

**Emergent Urbanism: A Framework for Responsive Connectivity
in Vancouver's False Creek Flats**

by

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DEDICATION

To Brian for an imaginative perspective that challenged me to push further than I would have otherwise.

To Susan for being a constant inspiration, and a source of aspiration.

To Roly for dedication to craft in all its forms.

To Martha, Maggie, Peter, Steve, Susanna, and Bev for boundless compassion and integrity during the past years.

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ABSTRACT

The city remains one of humanity's greatest challenges, demanding solutions to complex problems that arise from a network of interoperating systems at different scales. As urban centres densify across Canada, the dialogue of how to create vital, highly functioning mixed-use communities within urban environments is of utmost importance. This thesis assesses the methodologies designers have used to handle this issue, and proposes analytical and generative tools that contribute to a framework for emergent outcomes to assist balancing multi-scalar overlapping variables. This framework is tested on a site rich in conflicting contextual cues: the False Creek Flats in Vancouver, British Columbia. Following a hierarchy of urban, building, and pedestrian scales, information from analysis is implemented into design processes and critical response. Focusing on issues of connectivity, responsivity, and identity, the design proposal synthesizes the outcomes into a new district and building typology based on three dimensional environmental and social constraints.

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CHAPTER 1: INTRODUCTION

Lilting and swooping across the gondola's middle tower, we looked at the lights of Vancouver before the 1980s had its way with the city — an innocent, vulnerable, spun-glass kingdom. (Coupland 1998, 15)

Urbanization and Problem-Solving

The city remains one of humanity's greatest challenges, demanding solutions to complex problems that are created by interoperating constraints. Overlapping layers of systems functioning at different scales contribute to the dynamic system that comprises a metropolitan region. It is this complexity of multi-scalar, overlapping variables that makes cities so appealing as engines of creativity, technological progress, and social advancement, but also what creates problems when attempting to design a city from the top down that functions well and takes the needs of its citizens into the highest regard.

Now more than ever, this issue is of the utmost importance, as urbanization takes place at a rapid hold and the last remaining developable land in already established cities is whittled away. With buildings having lifespans of half a century or more and the environmental and social impacts of dogmatic architectural processes more clear than ever, we know that the decisions we make now will resonate for generations. It is for this reason that we must do everything we can to balance the oftentimes conflicting constraints that are present in any project. No longer is it practical to undertake the zoning exemplified by modernist town planning exercises in a response to the need for mass housing and sanitation needs, as our issues now focus on how to function within the cities we already have instead of levelling entire neighbourhoods. Indeed, many of the mixed-

use developments underway globally at present embody a level of complexity for programming, structure, fabrication, and mechanical systems that is unprecedented in history. To balance all these needs well in advance is problematic using current design practices. It will remain to be seen whether the decisions we are making now are enough to make up for our previous excesses.



Masdar City is an example of the massive scale that one design can reach, impacting issues of infrastructure and the flow of goods and services (Jenkins and Foster + Partners 2007, 45)

The rise of global communications networks, increased computational power, and new software has facilitated this new era of collaboration, analysis, and generation, for which the sharing and processing of information is a prerequisite. Computational analytical tools offer opportunities for modeling emergent outcomes of complex design decisions and optimizing their impact to the particular problem. Architects have been quick to embrace these new tools, but their use is accelerating as abstraction of intent increases. This research underlying the thesis is an anticipatory move to the issues created by this type of design, utilizing a

meta-analytic approach to determine the challenges and opportunities created by these new tools and techniques.

This ability to model emergent form based on analysis is - ironically - ultimately an attempt to return to the way cities once formed in an organic process based on a response to environmental and social pressures over an extended period of time. The shift towards a planned city is only a relatively recent development, and a response to the need to manage unprecedented numbers of people and infrastructure. The possibility to return to a more natural way of “planning,” and the more representative and dynamic city that comes with it, is an appealing one made possible by new technologies and the methodologies they create.

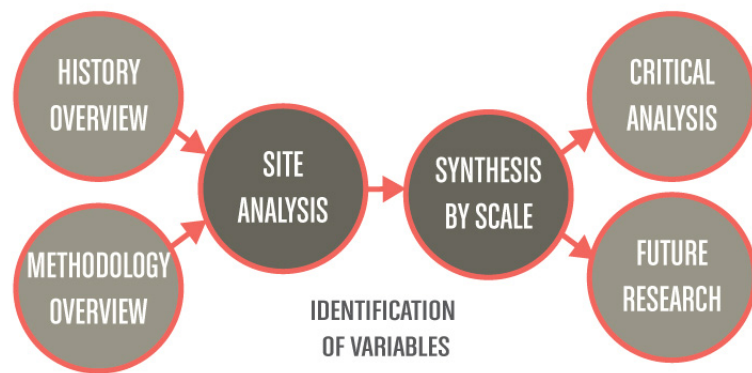
This research is tested in a design proposal for a site rich in conflicting social and physical cues: the False Creek Flats in Vancouver, British Columbia. Following a hierarchy of urban, infrastructure, and building scales, information from analysis is implemented into design processes in addition to analytical and generative tools. The design proposal synthesizes the outcomes into a new district and building typology that responds to context while defining its own identity using precedents from urbanistic thinkers to define areas of focus. This process provides an opportunity to reflect upon the impacts of the digital design framework and further possibilities for an emergent design process.

Problem Statement

How can analytical and generative computational tools be used to develop context-responsive projects that fit into an existing site’s environmental and social constraints to ultimately create a more connected city?

Method

The intent of this research is to provide a critical analysis of contemporary city building practices as viewed through the lens of new methods. It is arranged as an experimental project and not a design problem, meaning the problem is identified and tested in context and the hypotheses are tested for their success based on operational definitions of outcomes.



The process of the thesis is structured like an experiment testing ideas for validity.

The process of self-assessment during the research is of extreme importance. The end result is not necessary the design itself, but rather the procedure to get there.

CHAPTER 2: AN ISSUE OF (CITY) DESIGN

To be very simplistic, one could say that the system of the grid was established in the twentieth century. This system became popular throughout the world, as it allowed a huge amount of architecture to be built in a short period of time.

However, it also made the world's cities homogeneous. One might even say that it made the people living and working there homogeneous too. (Ito 2012, 33)

Bottom-Up vs Top-Down Processes

The role of the city in our current collective consciousness exists as a question into whether one is comprised of its structures or its inhabitants. Is it true that the “real city is made of flesh, not concrete” (Glaeser 2012, 21)? As Jan Gehl describes in *Life Between Buildings*, the public spaces in a city before 1500CE were not planned in the sense we know it today. Instead, they emerged from the needs of the population in a natural process that took an extended period of time (Gehl 1987, 41). Our cities can even be seen as the crystallized “urban exoskeleton” of our biological processes – solidified in bricks and defensive monuments - our role as a small cell in a gigantic organism to which we all contribute (De Landa 1997, 27).

Increased speed of production and the necessity of housing larger numbers of people in more complicated social arrangements have led to the cities of today, a tangled web of connections and forms that overlap in ways never dreamt of. To manage this complexity we saw the rise of architects and planners alongside the urban grid. The grid is a reflection of the growth of bureaucracy beginning in the time of ancient Egypt, and is a way of abstracting the world in a way that has allowed civilizations to flourish in the form of a city grid, map, or even a musical score (Higgins 2009,

8). Our grid has changed proportion from that of old, as the cities of the automobile and the pedestrian have vastly different scales, based on the speed at which each modality moves through the city (Gehl 1987, 73)

The ideas of modernist theorists were noble as a response to, among many others, the issues of sanitation and overcrowding. As our civilization develops new ways of living, our architecture must respond to the complexity of our current situation by itself being adaptable. Top-down solutions of grids are not an acceptable response to problems we now know to be extremely nuanced:

Following Lévi-Strauss, grids would be said to state the opposition between the detail and the totality, the chaotic and the ordered, and the individual and society geometrically, as a relationship between the square module (or what it contains) and the grid. This opposition is resolved by the homogenizing power of the gridded field. (Higgins 2009, 9)

Cerda's move to create the grid of the Eixample in Barcelona created a "currency" of homogeneous blocks that allowed for the easy interchange of units. Setting up the basic rules for the city to function offloaded the complexity of providing for individual needs into a rough bottom-up process in a top-down framework. De Landa's notion of exchange and currencies enabling markets to rapidly develop cities past the barter system applies to this system, where a common repetitive unit can make interoperability of businesses and individuals more expedient than otherwise (De Landa 1991, 36). Could Gaudi's brilliant facades have existed were it not for the grid for them to defy?

Standardization allows for the system to be parsed into smaller components that are easier to manage and understand. This concept is still in use today with the CRU

(Commercial Retail Unit) and TI (Tenant Improvement) spaces.



Homogeneity of the urban form of Barcelona in two dimensions can lead to the unexpected ability for self-expression in the third.

The outcome of this standardization was the dehumanization of the system. Once the scale had been lost, residents of a city often felt alienated. The homogeneous population is not a natural state. De Landa argues that

...whenever a heterogeneous group of people comes together spontaneously, they tend to organize themselves in an interlocking urban pattern that interconnects them without homogenizing them. (De Landa 1997, 31)

And indeed, many modern urban plans have had the exact opposite effect of this.



When portraying a dystopian city from another planet where love and self-expression are outlawed, filmmaker Jean-Luc Godard had to look no further than the dehumanizing direction that Parisian development was taking to provide a backdrop for his cinematography (Godard 1965).

The relentless repetition of housing typologies vertically and horizontally can potentially result in pleasing forms, and those are normally what receive acclaim and publication. However, the reality is that much of the slab towers developed as a solution to housing normally target low-income populations and provide a subpar solution to the greater problem (Sherwood 1978, 24). While architecture may not be the way to social deliverance, the ability to manage the complexity of the problem in a more humane and representative way is an appealing one.

