Patterns of Urbanism:
A Design Framework for the Networked Cities of Today

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Abstract

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Technology adds a new dimension to human experience and is an integral part of economy, industry, health, education, and design. The city of today is connected, functions in real time and is growing at an unprecedented rate. Requirements of livability and sustainability present a major challenge in contemporary cities and will require the collaboration of stakeholders at local, regional, national and international levels. This research identifies a nine point matrix as a design strategy for the rejuvenation of urban environments. Each of these points or 'Patterns of Urbanism' is elicited from a study of urban theory, precedence of real examples and culminates in a design synthesis. The matrix is designed to link concepts of sustainability with digital experience and would benefit cities, urban planners and architects in the design of sentient environments of the future.

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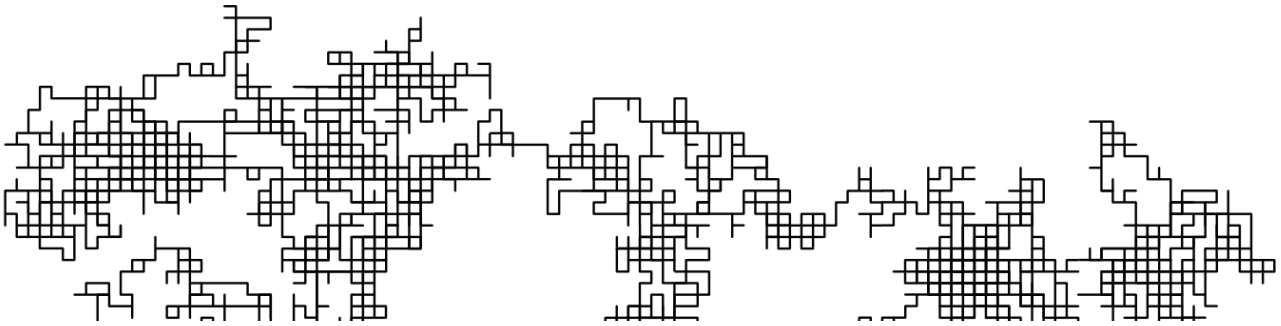

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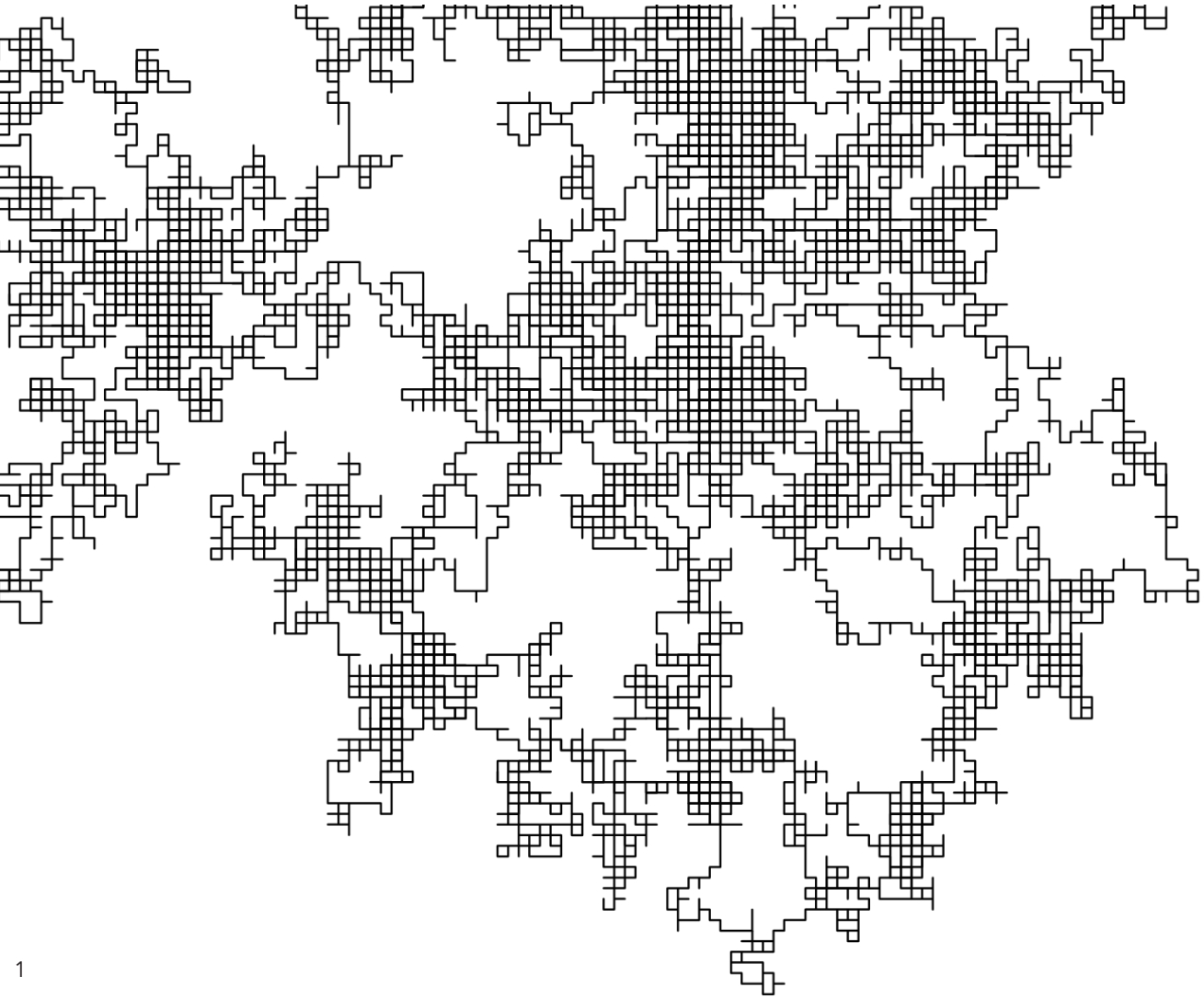

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For Ayesha,
the epitome of
quiet belief,
self assurance
and
determination

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Chapter 1 : The City

World populations are facing a steady influx from rural to urban centers, making for larger cities with greater population density than ever before. By 2050, two out of every three people are likely to be living in cities or other urban centers, according to a United Nations report.[1] There might be a number of reasons behind this great human migration to cities. One of these is that cities are increasingly becoming centers of innovation and networking that incubate ideas, knowledge and awareness.

Cities have always been places of economic and social opportunity. They emerged when hunter-gatherer societies were transformed into settled societies based on agriculture. From that time till today, human settlements have continued to adapt to change. And today, they are evolving and responding to change faster than ever and that has to do with information technology.

A city was typically an urban center surrounded by natural landscape or farmland. Post War America introduced a new definition of natural landscape: developers marketed housing where everyone could own a house with their own private acre of landscape.[2] This led to an economy relying heavily on the automobile and petroleum, and developments spread out and connected to each other by miles of roads. Within cities, natural landscape took the form of parks created as playgrounds for children. The city center became a hub of economic activity.

The networked twenty first century city of today allows unique interactions between people and technology. It can be argued that in the information age we live in, sharing of knowledge and cultures can be replicated digitally. However, the social and econom-

ic opportunity provided in these cities is unparalleled, but it comes with its own set of challenges.

These great urban centers have to be planned and run in a way that facilitates the life-style and needs of the 21st century society. It is for the city to realize its promise and be come a sustainable and healthy place to live in. It is for the architects and planners to foresee the effect of the growth cities; to help people understand the promise of living in a great city how it can be a good, long lived and sustainable place to coexist.

'Cities are akin to living things that take in energy, metabolize material, and spit out waste. They consume and grow, using digestive, respiratory, and circulatory systems. And, like living things, cities can, with a nudge from citizens and their leaders, evolve in directions that increase their prospects for survival.'[3]

1.1 The city in concept

The first step in understanding the evolution of cities is to look back at the development of urban centers of the past. Designers have illustrated imaginative concepts of what the city of the future would look like. In the 20th century, architects and futurists conceptualized what the city of today would look like. Whimsical ideas envisioning the urban metropolis of the future were drawn by the likes of Archigram and Archizoom.

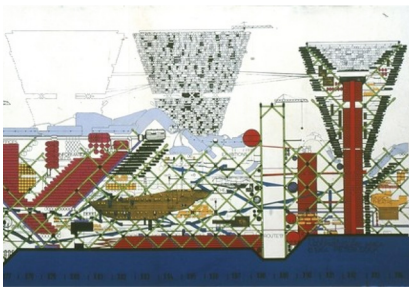


Figure 2 - The Plug In City

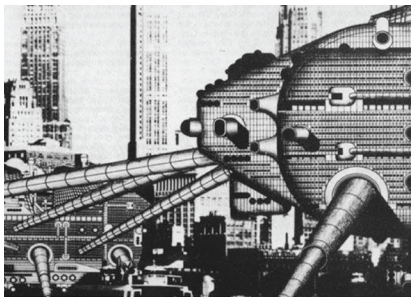


Figure 3 - The Walking City

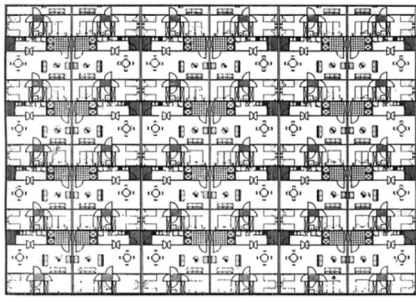


Figure 4 - The No Stop City

No Stop City was a theoretical project by Archizoom Associati, first published in 1970. This city had a repetitive pattern with multiple hubs and an equal and continuous structure. Dwelling typologies could be set up by the inhabitants themselves, and would come together to form a fluid and continuous urban environment. These typologies were meant to foster new ways of association in a seemingly endless city.[4]

The Plug In City, designed chiefly by Peter Cook of Archigram, was centered around modular units that were plugged into a central machine. Each machine contained provided transport and infrastructure for the residential pods. Each piece was designed to be transportable, making the Plug In City mobile and responsive to changes in the environment. The Walking City, developed by Ron Herron in 1964 was designed for a nomadic life in urban centers. Gigantic walking robots programmed with artificial intelligence walked to where their services were required and could even link up to create "walking metropolises".[5]

One could argue that these ideas of cities as creatures which change, evolve and grow like living beings came true to some extent, though not with the same formal expression. Some aspects of each of these conceptual cities can be seen in the urban centers of today; in the form of modular housing, gridiron planning and a digitally connected urban realm.

1.2 The city in reality

Today, humans inhabit cities that have lived through the Industrial Age, the Machine Age, the Information Age and are now in the Experience Age. They are living case studies that have responded to the technological advancements of each era. A very quick sketch of some of oldest continuously occupied sites in the world can help understand how the scale and texture of cities has changed over time.

Stewart Brand has authored the book 'How Buildings Learn' where he discusses economic and social aspects that dictate the growth of building typologies. One wonders what Stewart Brand would say about cities and the urban environments people live in. Do cities learn with time? With an urban history spanning 5000 years , Damascus is known to be one the worlds oldest continuously inhabited cities.[6] A cursory look at a map drawn in 1855[7] shows Roman aqueducts and canals going through the walled city. The city gates are the main landmarks and one major artery runs across the city, connecting all the other crisscrossing streets. Today, Damascus continues to be the center of a large metropolitan area constituting historic and contemporary architecture.

A comparison of built vs open maps of four cities helps gain an understanding of changing city patterns by time. Rome, Istanbul, Paris and Seattle are chosen and used

to identify big change agents in how cities have evolved over a period of centuries.

Romans lived in apartment buildings or *insulae* and walked around the city. Ancient Turks socialized in bazaars and walked or traveled on horse and carriage. The texture of the old cities of Rome and Istanbul is almost organic.

One can study the example of Istanbul. Thousands of years of warfare, religion and different planning morphologies overlaid and it still functions with an urban form that is not drastically different from that of other cities of the world. Carlos Ratti of the Senseable Cities Lab has given a reasonable explanation for how urban environments do or do not change over time. 'We will always need horizontal floors for living, vertical walls to separate us. What will change is our way of experiencing the city at the convergence of the digital and the physical.'[8] He is essentially talking about opportunity in networked 21st century cities and how change can be significant but intangible.

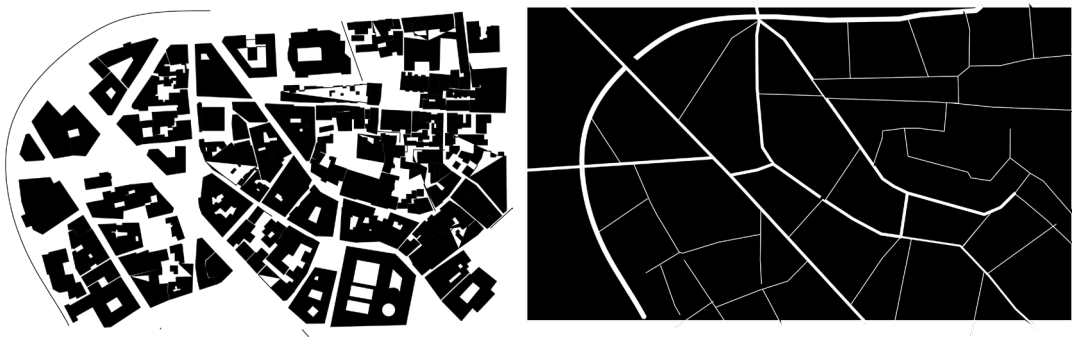
Modern day Paris was planned for control and ease of access, and in newer cities like Seattle one can see how the streets are organized in an orthogonal grid, the grid shifts in places to align with the waterfront but continues to maintain its rectilinear form. Freeways replace the hierarchical Main Street and no walls are required for the safety of the city. The openness and precise geometry of the layout shows a city planned for the expedient movement of the automobile.

