projects that scientific research would not. Architecture is a practice that builds upon both technical and cultural factors, and just as the technical aspects are mostly objective, the cultural many times aren't. Subjects such as, for example, art and social sciences are woven into architecture, and as these are highly subjective matters it is unavoidable that these aspects of architecture also should be subjective. Since my project focuses on an exploration of the material, spatial, and behavioral aspects of architecture, it is much better suited for artistic research, which is why that has been my chosen method for conducting this project and report.

Hyperdensity in the world

Overcrowding and hyperdensity is nothing new. When Friedrich Engels published his book *The Condition of the Working Class in England* in 1845 the higher classes of society were appalled by the stories it told. Rows upon rows of miniature apartments with families of ten living in the same room and sanitary conditions that would sicken most people to their stomachs today (Engels 2009). What Engels did with the book was raise awareness of what was actually going on in the lowest social classes to people outside them, and by doing so there was hope for things to change. And they did, although maybe not as fast as Engels would have hoped. But even though England might have rid itself of that type of hyperdensity it is not gone, very similar situations still exist in other places in the world to this day. Beyond that hyperdensity also manifests itself in a large variety of other forms, all facing their own sets of challenges.

Medellín

In the favelas of Medellín in Colombia, the density comes from necessity rather than planning or design. Here, space for expansion exists, but regulations and infrastructure are lacking. This in combination with the complex topography results in a low-rise yet very compact urban landscape, characterized by narrow passages, buildings merging into each other, and a complex system of private and public space. As they are built without government oversight they often have to come up with their own solutions for electricity, plumbing etc. The lack of oversight is also a problem since no one actually verifies that the buildings (which are often built in steep terrain and on top of each other) are structurally sound, which has led to horrible accidents in the past. The complex nature of these cityscapes also leads to communication between spaces being complicated, slow and sensitive to blockages. At the same time the unregulated nature and complex topography generate an urban environment like few others, showing a spatial adaptability that formal planning rarely achieves (Moore, Eiró & Koster 2022).



Comuna 13 in Medellín (Einarsson 2023)

Manhattan

A vastly different form of hyperdensity can be found in Manhattan, New York. In contrast to Medellín, the reasons for the expansion and densification are financial interest and popularity rather than necessity. Further, the space for expansion is nearly nonexistent other than vertically. As there are a lot of financial forces driving this densification as well as a strong system of regulation and oversight, it is possible to build much taller buildings, allowing for the vertical expansion. The result is a super high-rise, dense and very structured cityscape, one that has become world famous for the way it pushes the boundaries of what a city can be.

Even though it is all done with precision and structure, Manhattan faces its own problems with hyperdensification. Being the centerpoint of one of the world's largest cities, as well as the financial center of the world, the property values are as sky-high as the buildings. This results in an extreme social stratification where only the top layer of the population can actually afford to live here. The property values also lead to public spaces often being sacrificed or privatized. The super high-rise in combination with the density of buildings leads to the street level receiving far below desirable levels of sunlight. Lastly, the tall buildings create a heavy reliance on vertical communication systems such as elevators and escalators, leaving it vulnerable to systemic or electrical failures (New World Encyclopedia 2022).

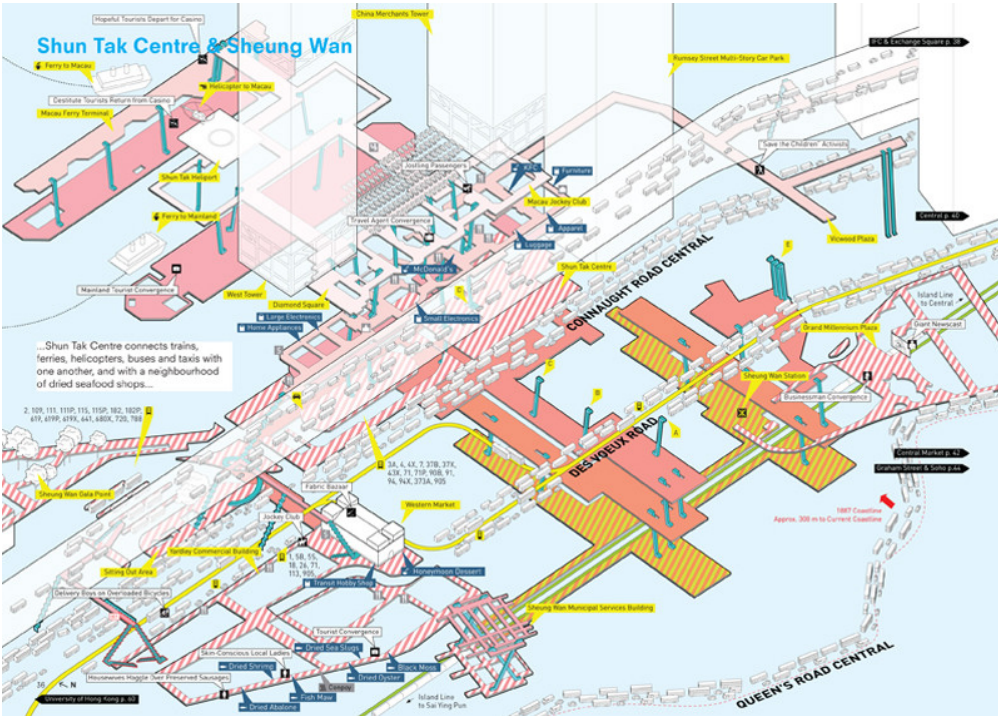
Hong Kong

Another interesting case is that of Hong Kong. Like Manhattan, the area for the city to expand is already maximized and as a result the city has had to grow vertically. There are however several key differences. Firstly, Hong Kong's limited area is due to strict regulations from the government, so while the city is not allowed to expand outside the pre-decided borders, there are plenty of untouched nature areas just next to the city. Secondly, Hong Kong is an entire city and not just a part of one like Manhattan. Therefore it contains the entire socioeconomic spectrum, from the very poor to super-rich. Thirdly, while building and planning is regulated, the regulations are looser and more forgiving than in Manhattan. For example the requirements for sun exposure and air quality are lower, and this has allowed for buildings to stand much closer to each other, creating an even denser cityscape. Since the city doesn't only cater to the very rich there is also a high demand for this type of lower standard living. But as the demand for housing in the city is so large this has also led to a large and many times illegal market, one that is often dealing in housing far below acceptable standards in size, quality and sanitation among other things (New World Encyclopedia 2024).



and 116 (Wolf 2009)

Something remarkable about Hong Kong is the innovative ways in which it has dealt with the challenges of spatial communication. The city has an intricate system of subways, car tunnels, roads, walkways and escalators making up layers upon layers of communication. In this way they separate the different means of transportation into separate layers and reduce congestion heavily. As the city is so dense both horizontally and vertically this approach also becomes something of a necessity, since vertical communication becomes almost as important as horizontal. It also allows for each layer to take up less space, making it possible to build even denser. For example, there is a system of elevated walkways that is placed above ground level. These move freely throughout the city and don't have to take roads into consideration. This layered system is of course a product of meticulous planning over a long time and not something that has come naturally (Wainwright 2013).



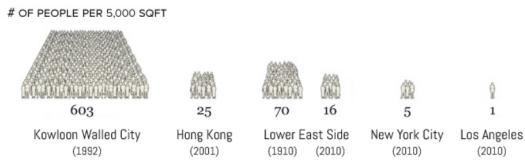
Shun Tak Centre & Sheung Wan (ORO Editions 2013)



A City of Organized Chaos (Lambot n.d.)

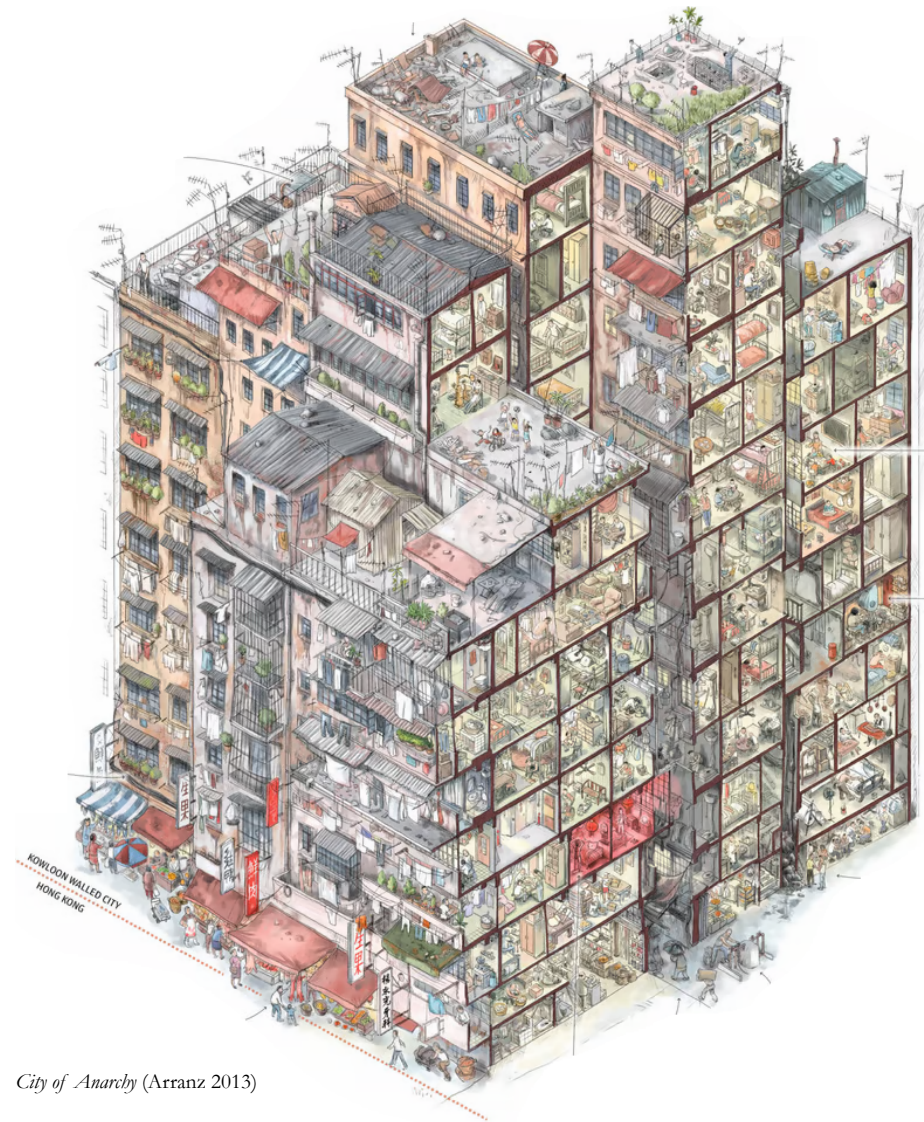
Kowloon Walled City

Continuing on the subject of Hong Kong, perhaps the most extreme and fascinating example of hyperdensity in modern history is the Kowloon Walled City that existed there until its demolition in 1993. As a Chinese enclave within the at the time British Controlled Hong Kong it was something of a legal grey zone. None of the countries really wanted to take responsibility for it and as a result it was left in a state of anarchy. Because of this it became a haven for people avoiding the authorities for whatever reason, and the demand for living was ever-growing. With a size of 210 by 120 meters the walled city was not much larger than a block. On top of this, its proximity to the local airport was responsible for one of its very few regulations: the buildings could be no taller than 13 stories. In other words, the buildable space was confined to this 2,6 hectare by 13 floor box. Because of the total lack of regulation and very high demand for housing the city gradually filled this box to the brim, with around 300 connected buildings and at its peak, 30 000 residents, making it by far the most densely populated place in recorded history (Blakemore 2025).



Population density in KWC (City of Darkness n.d.)

This was, as mentioned, attributed to the lack of regulations and oversight. The city was able to grow freely, but not in a planned or safe way. Most buildings were constructed by hand by whatever material was available and often without proper foundations. Because of the height limit buildings expanded horizontally and merged with each other, creating a massive enclosed block with almost no open space. From the outside it just looked like one big building, and from the inside it was a network of passageways, staircases and tunnels that stretched across multiple levels and made for a complex navigational system.



City of Anarchy (Arranz 2013)

Moving through this system would have been like few other places on earth. There were few proper streets, mostly just dark narrow corridors between the buildings. Often they were so overbuilt that no sunlight would reach the bottom. To get around, people would use a complicated system of routes: climbing stairways and ladders, crossing rooftops, walking through tight corridors and sometimes moving directly through other people's homes. Vertical movement was just as important as horizontal, and the entire city functioned like a three-dimensional system of streets rather than a conventional grid. "Ground level" could be anywhere from the actual street to the roof of a nine-story building. This maze-like system was hard to wrap your head around, and even harder to map. The residents simply had to learn the paths and know them from memory (Lee 2024).



Dark but vibrant (Girard n.d.)

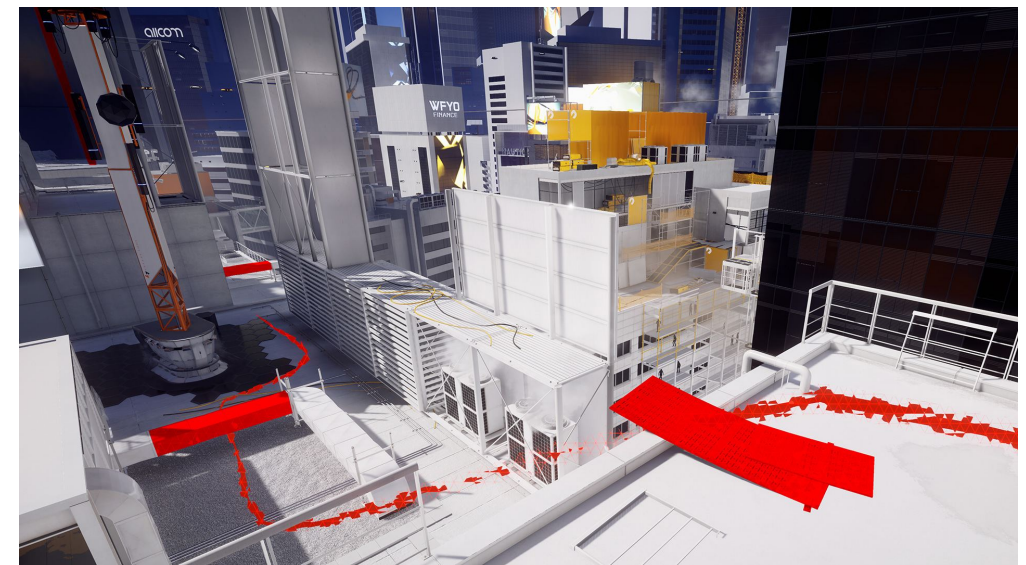
Though that was an inconvenience, there were quite a few even more pressing issues. With no regulation, services like plumbing, electricity, and waste management had to be done informally by the residents themselves. The water would often come from tanks on the rooftops with homemade pipes, leading to a constant dripping of water down on the lower levels. Similarly electrical wiring would be put outside the walls where they could fit, often exposed. Trash would commonly be put in the alleyways or on the rooftops for lack of better space. Because of the density it would have been impossible for fire trucks to reach the inner layers, and the threat of a fire outbreak was constant. On top of that, the lack of sunlight and proper airflow meant many of the inner spaces were dark, damp and dirty. These unsanitary conditions meant sickness was also a large issue (Portisch 1988).

This conglomeration of factors, not to mention the many illegal activities that took place in the city (technically not illegal since there weren't really any laws) eventually reached a limit for the Hong Kong government and by 1993 they had displaced the citizens and begun the demolition of the city. However, it remains one of the most fascinating examples of the extremes of urban density, hyperdensity in the word's proper meaning, and has inspired numerous works of fiction and studies, including this thesis project.

Fictional hyperdensity

A big part of this project is to design a city based on what is and has been, hence the previous references to different cities. Looking back is a key element if you are to create something for the future. But it is also of great interest to look at how others have imagined the future. Whether it be based on realistic predictions or pure imagination, it gives an insight to possibilities you might not have imagined, because it does not yet exist. The works that are about to be presented explore what dense, layered and vertically driven cities could become, many times doing so by exaggerating aspects of real cities to create new spatial logistics.