Hans Ibelings, in *Unmodern Architecture*, argues that:

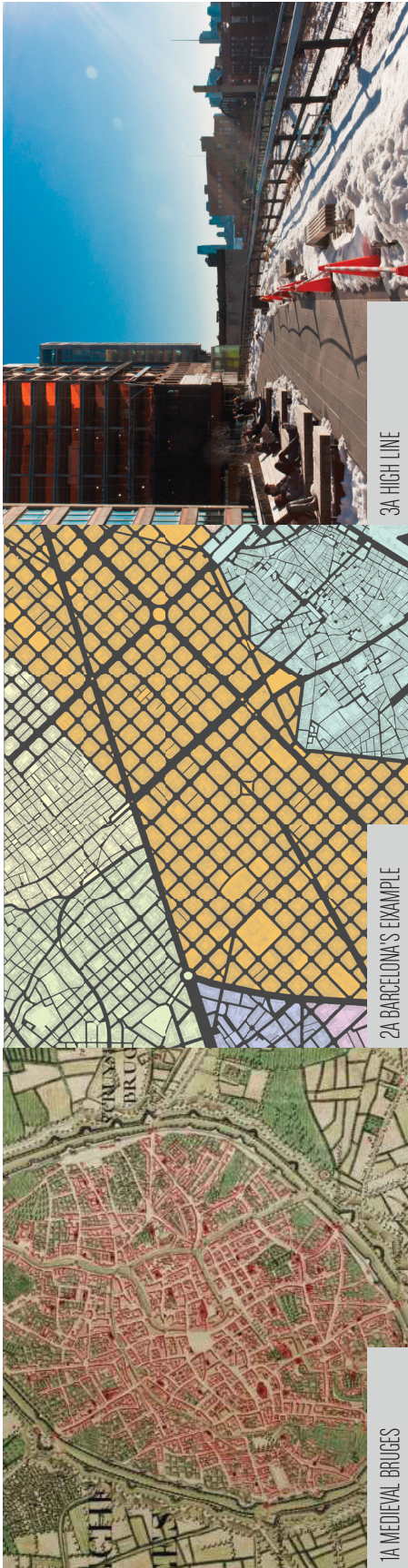
...harmony, however, is only possible if an environment invites such step-by-step development. This is not the case on locations where, based on the principles of modernist architecture and urban design, a radical break was in fact made with the old and the familiar. When contemporary traditionalists are asked to work in such locations, they often feel called upon to take a giant step back in order to restore a connection with what was there before. (Ibelings 2004, 23)

The implication of this is that the scale of modern architecture and the speed at which it happens has by definition a disconnecting effect. His thesis to return towards “contemporary traditionalism,” is a noble one, but potentially ignores the different issues that our society faces today. The issues of sustainability, scale, and construction speed are not always possible to be addressed by traditional methods, and arguably we are past a threshold where there is no turning back in terms of our population density and demands placed on construction projects. New construction methodologies like the Public-Private Partnership and the design-build timelines that come with them are forcing developments to take into account more complicated programs quicker.

New Methods for Handling Cities

Christian de Portzamparc provides a theoretical framework for understanding the three “ages” of a city (Portzamparc, Jacques & Lavalou 1996, 41 - 43). The first is the medieval, emergent city which characterized most development before top-down processes. The second is the regimented grid exemplified by the Roman Empire and modernism, which had the intent of making a complex environment manageable by parsing it into smaller components. The third age is how we react to those previous layers.

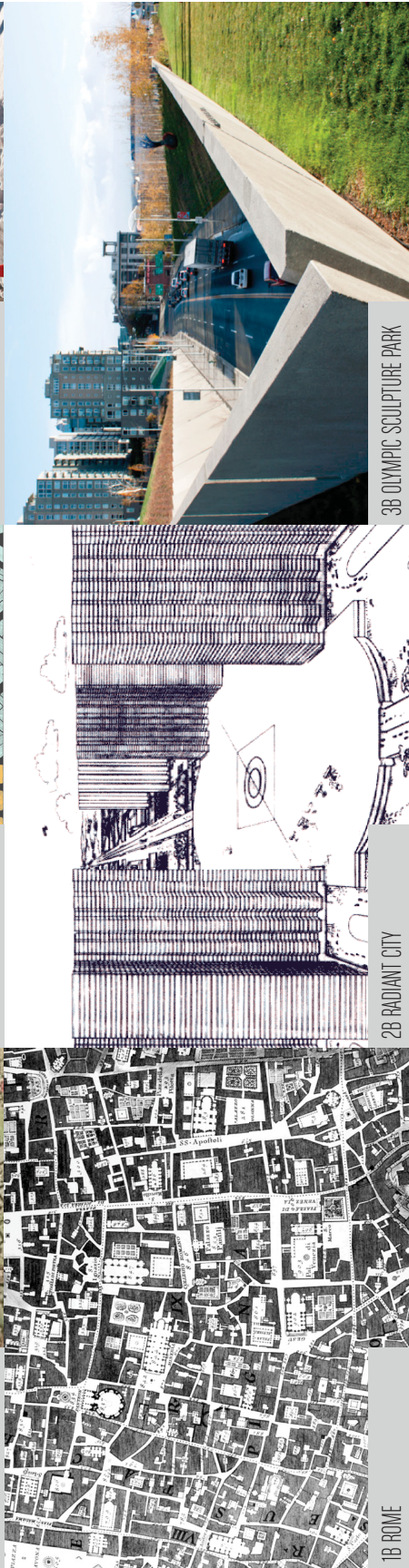
We are entering Age III of the city, having put Age II, the age of the domination of single objects, in the dock. [...] The classical idea of harmony and the necessary reproduction of finished models has come full circle. It is now only relevant for a few favoured pieces. Elsewhere, we must tackle heterogeneous situations where we are dependent on random forms and the inevitable disparity of today's architectures. We must invent another form of architecture, one more subtle and tenuous, less facile than the mere reproduction of classical rules. (Portzamparc, Jacques & Lavalou 1996, 64).



1A MEDIEVAL BRUGES

2A BARCELONA'S EIXAMPLE

3A HIGH LINE



1B ROME

2B RADIANT CITY

3B OLYMPIC SCULPTURE PARK

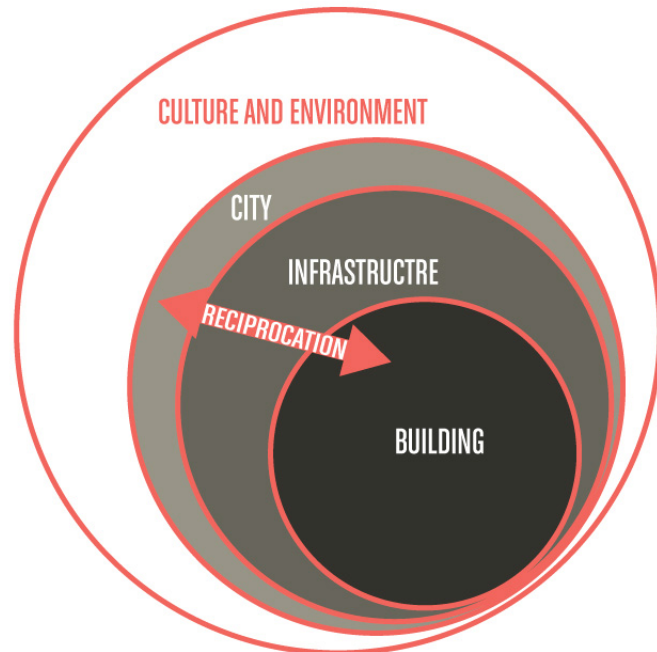
AGE I: THE MEDIEVAL CITY

AGE II: THE MODERNIST CITY

AGE III: THE FACILITATED EMERGENCE CITY

The city of facilitated emergence is a return to less centralized methods of planning, but with the ability to satisfy mass housing needs utilizing digital tools. The backbone of this new way of thinking is localized interventions into the city that work towards a greater goal. In this respect, the proposed interpretation of the Age III city combines the democracy of the Age I city with the goal directed planning of the Age II city (1A: Ferraris 1771 - 1778; 1B: Nolli 1784; 2A: Generalitat de Catalunya 2014; 2B: Curtis 1996, 246; 3A, 3B: Author).

The previous two ages are now the problem space in which we inhabit, and we must build off of their legacy for problems in existing city. The relationship between objects in the city now must conscientiously operate across scales to inform design decisions.



A proposal for the interaction of layers of the city based on Portzamparc's ages of the city. Infrastructure acts as the mediator between scales to help provide a framework for heterogeneous situations.

The work of Bjarke Ingels Group takes this way of thinking to its extreme conclusion, by beginning to define projects by their contextual constraints and transforming that directly into architectural massing (Ingels 2010). The explanations provided in a serial format present solutions to theoretical problems, defined by the designer. This follows Thompson's maxim of "form is a diagram of forces," where we begin to see the pattern emerge of built form responding to the societal forces and physical constraints placed upon it (Thompson 1952). The building is thus physically sculpted by its formal requirements (Appendix A).

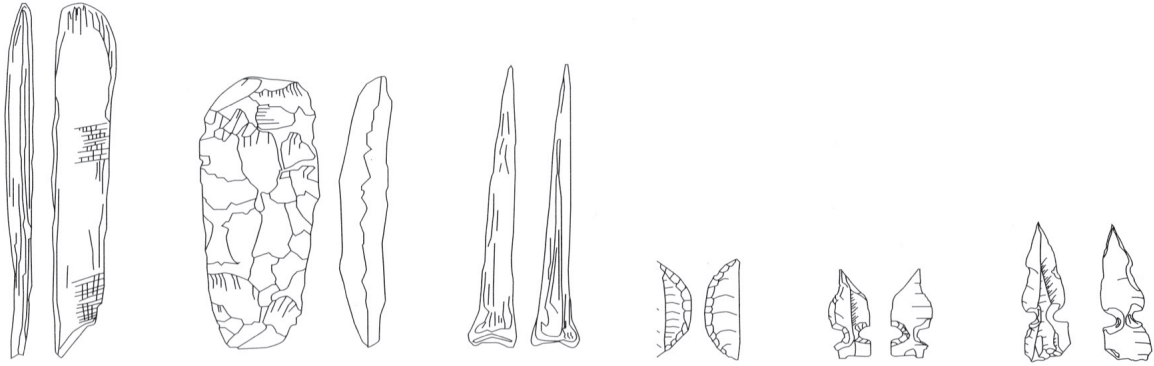
The use of digital technologies provide us the potential to manage these layers and make them visible. The design can be seen as a problem to be solved in steps algorithmically:

Theoretically, as long as a problem can be defined in logical terms, a solution may be produced that will address the problem's demands. An algorithm is a linguistic expression of the problem [...]

An algorithm can be seen as a mediator between the human mind and the computer's processing power. The ability of an algorithm to serve as a translator can be interpreted as bi-directional: either as a means of dictating to the computer how to go about solving the problem, or as a reflection of human thought in the form of an algorithm. (Terzidis 2006, 15)

The industrial revolution strengthened our production capacity, leading to the modernistic glass towers based on repetition to redo the same operation. Computational tools (when used properly) allow a designer to generate individual forms, taking into account numerous layers of constraints. By doing so, the digital revolution has strengthened our mental capacity by partially offloading the management of problem solving onto machines.

Ironically, this shift may signal a return to more sustainable modes of living. Tradition is based on practice that has been repeated to a beneficial effect for a community, allowing it to exist in harmony with its context. The current pace of change, and the irrevocable nature of the situation we find ourselves in with regard to resources and supply chains, means that there is not significant time for lasting traditions to be formed. Instead, we can simulate the outcome of extended periods of trial and error experimentation using digital methodologies. Things that once took a millennia to determine were a bad idea can potentially be discovered with less blood and sweat.



Tools evolve from crudeness to refinement in parallel with a societal change (Weinstock 2010, 152).

Our cities and our tools evolve in parallel to one another. Thus far, the dimensional change of urban form has been normally accompanied by a change in mode of transport, be it the tram, automobile, or elevator enabling taller buildings (Safdie 1997, vii). The practices of Toyo Ito and Cecil Balmond and their affinity for natural processes through digital means (such as Balmond 2007) are an indication of how the creation of tools to solve specific problems can redefine the city into a more natural way of life.

CHAPTER 3: COMPUTING COMPLEXITY

...chaos is the score upon which reality is written. (Miller 1987, 5)

Anticipation

With new technology comes new ways of thinking and making, affecting the formal organization of the built world to its very core. Just as Louis Kahn's work on integrating machinery into building construction was ahead of its time, and Louis Sullivan's in-depth analysis of the emerging skyscraper typology set a standard still worth its weight today, this research attempts to anticipate the permanent shift in architectural design and practice from the computing revolution and work through some of its consequences. By analogy, we can think of computation in architectural discourse as currently a river that with some work can be diverted. Once it becomes a waterfall, there is a great deal of difficulty associated with changing bad habits.