1.3 The city as a system of systems

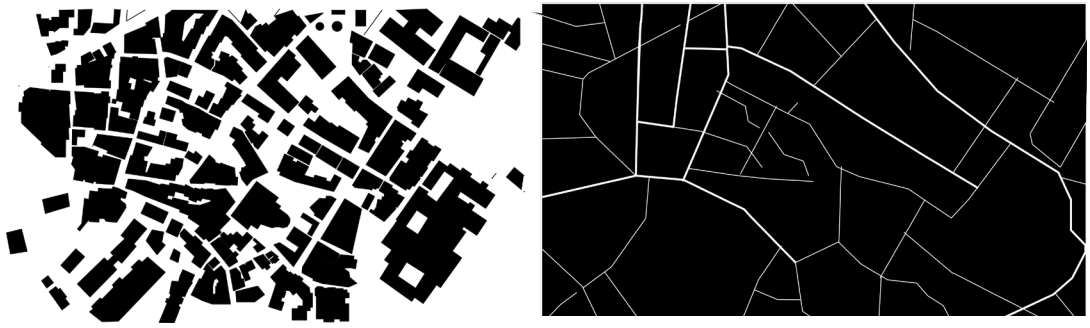
The city is a system of systems[9] with various entities coming together to make it work. It gives rise to certain institutional systems like the legislative , commercial, governmental, educational and residential systems. All of these institutions are connected by a system of utilities and infrastructure like garbage, sewer, energy and water. Together they form a complex layered network of urban ecology. This ecology is in a state of constant change.

Stewart Brand in his book ' How Buildings Learn', suggests that the best buildings are those that can be constantly reshaped and refined by their occupants. He talks about how architects use space to design and how time is as important when it comes to the design of buildings. All buildings adapt differently over time. Houses respond to family

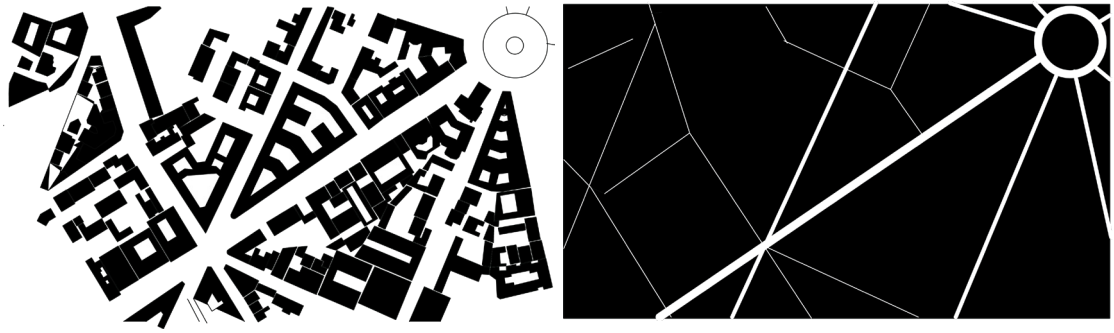
Rome



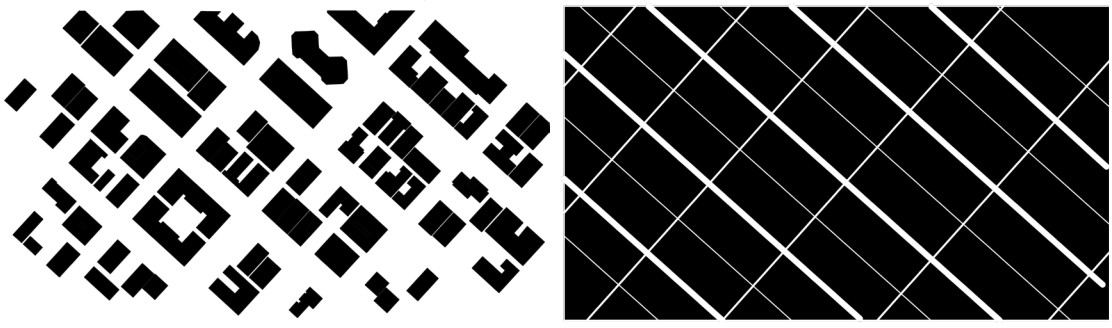
Istanbul



Paris



Seattle



tastes and idea growth. Institutional buildings age according to expense reluctance and delays. Commercial buildings are most up to date because they respond to competition all around them.[10]

Paul Hawken talks about change as a cyclical process of growth.[11] The tree sheds leaves which wither and die on the forest floor. They become food for earthworms who reduce matter on the ground and return carbon to the ground, enriching the soil. Industry, however, is established by man and is a linear process. A business is defined by three main variables ; what it takes, what it makes and what it wastes. He introduces the concept of a restorative economy for urban environments that regenerates resources and forms a loop. Businesses may get smaller but hire more people. Money can be made by selling the absence of something i.e. public utilities selling efficiency and not power.

Dennis Hayes has called the Bullitt Centre a six story "urban infill project'.[12] In doing so, he has described how an architectural intervention becomes an urban gesture. The Bullitt Centre is an office building but it opens up a new range of possibilities for shared urban infrastructure. It has been said that the building has been designed to last 250 years. It has been said that to change a market , the economics of the project must support it and the Bullitt Centre succeeds on those counts.

Carlos Ratti offers insight into information technology and big data in cities. Data affects reality and, hence, the way we deal with the city. He discusses the impact of real-time data on architecture and urban planning, using examples developed in the Sense-able City Lab. They demonstrate how the Lab interprets digital data as material that can translated into urban form and used for the creation of a different urban future. It also looks at the negative aspects of the city-related data acquisition and control.[13]

These systems strategies complement the built form of the urban environment. They can form an intricate web that affect the human experience of cities. The nexus for all networks in the connected metropolis of today is information technology.

Chapter 2 : The Internet of Things

Connectivity is a catalyst of change and one of the key drivers of connectivity is the Internet of Things. IoT is about every entity being aware, and it enables different devices, appliances , even street furniture to be able to connect and exchange data with its surroundings. This connectivity and vast pool of data spawns a number of services and opportunities.

Figure 5 - The Internet of Things

What happens, though, when every little entity in a city starts having a voice? The Internet of Things is about how every object in a city is connected to a system. It results in a stream of data which can be mapped and then studied to identify underlying trends.

Today, IoT allows objects to be sensed across existing network infrastructure, creating opportunities for more direct integration of the physical world into computer-based systems. These computer based systems enable services like Uber and Airbnb which are advancing concepts of resource management by sharing.

The Internet of Things may well be the most enabling aspect for urban life today. The Edge, in Holland, has been dubbed by Bloomberg as The Smartest Building in the world.[14] Life at the Edge revolves around the use of an application developed by the main tenants, Deloitte. Resource efficiency is at the core of everything at The Edge. From solar panels on the roof to the radiant heating and cooling pipes under each ceiling tile, energy conservation is prioritized and is one of the key features of the project. However, there are many other resources that, if managed correctly, directly impact the energy footprint of the building. One of these is resources is space. An employee driving in to work in the morning would be directed to a parking spot by an application developed for the building by the main tenants. Once inside the building, they would be directed to a suitable workstation based on their schedule for the day. A workstation is not necessarily a desk; it may be a lounge chair with a lamp if the agenda for the day is phone meetings. The building has 1000 workstations for 2500 employees. "Ownership" of one space is not encouraged and employees use lockers on each floor to keep their personal belongings for the day.

It is a perfect example of a transient community that makes use of all the resources the building has available without possessing any of them. It enables resource sharing among the occupants of the building and dramatically cuts down on waste of every sort. The chief executive officer of OVG Real Estate, the building's developer has been quoted as saying, "We think we can be the Uber of buildings."[15]

2.1 The Sharing Economy

One prominent by product of the Internet of Things is the sharing economy. It introduces the concept of sharing versus owning, taking the service an object provides without actually owning the object itself. It has shaped the way people commute (Uber and Lyft) , live (Airbnb and HomeAway) , shop (Amazon and ebay) and get their work done (with services like TaskRabbit).

In the sharing economy, owners rent out belongings that they are not using, such as a car, house or bicycle to a stranger using peer to peer services. One could look at different aspects of the sharing economy. There is the most obvious one : sharing of goods (Uber , Airbnb) . There are other aspects of it like recirculation (Craigslist and eBay) , Skill Exchange (Global Skills Xchange) and even amenity sharing (Piclo).

The digital revolution, the collection of gigabytes of data and the sentience of machines means that different ways of ownership and governance are emerging. The peer to peer economy is thriving, made possible by digital technology. The flip side to the sharing economy is that a small number of shareholders have ownership rights over many products and services. Internet based p2p platforms, boosted by superior network effects bring together a large pool of workers controlled by a few owners.

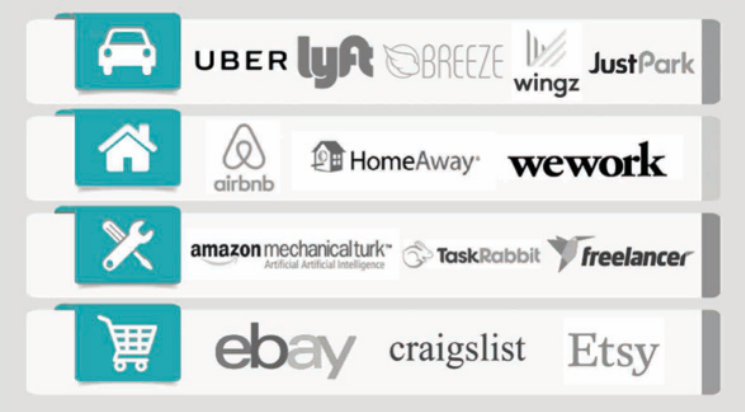


Figure 6 - The Sharing Economy

Traditional roles in society might undergo revision in the peer to peer sharing system.. A good example might be the energy systems. Traditionally, power has been supplied by large fossil-fuel generation plants to large sections of the population. Renewable energy sources like solar panels and geothermal heaters, however, have brought with them a fundamental change where individual buildings can fulfill part of their energy needs. These distributed energy resources allow previously passive customers to be more involved on the energy front. Energy generation, use and storage can be managed by the owner and in some instances surplus energy can be fed back into the central grid for the use of other owners. The line separating the provider and the consumer becomes hazy at best and the term ‘prosumer’ takes birth.

The electric utility gets all the energy and distributes it among consumers. One can-

not be sure that this system will continue for much longer. A race is on between start ups and other firms to develop p2p energy sharing platforms. These digital platforms would allow energy trading from one consumer to another, rather than having to go through their retail supplier. The role of the utility comes into question. The centralized, all knowing, all governing entity that manages intricate grid networks today could possibly become a virtual power plant that regulates and facilitates transactions for services that support the grid.

The Internet of Things and the Sharing Economy are facilitated by digital technologies and open up a world of possibility. They can be used as tools to shape the perception and user experience of urban environments. The first step in using these services as an instrument of change is to acknowledge the immense opportunity they offer. As systems, they are universal. To establish these systems as catalysts for urban evolution, an exploration into the built environment is needed.

Chapter 3 : The Built Environment

What way can the built environment be optimized or networked towards greater sustainability? Should we be rethinking the nature of our relationship to these systems in the sharing economy? Is there any need to own an asset or can entire populations function by sharing and reusing resources? How can cities be designed to benefit from all of these systems? The answer becomes about using current technology to stimulate economic growth and community vitality.

This research is about key attributes of future smart cities and how there are opportunities to make future cities better by learning from factors that have changed urban environments over time. It is also about projecting forward how some change drivers of the way cities get built might be implicated by Information Technology.

This piece is about identifying agents of change, coupling them with sustainability and information technology going forward and imagining how they implicate future development. The mechanism for doing that is a matrix of ideas that encompasses sustainability, information technology and the built environment.

3.1 From the Digital to the Physical

It is interesting to draw connections between information technology and the experience of the built environment. When fully autonomous technology pairs with sharing services it enables a different lifestyle. As people get more accustomed to certain services, building systems and environmental design can be optimized to benefit from it.

The advancement of autonomous vehicle technology is one such example of technolo-

gy that is geared to have a profound impact on the public transit, parking, land ownership and real estate development in our cities.