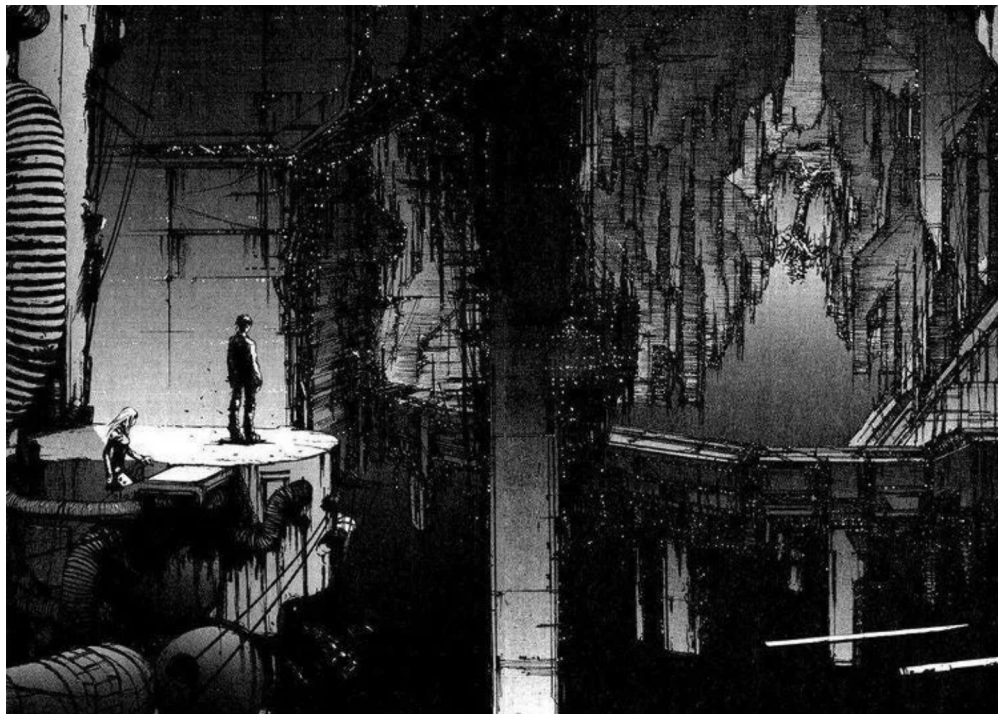
In the video game *Mirror's Edge Catalyst* from 2016 the urban landscape is imagined as highly vertical and overly clean and polished. What is interesting about it is how you as a player basically never touch the street level. Instead all navigation is done via rooftops, air ducts, ledges etc. It focuses on the in-between spaces and uses them as necessary parts of urban communication. This way of presenting alternative circulation paths, that exist outside of the conventional street grid, is what makes the game interesting and unique. It also offers a new exciting way to think about how connections can work in a vertical city (EA Digital Illusions CE 2016).



Navigating the city via rooftops (EA Digital Illusion CE 2016)

Another example is *BLAME!*, a manga by Tsutomu Nihei. The setting of the story is a seemingly infinite megastructure that has since long grown beyond human control. The expansion of the structure is automated and chaotic, simply expanding for the sake of expanding. Over centuries this has created an environment with layers upon layers of construction, no clear ground or sky, just endless spaces enclosed by generic and random structures, and with hardly any life to be seen (Nihei 2016).

It is a fascinating vision of what might happen when design is detached from the designer and becomes something self-generating. Traveling through this world is completely three-dimensional, with the auto-generated structures having no regard for moveability. It is also interesting how it shows hyperdensity not just as a matter of how many buildings or people are packed into a space, but as a state where the city becomes so complex that it is almost impossible to understand and where life in it depends on constantly adapting to it. It is an interesting idea of what urbanism might look like without regulation, taken even further. In the case of the Kowloon Walled City, there were little to no regulations, but the new structures were still designed *by* humans *for* humans. Instead Nihei imagines a reality where even that last bit of continuous design is stripped away, and the result is a truly interesting fictional world.



(Nihei 1997)

Citizens of No Place is a graphic novel by architect Jimenez Lai that explores architectural ideas through short, illustrated stories. What stands out about it is the use of storytelling as a way to imagine new spatial realities. It doesn't focus on traditional plans or finished buildings, those are not the relevant bits, instead it explores how people might interact with spaces in unusual and surprising ways. The focus is not so much on function or form, but rather on new ways of thinking about architecture through behavior and experience. Lai uses design the other way around, he starts with how someone behaves or moves, and lets that shape what the architecture becomes. In hyperdense contexts, where conventional design strategies often aren't enough, this kind of thinking becomes a way of exploring alternative solutions, more focused on the user (Lai 2012).

Lastly, the *Blade Runner* movie franchise offers a view of futuristic hyperdensity where the most important factor is what atmosphere it mediates, something that makes sense given its format. The cityscape is very dystopian with tall structures, bright neon lights and an overwhelming scale. The way things actually work are secondary to this design which has psychology at its center. It is used as a way to put the viewer in the same mood as the protagonist, trapped and hopeless (Villeneuve 2017). Using architecture as a means to steer someone's mood is an uneasy way of utilizing your tools as an architect, but also something that can be of great use, especially when working with larger scale environments the way this thesis project is.



Los Angeles as presented in Blade Runner 2049 (Warner Bros. 2017)

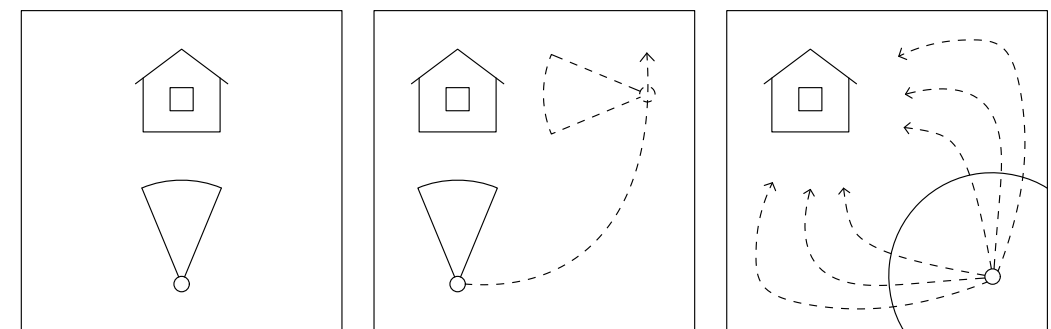
Digital tools and different levels of representation

Over just the last few decades, architecture has shifted from being something primarily drawn and modeled by hand, to having most of its material produced digitally. Not only have the digital tools upped the work efficiency drastically, they have also opened numerous new doors for how architects can work with designing. Tools like 3D modeling software, game engines, and parametric design platforms allow architects to visualize complex environments in a way previously not possible. They can interact with them in new ways: walking through them, changing them, and experiencing them at human scale, all long before they're ever built. When working with complex issues like hyperdensity and spatial layering these tools have huge value. Environments that are very three-dimensional and too complicated to fully understand in plan or section can be built virtually and explored from within.

A static image, no matter how polished, offers the lowest amount of information. It shows only what the designer wants to show, from a carefully chosen angle, and with after-edits to hide flaws. Dynamic representation is the next level, for example a video where you move through a space. This offers more information, showing how the space unfolds over time and conveying a greater sense of atmosphere and movement. But in the end this level of representation is also pre-decided. You see only what the creator wants you to see and follow a path they have set, and you have no control of the experience.

That all changes with the next level, which is interactive representation. This provides a much higher level of information and honesty. The users are in control and free to explore themselves. Depending on what level of freedom the designer wants they might even be able to adjust lighting, move objects etc. Since the creator can not control where the users explore in the same sense, it becomes much more difficult to hide flaws or mistakes, the architecture has to hold up from every direction. For complex spatial environments like those found in hyperdense cities, this kind of real-time exploration becomes something of a simulation. It allows the designer to observe how light falls, how navigation works, how compression and openness are felt, and how people might move through these spaces. It makes it possible to test how a space looks, functions and feels.

Something else that these tools do is open up for a more experimental workflow when designing. They allow architects to borrow methods from other creative fields such as game design and filmmaking where there is a heavier emphasis on pacing, narrative and spatial logic. It creates a way of making architecture as something you can experience, more so than you would have through plans or pictures. It also allows for very fast iterations, where you can evolve your designs constantly by testing and adjusting, creating a more fluid and adaptive design process. Imagine building a wardrobe in seconds to see if you like it in your room, and then being able to remove it just as fast if it turns out you didn't. Or to take it further, doing the same thing with an entire building in a city. You can change things based on how they perform, not just how they look on your screen.



Three levels of representation, static, dynamic and interactive

Process

Research

Before I started any creative aspect of this project, there was a lot of research to be done. As the project was initially supposed to be about level design and architecture I started by studying that. I began by reading the book *An Architectural Approach to Level Design* by Christopher W. Totten, which not only taught me about level design, but also contained many new perspectives on spatial planning in general. Many of the ideas and philosophies used for level design are very applicable in the field of architecture as well (one can assume that is why he wrote the book). To get some practical influence I played computer games that in architecturally interesting ways tackle level design, the main one being *Mirror's Edge Catalyst*. That is one of the first times in my life I've played games for academic purposes, it's too bad that not the entire process could continue like that. The game takes place in a very vertical environment where navigation between tall buildings is essential. That aspect was not why I played the game to begin with, but it has turned out to be relevant in what I ended up doing. It offers new means of thinking about communication in less conventional ways. Not long after I finished the book and game I decided to drop the idea about level design. I could extract some useful information from both, but at the time I felt like I had just wasted my time. I knew that I still wanted to work with interactive design and Unreal Engine. I was also generally intrigued with interactive design after trying it out during the level design-phase, the possibilities for what the tool could be used for seemed nearly endless. It was at this time that I chose to change the focus of the project to hyperdensity. Not only did I find it to be a fascinating subject, but also one that I felt could benefit greatly from the use of interactive digital tools. Because hyperdense environments often tend to be very complex and three-dimensional, being able to perceive and map them out digitally is of great use. While that is very challenging to do with conventional methods of representation, interactive design allows you both to explore and understand them more the way you would with a physical place. I spent much time researching different forms of hyperdensity, and various forms in which it has manifested itself over the globe both historically and in the present. I also consumed a multitude of fictional works portraying the subject in different ways (some more fictional than others). Among them all, the case that particularly caught my attention was the Kowloon Walled City, hardly surprising considering the extreme nature of it, and the fact that it actually existed. Even after watching a number of documentaries and videos from the inside, as well as looking up as many maps and sections as I could find, I could not even begin to grasp the structural layout of it. I felt that would have been a truly useful case for interactive renders. But I was also thinking about the size of it, what it would look like if you had that density, but at a much larger scale. I decided that rather than creating a digital version of an existing place, I would create my own hyperdense environment from scratch, but base it on the many sources of inspiration I had researched. Think of it as if you would take one of the existing cities, but have more and more people constantly moving in over many decades. How would the densification happen, and how would you navigate such a city? And importantly, how can the interactive digital tools be used to explore and experience such an environment?

Framework

The setting is something that has evolved beyond anything that exists today and much of it is based on my guesses and predictions about how things might turn out if you let such developments happen to a city. Because of that, let's star with a few disclaimers:

- The focus of this project is not realism. This is not necessarily how I believe things would turn out. I've based it on guesses, sometimes allowing myself more creative freedom and focusing on creating something that would also be exciting to explore.
- Figuring out how a city works is an enormous task. I have chosen to focus on areas that are relevant to someone experiencing it through an interactive medium, namely how navigation and communication work, and the things you can see around you, such as material usage, building typologies, etc.
- The city is not a continuation of any existing place. It is created from scratch and isn't located in any specific place.
- There are no sci-fi elements to this project, the city uses the same technology that we have today (although the structural integrity of some constructions may be questionable)

Now that we have established a basic framework for this project the rest of it will hopefully appear less confusing. To explain why I have chosen to design things in certain ways, I will need to explain my logic behind the city. The following chapters will, aside from explaining how things work, feature a lot of worldbuilding, because it is necessary for understanding how things work and look, and why I designed them as I did. It is also something that helps build an atmosphere once you get to experience these environments digitally.

Creating the setting

I knew I was more interested in exploring the finer details of the city rather than its entirety. My idea was to focus on one place in the city that I could experiment with and explore. Since I knew the city would be very high-rise I was particularly interested in how that would affect navigation and communication, given that moving vertically would be equally as important as moving horizontally. I was also interested in how the high-rise density would affect the visibility and lighting conditions. That's why I chose to center the project around a space formed between several tall buildings, a kind of vertical opening, *a well*. In this way there would be a variety of different environments, allowing me to show different aspects of the city, while not having to design an impossibly large amount of space. But I still needed a setting around this focus point, and that couldn't just be the visible building, then it wouldn't be a city, and it would be hard to design in a sensible way.

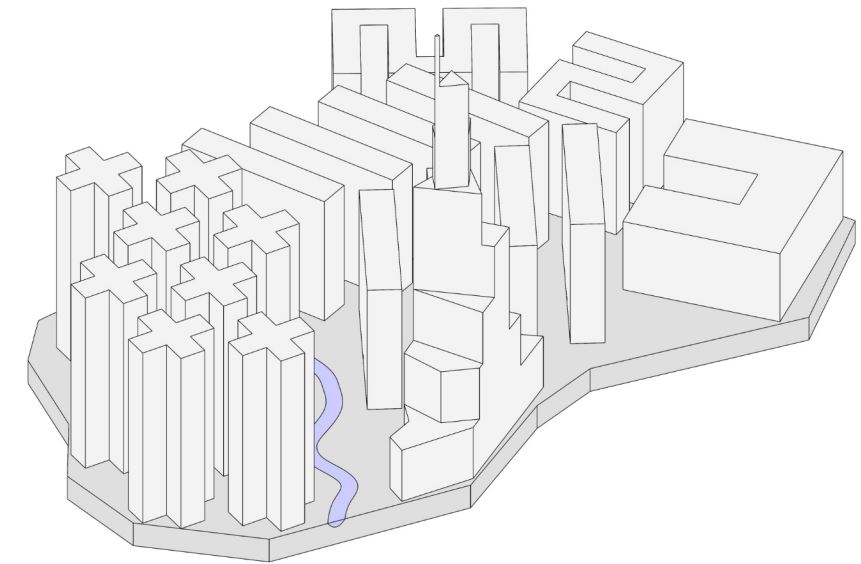
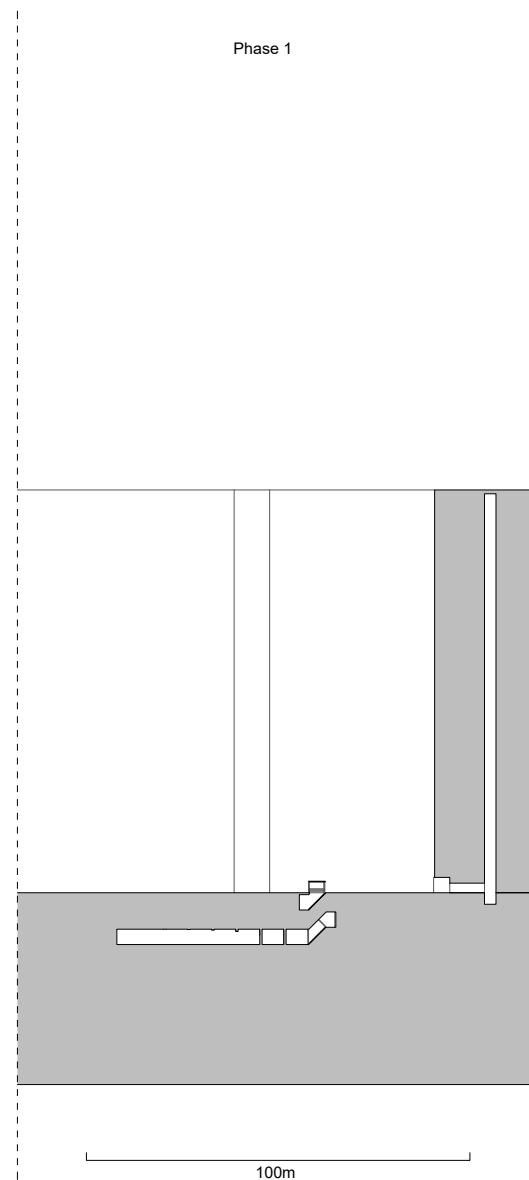
To simulate hyperdensity I needed to think about how it emerges. You don't just build hyperdensity from an empty lot. It happens over time, something that was in the beginning a normal city densifies over years or decades until it no longer resembles the original. My strategy to simulate this was to create the city in phases. First I would create a lot with a border that could not be expanded beyond on which to build, forcing the city to densify rather than spread out. The first phase would be a city that could exist today, dense but not unreasonable. By each phase the building regulations would get looser, with buildings creeping closer to each other and less formal building methods being used. As each phase would compact the city, there would be less space for larger structures. This means that by the later phases, additions are larger in number, but smaller in scale. Because of this, the changes of the last phases are mainly focused around the well where they can actually be observed.

The site

The city needs to be limited by a border as to remove the option of densification by spreading, the only growing options should be up, down and inbetween. Since the outskirts aren't all that important in the project this border is just a line outside which nothing can be built. The shape stems from nothing in particular, it is somewhat even in shape and has straight lines, making building on the border easy. The size is 19,1 ha. That gives enough space to make something resembling a city and highlighting the densification process without making it an overly large task. The site is flat simply because it is the easiest to work with. Inclination in the site isn't really of any relevance or interest for the project and would only serve to make the plotting of buildings harder. You have to imagine that there is more city outside the borders, that just isn't shown in the project.