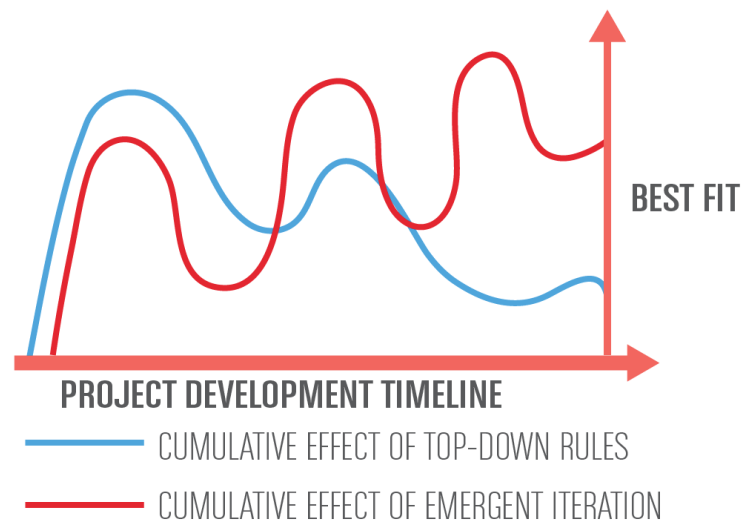
As stated by the editors of *Distributed Intelligence in Design*:

The generative, representational and collaborative potentials of various digital media and embedded computing are already well documented and discussed in various conferences, biennales and publications. Yet it would be fair to say that although the potential is huge and endless, the technological transformation the architectural profession is going through at present has not been as smooth as one would have hoped. (Distributed Intelligence in Design Symposium 2011, xii)

This technological transformation goes beyond the changes in modes of representation and tactile interface. The change is also a shift in the fundamental processes by which we approach design. The possibility to create unique and generalizable tools for a project is an option to work with traditional design methodologies that can impose top-down

concepts such as grids to improve the ease with which a design can be generated for a complex situation

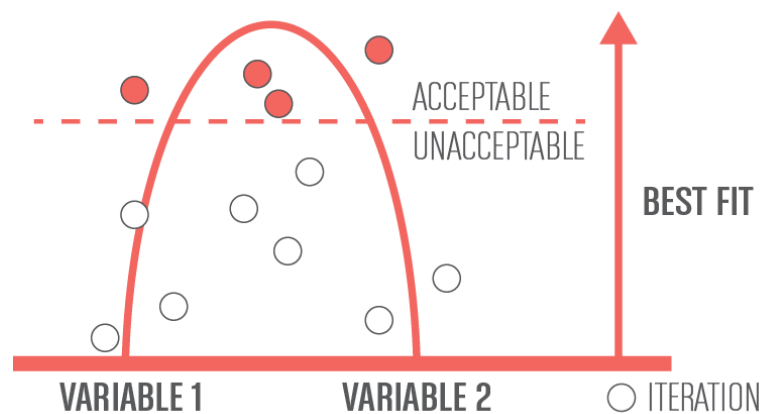
The use of bottom-up digital tools is a balance between the specificity of the tool and its utility. As design is a generative process requiring numerous segues among paths that often end in dead ends, the utility of a tool that is over-specific can be affected adversely. Design processes that are highly frontloaded with preconceived rules of thumb begin out highly on their utility, but soon fall off on their specificity to the problem at hand.



The cumulative effect of rules using different design strategies affects the quality of fit for any given problem. Using top-down strategies can provide an extraordinary head start when it comes to satisfying basic issues such as floor square footage, but can miss the mark significantly as a project develops. The early decisions become restrictive.

It is important to note that this is not to completely disparage rule of thumb methods for design, but rather an explanation for their appeal and an analysis of how new tools can be used to generate possible solutions more in line with the solution sets. Some of these concepts assist only with the iteration of an idea at a rapid speed. Providing new viewpoints can help us figure out what it is we want to say.

One way to imagine what a “parameter” in a digital parametric tool is to utilize Corbusier’s moduler. We can imagine a parametric model of a work-station to follow these rules of measurement, and the rules could be used to define an entire building, city, or planet. The digitization of the process is merely adding the ability to utilize the parameter in a more rapid and interconnected fashion, leading to more rapid iterations and solution sets.



When balancing a simplified design example of two variables, iterations of a design fall within a range of acceptability. Constraints need to be placed on the range of acceptable possibilities for the outcome.

But the use of digital tools and their ease can also result in a solution to a problem that is a worse fit:

Even today, architects not infrequently seem prone to an unreflective enthusiasm for digital formalism. The issue of whether a digital design approach to generating forms is also appropriate in the constructional and technical sense is generally shuffled aside. When this problem is regarded from an overarching perspective, the question arises: Should we do everything we can do, just because we can? (Gleiniger 2008, 65)

Working by abstraction and proxy can cause blips in the actual feasibility of a project and lead towards solutions that do not actually fit the problem. This is an issue faced by any

of the tools that designers use to abstract their intention, being it drawing, model, or tool. The tendency for digital projects to tend on formalism may be a byproduct of the novelty of the recent development of the technology. This only underscores more the importance of developing a process model for good digital workflow.

Framework

If the city is not simply a mechanical system but an evolving biological one, how can we best serve the “organized complexity” as defined by Jane Jacobs (Greenberg 2011, 79)? It is difficult to manage the conflicting needs of large amounts of individuals in one place without resorting to the top-down methodologies discussed earlier. Defining key principles for how to enable an optimum city to develop is akin to setting a performance-based code for connectivity.

A loose fitting solution is better suited to a variety of environments, as in the example of Barcelona. Solutions have a ripple effect that can cascade through different scales at a city, hinting at the possibility of breaking a problem into smaller components contributing to good city design, as Gehl notes:

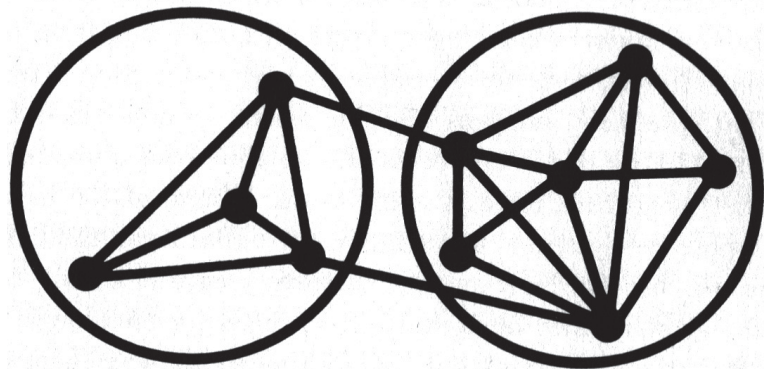
Decisions at the large scale, in city and regional planning; at the medium scale, in site planning; and at the small scale are inextricably linked. If the prerequisites for reasonably well-functioning and well-used public spaces are not created through decisions at the primary planning level, a basis seldom exists for working at the small scale. [...] The battle for high quality in cities and building projects must be won at the very small scale, but preparations for successful work at this level must be made on all planning levels. (Gehl 1987, 85)

Christopher Alexander, in *Notes on the Synthesis of Form*, defines design as problems that can be broken down into

their constituent parts (Alexander 1964). These parts are interrelated and react from each other, as if connected by elastic bands. This way of thinking is not a new way of thinking, and can be attributed to the harmonious properties of great works of architecture:

The end result of the breaking down of a problem into its constituent components is a better logical and material order, which can be traced to the beauty of works of practitioners like Gaudi, Nervi, and Otto. (Hauschild, Karzel, and Hellstern 2011, 7).

Cities, despite all of the top-down planning, are still emergent based on the linkages of variables, except with the layer of planning acting as another constraint on the development. By definition almost, cities are emergent forces responding to their context (Weinstock 2013, 16).



A theoretical diagram showing the relationship between interconnected variables in a design problem (Alexander 1964, 43). Cities can be seen as networks of interconnected variables resulting in emergent form.

Given this approach to city-building, goals for a digital process can be formed. The built form of a city does not act in isolation, instead it responds to its adjacent context and also connects to it. Our goals, therefore, are responsiveness and connectivity. We will see that these have precedent in historical approaches to urban design.

Responsivity

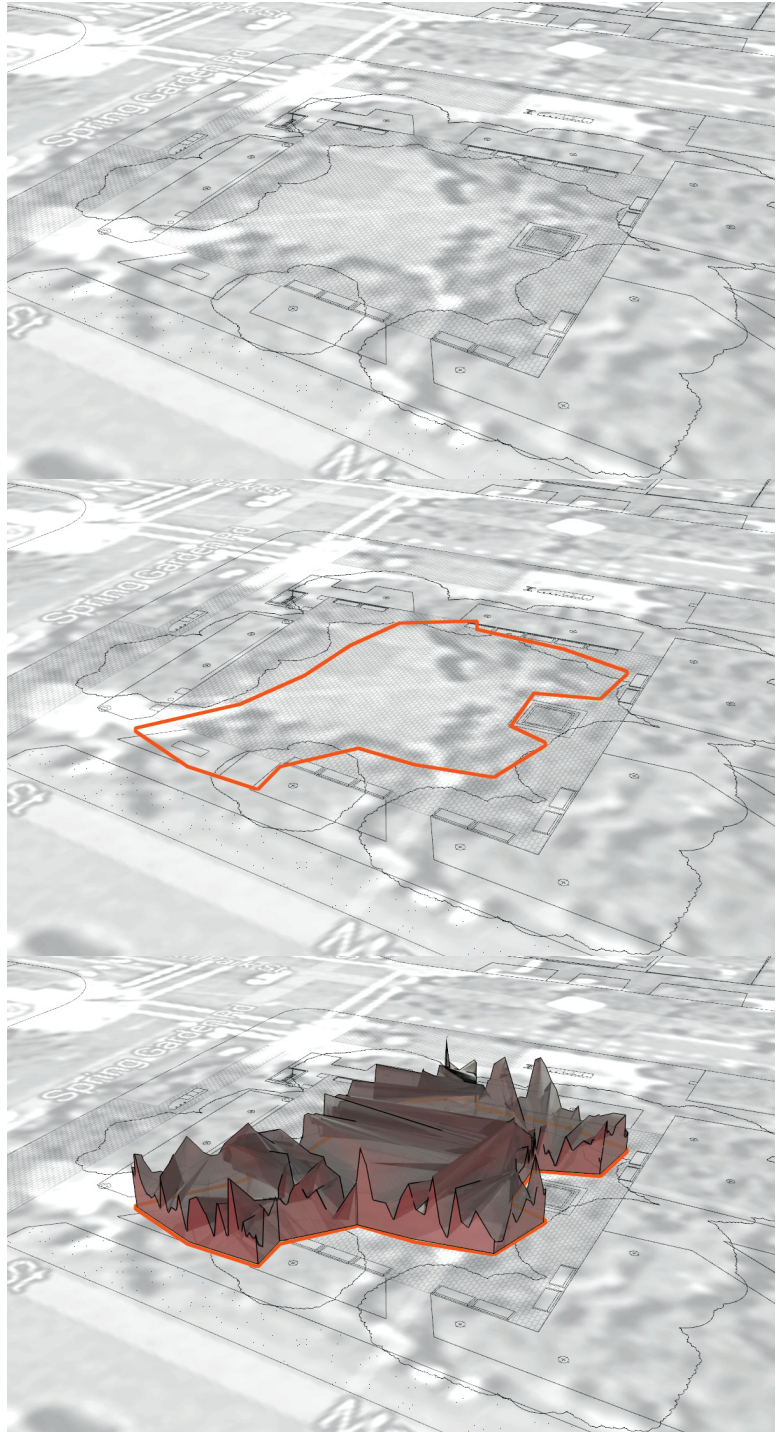
Responding to context requires a foundation in how to interpret it. As a highly subjective notion, what defines our physical and social environment, and who is to say what is important and what carries weight? The notion of an objective interpretation of a site is an appealing one, but can it actually exist?