Parking structures being built today are designed for easy conversion to office or retail space. A research initiative estimated how many car owners were likely to shift to driverless cabs and how that would affect urban environments. The findings are presented in report called Driverless Future; prepared as a collaborative effort between Sam Schwartz, Arcadis and HR&A.[16] They found that 60% of the people driving in the New York Metro Area would find is economically feasible to use an application to shift to those services. In comparison, there was only a 31% drop in Dallas. Conversely, the shift to more ride hailing might mean that families are willing to move further away from the city because of access to cheap transportation options.

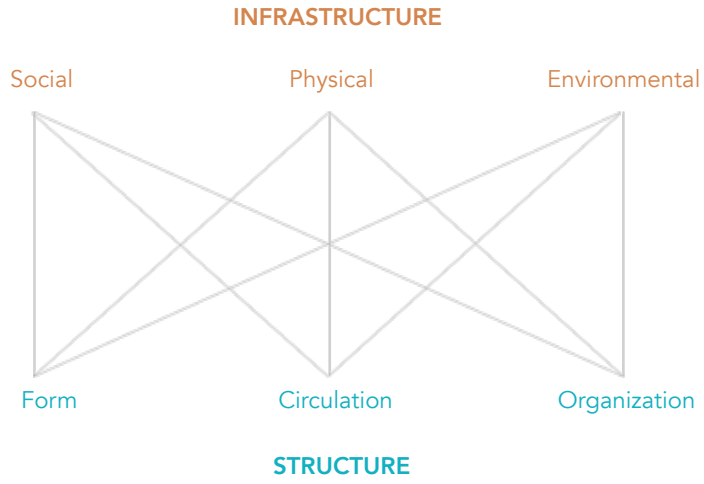
The different building forms in the city are the houses, schools, offices, hotels, data centers and parking structures, to name a few. With self driving vehicles a very real possibility in the near future, parking structures have been a focus for urban developers and city planners. People navigate the city in cars and it remains to be seen how the road infrastructure changes to accommodate these new developments. Transit agencies need to be up to date on the autonomous vehicle front; the convenience and time saving offered by Uber and Lyft are luring drivers off buses and into shared vehicles. What would be the new role of mass transit?

Autonomous vehicles are just one example of the many agents of change in the urban realm. Services like UBERpool mean people share a ride with strangers and get dropped off a reasonable distance from their destination. Others like Locavore help locate and purchase organic produce grown in urban farms. Gather is about discovering spontaneous pop up events around the city. Flex Market is about a more utilitarian service; it allows neighbors to exchange services like energy. These services enable a fast paced global lifestyle and human experience might become so rooted in them that they may become central in the design of the built environment.

3.2 Structure and Infrastructure

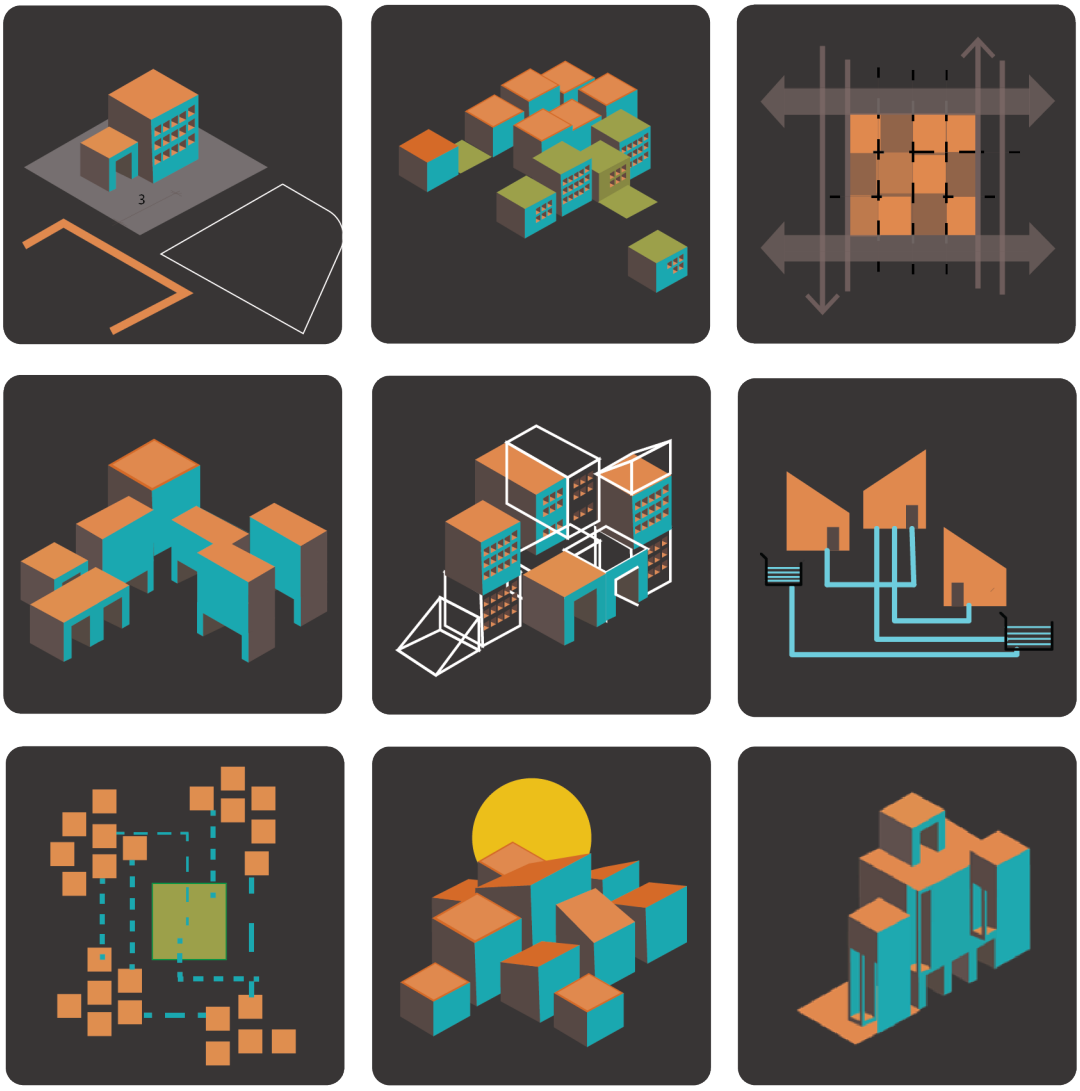
The focus for this study has been the built environment , how its value can be maximized and leveraged it to solve multiple problems at once. The built environment includes all of the tangible aspects of cities such as buildings, streets and freeways. For the purpose of this paper, that will be called the 'Structure'. The 'Structure' of the city becomes about how humans 'organize' 'forms' and 'circulate' around them.

The built environment , however, would not be complete without the intangible or hidden features, which are the networks that make a city function. These will be referred to as 'Infrastructure,' where infrastructure is the social, environmental and physical factors.



This understanding of infrastructure is based on the writings of British planner Janice Morphet.[17] Physical infrastructure is the more conventional definition of infrastructure; the transport nodes, hubs, waste , water and energy systems. Environmental infrastructure is about air quality , biodiversity, carbon reduction and the urban features that support such qualities. Finally, social infrastructure typically includes assets that accommodate social services. In the context of a city it could be seen as meeting spaces and town halls.

This leads to an exploration into the structure of a city in the light of social, physical and environmental infrastructure or the social, physical and environmental networks in the city and how they affect the design and layout of the architecture that it constitutes.



The Nine Patterns

Chapter 4 : The Nine Patterns of Sustainability

The urban environment is formed when complex systems overlap in a social construct. Commerce, education, healthcare, energy , transportation security , food and water come together in cities. The integration and interaction of these distributed systems provides a functional and creative environment. All of these aspect or 'patterns' come together to form the intricate networks that people exist in.

As the authors of the acclaimed book A Pattern Language write in the introduction, "All 253 patterns together form a language."[18]

This chapter is about identifying key change drivers in how the city of the future would be designed. This is done by proposing a design framework and introducing nine patterns as points of change. They are drawn out by establishing the three types of infrastructure and what each means for the form, circulation and organization of the city. At the intersection of each of these points are the nine theories about how cities will, or should change. The matrix thus devised is the proposed strategy to redesign neighborhoods for a sustainable future.

The nine patterns are a rulebook that can be applied to existing or new urban environments. Some patterns complement each other and others can be executed on their own. The patterns are generic and can be applied to any scale of intervention. They will be studied together and in isolation. These patterns on their own introduce alternate ways to address the technological advances of today and are pieced together to envision sustainable environments for the future. Each pattern can exist independently and be applied to an existing neighborhood. All the patterns can be woven together to create a compelling image of the city as we will know it.

Each pattern has emerged from the careful study of theory, precedence and is then synthesized into one idea. The theory for each is based on contemporary writings about the city and its constituents. Precedence is based on practical instances of how each pattern plays out at different scales in examples from around the world. The synthesis is a diagrammatic representation of how each idea could play out in the built environment.

Finally, each pattern is represented as hyper realistic, surreal imagery. Each idea is collaged from everyday images acquired off the Internet. This imagery is based on ideas that are real but fantastical at the same time.

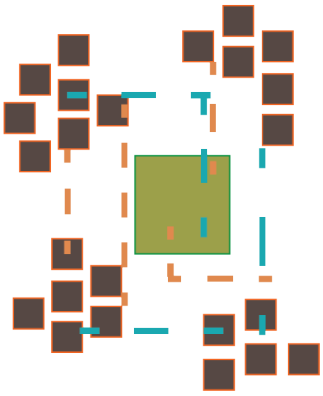
The hypothesis thus becomes that this matrix covers all aspects of the built form at differing scales and represents a future oriented ideal approach for a particular neighborhood.

Patterns of Social Infrastructure
Social Infrastructure affects the perception of a built environment from a human scale. It is about social interaction and is focused on experiencing a city at an individuals' level.
These patterns are The Green Space, The Three Minute Walk and P2P Infrastructure.

Patterns of Physical Infrastructure
Physical infrastructure is about buildings, roads and physical networks. This type of infrastructure is built and facilitates public life.
These patterns are Porous Form, Elevated Travel and Orientation and Zoning.

Patterns of Environmental Infrastructure
Environmental Infrastructure is about large scale issues and the environmental quality of the settlement. These examples are ones that will take longer to get established but will eventually affect the climate and ecology of the city.
These patterns are The Elevated Green, The Layered Grid and Closed Loop Systems.

Patterns of Social Infrastructure



4.1 The Green Space

Once we can accept that the city is as natural as the farm and as susceptible of conservation and improvement, we work free of those false dichotomies of City and country, artificial and natural, man versus other living things[19]

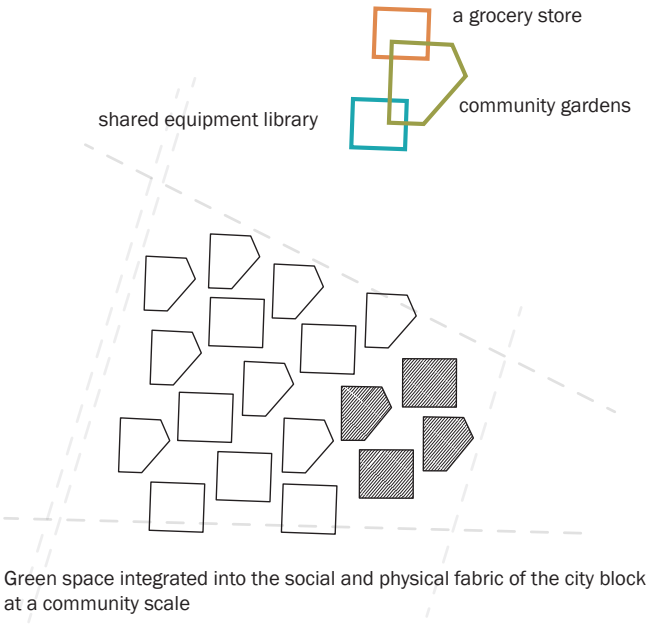
Kevin Lynch
Good City Form

Kevin Lynch spoke about the city as an entity that is as natural as the farm and rejected ideas of how city and country, natural and artificial should be different. Urban landscape is as natural as country landscape, one facilitates the life of human beings and the other: the life of animals and plants. Humans are as "natural' as any animal or plant and like other living creatures, they create a habitat that is suited to their personality and lifestyle. The buildings and the green can be knit together to create an environment suited to all nature.

One precedence is Singapore and urban farming within the city. Limited land and a growing population has meant that Singapore has innovated in urban life and Sky Greens is one such example. A functioning urban farm in the center of the city provides food for the people, making the city an independent and viable entity.