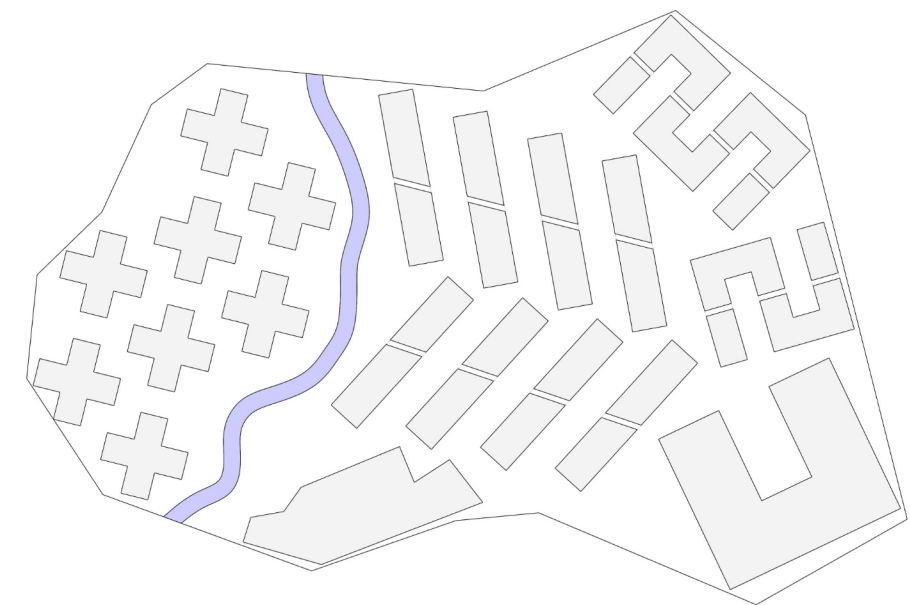
Phase 1

Phase 1 is meant to act as a base for the rest of the phases and is trying to be anchored in reality somewhat. Something that could actually exist in a contemporary context. It is structured but very dense if you compare it with real world examples. It consists of only larger structures and no informal buildings. They are structured in groups which follow internal rows. The residential buildings vary from 30 to 50 floors in height making the cityscape very tall from the get-go. The distance between the buildings isn't necessarily super dense in the plan but considering the height it is very dense, on par with some of the world's densest high-rise neighborhoods. Since phase 1 only contains larger structures the spaces in between are left empty to be used as buffer zones for parks, squares etc.



Phase 1

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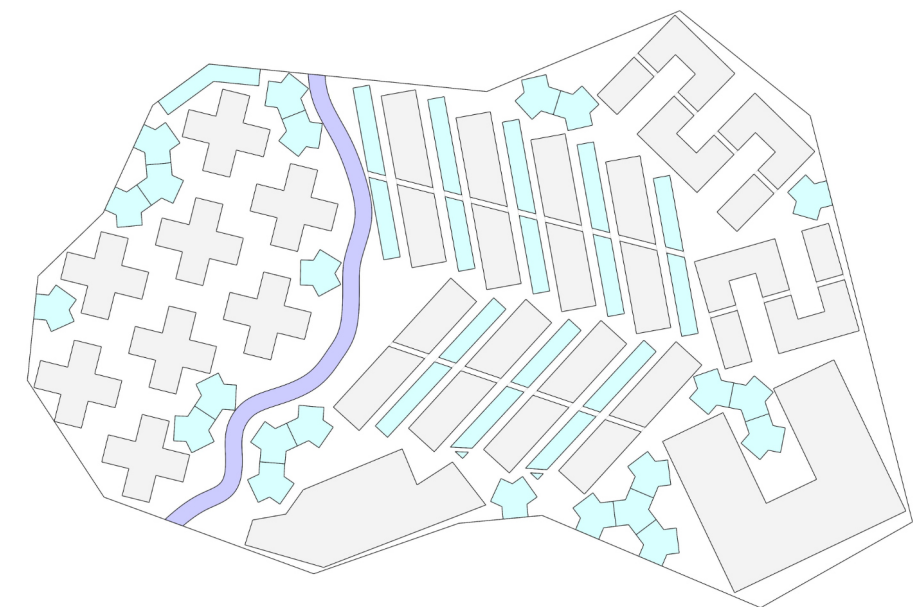
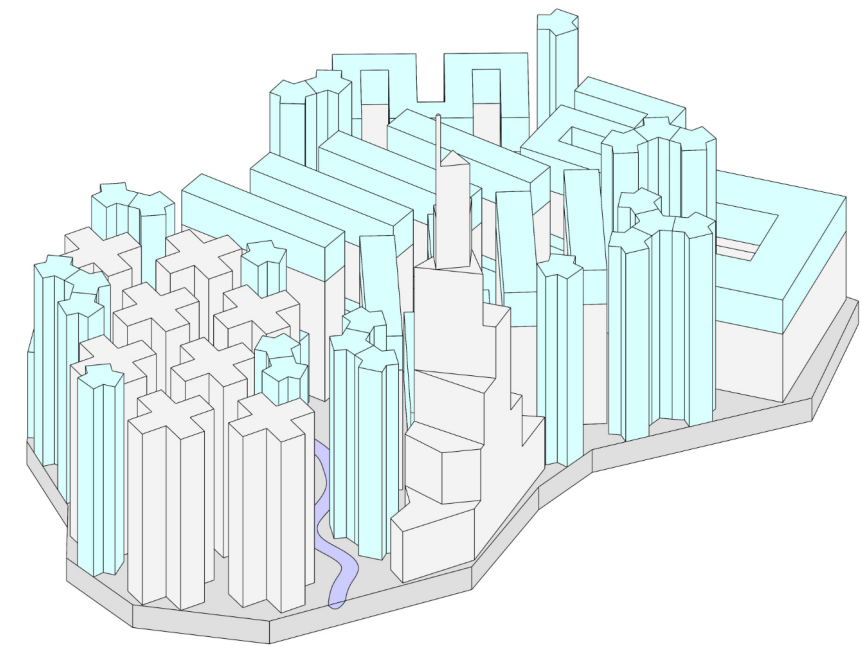
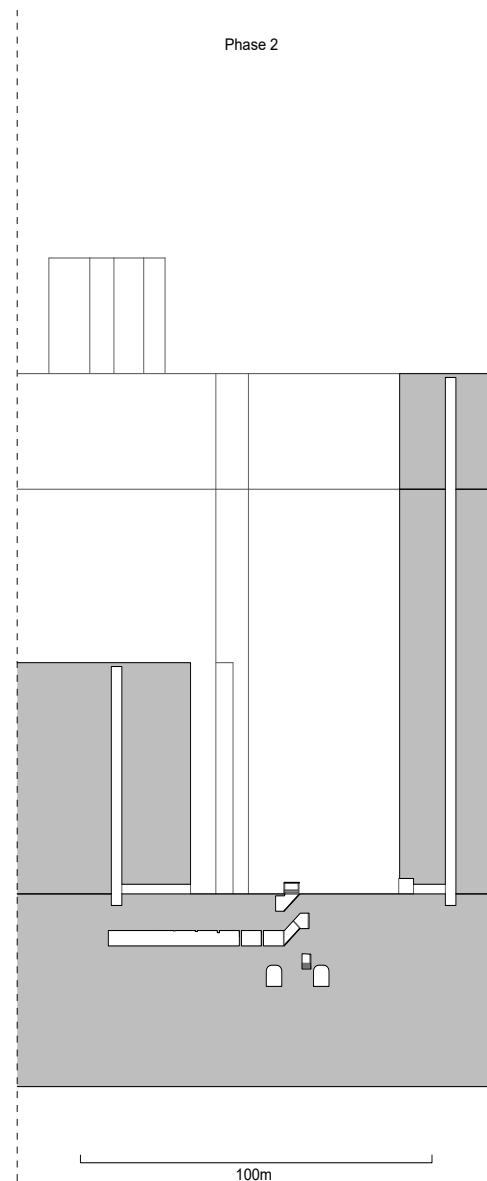


Phase 1

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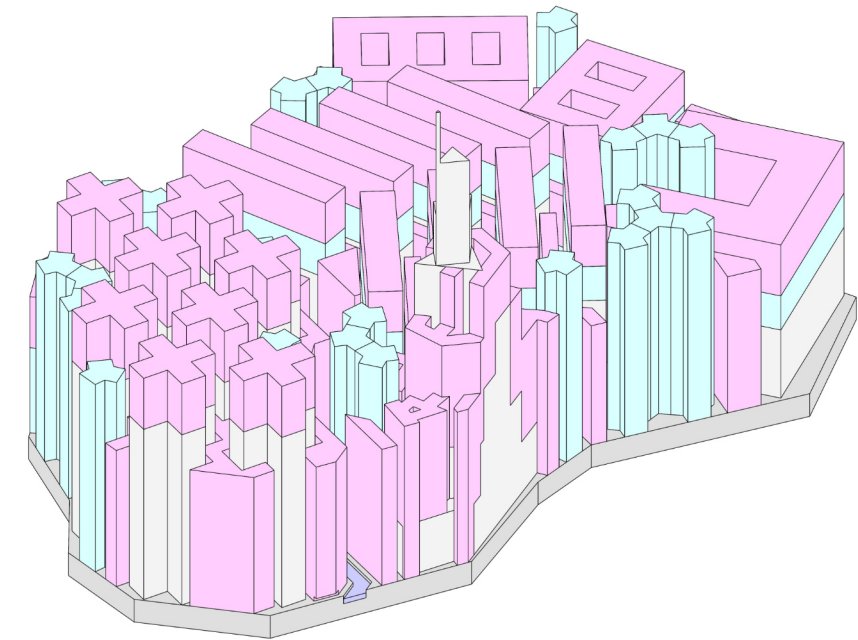
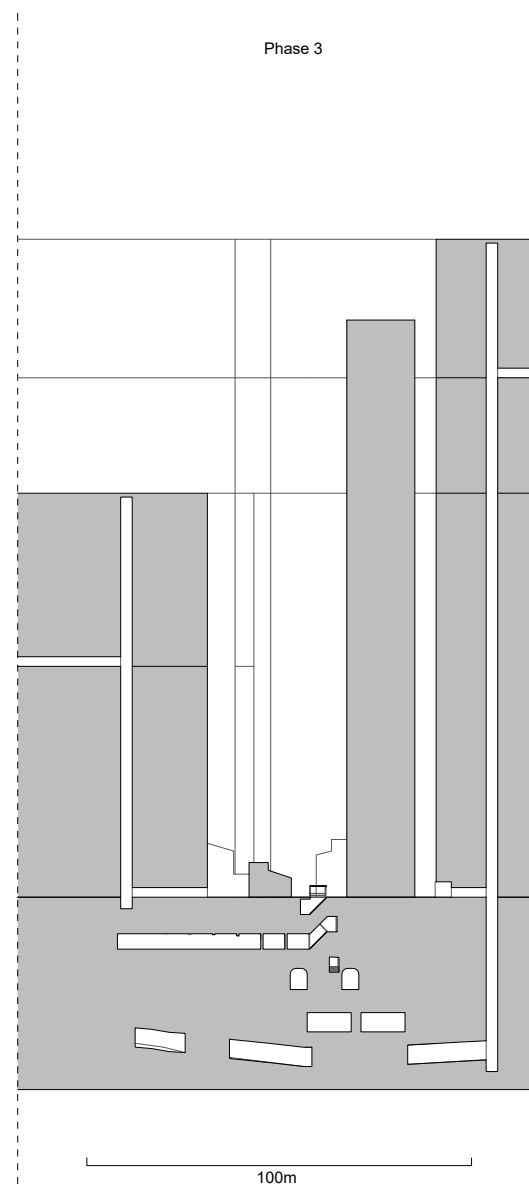
Phase 2

In this phase the regulations on proximity to other buildings have been loosened noticeably. Structures are added in several ways. The first way is the additions of smaller modular units that can be built in chains depending on the amount of available space. These fill out many of the buffer zones from phase one and are 55 storeys tall. Longer but thinner rectangular buildings fill out other spaces, mainly the empty slots between some of the rows of buildings from phase 1. They don't go nearly as high as their phase 1 neighbors, only 20 storeys. Lastly extensions to some of the phase 1 buildings have been added on top of them, making them taller. These extensions add an additional 10 storeys per building.

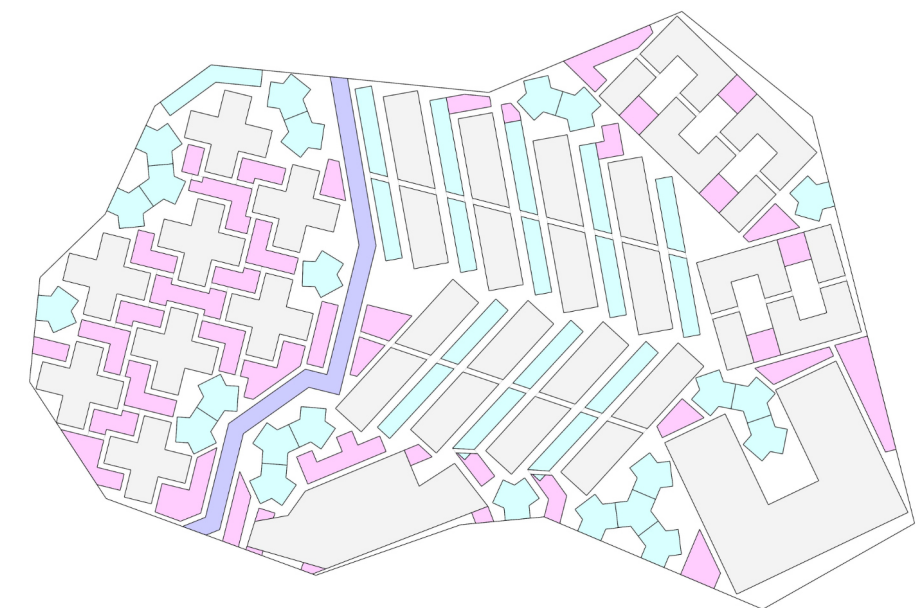


Phase 3

By phase 3 the proximity to other buildings is pushed close to the limit and most empty spaces between buildings have been filled in. The proximity to new buildings is just 4 meters. Because of the need to maximize the available space many of the new buildings take on irregular shape simply to fit into the gaps. Structures from both phase 1 and 2 get additional extensions on top, making them 15 storeys taller. Informal settlements start to pop up on the street level and on some rooftops.



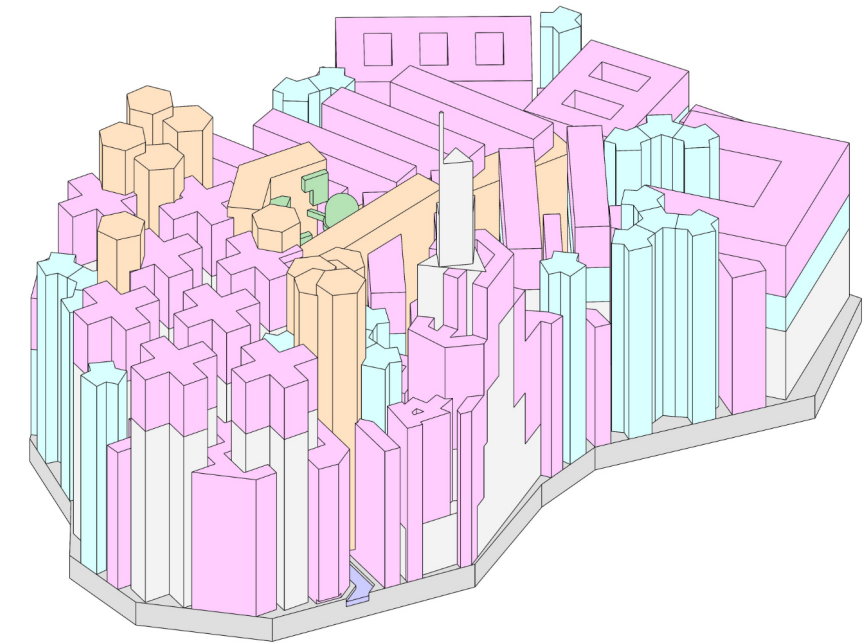
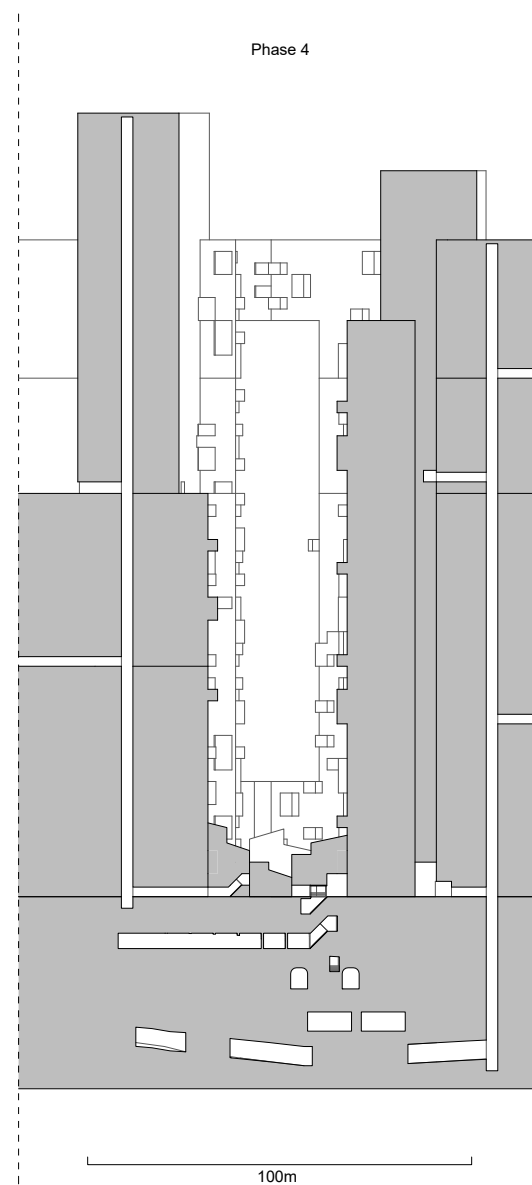
Phase 3



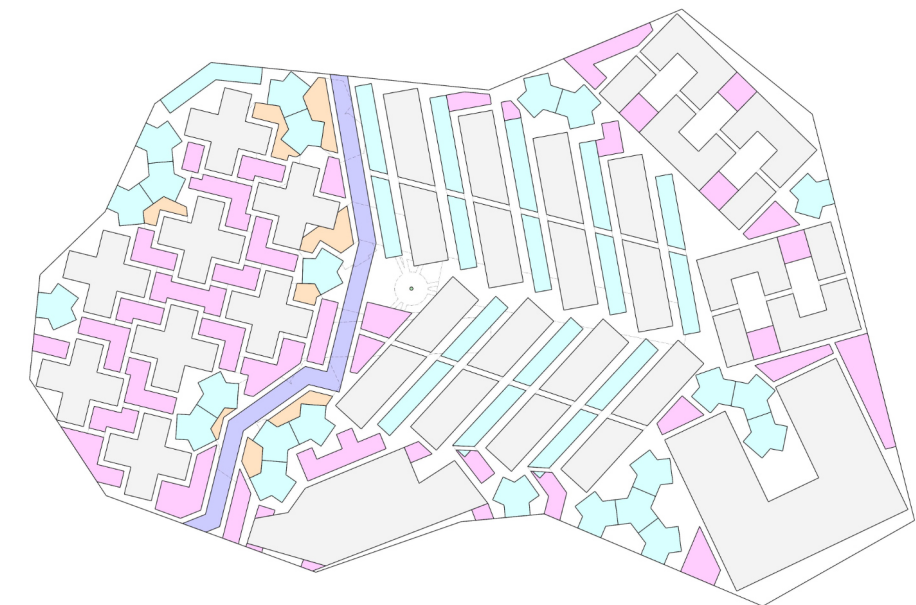
Phase 3

Phase 4

At this point regulations on where and how close to build are basically not in use anymore. As there is virtually no more empty space to build, new structures are erected between existing buildings, bridging them and leaving no space in-between. The informal settlements at the bottom of the wells and shafts are starting to build on top of each other, forming a layered network of buildings. Extension kits are being sold so that you can add an extra room to your apartment on the outside wall, utilizing the unused vertical spaces of the city. This gives all buildings a somewhat grainy surface. A system of external pathways starts to take shape on and between the buildings to offer relief from the overcrowded internal communication systems.