Searching for an alternative method to detect site parameters to respond to, an experiment was undertaken to divorce the designer from the collection of data and see what the results were. By using a drone to collect and interpret data automatically, a tool was created to emulate the process of interpreting the environment in order to have something to respond to. The variables that the drone measured would provide the basis of how contextual data could be parsed and interrelated with design thinking. The abstraction of site metrics also provided an analogy for the disconnect that tools can create for the designer.

The results indicated a need for not just data, but also the ethnographic information that could be used to temper it. This approach echoes the studies of William Whyte, where environmental data and ethnographic observation assessed how properties of a space affect the behaviour which it enables (Whyte 1988). A model of context that encapsulates only physicality is incomplete, just as is one that only looks at social context. The essence of architecture of modifying the social and physical environment working together provides the foundation for a framework of responsivity. Site metrics and cultural context are key. As well, the experiment identifies how analysis of these variables is an important pillar to properly parse the information.



A remote controlled drone was used to obtain a different perspective on the data used in computational design processes. Sensors included GPS, vibration for ground material, a photosensor for light level, ambient noise levels and video through the camera. The intent was to view the city in a different way, distorted through data.



Using a drone to map an alternate interpretation of a site provides insight in how to bridge between algorithmic and computational problem solving and the function of a city. Operating at different scales is an excellent starting point to begin dividing a problem. The drone's GPS was synced up with the values picked up by the onboard sensors in the z-axis. This reading from the photosensor in Halifax's Victoria Park depicts lower light levels beneath tree canopies on a sunny day. The values in between are interpolated.

Connectivity

Urban design is always concerned with the question of making comprehensible links between discrete things. Furthermore, it is concerned with making an extremely large entity comprehensible by articulating its parts. (Maki 2008, 59)

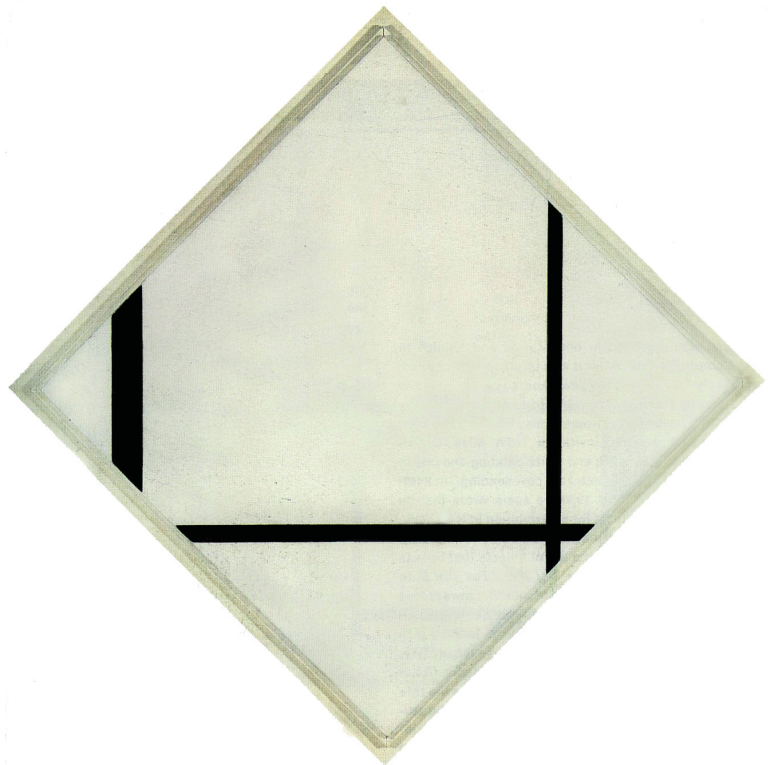
Connectivity is a fundamental feature of urban life that has the potential to be improved by digital tools. It is the connections between forms in the city that allow for identity to emerge, and for formal relationships to be solidified. As the ethnographic study below indicates, the flow of pedestrians through connections in a space recursively redefines the space, but could also be likely largely predicted based on the locations of “nodes” of entry and exit on the site. The context informs what happens inside the boundaries.



In addition to physical data and site metrics, a site can be assessed through ethnographic observation following the model in William Whyte's *The Social Life of Small Urban Spaces*. Pathways through the site generate “islands of inactivity,” hinting at areas for connectivity and areas for lingering that can be applied at multiple scales.

In this case, an analysis of the site generates a form as a result. The two ways of thinking are intertwined, and an emergent form is created by virtue of undertaking the process. Once again, the importance of site metrics is key to a connective analysis, which is an overlap with the goals identified for responsiveness.

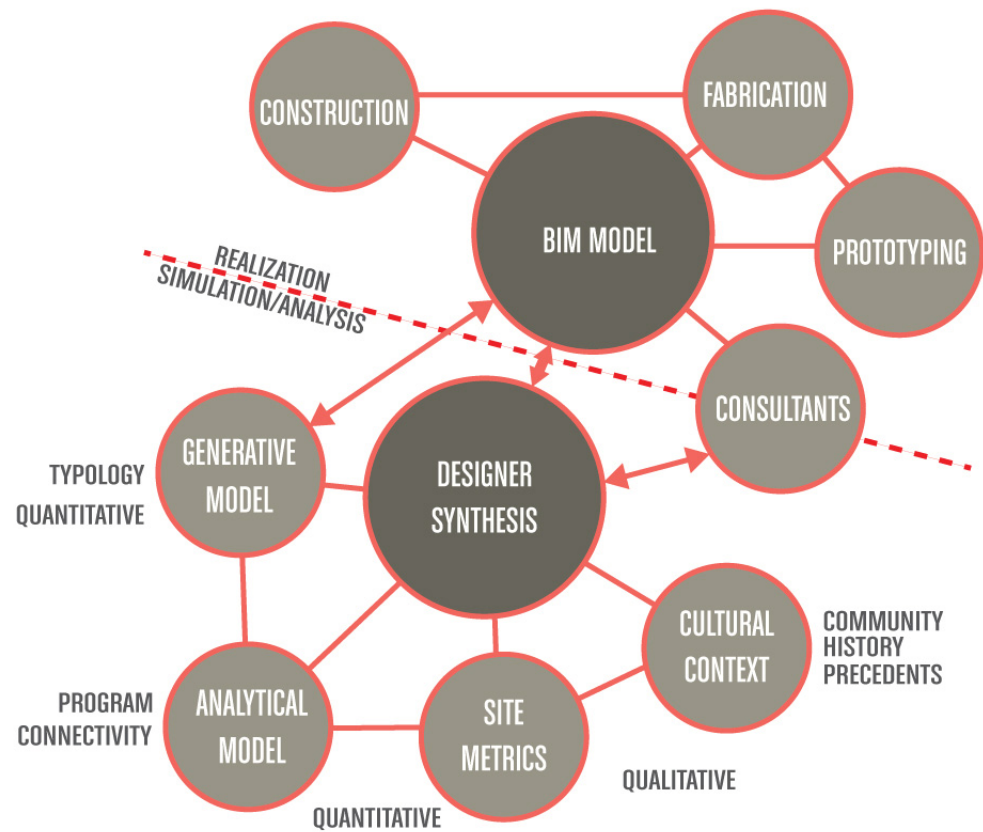
Connectivity does also not need to be taken literally as a direct connection as studied in the ethnographic research. Many methods exist to hint at connectivity, including using visual, acoustic, or material choices to link or transition environments psychologically within the minds of users. The methods are up to the designer.



Some of the intersection points of the Mondrian *Schilderij* series are tellingly located off the boundaries, hinting at each painting's role as part of a larger painting of mass interconnectivity. Part of a greater whole, by denying a direct link the effect is stronger.

A Model of a Digital Emergent Process

The research studies into data gathering and the tension between social and physical forces has provided the foundation for a framework to use new digital tools in the age III city. With the goals of creating connectivity and responding to contextual cues, this model takes into account numerous actors to understand a project.



The digital process model was developed through a meta-analysis of urban research. The division between the two halves is not necessarily as sharp a divide as depicted, based on any given project.

The model is divided into two distinct sections: simulation/analysis, and realization. These correspond to the two traditional phases of design and construction associated with built form, but acknowledge that this boundary is not necessarily a constant as new construction methods like

design-build are blurring this boundary. Having an adaptive model taking into account both sides of the line can help to create more vibrant projects. The design of large developments are largely carried out on a trial and error basis by hand, using general problem-solving approaches to making things easier – ultimately resulting in uniformity and monotony in the layouts (Hovestadt 2009, 24). A rigorous emergent process can allow for the potential to break this cycle.

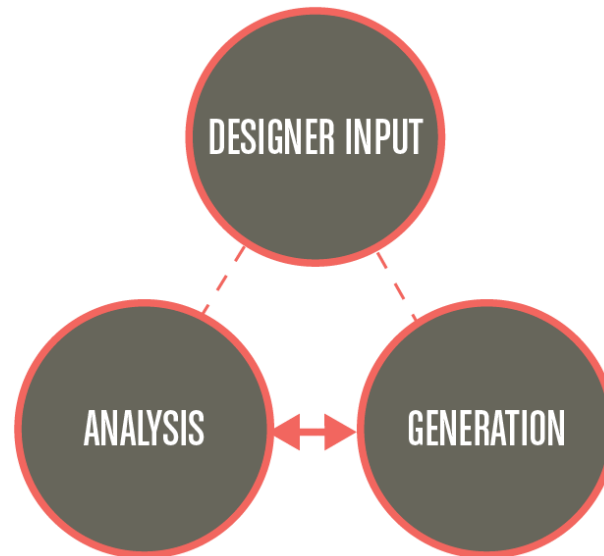
Simulation/Analysis

Corresponding to design in a traditional process, the simulation and analysis of a project allows for social and physical variables to coalesce into potential outcomes. As the linchpin of a digital design process, the designer continues their role as a cultural conduit and interpreter of social context. As the practice of Toyo Ito indicates, even though computational tools are used to relinquish some design decisions, the decisions are ultimately that of the designer and their own individual vision (Ito & Daniell 2011, 8). The information tableau of a design problem exists in the physical and the social realm.

As indicated by the research using the remote controlled drone, there is an important distinction between models that can analyze a current or theoretical situation. The processes of understanding data and manipulating it to create new form are distinct operations that work in tandem with each other. Analysis and generation are two sides of the same coin and occur contingent on one another.