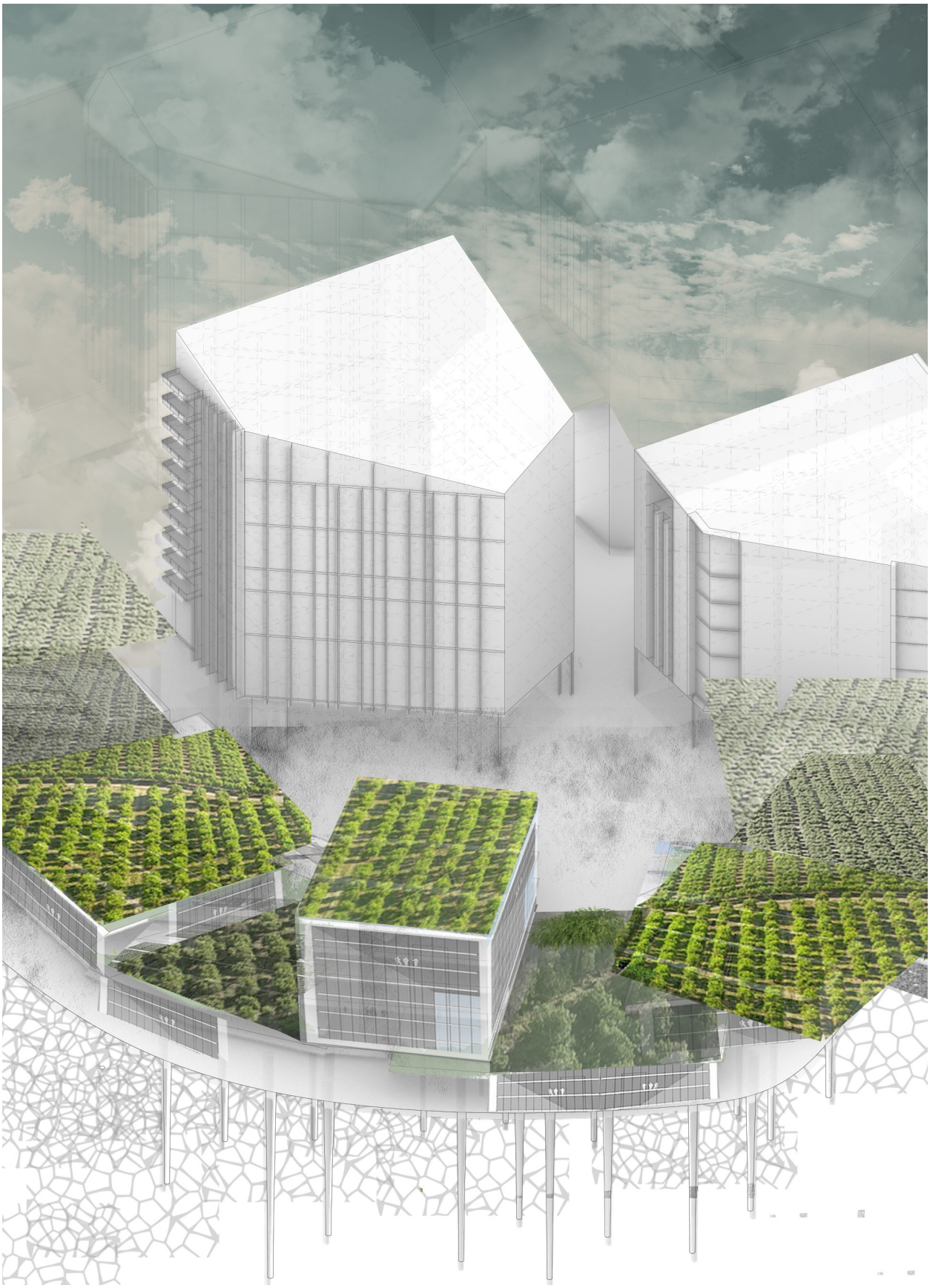
Such urban farms can become social spaces for the locality and can be grouped to

supplement other functions such as grocery stores. Neighborhood libraries create sharing networks for goods and services. The green becomes the neighborhood park and social infrastructure is centered around it. It takes formal expression as a hub of activity and exchange.



Green space integrated into the social and physical fabric of the city block at a community scale

The Green Space is thus about creating a flexible space for people. It essentially becomes the village square; with a lending library, an urban farm and a grocery market. It is the town square, centered around day to day activities and informal spaces for meeting. The library allows people to check out items and return them, leading to a shared social ecosystem. The farm supplements the grocery store and becomes the neighborhood park. Together they become social cues to engage the community.



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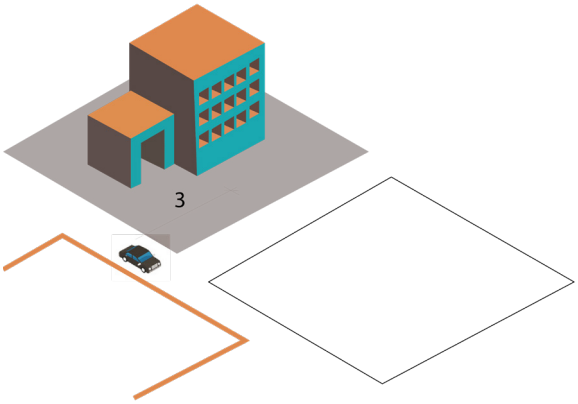


4.2 The Three Minute Walk

A city that invites people to walk must by definition have a reasonably cohesive structure that offers short walking distances, attractive public spaces and a variation of urban functions. These elements increase activity and the feeling of security in and around city spaces. There are more eyes along the street and a greater incentive to follow the events going on in the city from surrounding housing and buildings.[20]

Cities For People
Jan Gehl

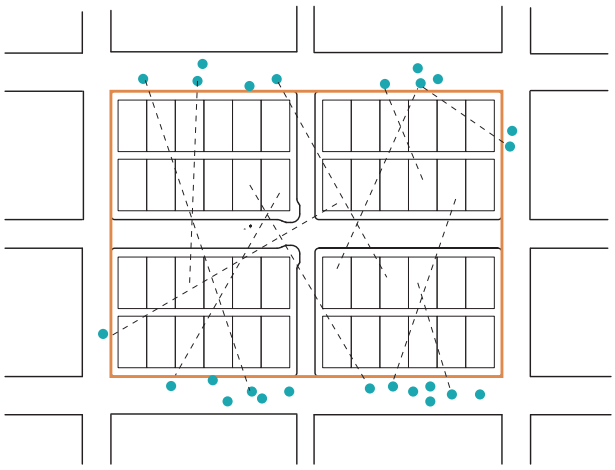
A city where people walk. Jan Gehl spoke about public space and human involvement in cities which invite people to walk around instead of an automobile. He has written about how city planning has been designed to be 'rational' above everything else and towards creating a 'streamlined setting' for all urban activities. He calls the city the 'meeting place' and highlights the importance of the street as a place for processions, trade, events and even punishments.

The street gains character and becomes a civic space; designed to be inhabited by people and not as pass through spaces for automobiles that cut across the city for speed and convenience.

The city of today cannot totally exclude vehicular transport but one possible way to implement the walkable city is to limit the accessibility of the automobile. A hybrid model that combines vehicular and pedestrian movement can be developed. Longer distanc-

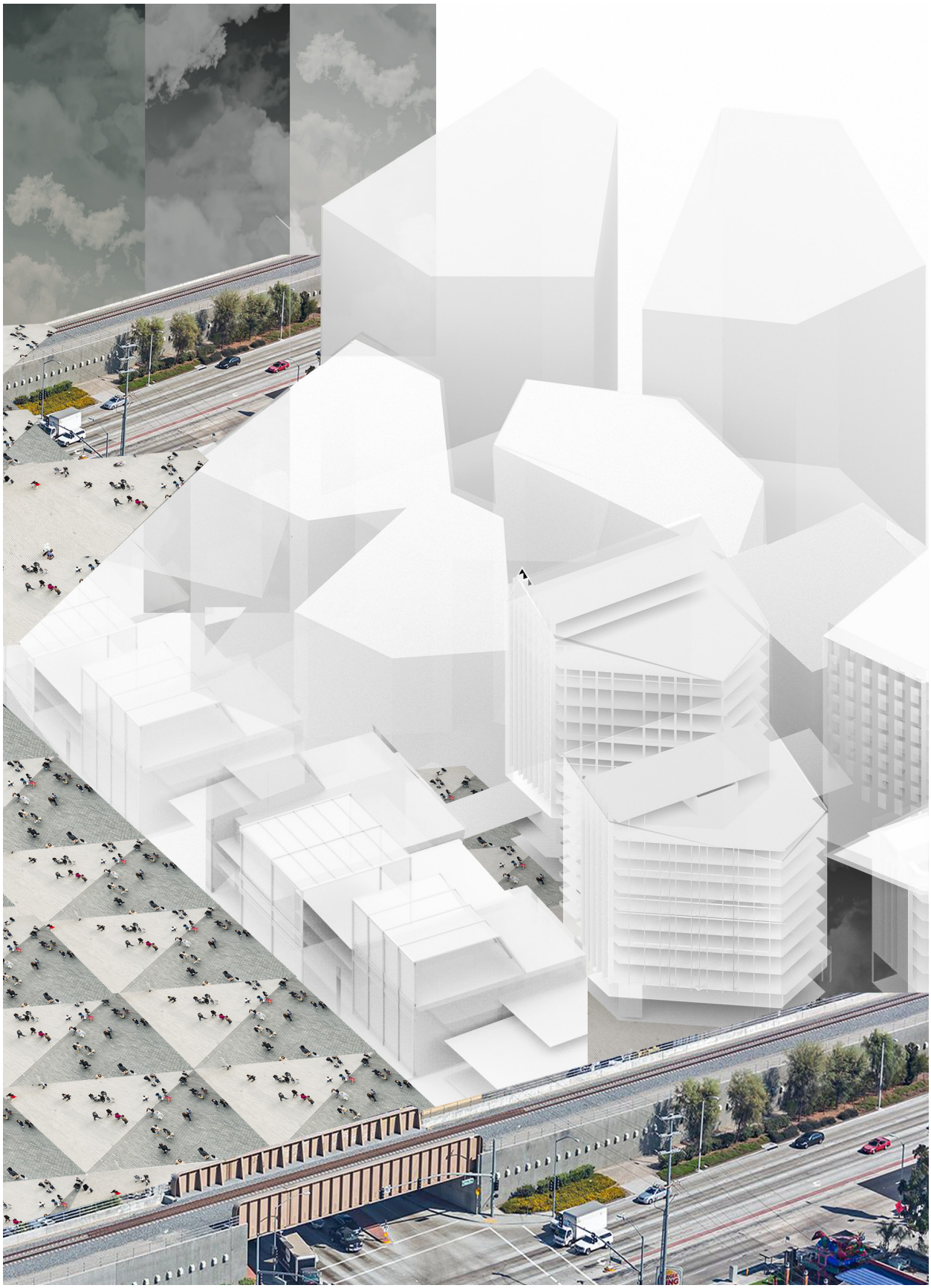
es can be covered on private/public transit and shorter commutes within the city can be addressed to the pedestrian. Enforcing some pedestrian traffic on the streets would create a shared space that people use and offer cues for visual sociability.

The urban layout of the neighboring cities of Seattle and Bellevue is an interesting case study. The block size in Bellevue is twice that of Seattle. While the tighter road layout in Seattle creates smaller blocks that people can walk around and navigate easily, it does so by adding another layer of streets and alleys for cars to drive through. These roads disrupt the otherwise continuous urban environment and also define large areas solely for the use of cars. The larger block size of Bellevue, in comparison, creates deeper spaces that are accessible only by walking a short distance.



Reduced roadway frees up space and creates walkable neighbourhoods

The Three Minute Walk is about a neighborhood where the block size is optimized for a few minutes of walk either way. All private and public transit drops off a person at least three minutes away from their final destination. Neighborhoods can be designed with larger block sizes and less roadway. Walkable neighborhoods increase the opportunity for daily interactions between neighbors and can strengthen these bonds within the community



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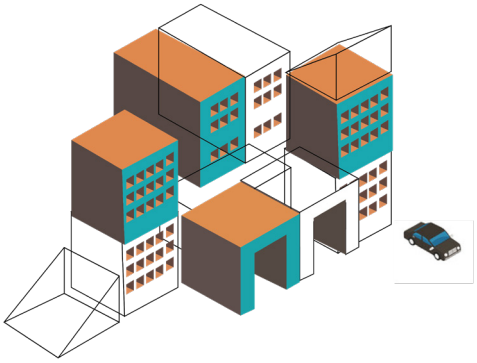


4.3 P2P Infrastructure

One criterion to increase infrastructure sustainability is to design and build it so that it is off grid, in locally based, decentralized and discrete units; rather than inflexible, large-scale, capital intensive monopolies, such as highways, other transportation facilities, water and sewer lines, and communications systems.[21]

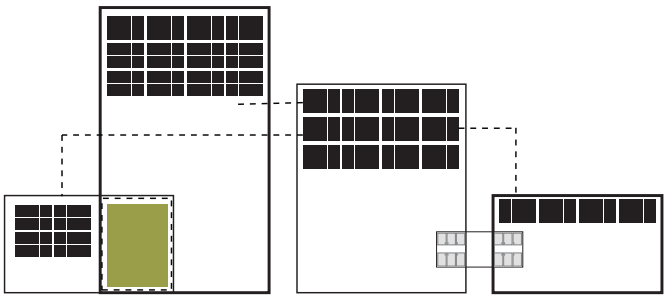
Michael Neuman
Encyclopedia of the City

Michael Neuman spoke about local and decentralized infrastructure instead of large scale, capital intensive monopolies. He makes a case for local systems over distant distributive systems and elaborates on how a large infrastructure constitutes a number of processes. Each process has its own energy, material and environmental costs. The high management cost of large scale infrastructure systems also contributes to its ineffectiveness. Planning, financing, designing and operating is 'fragmented' and therefore maintained only at high capital costs. Such systems also come at a high social cost; access to such services is not always equitable.