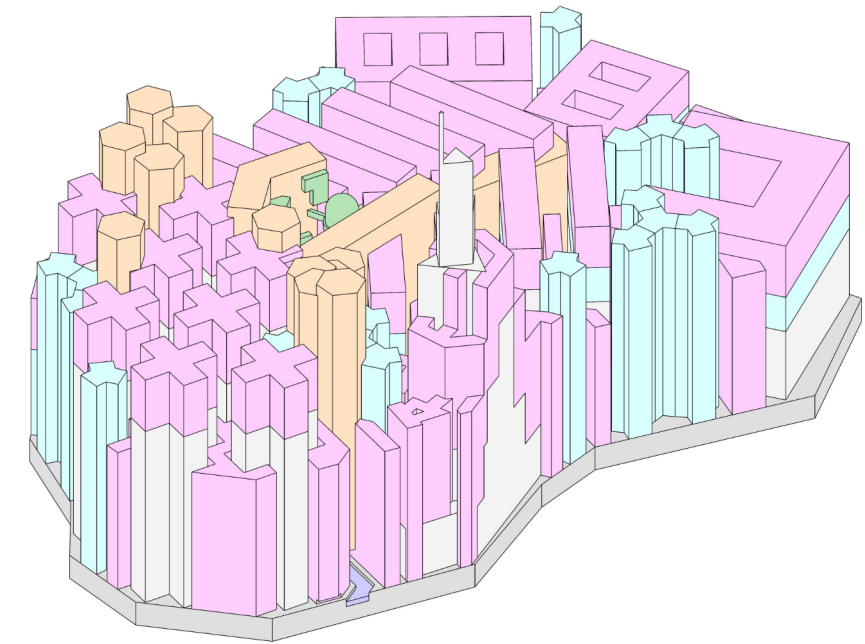
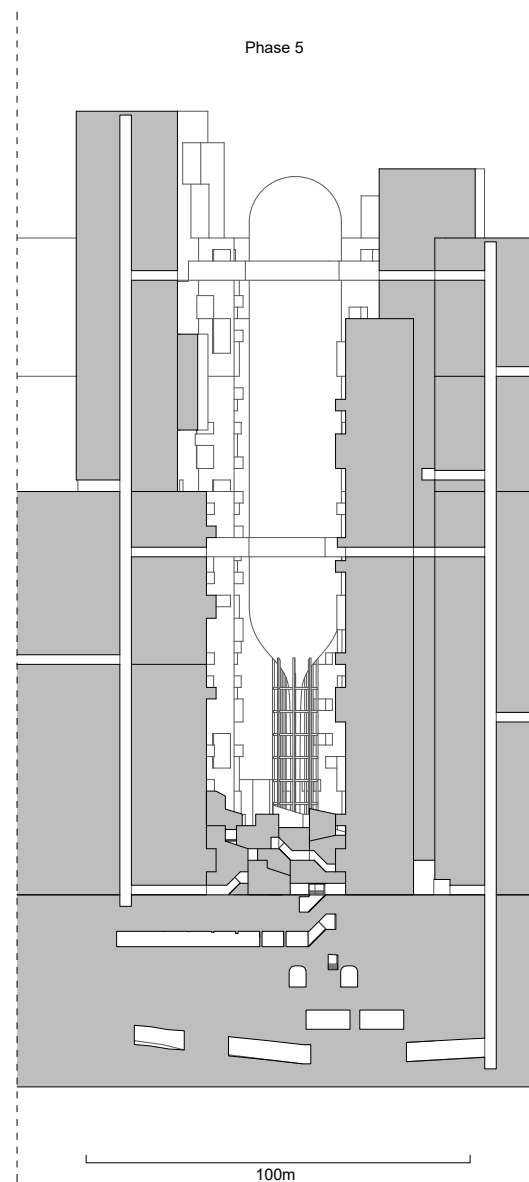
Phase 4 & 5



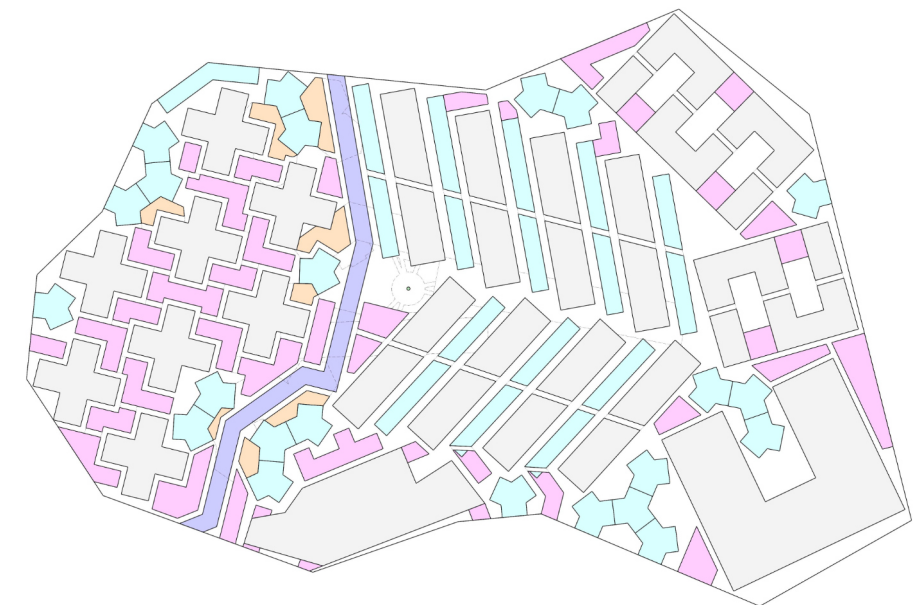
Phase 4 & 5

Phase 5

In phase 5 there isn't really any space in between the buildings to expand anymore. Most expansion now happens on a smaller scale on the exteriors of the existing buildings. Apartment owners are now renting out their extension kits as external housing units and a large number of informal ones are popping up as well. The informal dwellings on the lower levels keep expanding both up and down, creating a complex layered system of tunnels, stairs and structures built from scrap material. The network of external paths expands to give better coverage. The internal communication systems are now so overcrowded that using them is becoming a luxury not everyone can afford, leaving the external system as the only option for the poorest.



Phase 4 & 5



Phase 4 & 5

External pathways

Because the internal system follows a tight grid and structure it offers little flexibility. While most buildings are connected by the later phases, that doesn't mean you can go straight from one place to another, the internal connections between the buildings are not that straightforward. For example, there might be a business or apartment where the connection would go, but the occupants are not willing to give up their space.. The connection might then need to be placed on a different floor. As this happens over and over the paths from point A to point B can become highly irregular and winding. Besides this, many interior spaces are not open to the public. They might be limited for usage by employees, residents, or simply put behind a paywall.

The system of external pathways developed as an alternative to this. They are informal structures that are mounted to the exterior walls of the buildings. Because they exist in the spaces between buildings, they can be arranged more freely, creating more flexible alternative routes than those available indoors. If a new building is erected, they can easily be rebuilt into a new configuration. In that sense, they function more like a street grid would in a normal city, only spread across many vertical levels at once. They are structurally limited to the walls, and in order to more directly be able to cross over the gaps between buildings there is a system of bridges and ferries going across.

One important factor about the pathways is that they are free. They are built out of a demand and a necessity of the less wealthy inhabitants of the city. This comes with several problems. Firstly, as informally built structures suspended high above the ground, they are not very safe. Neither do they offer the support in moving upwards the way elevators or escalators do. If you want to go up using this system, you'll have to take the stairs.

Lastly, these pathways are also necessary for many of the parasitic structures on the walls, serving as their only link to the rest of the city (particularly those disconnected from the apartments within their host buildings). In a sense, the exterior walls of the buildings become their own neighbourhoods of the city, with streets and dwellings.

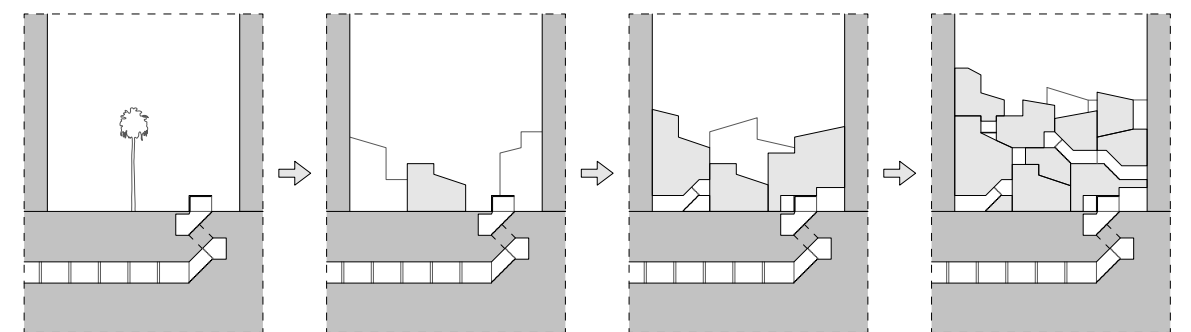


Layering

A city being structured into layers is commonplace. You have your street level, below that comes pipes for sewage, drainage, electricity, etc. Below that might be a car tunnel and even further down, perhaps a subway. In denser cities the layers start building upwards as well. Besides the obvious layers within a building, you might see bridges, elevated rails, walkways and so on. This stacking of structures creates layers, all of which must connect to each other in one way or another, making the city vertically complex.

In the later phases in my city, the layering has reached extreme levels. To maximize buildable area, both subway and car roads have since long been put underground. The former street-level roads have been overbuilt by informal settlements, with smaller paths in between. These structures have over decades had to stack on top of each other for a lack of space, making for a complex system of buildings and pathways. In many ways they resemble the Kowloon Walled City, except that they are placed between even larger structures. These informal areas are dug downwards as well, carefully dodging the pipes below. They continue down to the subway, creating a constant sequence of man-made structures extending all the way down.

At the top of these informal areas begins the network of external paths. These paths cling to the walls of the surrounding buildings and continue all the way up to the rooftops of the city. This creates even more layers to space between the buildings, but a space that is irregular, complicated and unmapped. This is in contrast to the interior of the formal buildings, which are much more structured, thought-out and legible.



Stairs and elevators

When you are traveling in a city, walking is always free. If you want to get somewhere faster you take the subway, a taxi, etc. In this city, the flow of people is enormous, simply because of the sheer number and density of people living in any given space. Considering the height of the buildings it is more than likely that your destination will be on a different level than you, probably tens of floors in difference. This creates a constant need for people to move vertically, a lot more than any existing cities have. Walking up 40 flights of stairs is tough for almost anyone and impossible for some, just as walking across a large city is. Elevators are a much more convenient choice. But considering the constant and enormous flow of people wanting to move vertically, the elevators cannot account for all, especially if people only go a few floors up or down. In the same sense that people pay to take a faster or easier means of transportation than walking, the elevators would also be something to pay for rather than something free, after all, they serve a similar function to buses and, like buses, cost their operators in both maintenance and space (space is an incredibly valuable resource in a city like this).

All over the city there are these elevators that you can take to get further up, just like there would be subway or bus stops all over a city. These would be the elevators that were originally meant for the users of the building, but as all buildings now are interconnected, they serve anyone who needs them. They would still be owned by the building, or by whoever has bought the rights to them, and the owner can then collect the money for them. There are free elevators that are city owned, but nowhere near the required number. The lines for these are enormous and their placements are not always convenient, which is why many choose other options if they are only moving a few floors up or down. Many people use elevators mainly to get up. Stairwells are generally free and walking downstairs is a lot easier. This leads to a flow of people in which elevators are full of people going up and mostly empty going down, while stairwells are the other way around.

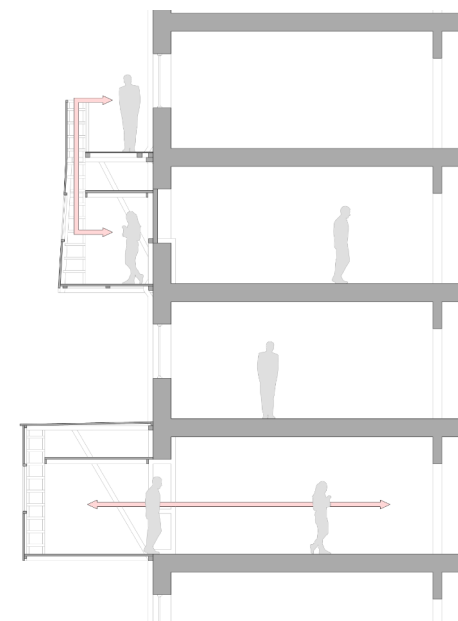
Parasites

By phase 4 virtually all buildable space is occupied. All major buildings are clustered up into enormous structures, while the little available space there is left on the ground and roofs are also overbuilt with layers of informal buildings made of scrap-material. There are however still large unbuilt spaces: the walls of the larger buildings. As all horizontal space is occupied, these vertical lots become the next logical place to build. Initially they are used to add extensions of the apartments inside the buildings, as a way to make your living space larger. These extensions follow clear structures and sizes, and are sold as modular kits, like buying an extra room for your apartment.

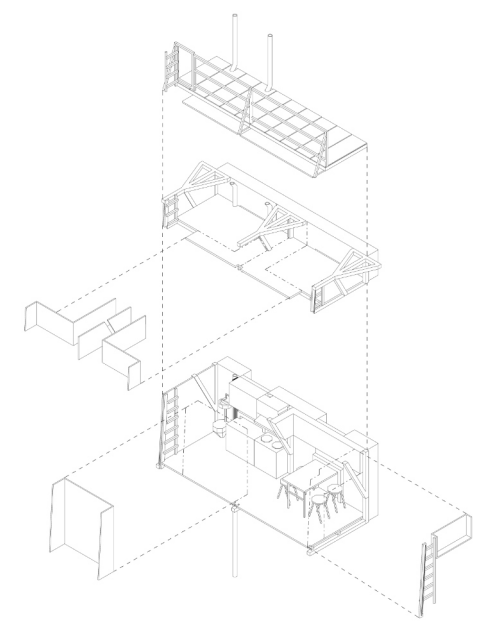
All buildings erected during and after this time are built so that these extensions can be easily added, with holes in the wall where you can mount the beams necessary to hold the extensions up. On the older buildings, other mounting structures become necessary. These use a system of beams that are mounted inside the apartment, connecting via the windows. In this way they can connect without interfering much with the structural and load bearing elements of the main building.

Quite quickly, as the lack of space is ever-present, less formal versions of these extensions start to show up. These act more like parasitic structures on the buildings. Much like the structures at the bottom, these are constructed from salvaged material and built without proper planning. There is however still a large emphasis on structural integrity, as lack of it would be fatal.

A system quickly develops where these parasites become their own dwellings, separated from the apartments inside. The owner of the apartment rents out their wall space for someone to house their parasite, just like a landowner would, only vertical. Some of the parasites are still connected to the apartments, allowing their residents to use the stairs or elevators. Others are entirely disconnected, having to instead rely on the system of external pathways and stairs for communication.