Applying the digital process model to an urban problem, the reconstruction of traits associated with the historical

emergent city begin to return. By conscientiously offloading certain levels of decision-making away from arbitrary designer-led choices, the true constraints placed onto the system are made visible and begin to define formal architectural decisions in a legible way specific to the site. The importance of a site reading to this process is crucial.



In simulation and analysis, a loop is generated between analysis, generation, and the designer input that mediates the process

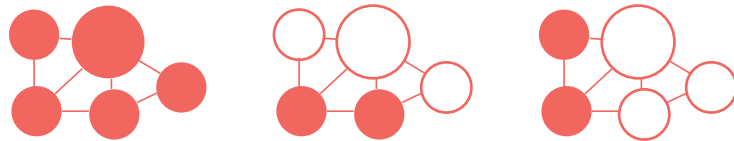
Realization

At its core is the relationship between the designer and the BIM (Building Information Management) model, acting in tandem to manage the complexity of information at our disposal. Off-loading cognitive complexity to the BIM model and its subservient generative models allows for projects to be parsed for their multiple layers of complexity. This process also necessitates breaking a problem down into its constituent parts, akin to Alexander's model of interconnected variables.

Generative architectural systems blur the difference between model and the actuality of the constructed form (Gleiniger and Vrachliotis 2008, 71). The model becomes

the intermediary between the designer's will, and the information provided through the other actors. Consultants bridge this gap in practice, providing the intermediary between realization and the design process.

The use of mass production and highly regular and repetitive components is an outcome of the industrial revolution, and is a safeguard to manage just how complex architectural problems are (Hovestadt 2009, 20). Using new digital fabrication technologies, the cost to having entirely unique components is rapidly becoming more accessible to the construction industry, and soon it may indeed be more expensive to use repetitive components due to their inherent inefficiency in handling the issues of energy and economy of floor space. The direct link between fabrication, construction, and consultants to the process provides a more agile system for responding to site constraints. The use of the computer as tool for representation is well established, but it is only now that the computer as an "open system of architectural production" is coming to fruition (Gleiniger and Vrachliotis 2008, 67).



This icon will appear next to experiments corresponding to the model. Its fill levels correspond to the elements being tested.

With the hypothetical model established, the next step is application to site in order to establish a cultural context to work in.

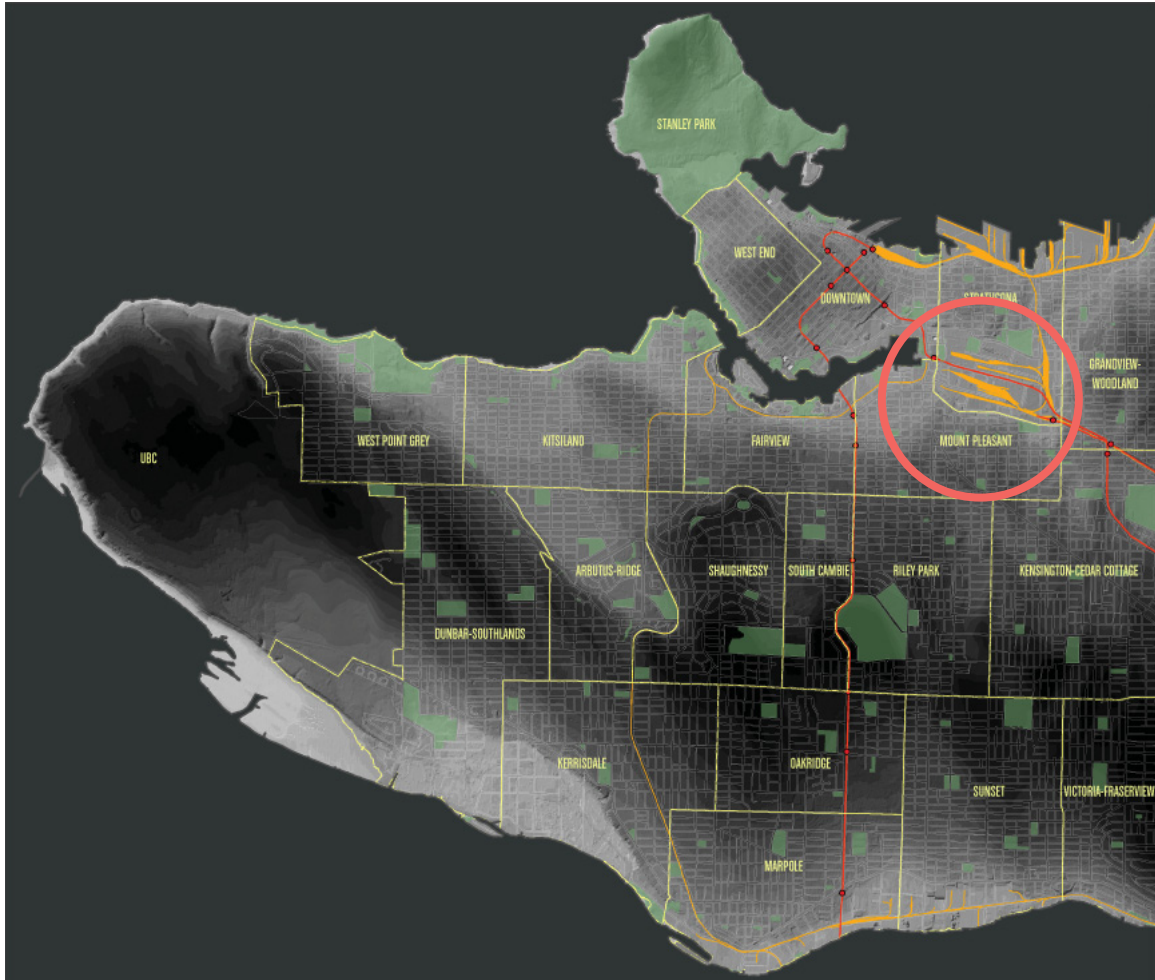
CHAPTER 4: URBAN CONDITION

Suppose you land in Vancouver, as seems reasonable. So far not so good. McGoff didn't have much use for modern Vancouver. [...] But no one in a certain sense lives there. They merely as it were pass through. Mine the country and quit. Blast the land to pieces, knock down the trees and send them rolling down Burrard Inlet... (Lowry 2007, 92)

Establishing Variables

With a digital process model in mind, we return to the necessity of identifying cultural context and site conditions. The foundation of any good digital design process lies with the qualitative variables that are parsed from the designer, avoiding a project that exists without place. While the tools developed from the model can result in generalization across sites, by no means is the intention to ever create a design process that avoids cultural context. On the contrary, the intent is to amplify these qualitative variables to the forefront of design thinking by allowing them to mesh with other constraints.

Given the nature of this study and its focus on connectivity and responsivity, a challenging site has been chosen to test the validity of the variables. The False Creek Flats in Vancouver, British Columbia is located in a critical position between peninsular downtown Vancouver and the greater urban region. For testing connectivity, this area is crucial, and development patterns make it an ideal candidate for an overarching urban plan. With that in mind, the history of Vancouver as a whole and the neighbourhood in particular are taken into consideration. A cross-section of historical environmental, social, and economic forces provides a backdrop for research.



The elevation map of Vancouver reveals it to be developed at the lowest point of glacial recession. The peninsula where the downtown core resides becomes the terminus of trade, with a still active port. Rail lines (in orange) make the region to the east of the downtown core highly important in terms of the city's function, but also create a physical boundary (Vancouver 2013).

Vancouver: Rise of an Urban Region

Water G. Hardwick identifies Vancouver's development trajectory after the First Nations period as one of transition from a resource town in the mid 19th century towards an urban region with a mix of usages (Hardwick 1974, 1 - 23). A rapid growth in the late 19th century industry was evident as exports from BC increased threefold from 1890 to 1900 (MacDonald 1992, 29). This led to the infill of the False Creek Flats in the early 19th century to make way



Vancouver is defined historically by its between geography, resources, commerce, and infrastructure. Pictured is the Port of Metro Vancouver in 2012, to the north of the False Creek Flats.

for the Canadian Pacific Rail terminal, where it remains to this day. The terminus facilitated Vancouver's growth as a trading city, resulting in the surrounding regions being developed extensively. As part of a terminal city, Vancouver established itself as a major node in the transportation of physical commodities via rail and port.

Development Focus

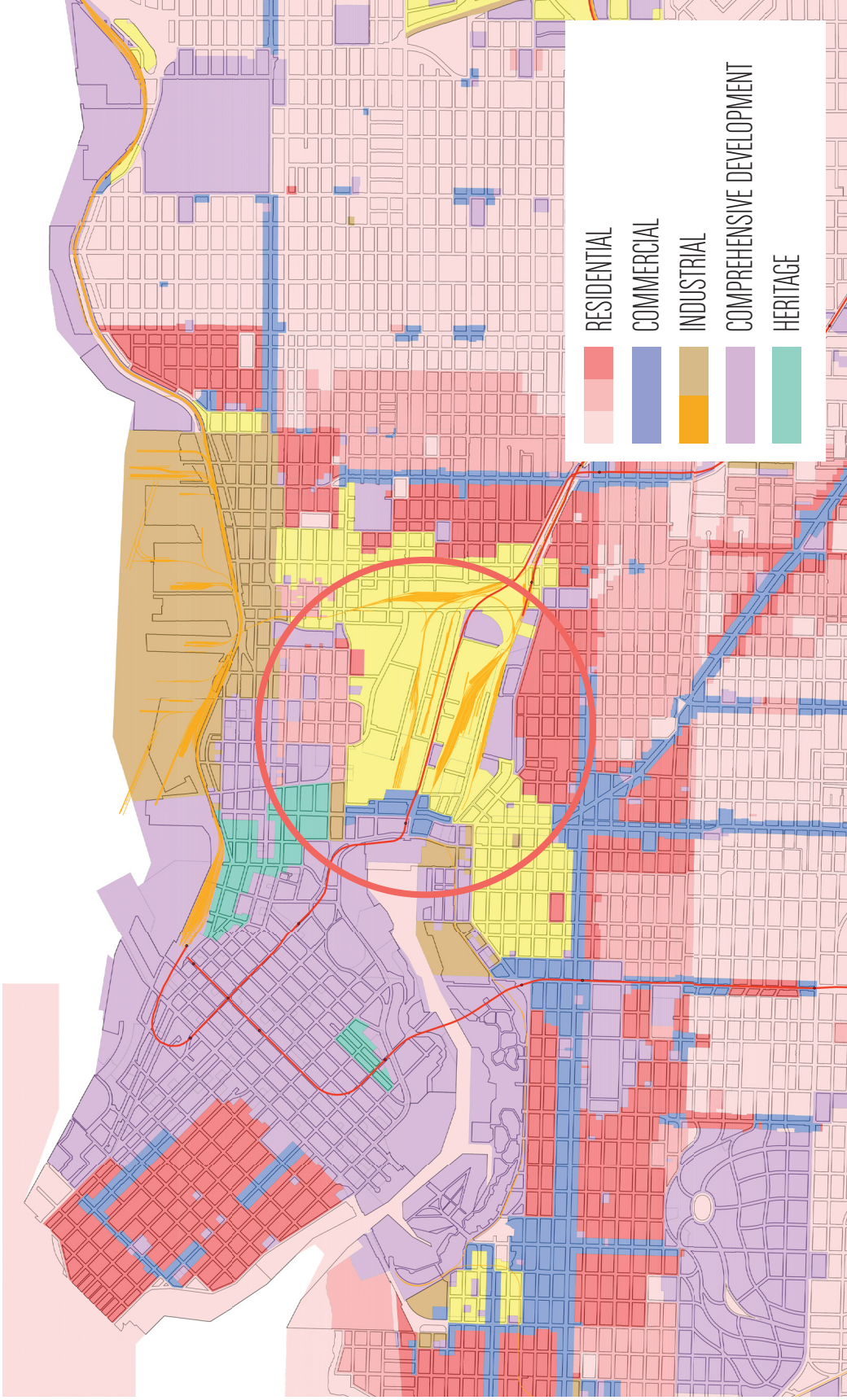
Expo '86 saw the sale of the False Creek lands - the industrial heartland of the region - for development (MacKenzie 1993, 62). During this period much more industrial land throughout the Greater Vancouver region was commercialized, with much being converted directly into box stores. The far-reaching SkyTrain rapid transit network facilitated the downtown core's further residential densification.