One example of shared and decentralized infrastructure could be energy sharing. Instead of depending on large power plants outside the city that generate energy which is sent to urban areas through wires with a high percentage of energy being lost in the process, energy systems can be scaled down to the neighborhood level. Photovoltaic panels provide a minimal intervention, small scale solution to energy generation for individual households. The small energy generating buildings can be linked to form

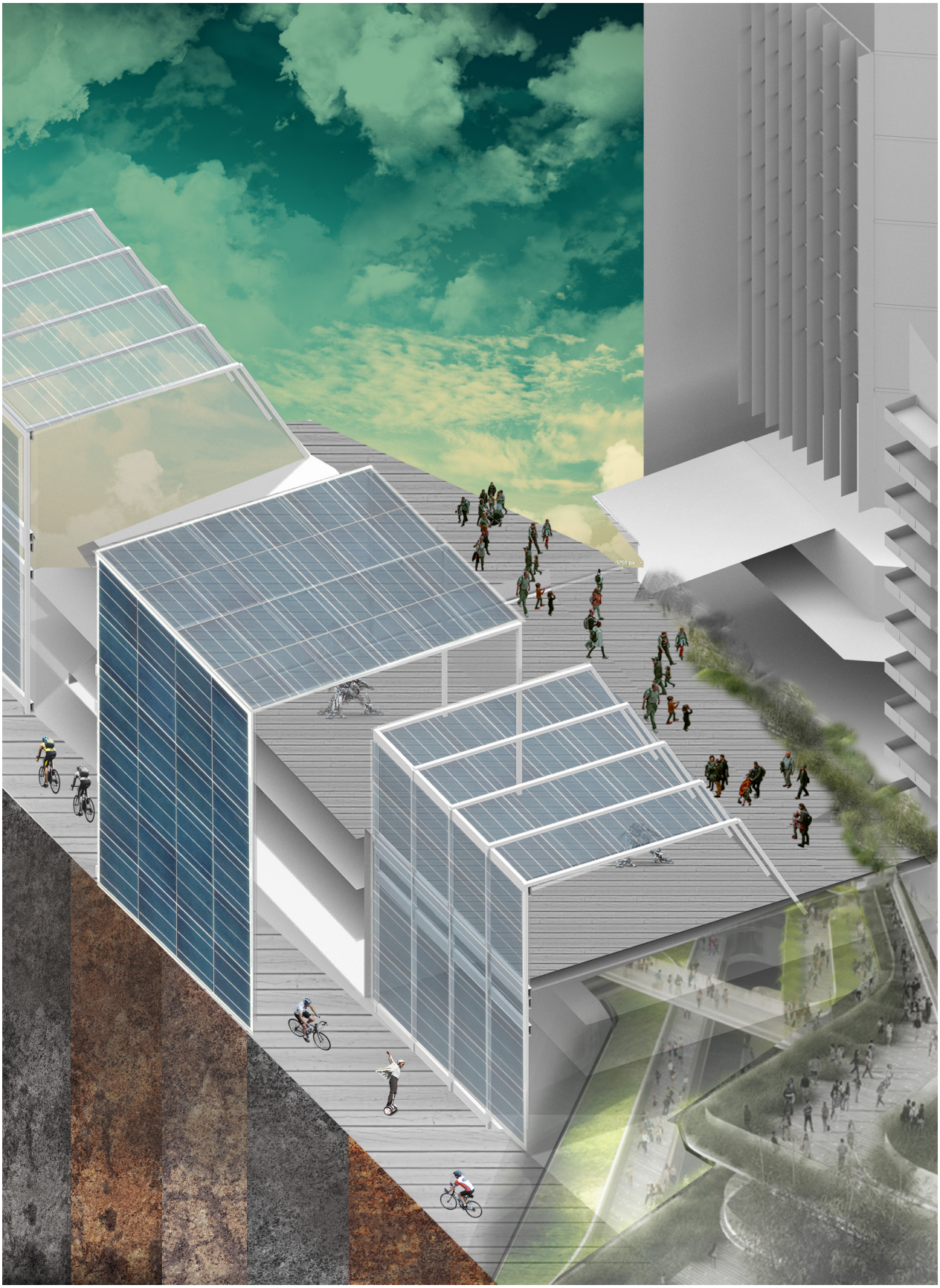
multiple small networks within the city. This idea of decentralized infrastructure can be applied to other utilities such as rainwater catchment and distribution systems.

Piclo in the United Kingdom, is an independent marketplace for buying and selling smart grid flexibility services. Currently a web service, it can be designed as an application that connects people within a three mile radius. It describes a system in which 'any human being can contribute to the creation and maintenance of a shared resource'.



P2P sharing of services like energy and spaces like kitchens and yards

P2P Infrastructure initiates a new medium of social interaction, one that is entirely digital but knits a community of people in a symbiotic weave. This is a new mode of production and exchange that makes peer to peer sharing a type of social relation in human networks. Energy, water and waste are handled within each neighborhood. The utility is decentralized and each user becomes a prosumer. Neighborhood layouts account for the energy generation capacity of each building and are sized accordingly.



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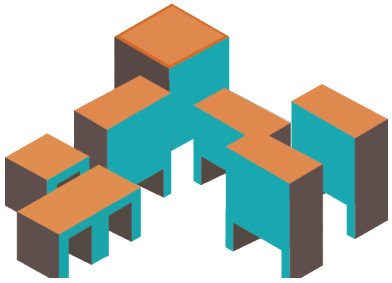
Patterns of Physical Infrastructure



4.4 Porous Form

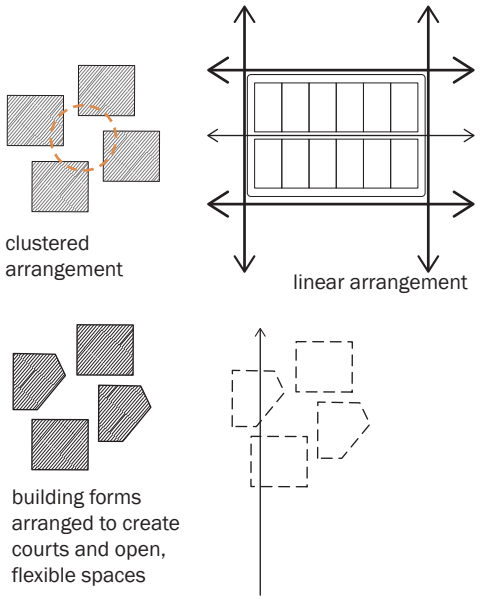
Connect your building up, wherever possible, to the existing buildings round about. Do not keep set backs between buildings; instead, try to form new buildings as continuations of the older buildings.
Connect buildings with arcades, and outdoor rooms, and courtyards where they cannot be connected physically, wall to wall[22]

Christopher Alexander
A Pattern Language

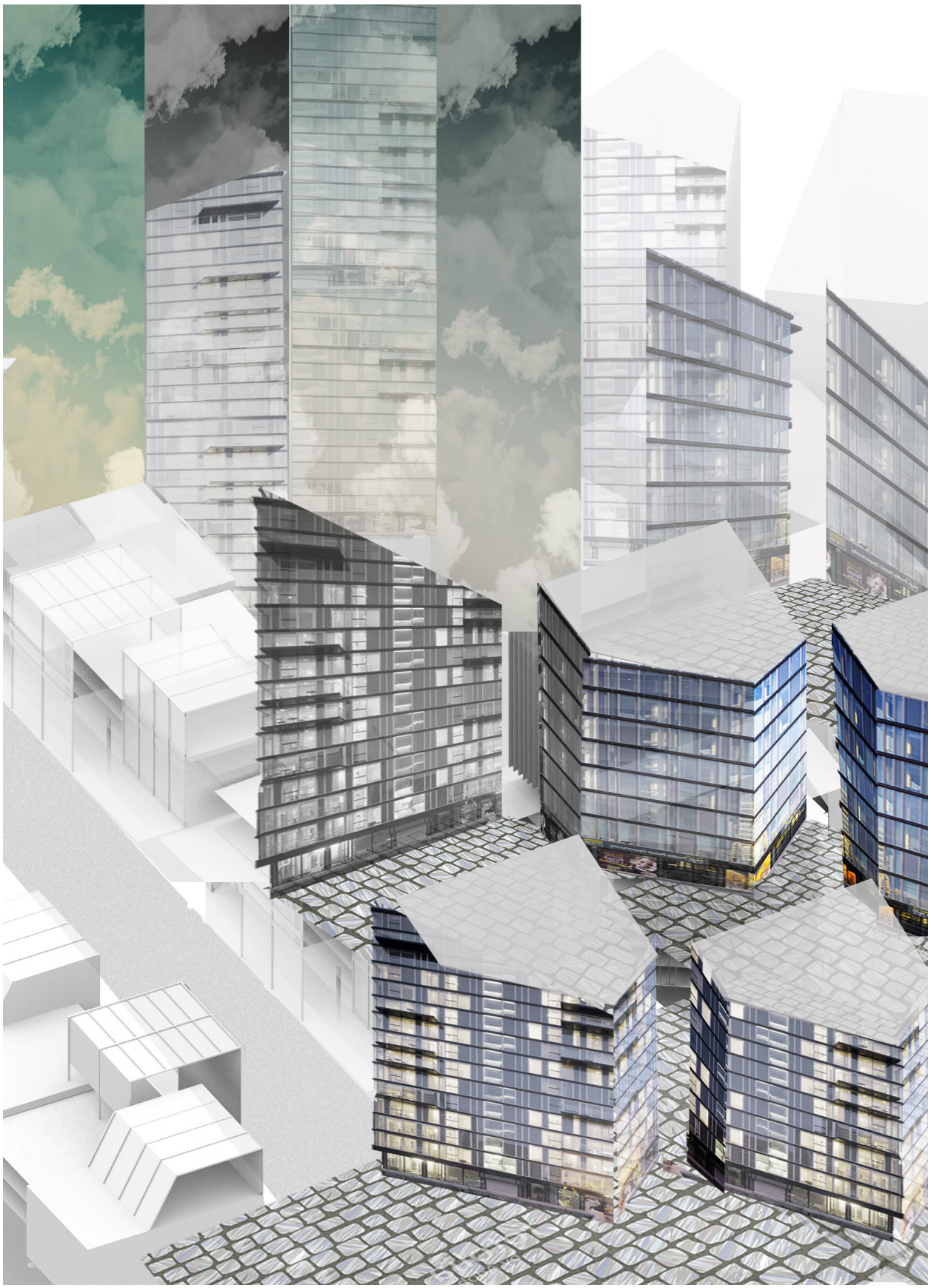
Pattern 108 in A Pattern Language by Christopher Alexander is about fluid urban connections. He has identified formal and spatial connections between buildings and has denounced isolated structures, calling them symptoms of a 'disconnected, sick society. Connecting buildings with outdoor rooms and courtyards would create intermediate spaces for human habitation.

These spaces are different from streets and roads, mainly by virtue of their proportion. Streets are linear spaces that facilitate movement; courts are centered spaces that lend themselves to be inhabited. These inward facing spaces create a sheltered and semi private environment which is more private than the street but more public than the house. It is flexible and lends itself to different activities depending on area and the time of the day. These 'squares' can be designed as a point of orientation for the pe-

destrian in the city and can be useful for wayfinding. A formal expression of this idea can be an urban environment which is porous.
One interesting case study of this can be the markets or bazaars in South Asia, where one can cross over from one building to the other , indoors and outdoors without knowing it. The buildings partially enclose public space around them. A variety of canopies, awnings, courts and verandas blur the boundaries of ownership and create space that allows for a variety of social interaction. These bazaars are use as a marketplace during the day used as the neighborhood social space at night.



Porous built form creates open and accessible urban environments that provide a diversity of spaces. Buildings are designed as a sponge; with the ground and roof levels of each building porous. Buildings within each neighborhood are not connected by streets; instead, a network of open and covered courts create a district of buildings connected by space and not path.