Communication via external network and via host apartment



Exploded view of a parasite connecting to the external road network

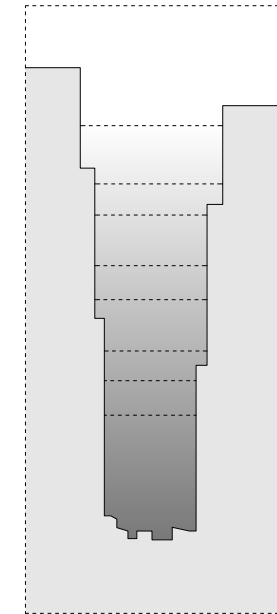
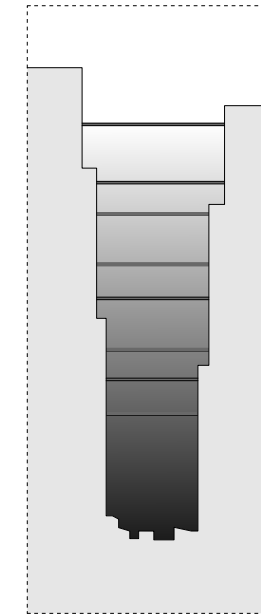
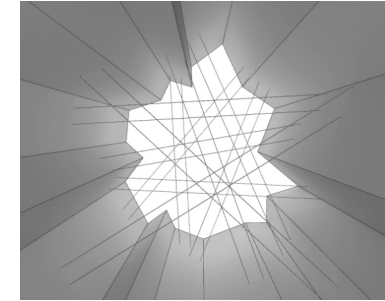
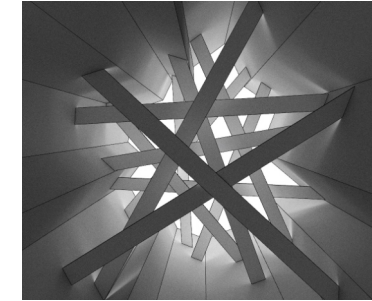
Bridges and ferries

As I mentioned previously, to make faster connections across the gaps between buildings, the external pathway system uses bridges and ferries. You could think of it as digging a tunnel through a mountain or building a bridge over a lake. Before you would have had to go around it, but now you can cross it, cutting travel time. More extreme examples would be the likes of the Suez or Panama canals, where you would save weeks or months of a journey. In this case we're perhaps talking about shaving off just a couple of minutes.

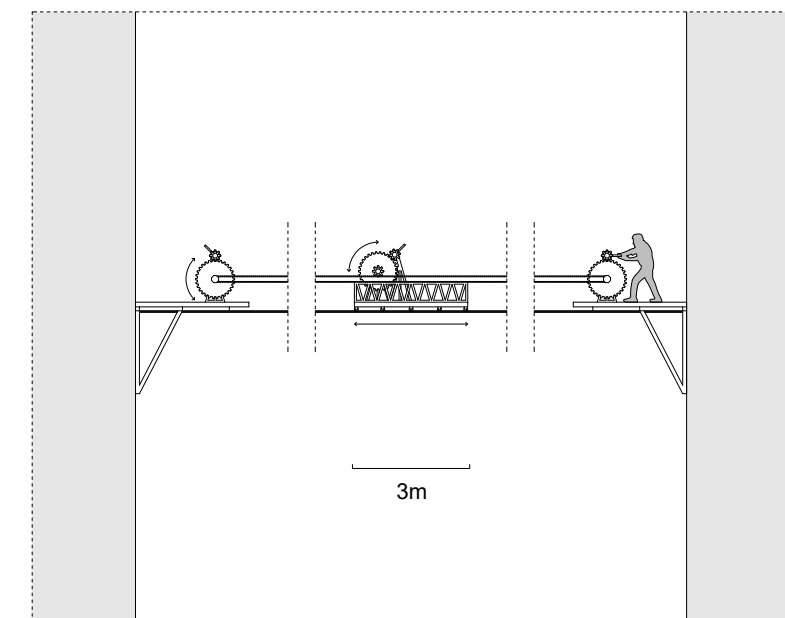
These transversal connections do not come into place until the external system has already developed quite a bit. You don't start by building a bridge, you build a road around the obstacle first. The first crossings are all static bridges. These can be built using the same materials and design principles as the other pathways. They require minimal maintenance and allow travel in both directions. However, they have several flaws that quickly become apparent. To begin with, they require large amounts of material and become heavy, requiring strong reinforcements where they are mounted to the walls. If they are long they might even require a support in the middle as well. They also clog up the open space between the buildings, especially when many are built above each other. This blocks out skylight and further congests the city, reducing visibility and restricting airflow. The already dark lower levels now become even darker, damper and unhealthier.

As a response to this problem, a new technique is introduced, building ferries instead of bridges for crossings. They consist of wires being installed between two fixed points, and a manually operated, hand-cranked ferry that goes between these, using a mechanical solution. These take away the two main problems of the bridges. The construction is lightweight and doesn't require complex mounting systems. More importantly, it doesn't congest the open space nearly as much, the only thing you might see looking up is a ferry going across the gap and, if you look closely, a few wires. It is also a lot simpler to move the anchor points of the wires when necessary than it would be changing the direction of a bridge.

There are downsides however, the construction is more complicated and with moving parts, maintenance is much higher. It also offers much less flexibility of movement as it can only move one way at the time. But because of what there is to be gained in terms of preserving natural light, the ferries see use particularly at the higher levels where their impact on the light is greater. This pattern is clearly visible in the city: lower levels predominantly use bridges, while upper levels rely on ferries.



The effect on light at the bottom of the well with bridges contra ferries



The ferries operate with a hand cranked, mechanical solution

Light and visibility

Darkness is a major issue for the city. Because of its compactness, with buildings merging into and stacking atop one another, a great deal of the city has no windows. For all of these, artificial lighting is essential. Likewise, because the city is so tall, the spaces in between are often very narrow, as is the case with the well this project focuses on. Very little natural light reaches the bottom, which is dark and damp. Most public spaces of the city are artificially lit at all times, and many people very rarely see the sky. Because of this, much of the population doesn't follow a sleep cycle based on day and night as this isn't something that they notice. In the city, any time can be day-time and many businesses run 24/7. While this may seem very chaotic it is good for the transport systems, as it evens out the flow of people. There are no rush-hours in the lower levels as there is no clear sense of "morning" or "afternoon". But it is also deeply problematic as the human body doesn't function properly without natural light. Common issues include sleep disorders, vitamin D deficiency, and mental health problems.

The only places that receive decent amounts of sunlight are the upper floors of the tallest buildings. Naturally these become the most sought-after and expensive, housing only the richest residents. This creates a balance where the richest people spend all their time at the top, never really venturing down to the lower levels. The top levels contain their workplaces, restaurants, stores, etc. and the lower classes rarely come up here. The middle levels receive lower levels of sunlight and the bottom none. The pricing follows this trend, leading to the city being vertically segregated, with the poorest living at the bottom, and the quality of life improving as you move up, following the amount of natural light.

Materials

For the larger and taller structures it is necessary to have very sturdy and long-lasting materials. These are almost exclusively built from reinforced concrete and steel, just like most skyscrapers. Because many of them are residential, the facades aren't covered in glass, but instead feature evenly spaced apartment windows. For older structures brick is not uncommon, but as the structures grow taller and heavier, brick simply can't support the weight. In the later stages it is solely used as a facade material. Some of the concrete buildings are left bare while others are painted. However, maintenance is often poor, leaving the buildings looking patchy. Iron and steel in various shapes are used a lot. It is easy to salvage and reuse, and usually age well. Much of the informal structures are built from it, with sheets, wires, and hand-welded beam structures featured heavily. There are however a lot of problems with rust, and many paint the surfaces to prevent this. This has varying levels of success, depending on at what stage you paint it, which can be clearly seen all over the city. For insulation, Styrofoam and mineral wool are common, mostly because they are cheap, low-maintenance, and easy to reuse. Wood is a rare material, reserved for the likes of furniture of rich residents who want an antique feeling, but hardly something used for construction. In a reality where space is so scarce there is hardly any place to grow the trees necessary for wood to be an option. Instead, industrially produced and manufactured materials dominate, such as steel, concrete and glass. The type of wood that is in use is various materials made from excess material, such as OSB or MDF boards, as these can be produced at much smaller costs and manufactured from discarded wooden structures.

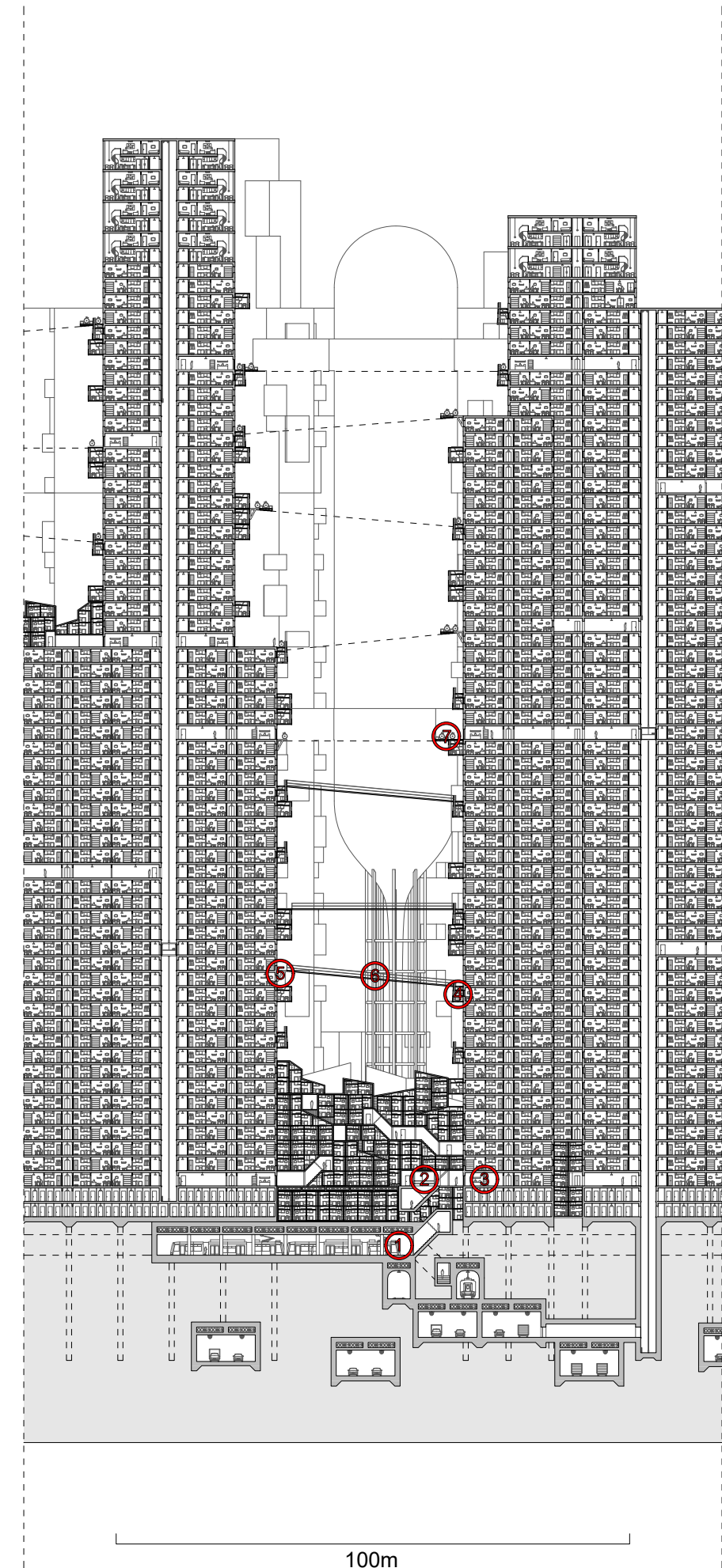
Mediums for presenting

As I was working on my city, I thought a lot about how to present it effectively. I wanted to make sure that the audience would get to experience all the most important bits, while at the same time keeping to the presentation timeframe while also making it nice and streamlined. For the purpose of this, I decided I would make a video showcasing it. In that way, I wouldn't actively have to control the walking through the environments, making it easier for me to focus on the presentation. I do realize this might seem counterproductive, given all my previous talk about dynamic and interactive representation. It was simply the best option given how the presentations are to be carried out.

The format of the video is a journey from bottom to top, trying to cover as much of my work as possible. It is divided into seven scenes. In between each of these are informative graphics, aiming to further explain what it is you are seeing in the scenes.

1. The first scene shows the subway and explains how communication works horizontally over larger areas.
2. The second scene shows what used to be the street level, but is now overbuilt by informal housing. You walk through artificially lit tunnels and can't see the sky.
3. The third scene shows how the elevator system works. You enter a ticket office and take the elevator upwards.
4. The fourth scene gives a view of the parasites. As you exit the elevator you move via an apartment and a parasite onto the external pathway network.
5. The fifth scene is a first look at the large well, the space between the buildings. It illustrates how the external pathways function.
6. The sixth scene shows the bridges and how they congest the space and block natural light.
7. The seventh scene shows the ferries, how they are used and their positive impact on light and congestion.

As most of these scenes play out in different places in the city and have cuts in-between them they are not interconnected within UE. I created them as different files and it is not possible to walk between them. However, the well is one big open zone (it would be hard to split that one up) in which it is possible to move around, walking from the bottom to the top should you want to.



Density in numbers

While exact measures and numbers aren’t relevant to the project in itself, they can be a useful tool to understand the density in a more measurable sense, and to compare the phases to each other as well as real life cities. For this I have used FAR (Floor Area Ratio) as well as DR (Development Ratio) calculations for the different phases. These are standard tools within urban planning used to control how much can be built on a site in relation to its size and can therefore be used as an indicator of intensity. By having these calculations I can also put this speculative project into a quantitative context, it allows for larger clarity in what this city is compared to real life examples in a way that the visual material does not.

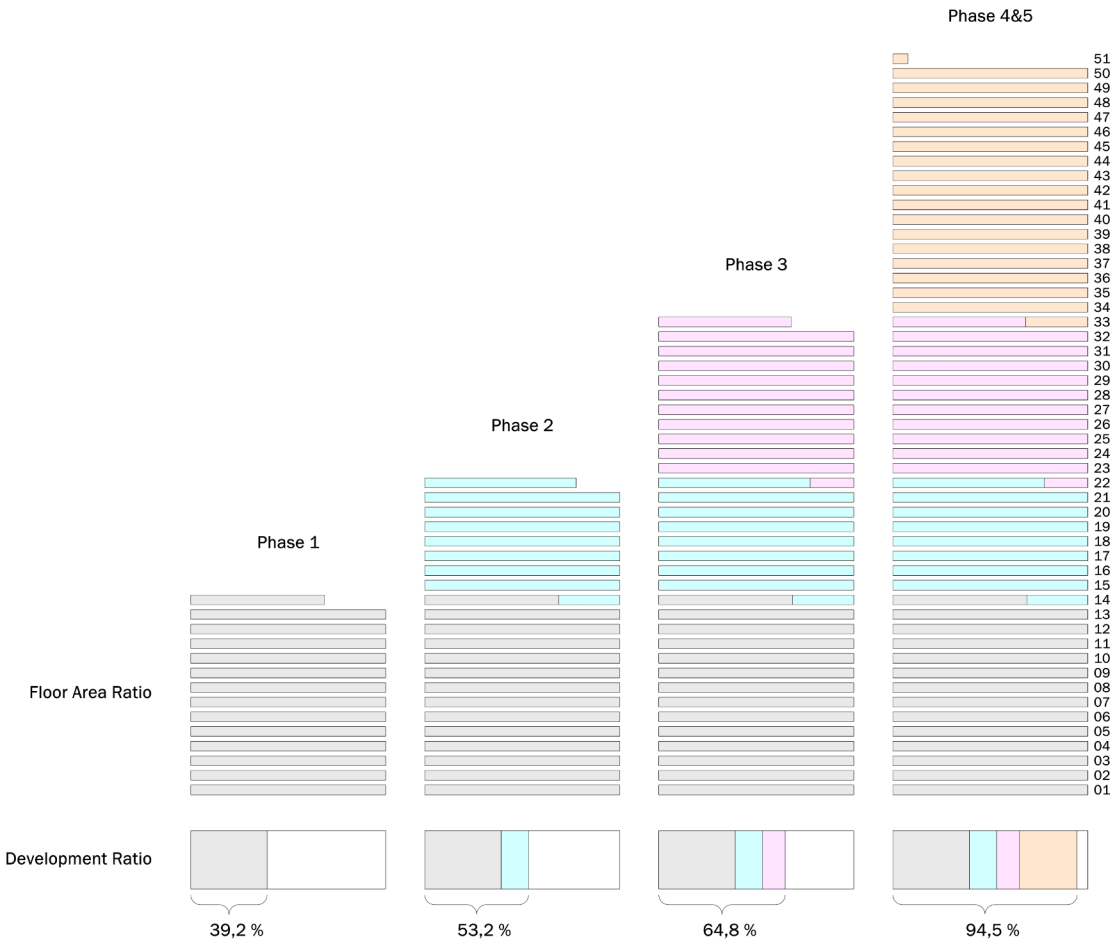
The DR indicates how much of the surface of a plot that has been built upon, strictly in a two-dimensional sense. 30 % DR means that 70 % of the plot remains unbuilt, regardless of how many floors the building has. FAR indicates how much usable space has been built, so here is where the number of floors becomes interesting. The FAR is still based on the plot size, meaning 100 % FAR equals the size of the plot, but it could be divided in different ways. For example it could be a one-storey building covering the entire plot, or it could be a 10-storey building covering 10 % of the plot. What this means is also that the FAR can go above 100 % (which is very apparent by the numbers presented on the next page), unlike DR which can never reach higher than 100 %.