Photos from Vancouver photographer Fred Herzog depict the intensification of the city around a basis of light industrial, from top to bottom: Foot of Main 1968, Blue Car Strathcona 1967, CPR Track 1971. These photos from the south, north, and northwest of the False Creek Flats respectively (Herzog, Arnold, and Turner 2007).



The view along the CPR track towards contemporary downtown Vancouver in 2009 demonstrates the change in Vancouver's values from Herzog's photo in 1971. Incorporating both sides of the contemporary city leads to a more sustainable conclusion while embracing the city's heritage.



Vancouver's current zoning reveals a very dense, mixed-use and residential downtown core separated by a band of light industrial. This industrial is critical to the heritage of Vancouver's identity (Vancouver 2013).

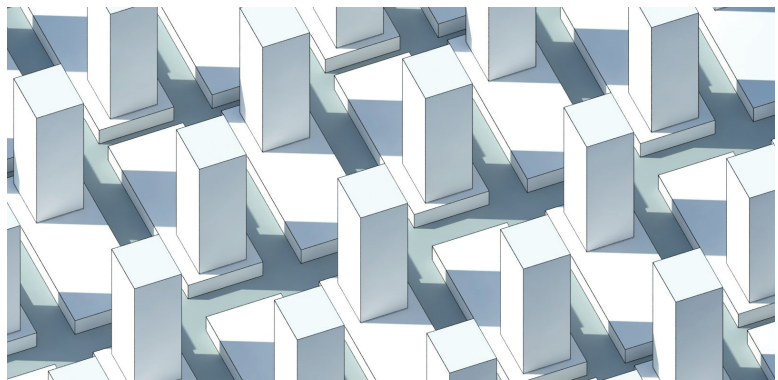
Vancouver development is characterized by the "tower and podium" typology, which comprises a commercial or community oriented street-level volume with one or more towers above. The effect is one that successfully balances pedestrian needs with density and development. This approach is in stark contrast to the New York Zoning Bylaw's constraints as identified by Ferriss, and results in more rectilinear forms and extrusions. Paired with curtain wall on the exterior face, the effect can be dizzying and repetitive. It also encourages cheap construction and unimaginative forms. The rules of thumb identified in the previous chapter have analogy here.



The tower and podium typology with curtain wall, while providing a good baseline for urban design, can be relentless and oppressive (2010). Could another typology offer an alternative?



The City of the Captive Globe and the grid that enabled diversity by providing a constraint (Koolhaas 1994, 295)

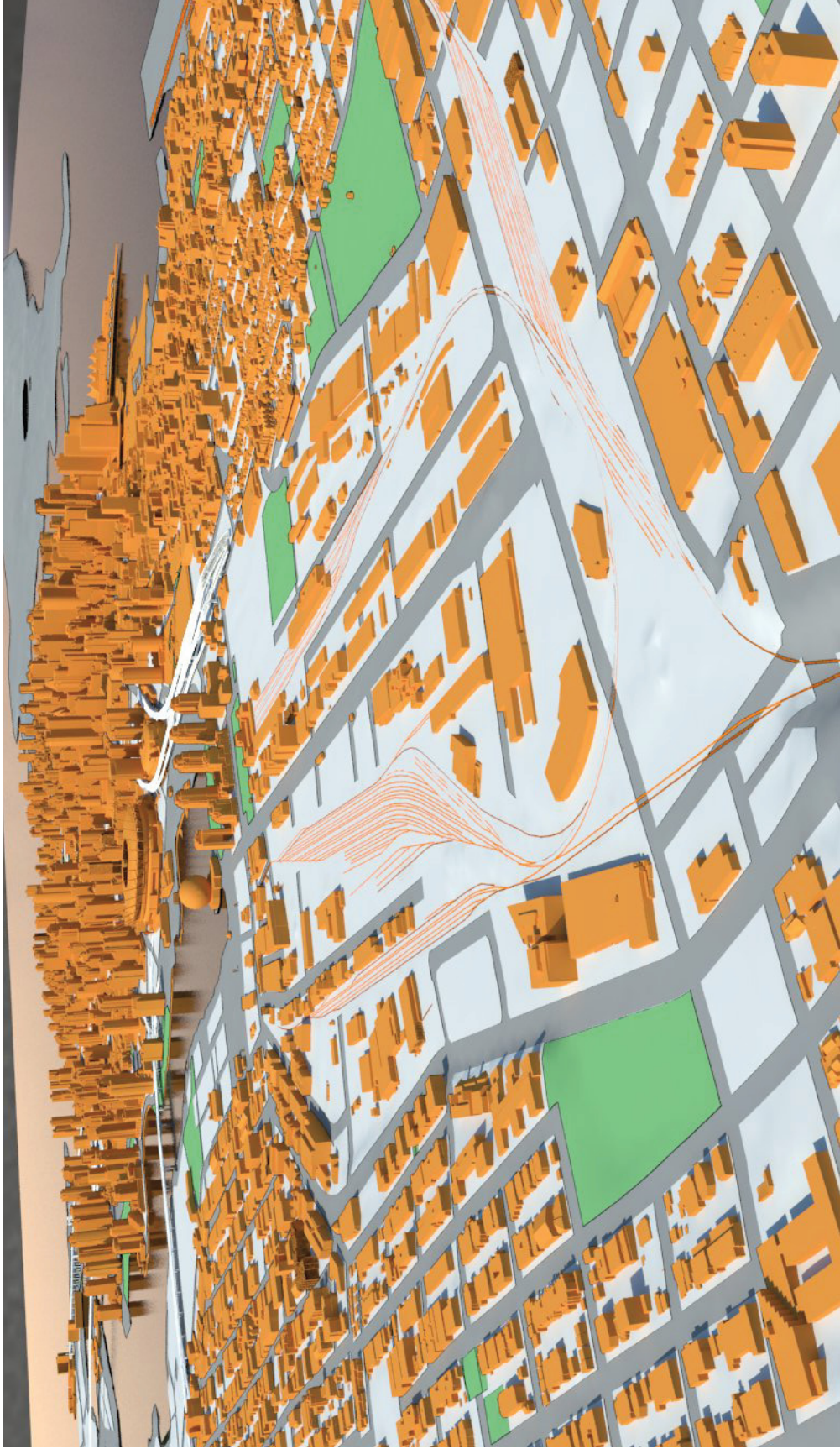


Vancouver's repetition of the tower and podium typology as a relatively effective rule of thumb, but developmental pressures result in high levels of repetition to achieve the optimum floorplate.

The False Creek Flats

Actually, as far as city slogans go, Vancouver could do far worse than "Nevertheless a Wonder Despite its Brutal History!" (Demers 2009, 18)

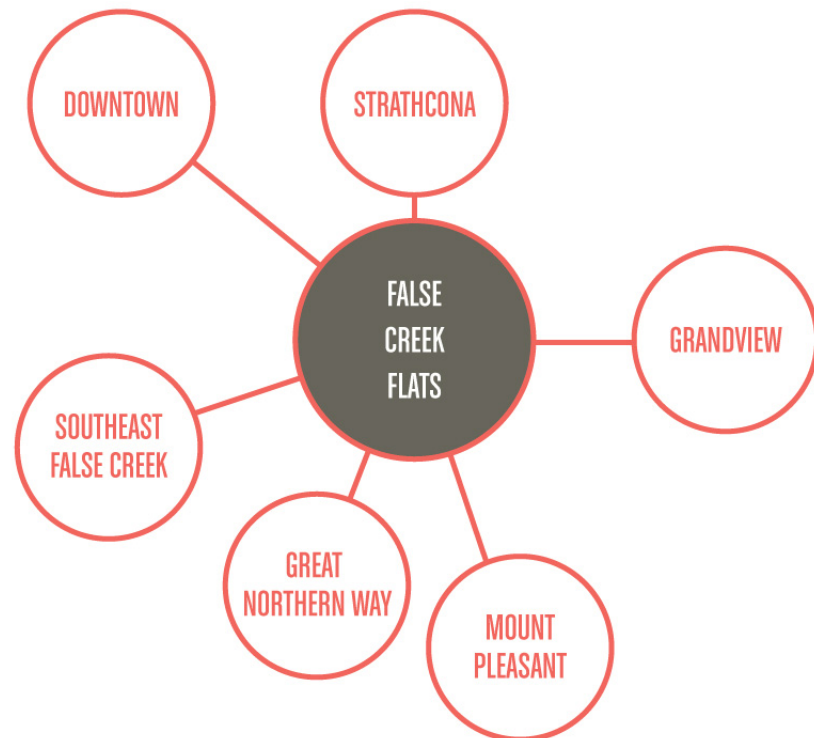
For many residents of the city, this area is a mental black hole due to its lack of connectivity to the surrounding regions (as in Lynch 1960, 20). When travelling through it via the highway in the middle, it is difficult to know exactly where you are due to the difference in speed and the disconnect between the street grid.



An overview of the False Creek Flats from the southeast. Its role as a connection to the downtown core via Terminal Avenue down its centre is crucial, but will be compromised by the removal of the Georgia Viaducts to which it connects.



Photos from around the False Creek Flats demonstrating the varied conditions of the site, and encroaching development onto some of the last remaining light industrial land in the area. The transition between the surroundings requires architectural sensitivity.



The False Creek Flats are a crucial part of the greater urban network that has been underutilized.

Simultaneously, development is encroaching in on the site on all sides due to relatively low value caused by proximity to active industry and railyards. These developments of condominiums and car lots are underutilizing the site, and a master plan is needed before the process proceeds further. The transitory nature of the site is made through evident by the fact that the City of Vancouver's building footprint data cuts off in the middle of it, along with the United States' Scanning Radar Topography Map (SRTM).

In 2011, an open ideas competition was presented by the City of Vancouver, which can be seen as an expression of the desires of the community and the world, and gauge their interpretations of the site. Just as the Chicago Tribune Tower competition was an indicator of the zeitgeist, so too do the entries convey the desires for what direction we should go in

(Dupré 2008, 33). Key themes for the entries included issues of density, the creative economy, and connectivity. The railway that crossed the site was seen more as something to be avoided as opposed to its opportunity in an attempt to reconnect the urban fabric. The light industrial heritage of the site was not considered.