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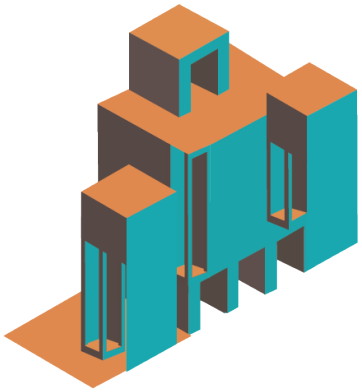


4.5 Elevated Travel

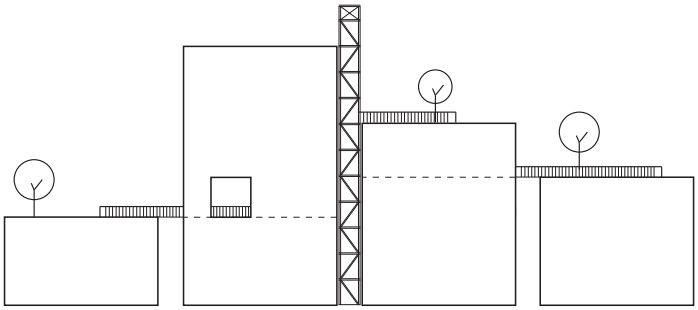
In Esmeralda, city of water, a network of canals and a network of streets span and intersect each other. And since the shortest distance between two points in Esmeralda is not a straight line but a zigzag that ramifies in tortuous optional routes, the ways that open to each passerby are never two, but many..[23]

Italo Calvino
Invisible Cities

The city of Esmeralda in Invisible Cities is where two different networks span and intersect each other and the shortest distance between two points is not a straight line but a zigzag….Italo Calvino describes Venice, with its network of canals and roads supplementing each other. Both networks are used by different modes of transport and each has its own distinct qualities. Together they create an intricate weave that offers a person multiple ways of getting to the same destination.

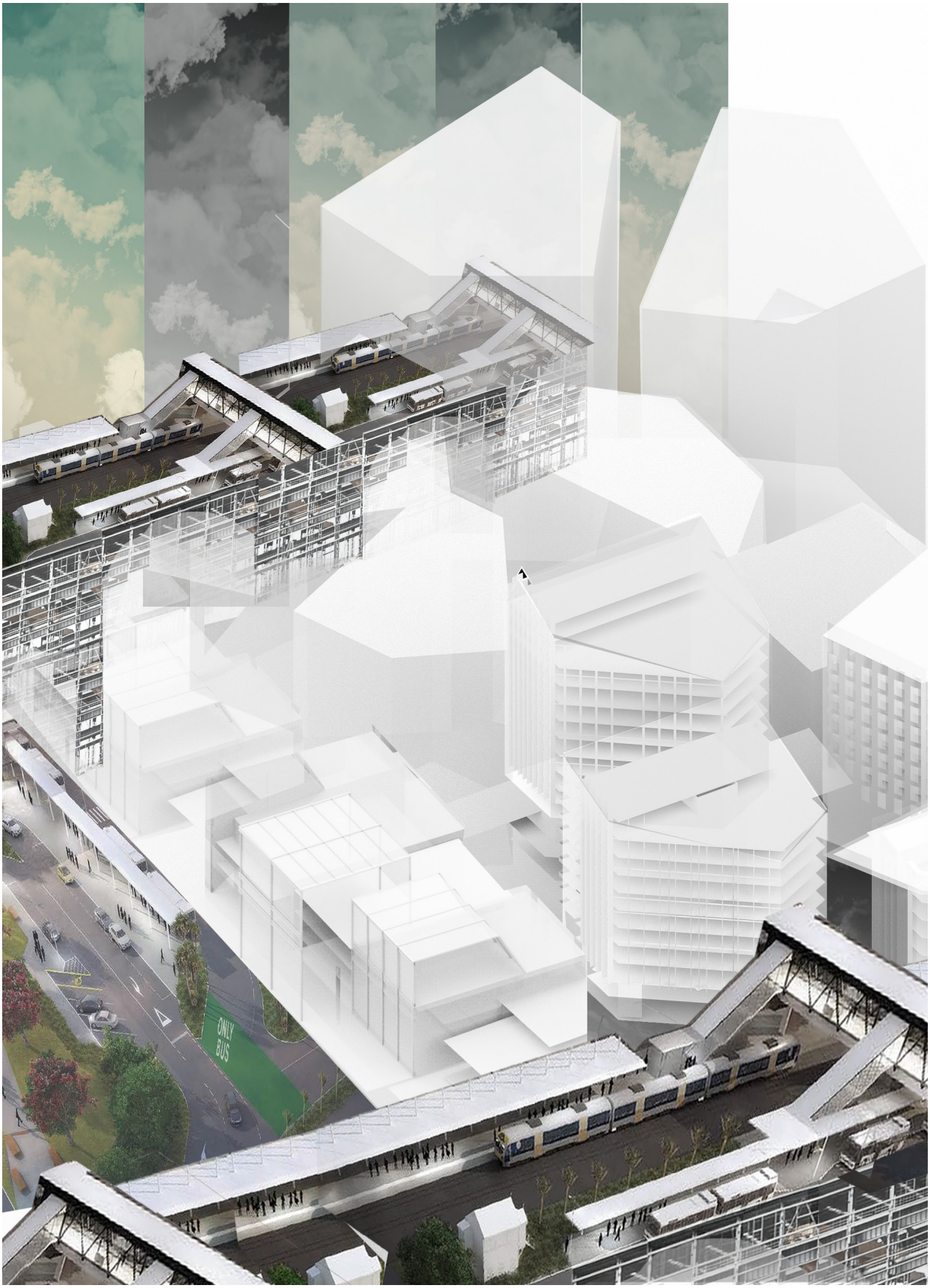
The New York High Line is an example of a different organizational principle for a city, where public transit and other vehicles travel one level and humans on another. The High Line winds through the city, offering a soft landscape and views suited for slow moving human traffic. It offers a visual and experiential quality that is very different from that of sidewalks in the city. It passes by buildings and offers a different perspective of the locality. Most of all, it offers the pedestrian an experience of the city that would not be possible otherwise.

Pedestrian circulation is conceived as an original transport network and it not resigned to be the space left over from cars and buses. This pattern creates opportunities to manage traffic flow by operating at different levels. It also differentiates between quality of space; people perceive environments very differently from automobiles and walkways designed for human traffic might prove to be more effective than current mechanisms.



alternate levels of travel for pedestrians , facilitated by Porous Form

Elevated Travel is where pedestrian and vehicular circulation is separated. Building rooftops are used for pedestrian circulation and heights are optimized to create a visual connection between the street and the rooftop. Public transit functions at a higher level and private cars take the street. People walk off public transit and across building rooftops to get to their destination. A walkable and human scale environment is created.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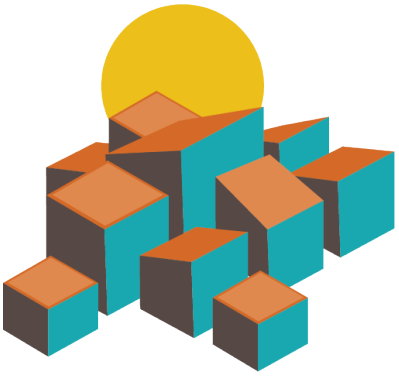


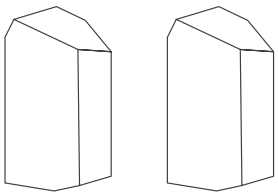
4.6 Orientation and Zoning

We will always need horizontal floors for living, vertical walls in order to separate spaces, and exterior enclosures to protect us from the outside. The key elements of architecture will still be there and our models of urban planning will be quite similar to what we know today. What will change is our way of experiencing the city at the convergence of the digital and the physical [24]

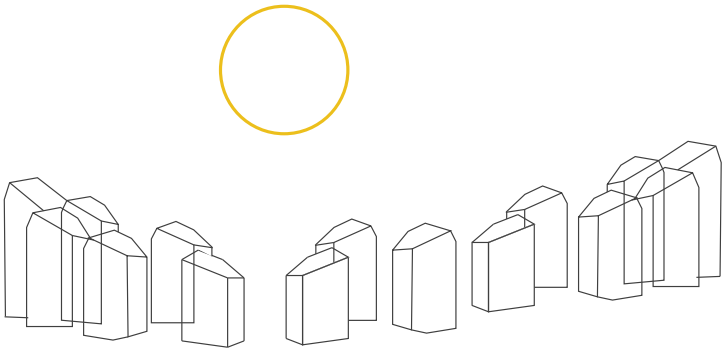
Carlo Ratti
Sensing Cities

Carlos Ratti has spoken about big data and the digital networks in cities. The influence of the digital world on the physical realm is where opportunity arises. One possible example is the city of Ørestad in Denmark which was built and remained uninhabited. With Ørestad 2.0 the strategy is to improve on the existing plan from 1994.

'The district of Ørestad north is well integrated with Copenhagen. The districts Ørestad city and Ørestad south are more remote and regarded as the actual Ørestad. There are many challenges, however. The two districts are divided by a highway and a railway cutting, and the conditions for public life are poor. The proposal is to condense the current plan, within the street scape, below the elevated metro tracks and on top of the highway. The new urban structure improves the coherence of the two districts and defines new center with public space and buildings with various scales, expression and functions.'[25]



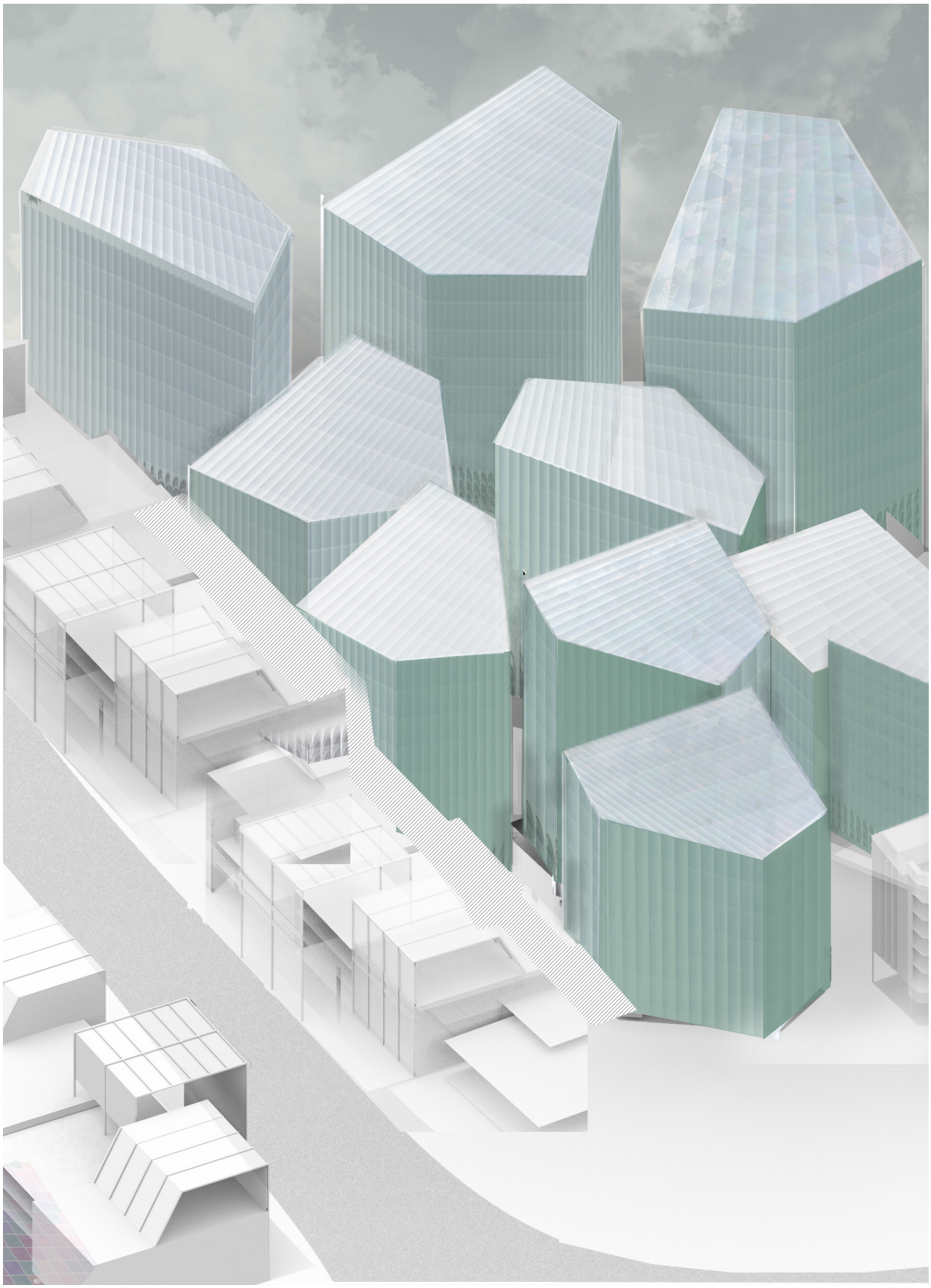
building form optimised for high energy performance



Zoning and building height regulations that allow for maximum sun and air

Orientation and Zoning is where building heights, forms and layouts are optimized to get maximum air and solar exposure. Buildings are oriented to maximize on sunlight and ventilation. Building height regulations allow every building rooftop to get solar and wind access year round. Zoning regulations allow for building form to be designed for high performance architecture.