As the phases progress both the DR and FAR increase to extremely high levels, far beyond anything existing. By translating the visual and experiential densification into these numbers I can as previously mentioned show the escalation of intensity in a more explicit and comparable way. Both DR and FAR are strictly regulated in most places to ensure a higher quality. Showing the progression in the phases numerically therefore further strengthens the discussion about regulation as a tool of structuring. When constraints are gradually loosened, the measurable intensity of the site increases accordingly, showing how a framework of regulations directly shapes and influences the outcome.

As seen by the numbers presented in the table, by the later phases the DR is nearing 100 %, leaving only very very few areas (such as the well) unbuilt with open sky. Even here it can be debated whether the informal housing at the bottom should be counted towards these numbers or not since the plots are technically not unbuilt. By the last phases we can also see that the FAR is roughly 5000 % which, considering the almost 100 % DR, means that for any given space there would be roughly 50 floors vertically which are truly staggering numbers. Using the same method you can deduct that in phase 1 each building averages 35 floors, all while the phase 1 FAR is only 27 % of the phase 5 FAR. What this tells us is that while the city has grown a bit taller over the phases, the bulk of the expansion has happened between the buildings, coming back to the theme of densification.

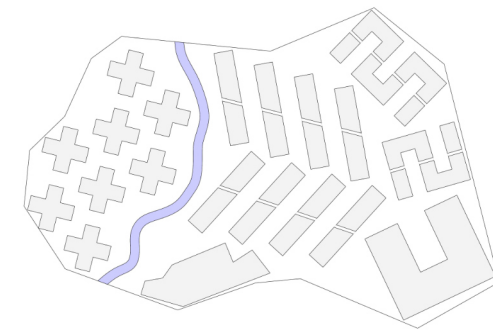
To put these numbers into perspective, the Mong Kok area of Hong Kong, which is one of the densest in the world, typically has a DR of roughly 85 % and a FAR of around 1100 % (Ng 2010). Copared to my phase 1 the FAR is not far off, but the density is much higher, meaning Mong Kok is more compact and low rise compared to phase1 which is more spread out and high-rise.

	Development Ratio (Phase)	Development Ratio (Total)	Floor Area Ratio (Phase)	Floor Area Ratio (Total)
Phase 1	39,2 %	39,2 %	1368,6 %	1368,6 %
Phase 2	14,0 %	53,2 %	808,0 %	2177,6 %
Phase 3	11,6 %	64,8 %	1090,5 %	3268,1 %
Phase 4&5	29,7 %	94,5 %	1739,7 %	5007,8 %

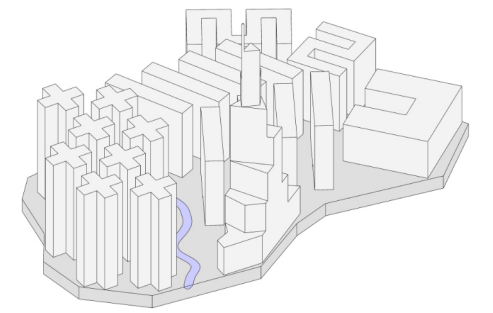


The lower bar represents the DR of each phase. The white part represents the area yet unbuilt, so that you can see the DR filling up like a bar with each phase. The upper bars represent the FAR of each phase. Each bar represents 100 % FAR (that is why they are the same length as the DR bar). The goal of this diagram is to help the reader get a more visual representation and understanding of what the numbers in the table mean.

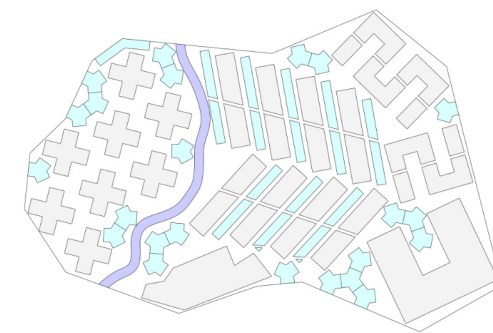
Phases



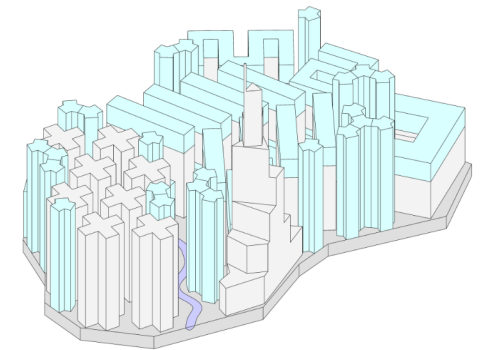
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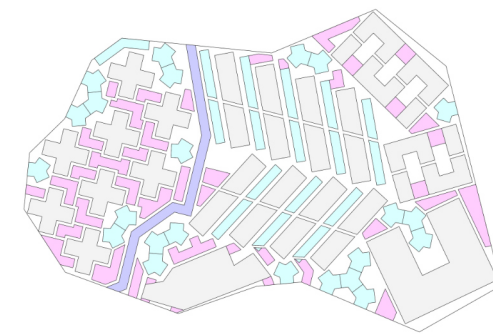
Phase 1



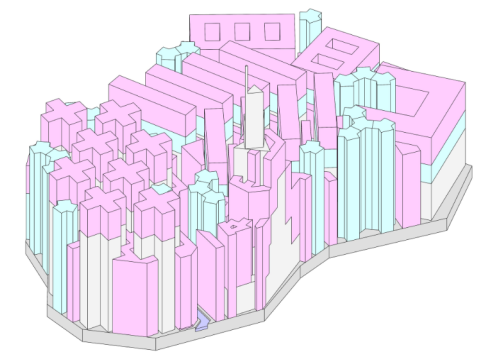
Phase 2



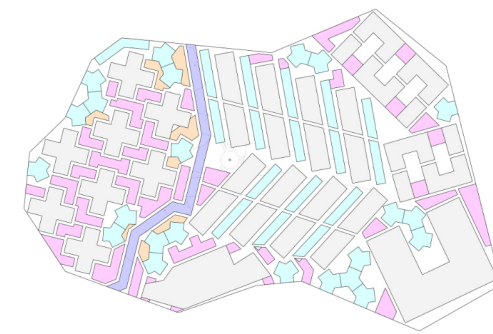
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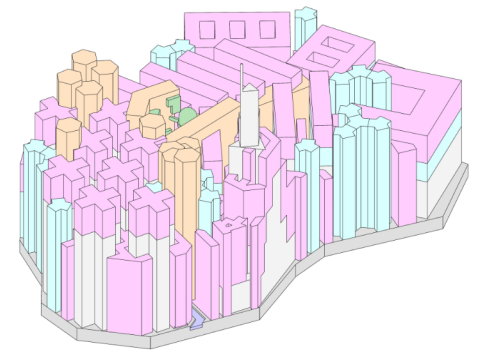
Phase 3



Phase 3



Phase 4 & 5



Phase 4 & 5

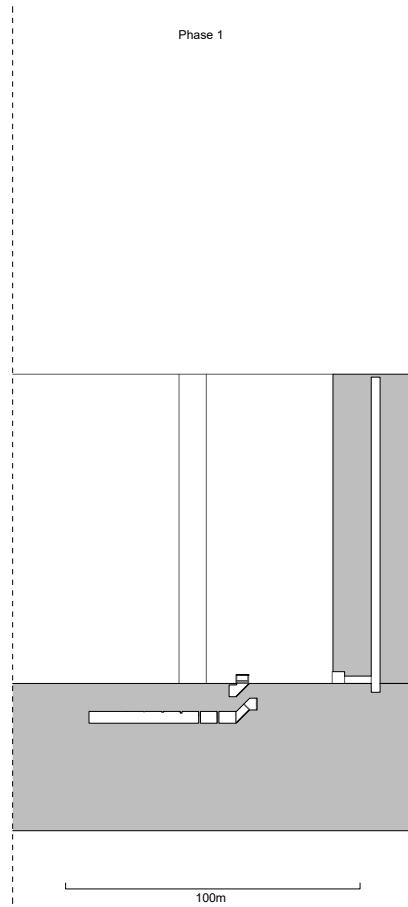
Material

The video

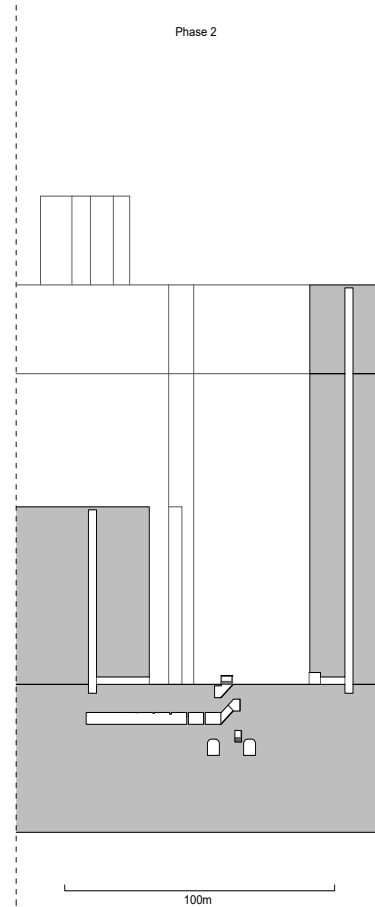


<https://youtu.be/8YtZLOkanqM>

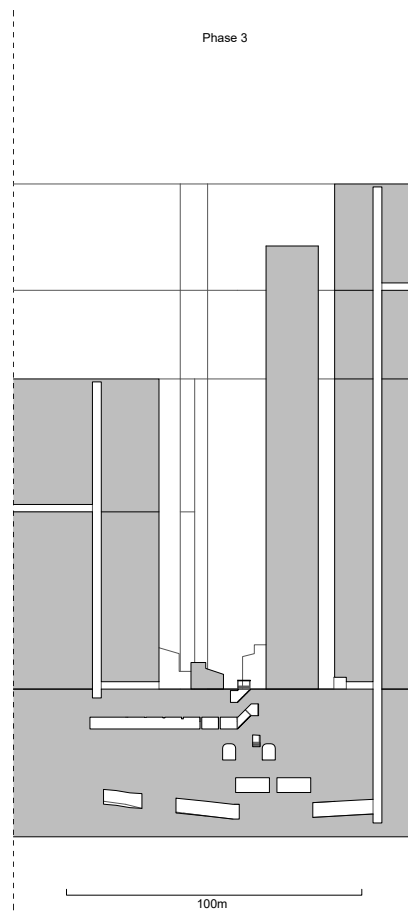
Phase 1



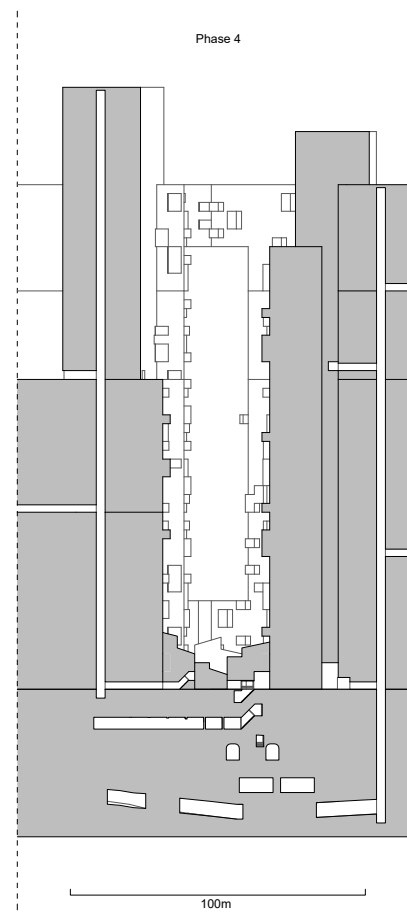
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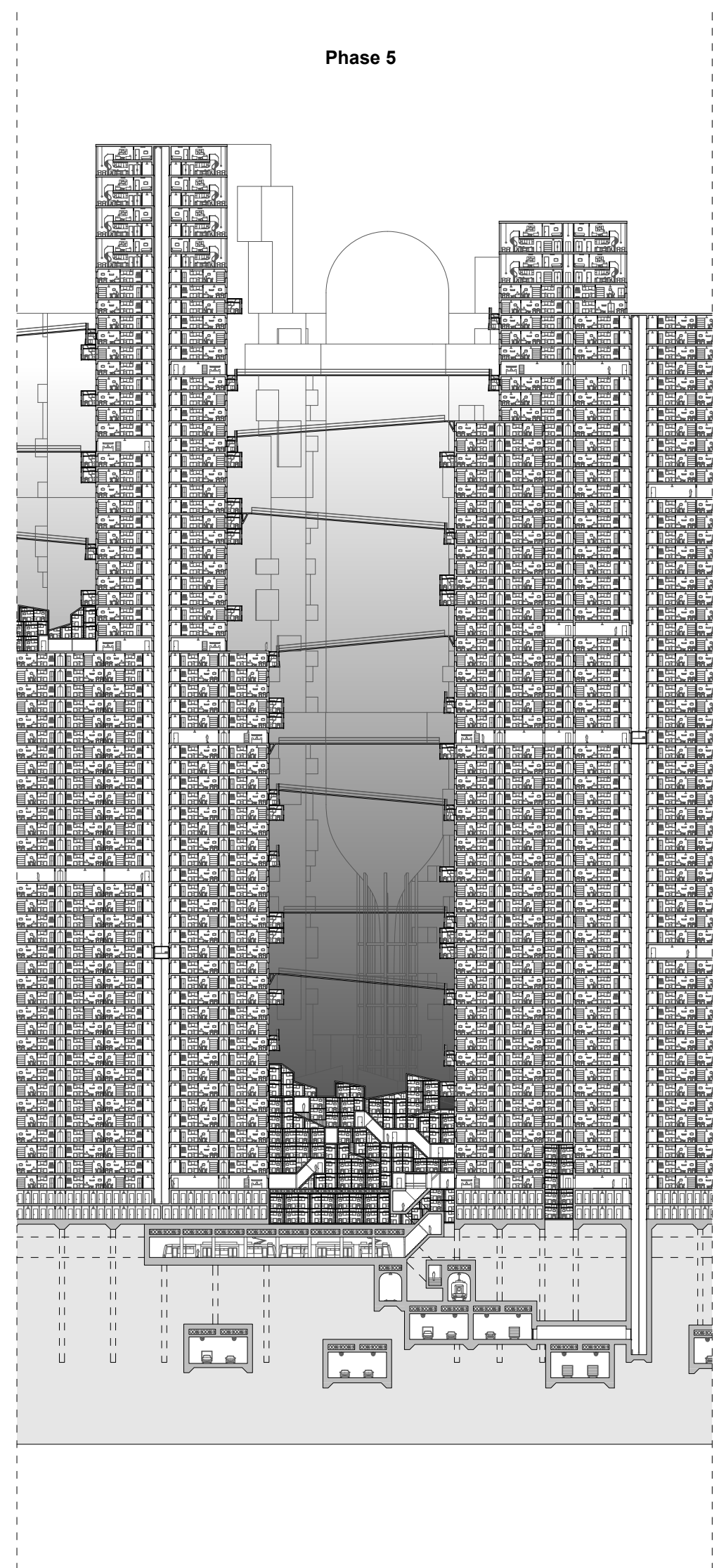
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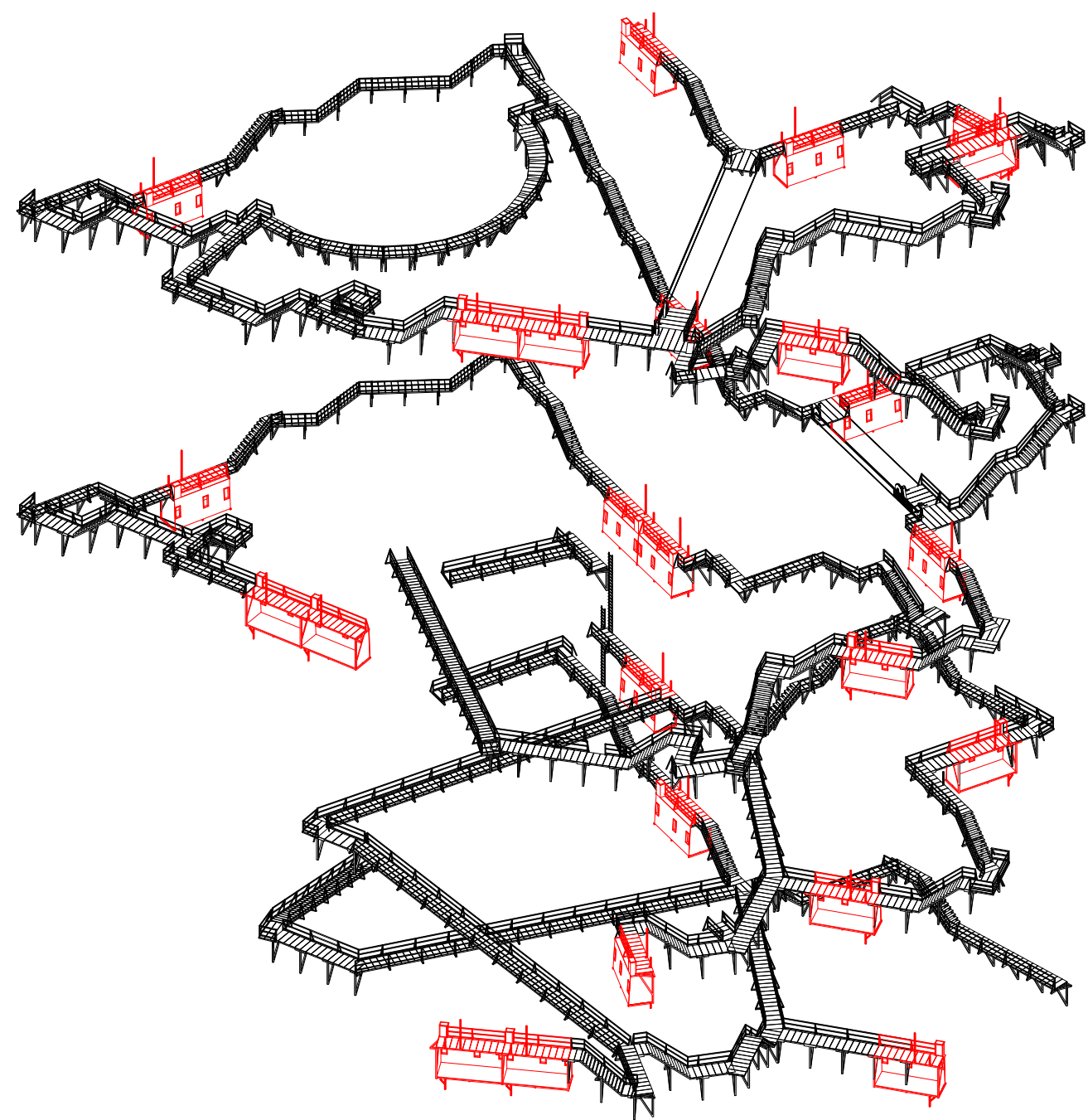
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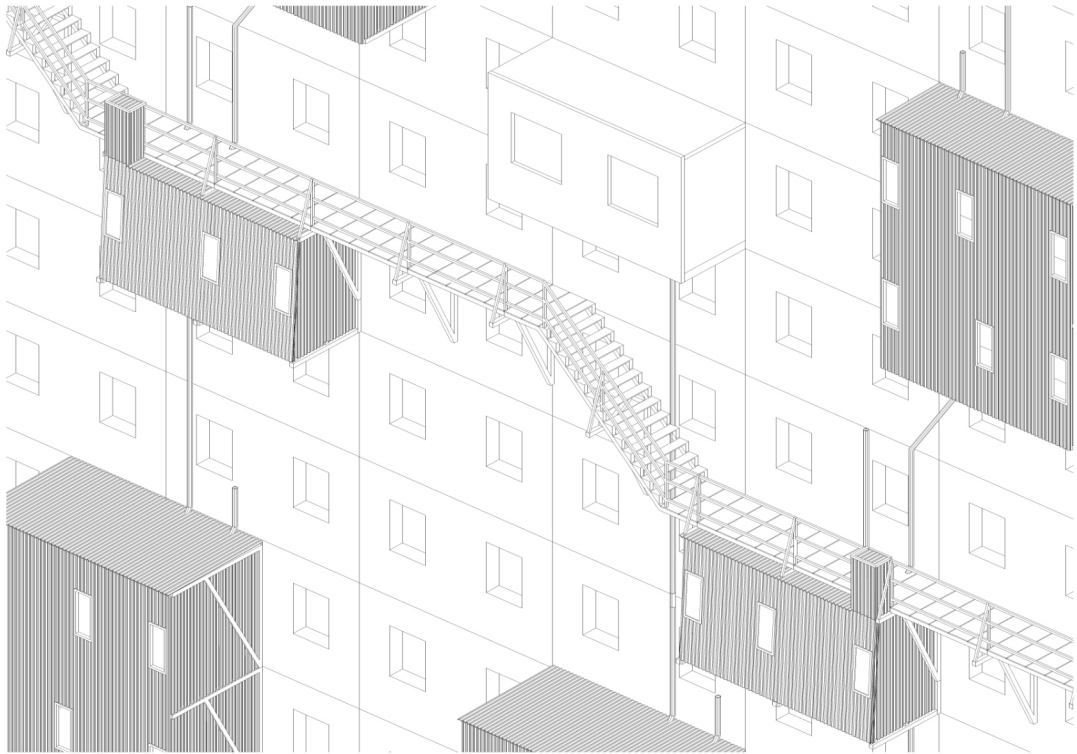
Phase 5