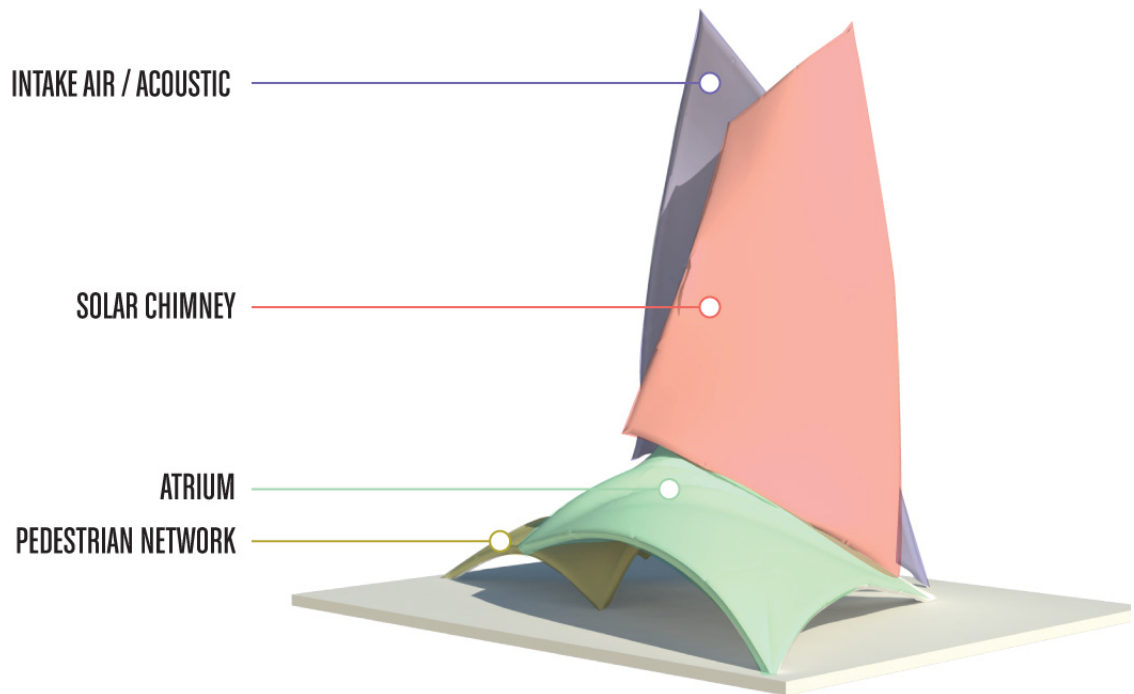
Looking beyond the site to the future of the city, Vancouver has released its Greenest City Action Plan with the broader goals of addressing climate change, becoming a leader of the future green economy, and improving general quality of life (Vancouver 2012, 5). When looking to redesign a substantial portion of the city, it is important to keep these principles in mind. The cultural context is clear in this instance, and will be considered when moving forward.

CHAPTER 5: ANALYSIS

The hope of the use of these tools is to identify the potential available before setting standards on the design process. Shifting to parametric design requires a new set of skills that are not commonly associated with design thinking, and results in another level of abstraction and formalization of the rules as the designer steps back to re-frame the problem at hand. [...] The use of these tools is by definition complex, and inspires its own level of “craft” garnered by exploration. (Woodbury 2010, 24, 47).

Experimentation

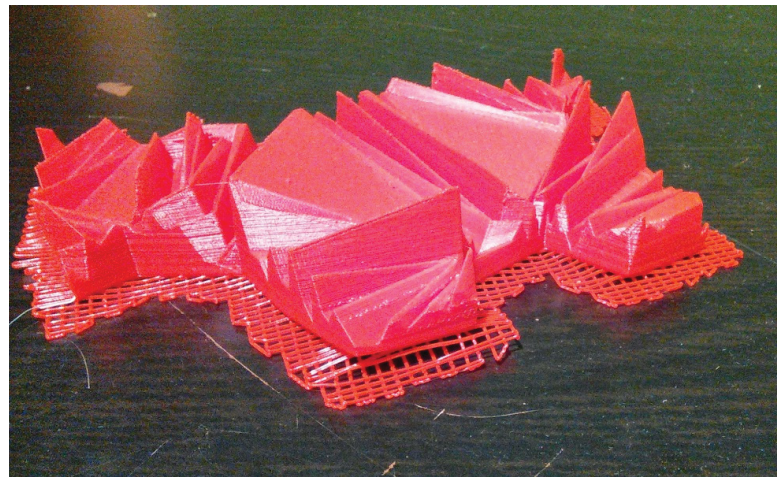
The research underlying this thesis is based on the idea that contextual cues can be utilized to inform good design, and this context can be interpreted with computation to provide solutions that best fit a site. With the cultural context established through a study of the site’s history and current state, we can now begin to explore different methods of harnessing the social and physical data which we have.



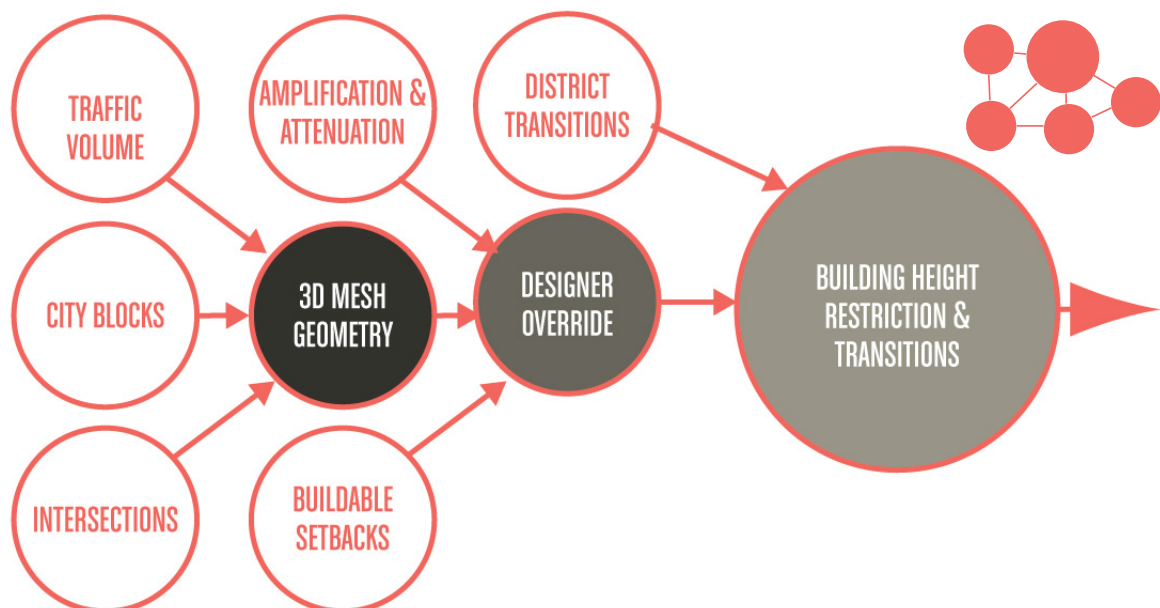
Using the assessments from the previous chapter, the analysis is constrained to studying certain variables related to urbanism.

Form by Data

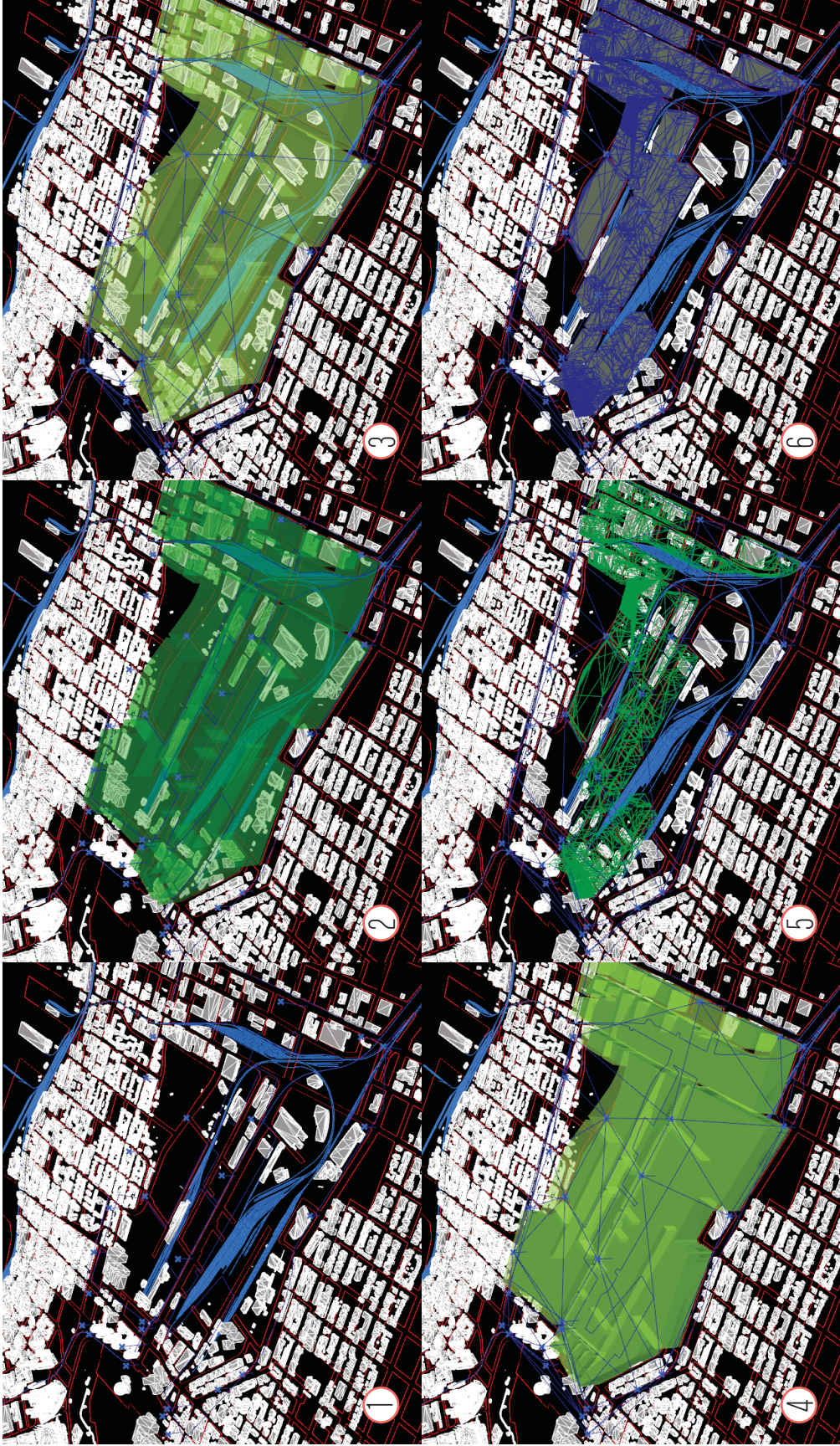
Beginning with the precedent that data can drive form gleaned from the done data gathering experiments we can begin to assess the implications that the disconnect between designer and data has for the form of the city. This experiment tests the analogy of traffic counts serving as a proxy for building height, commonly associated with the process of urbanization along commercial corridors.