The neighborhood skyline is a series of hills and valleys, allowing enough distance between tall buildings to allow sunlight and air to circulate freely in the environment.



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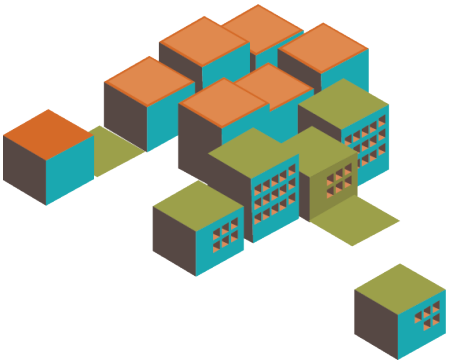
Patterns of Environmental Infrastructure



4.7 The Elevated Green

In a world of spatial networks, the proper connection between these different networks is essential to link up the global and the local without opposing the two planes of operation. This means that planning should be able to act on a metropolitan scale, ensuring effective transportation, accepting multinodality,.. it should seek integration of open space and natural areas in the metropolitan space, going beyond the traditional scheme of the greenbelt.[26]

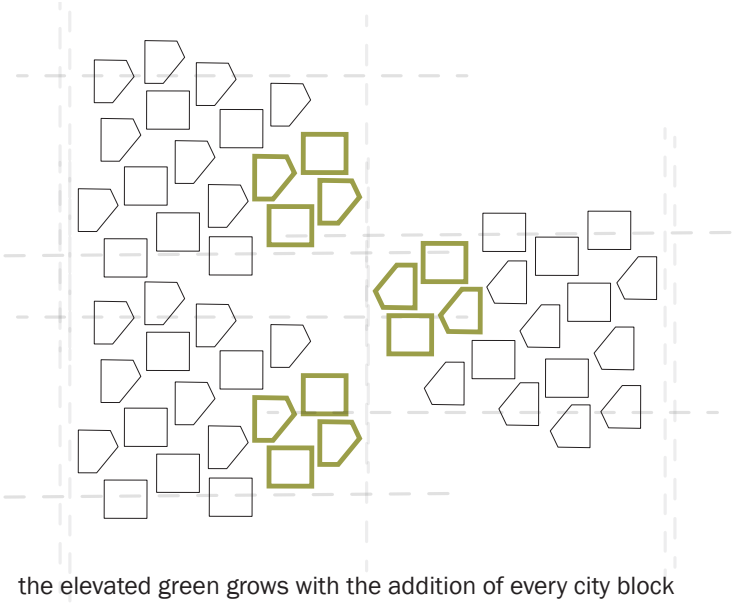
Manuel Castells
Space of Flows,Space of Places: Materials for Theory of Urbanism in the Information Age

Planning should seek the integration of open space and natural areas in the metropolitan space. That is Manuel Castells talking about Urbanism in the Information Age. He talks about how the new metropolitan space is characterized by its multi functionality that 'supersedes the segregation of modernist urbanism'. The new metropolitan space therefore is balanced and leads to the creation of an ecological realm in the city.

One example of a multi functional metropolitan space can be seen in the old city of Rome, where roof gardens on buildings serve as social spaces but also in a larger, environmental context, would help mitigate environmental issues such as rainwater runoff and the urban heat island effect. These roof gardens are private but can be connected

to form an urbane green that is contiguous both visually and physically.

This urban green can function as a connector at an urban scale and can be leveraged to address multiple ecological and climatic problems of the city. It would help regulate temperatures during extreme weather and if conceived as an elevated garden, it would use existing vacant rooftops and save valuable real estate at the street level. The elevated green also serves as insulation for building rooftops and helps main constant temperatures indoors.



the elevated green grows with the addition of every city block

The green spaces of each neighborhood come together to form the Elevated Green. The elevated green is a park, it is an urban farm and it creates an urban ecology that can reinvigorate life in the city. It is a continuous lung that helps mitigate pollutants and maintain air quality . It is used by pedestrians to get around and helps sustain the city in terms of food. Gardens and hardy plants flank the walkways. A natural environment is created that attracts birds and bees in the urban environment. A new urban ecology is introduced within the city

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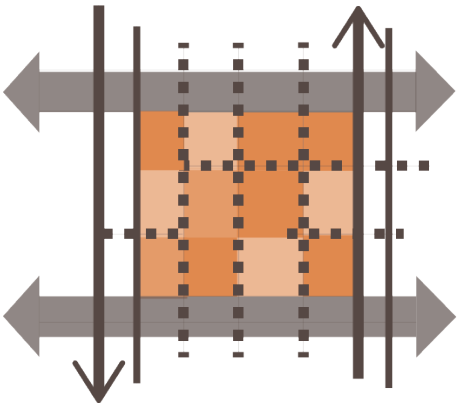


4.8 The Scaled Grid

We have to be careful that large-scale connections are established strictly according to their place in the hierarchy. Failure to understand this process leads to appeasing transportation forces which push for building more superhighways, while all the lower levels of the transportation hierarchy are erased.[27]

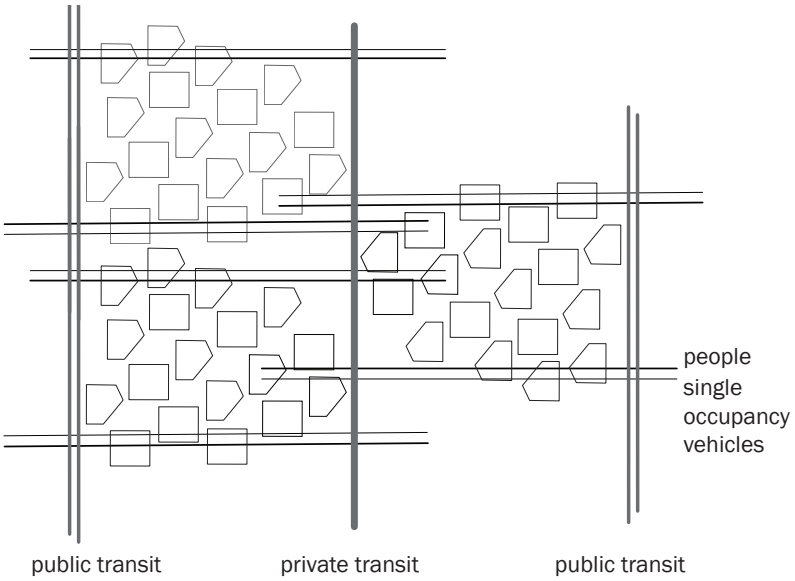
Gabriel Dupuy
Urban Networks - Network Urbanism

Gabriel Dupuy in Network Urbanism has spoken about establishing connections or transport networks strictly according to their hierarchical importance. All the roads and grid networks in the city do not have to respond to the same means of transport. He establishes that many problems of urbanism have to do with scale and a city needs to be connected at all scales to be efficient. Smaller scale networks are at a risk from stronger networks and need to be protected. All the networks in the city are at the ground plane and are in a state of competition with each other. This creates an environment with multiple networks in constant tension

The Skyway System in Minneapolis is an interesting case study; with a grid that is scaled according to need, there is a route for people on foot and another for cars and buses. There is a very practical reason for the Skyway system, temperatures dips below freezing levels and the enclosed tubes offer protection from the elements for the pedestrians. Buildings are perforated at various levels wager these sky bridges rest

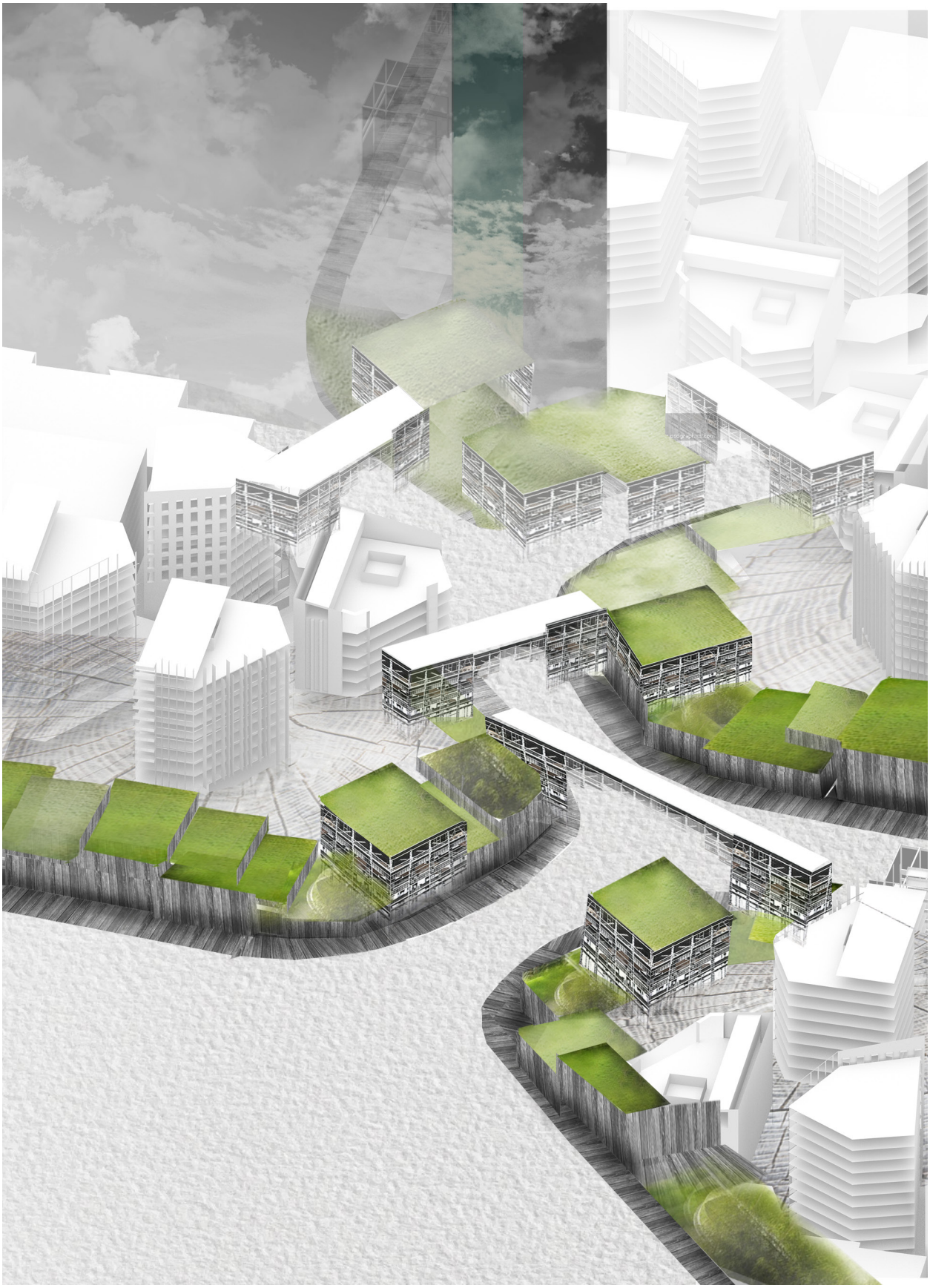
against them.

This strategy can be implemented in high density urban environments that can sustain the multiple tiers of movement and activity. The future is about single occupancy vehicles that take less space and require less roadway. If mass transit is the main circulation system, it would lead to less cars on the roads and a walkable environment with less sprawl. This compact, connected urban realm is made possible by establishing specialized transportation routes.



Circulation grids separated by activity and operating on multiple levels

The Layered Grid, acknowledges the different modes of transport; how each moves and the quality it requires. It is focused on creating walkable environments that lead to less sprawl and tighter knit cities. The street weave is tighter knit in some places and become a loose knit in others. It is multi dimensional and not restricted to the ground plane. Public transit, cars, single occupancy vehicles and human circulation takes place on layered surfaces. Each layer responds to the medium using it; drive through urban forms for cars, porous storefronts for pedestrians and quick stopovers for single occupancy vehicles.