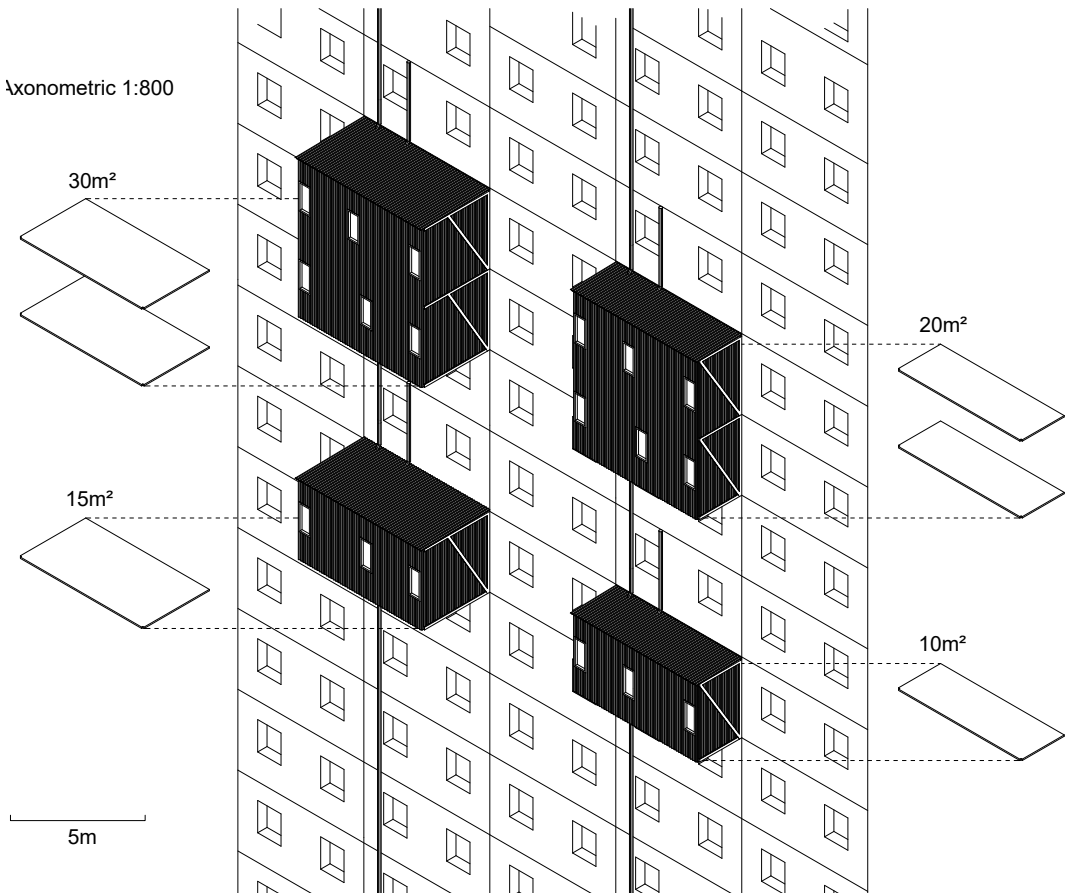
External pathways and parasites



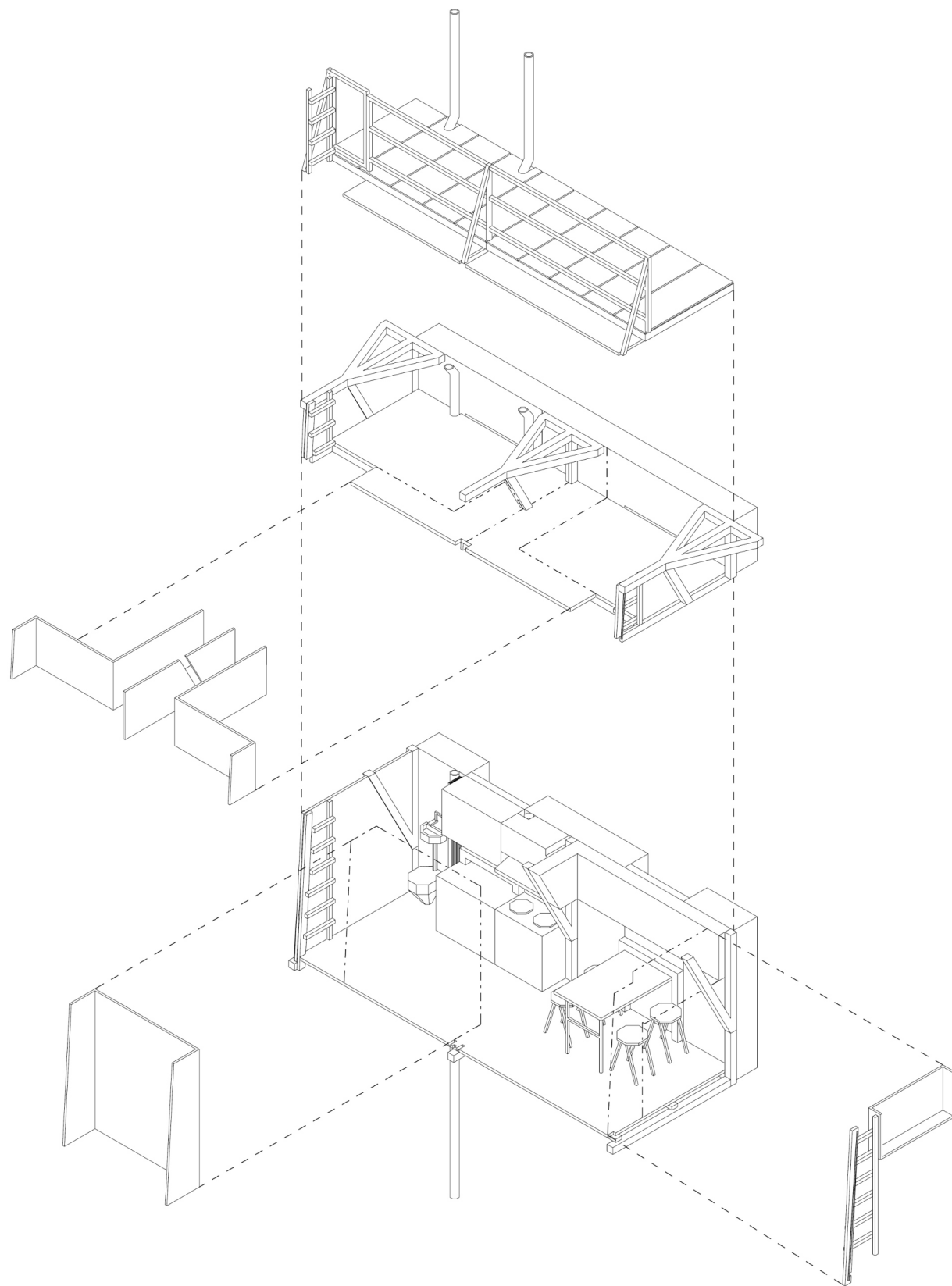
Map of external pathways (black) and parasites (red). Isolated without buildings



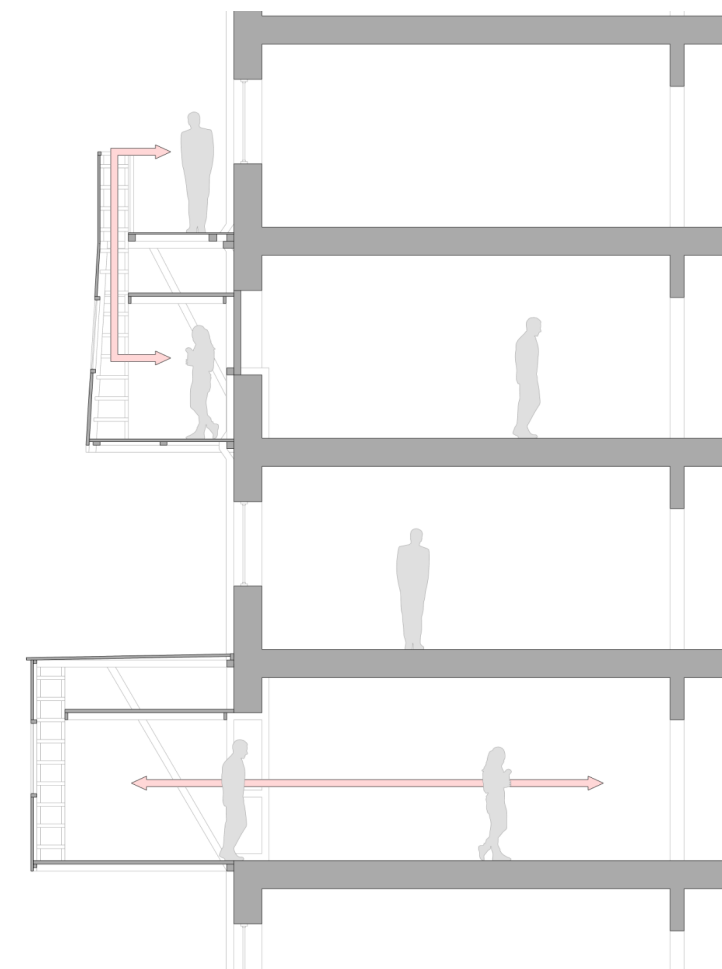
Parasites and pathway on a building wall. The apartments inside have been marked by the visible grid



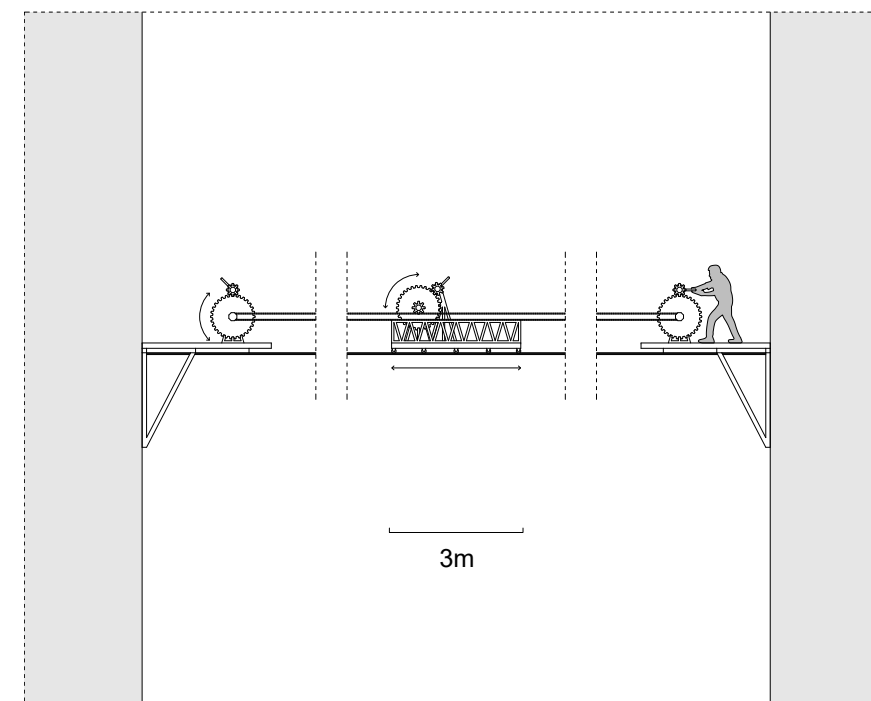
Different varieties of parasites, some taking up two floors and therefore paying rent to two landlords.



Exploded axonometric of a smaller informal parasite (~10m²)

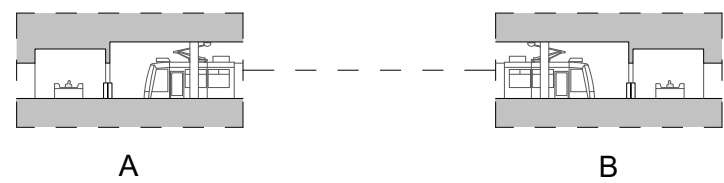
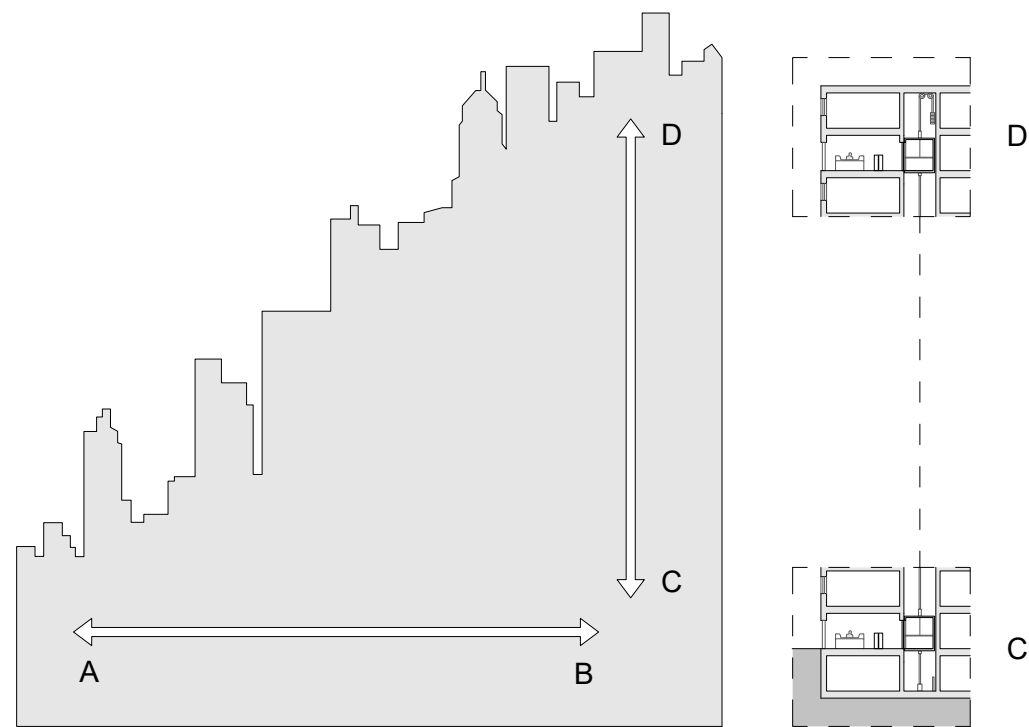


Some parasite connect to their host apartment, others to the external road network

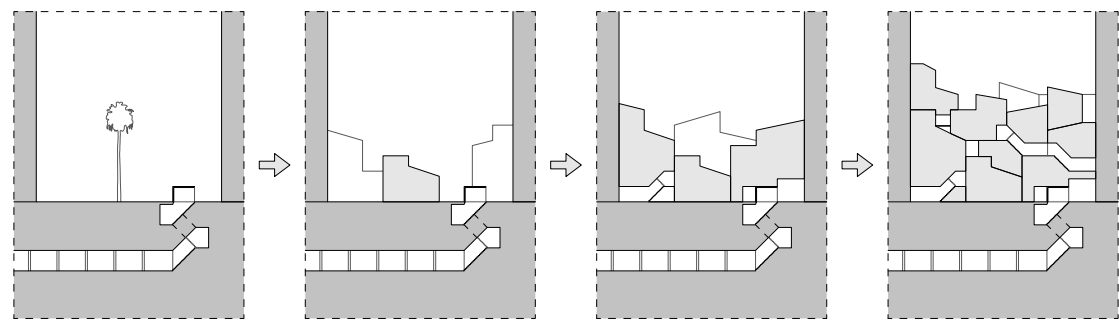


Schematic of the ferries, which operate mechanically via hand power

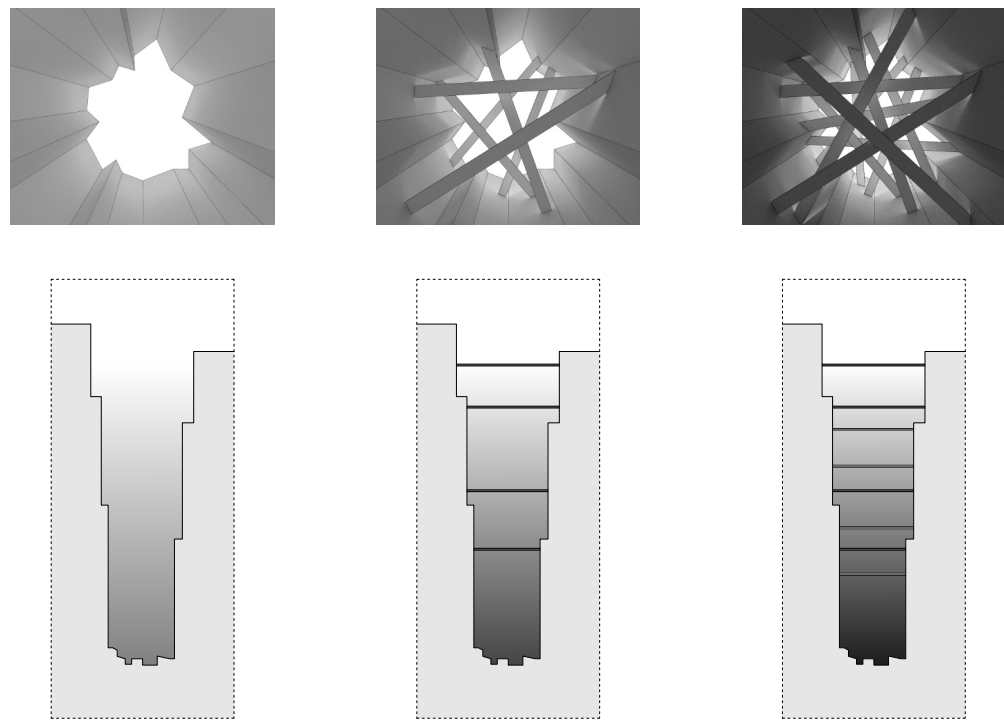
Diagrams and graphics



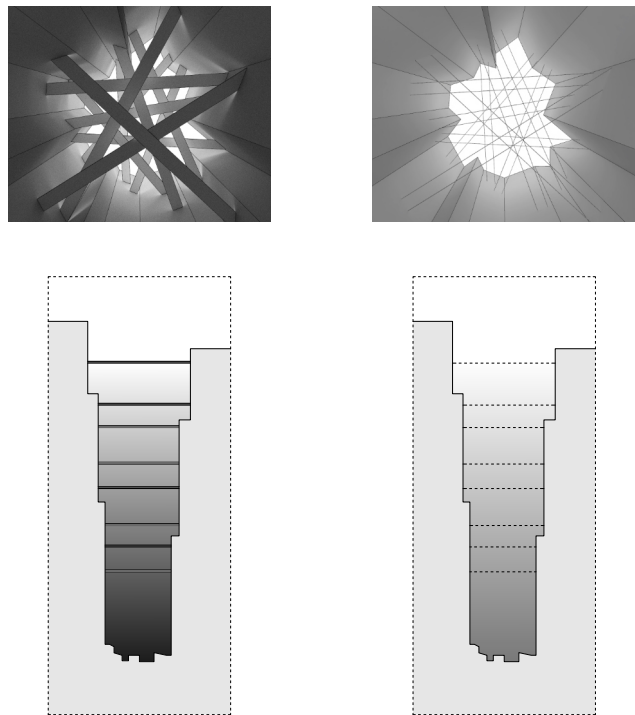
Just like the subway quickly transport you horizontally for a fee, so do the elevators veritcally in this high-rise city



Over the course of the phases, the street level has been overbuilt, so much so that the original street level is now subterranean



As more and more bridges are built, the space become increasingly congested, and the bottom increasingly dark



By building ferries rather than bridges, the space can be kept more open

Unreal Engine Subway



Subterranean ground level



Elevator ticket office



Apartment with parasite



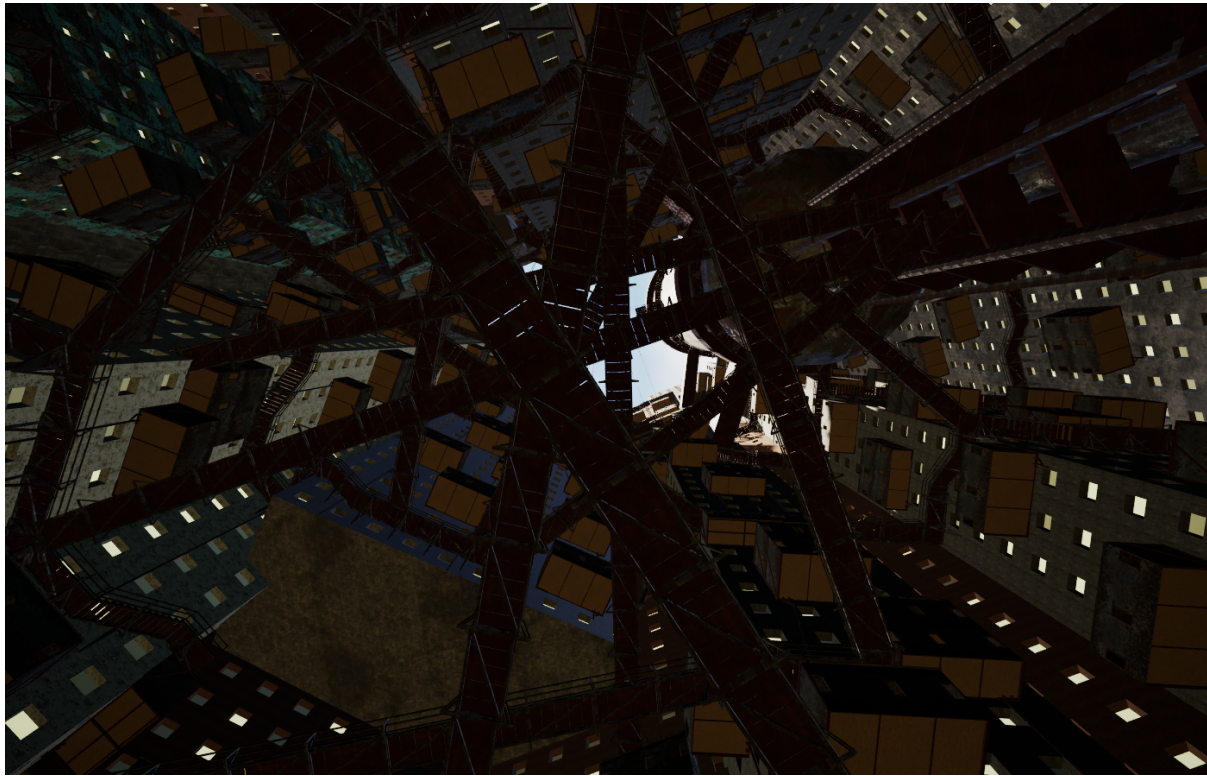
Office with door leading to parasite in the background



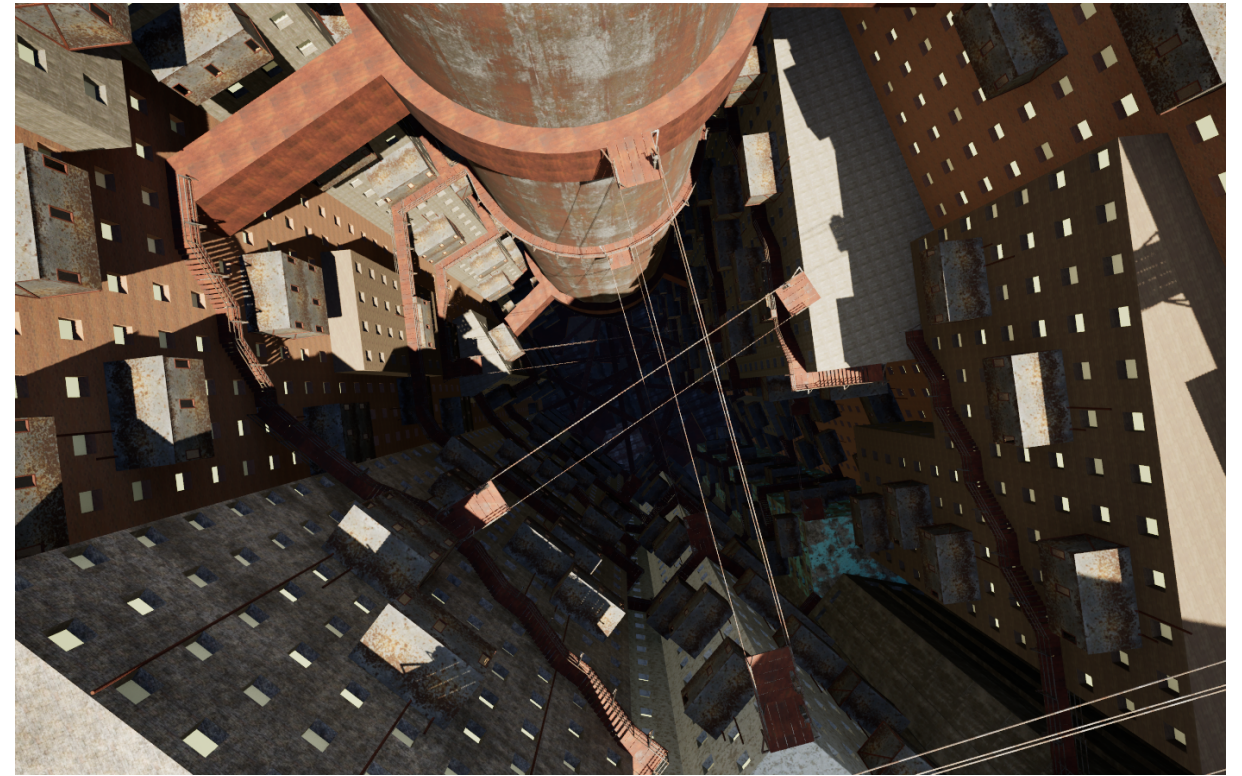
Interior of a parasite apartment



The well



Looking up from the bottom, the bridge congest the space and block the sky



Bird's eye view looking down at the dark bottom



Just above the bridges you see the ferries and their wires (barely)





The external pathways acts as an alternative to moving within the buildings, accessing places previously inaccessible



The ferries are hand driven with a large gearing exchange, making it possible for anyone to move it



Discussion

This project has examined hyperdensity as a condition rather than as a proposal or a way to solve the problems it brings. It uses speculations to test how spatial relationships change when density is pushed beyond anything from reality, but builds on observations and examples from the real world where vertical layering and compactness already challenge the limits of conventional cities. By extending these things into a constructed scenario, it focuses the project more on how architecture responds to extreme scenarios rather than attempting to predict what will happen in the future.

Working through an interactive digital model has made it possible to study how light, circulation, and regulation interact as density increases. This is not only as separate factors but also as factors dependent on each other in shaping out the environment. When the city grows denser, access to natural light becomes unevenly distributed and begins to structure the city vertically, making the floor level more interesting than horizontal location for spatial quality. Upper levels retain orientation, views, and environmental quality, while lower levels rely increasingly on artificial lighting. This first imbalance leads to other imbalances in the spatial and social, which shows us how light can work as an organizing element when horizontal expansion is no longer possible. What can be taken from the study is that in highly compact conditions, light is no longer something that simply enters a building and that everyone can have, it is something that must be actively negotiated through infrastructural decisions, rather than something to be taken for granted.

Circulation develops in a comparable way. Movement shifts from a normal, ground-based network of paths into a multi-layered system where vertical and lateral routes overlap and together fuse in a highly complex way. As the city becomes denser, the formal systems alone can not handle the enormous flow of people, and alternative paths form in the excess spaces. For that reason, circulation becomes adaptive rather than predetermined and is shaped by proximities, obstacles, and opportunities. What the project highlights is how in such contexts efficiency is not achieved through a clear system but rather through many parallel lesser ones, compensating for the limitations of the larger. When thinking about movement in dense environments it is beneficial to not think of circulation as a fixed system, but rather as an everchanging ecosystem.

Regulation plays an important role in trying to control these spatial effects. The phased reduction of constraints shows how rules regulating distance, access, and construction do more than only controlling safety or land use, they also structure how clearly the space is organized. When the regulations gradually disappear, the buildable area increases and spatial use becomes more chaotic. This comes at the cost of coherence, environmental quality, and easy navigation. From the project it can be interpreted that regulation is not only a limitation on design, but also as something that maintains a balance between density and usability. With this in mind, the simulated environment can show us how architectural order is not made possible by individual design decisions as much as by the frameworks in which they happen.

What has made these observations possible is the speculative design, which has functioned both as the method and the subject of evaluation. The advantage of this is to allow spatial conditions to be tested beyond the borders of what could actually happen or work in reality. By removing economic, political, and technical limits, relationships between light, movement, and form can be isolated and explored more easily and directly. By doing this speculation becomes an interesting and useful way of trying different scenarios and asking questions that conventional methods could not as easily do, especially concerning very large-scale or long-term transformations.

This is of course also a big problem, as the lack of real constraints leaves a lot of uncertainty regarding how these environments would actually work and perform. Without external factors such as structural, social and economic the project not only risks, but is in fact very likely to present the spatial logic in an overly simplified form (With that being said the conclusions drawn can still be very useful). For that reason speculative design is most effectively used not as a prediction as much as a conceptual testing ground. The value of it lies in finding tendencies, conflict and dependencies that can be used for later and more grounded investigations. So while imagining a future city has been a part of this project, that is not its main value, beyond for myself who made it. Rather the value for others lies in constructing a situation in which architectural factors can be observed at a more extreme level.

Interactive modelling is also turning representation into a new way of answering questions. Rather than describing something finished, the digital environments allow the spaces and their conditions to be explored sequentially and at a human scale, making it possible to get a feeling for how compression, visibility and connectivity are experienced. This project further strengthens the idea that digital tools have a rapidly growing role to play in architecture as a way to not simply visualize different outcomes but also to find answers to questions that would be hard to access from drawings alone.

To conclude, this project does not propose any proper solutions to hyperdensity, but it shows how architectural knowledge can be generated through digital exploration and speculative construction. It shows density as something that reshapes access and systems of movement and how this development is dependent on some form of regulatory frameworks. It also shows how modern ways of representation can help architects (and others) in working with such complex environments. At the same time it shows speculative digital space as an alternative for architectural research with the capability of testing ideas that conventional methods would struggle with.

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