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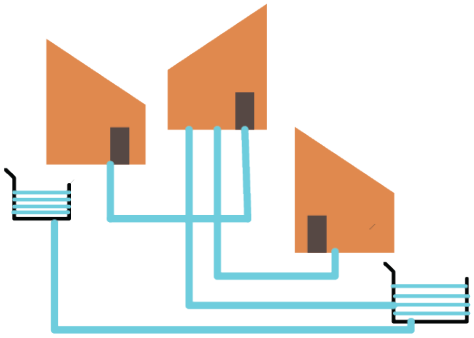


4.9 Closed Loop Systems

The city can be modeled as an ecosystem with inputs of energy and water, and outputs of noise, climate change, sewerage, garbage and air pollutants.[28]

Ian Douglas
The City as an Ecosystem

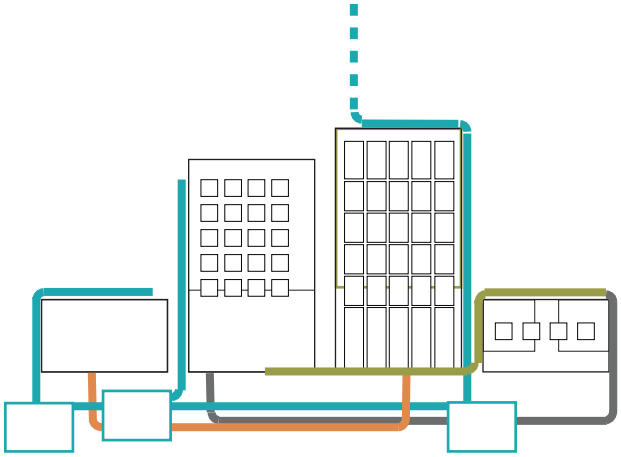
The last pattern is about how the city is an ecosystem on its own with inputs of energy, water and outputs of waste and sewerage. At an ecological level the outputs are nitrogen, carbon dioxide and carbon mono oxide. These outputs cannot be seen but stay in the atmosphere as pollutants. Over a period of time these gases affect the climate, air quality and ecology of the city.

One way of tackling such challenges is to design the city taking cue from a natural ecosystem, where most processes are cyclical and nothing goes to waste. These examples can be applied to energy, with waste heat from buildings being used in others. It can be applied to water in how rainwater and gray water is managed. It can even be applied to materials, with certain buildings being dismantled and parts of them being used in new developments elsewhere. Human waste is managed within each district and used to supplement other services in the city.

Closed loop systems can also be introduced by studying building use patterns and how different building typologies each have their own requirements. Office buildings require energy and residential buildings have showers and kitchens that have high water

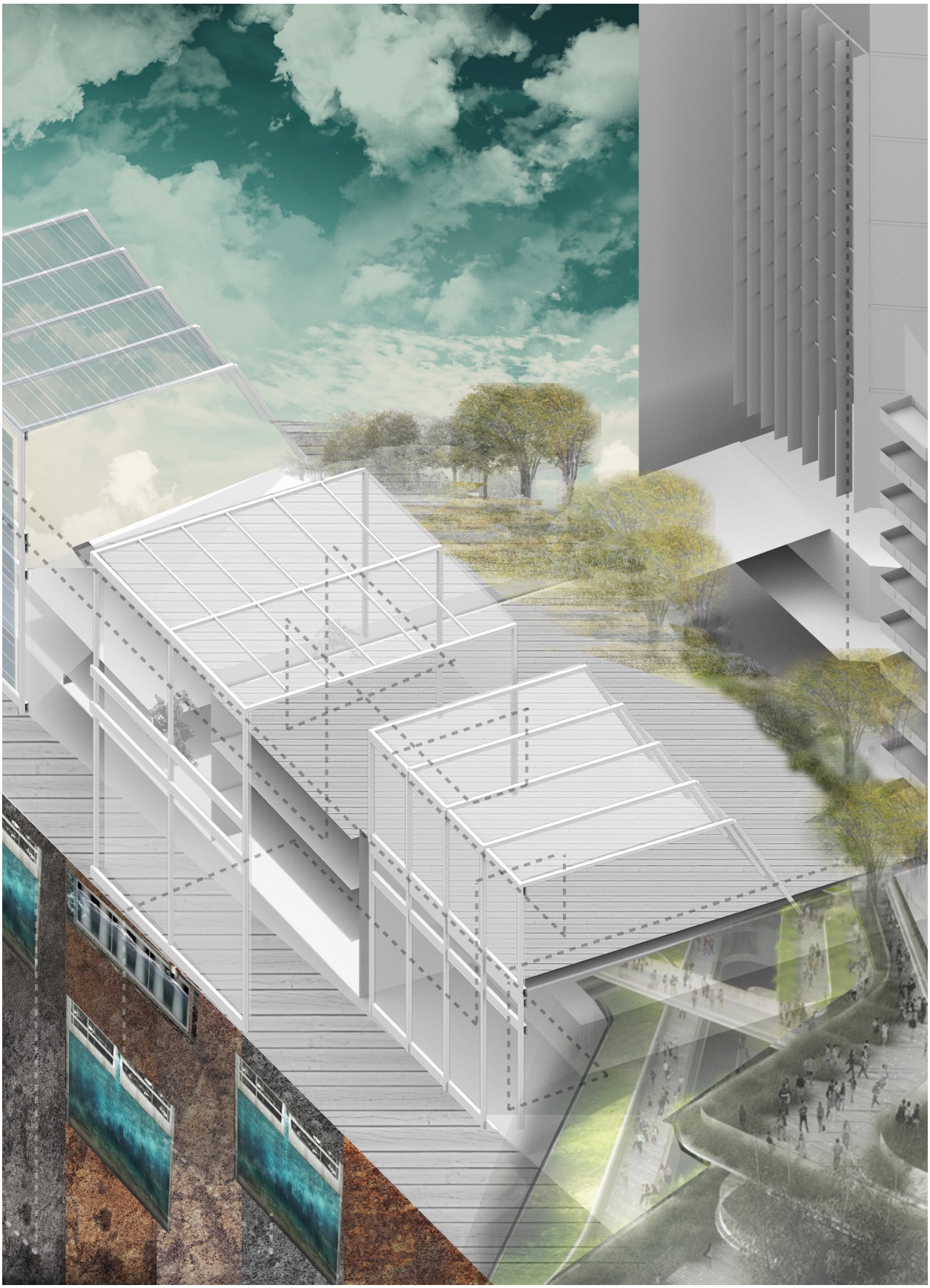
needs. Office buildings function mainly during the day and residential buildings come to life at night. Closed loops can be formed by day and night usage of building types.

One example is a water runoff strategy proposal for Phoenix, Arizona where water runoff is collected within each neighborhood. The desert climate means water is an important commodity and is valued above all other natural resources. Water runoff collected from streets is not sent to a rainwater treatment facility on the outskirts of the city. The proposal suggests collection of water runoff in tanks within each neighborhood. This water is then used in the area for irrigation during the course of the year.



Energy, waste and water patterns monitored by occupancy and building type and tied together in closed loop systems

Closed Loop Systems is about creating cyclical systems in cities and imitating a natural ecology where nothing goes to waste. Energy, water and material systems are designed in closed loops to create an urban ecosystem. Each city block has mixed use buildings with different energy and water needs. Gray water is treated in the neighborhood and stared. Waste heat from one building is used in another. Human waste is treated within each neighborhood. A small community is sized so it can sustain itself in energy, water and waste systems.



Conclusion | Future Works

		STRUCTURE		
		Form	Circulation	Organization
INFRASTRUCTURE	Social	The Green Space	The Three Minute Walk	P2P Infrastructure
	Physical	Porous Form	Elevated Travel	Orientation and Zoning
	Environmental	The Elevated Green	The Layered Grid	Closed Loop Systems

The patterns are plotted in a matrix within two broad categories: Structure and Infrastructure. The Form, Circulation and Organization of a city is studied in light of Physical, Social and Environmental infrastructure principles.

The patterns plotted within social infrastructure are human-centric and are based on the individual's experience of the city. Patterns of physical infrastructure are best executed at the scale of buildings and neighborhoods. Environmental infrastructure is aimed at a regional scale with an impact on the nature and hydrology of urban environments.

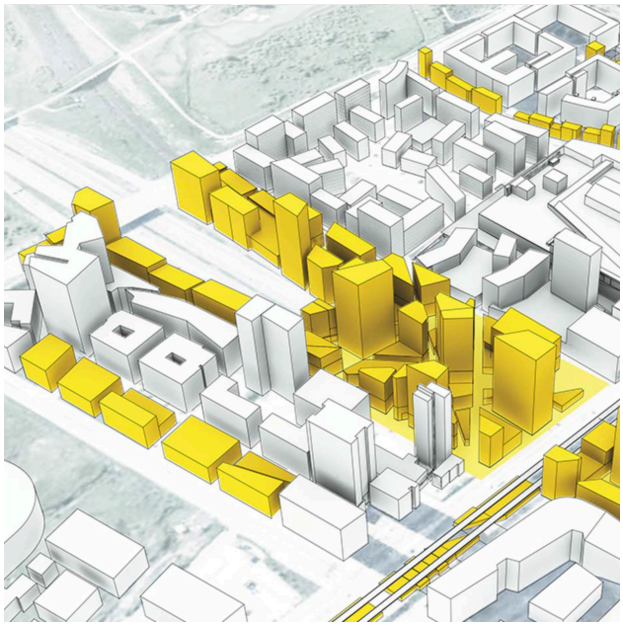
Each pattern is a moment that can be seen in a contemporary built environment. The Elevated Green may already exist in the roof gardens of Rome, but has just not been seen yet. With little design interventions, they offer all the possibilities an Elevated Green does. A green roofscape makes a difference to the temperature and offers a possibility for Elevated Travel. The Elevated Green combined with The Layered Grid creates a natural and interactive public realm on one layer supplemented by a vehicular transportation network below. Porous Form makes The Three Minute walk a viable as-

pect of city planning. Closed Loop Systems are the driving factor behind establishing a P2P Infrastructure network. Porous Form facilitates Elevated Travel by making buildings accessible and generating a safe, visible and connected urban realm.
The smart city confronts its many categorical imperatives. Each pattern is about connectivity and in some way affects the distributional networks of people and resources. The influence it exerts might be utilitarian or just experiential.

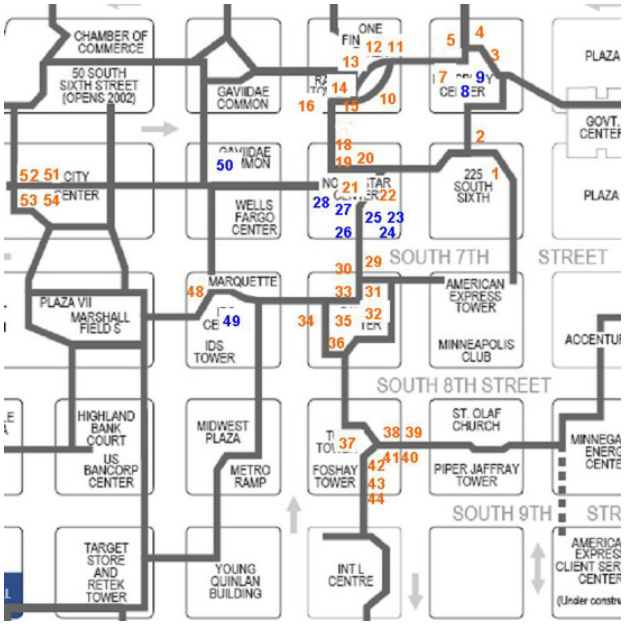
The way forward is to apply the framework of patterns to an existing low performing urban area of high density. It would be an analysis of what works where, and what patterns can be linked with each other. A metropolis offers challenges of density and connectivity and is hence more suited for the application of the patterns. Such an urban restoration project of nine insertions in neighborhoods would offer a chance to test the matrix and study its outcomes.

Appendix

Roof Gardens of Rome
Source: http://mentalalchemy.tumblr.com/post/74131079977/enochliew-roof-gardens-in-rome

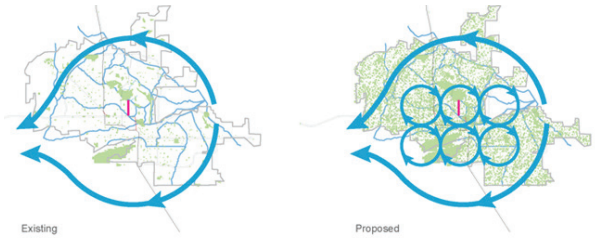


Ørestad 2.0 - Urban Power
Source: http://urbanpower.dk/orestad-2.0.html



Minneapolis Skyway System
Source: https://skywaygourmet.wordpress.com/skywaymap/

Piclo Flex Smart Grid Services
Source: https://piclo.energy/flex



Water Management Proposal for Phoenix, Arizona
Source: https://www.asla.org/2011studentawards/328.html

Maps of Seattle and Bellevue
Source: https://hebstreits.com/product/bellevue-washington-downtown-vector-map/

Sky Greens, Singapore
Source: https://nigeldickinson.photoshelter.com/gallery-image/Vertical-Agriculture-Farming-Sky-Greens-Singapore/G00008vBc-JPhTAjM/I00008yqD8q_iACQ/C0000_jswOvU.Bf4

Bazaars of South East Asia
Source: https://www.istockphoto.com/photo/city-life-main-bazar-paharganj-new-delhi-india-gm541283954-96796291

The High Line, New York
Source: https://www.thehighline.org

Figures

All images are made by the author, and all photographs have been taken by the author, unless noted below:

Figure 1 - László Németh - Random walk with 25000 steps (2013)
https://commons.wikimedia.org/wiki/File:Random_walk_25000.gif#file

Figure 2 - The Plug In City. Peter Cook, Archigram. 1964
https://www.archdaily.com/399329/ad-classics-the-plug-in-city-peter-cook-archigram

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