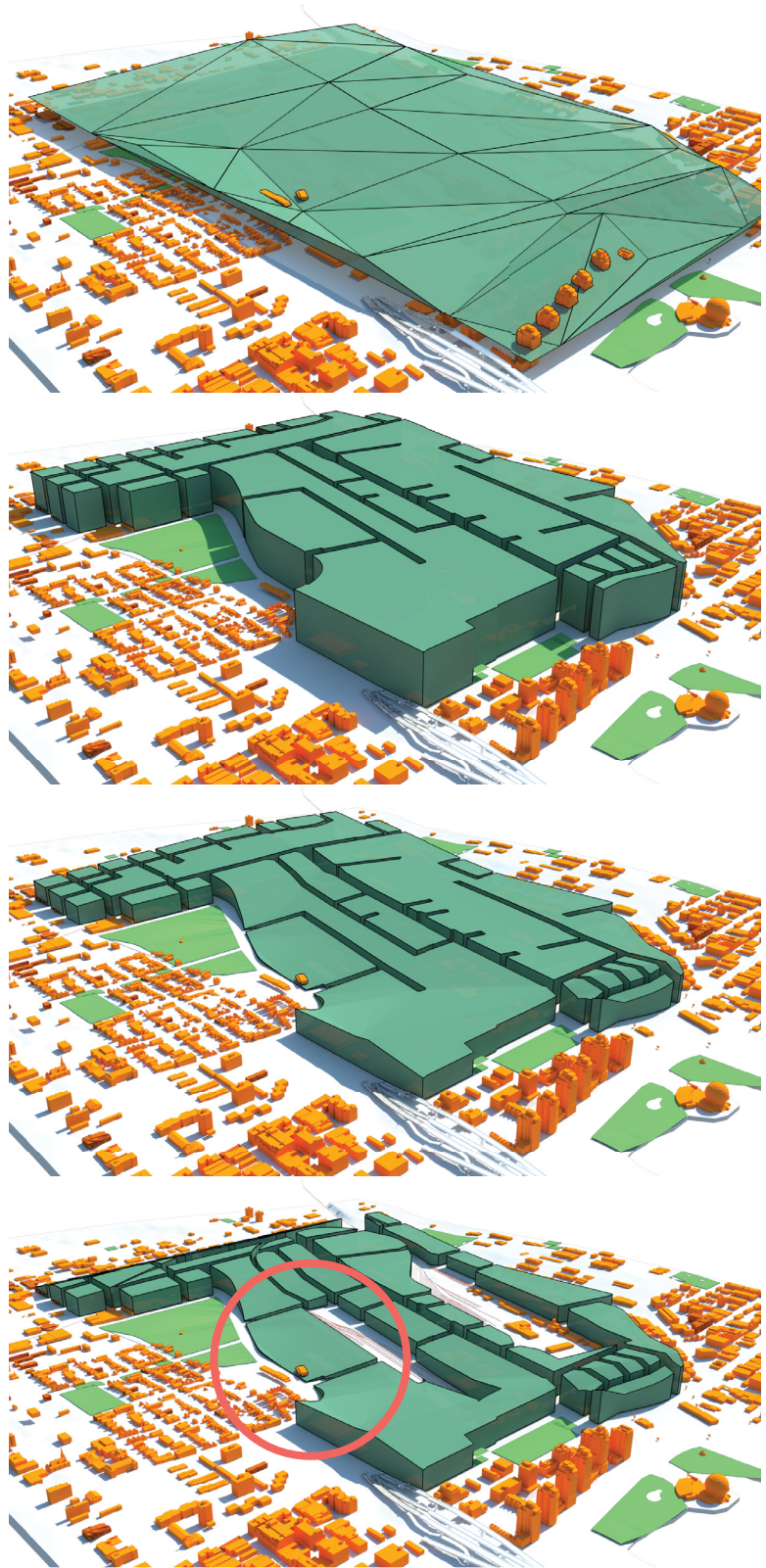
Drone data 3D printed demonstrates the direct link that can sometimes occur between information and form.



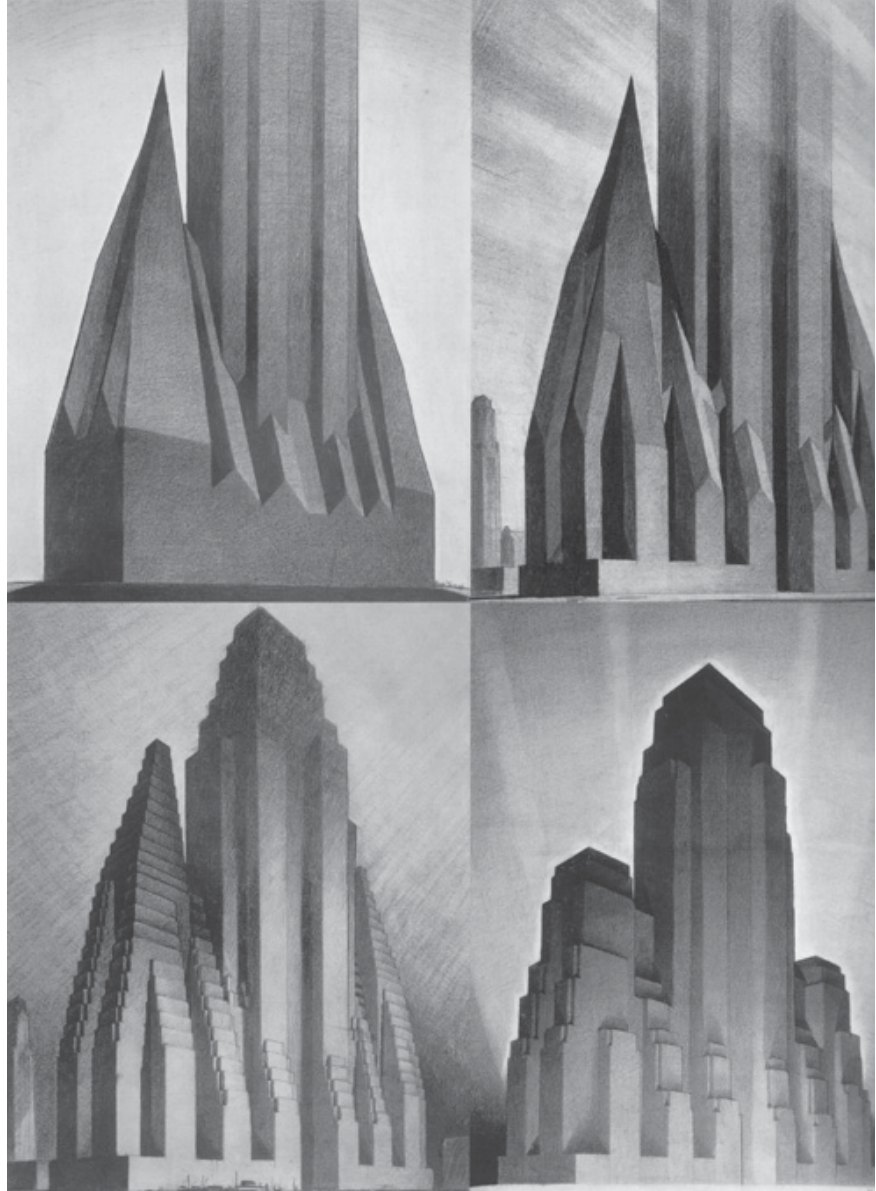
Traffic data can affect building heights to create a zoning envelope by controlling the relationship between variables.



Using contextual physical and social data the script generates a theoretical zoning envelope by looking at traffic flow as an analogy for densification of the city. The urban context (1) is built out to its theoretical maximum (2). Traffic data on the z-axis forms a mesh (3) that cuts the theoretical maximum (4). Based on setbacks and reasonable blocks to build upon, the form is further refined (5), and transitions between the adjacent neighbourhoods create the final height restrictions (6).

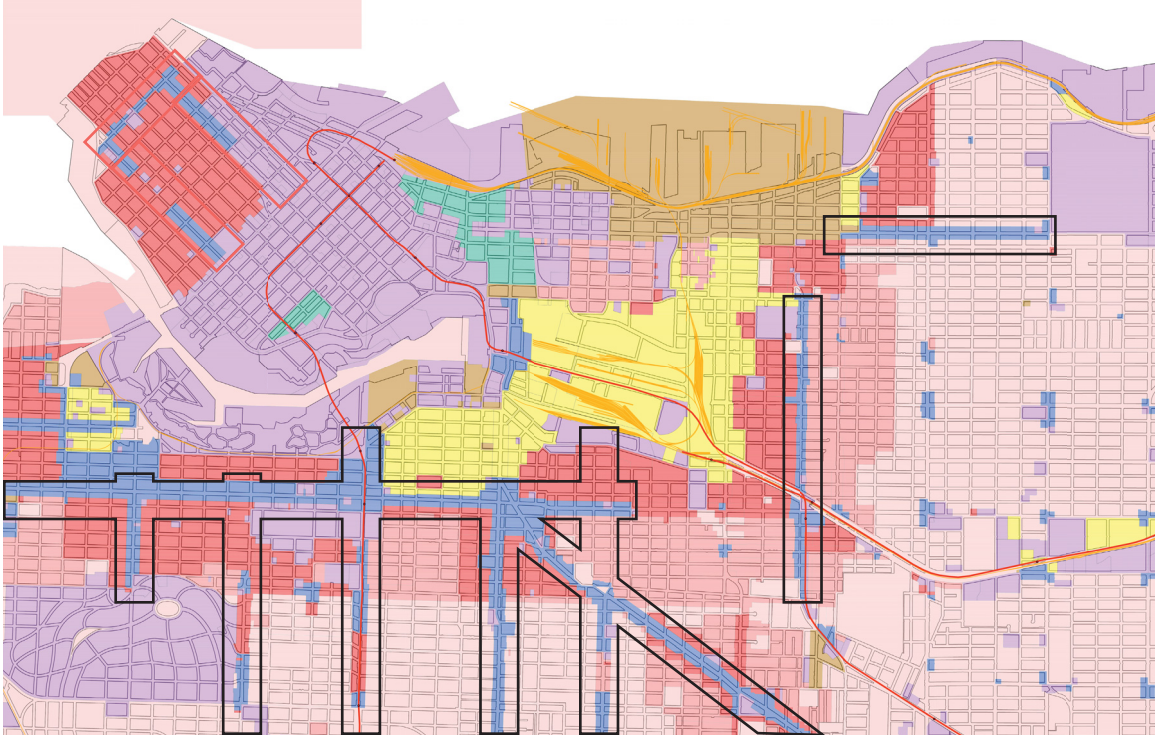


The procedure generates interesting moments in the city of transition, such as the depression towards Strathcona on the north side of the site.



Ferriss' studies of the New York building guidelines were forms in themselves, which were echoed in the design of skyscrapers afterwards. By making the constraints visible, the design solutions were made visible as well (Ferriss 1929, 73-79).

Using traffic data to drive built form is a way of looking at an urban situation through a different lens. Like Hugh Ferriss' zoning studies, the result is an envelope of potential in which built form can exist. The flow of traffic down streets is what becomes evident here is the designer's role in using the data to assess form. Constraints, by means of their analysis, become generative.

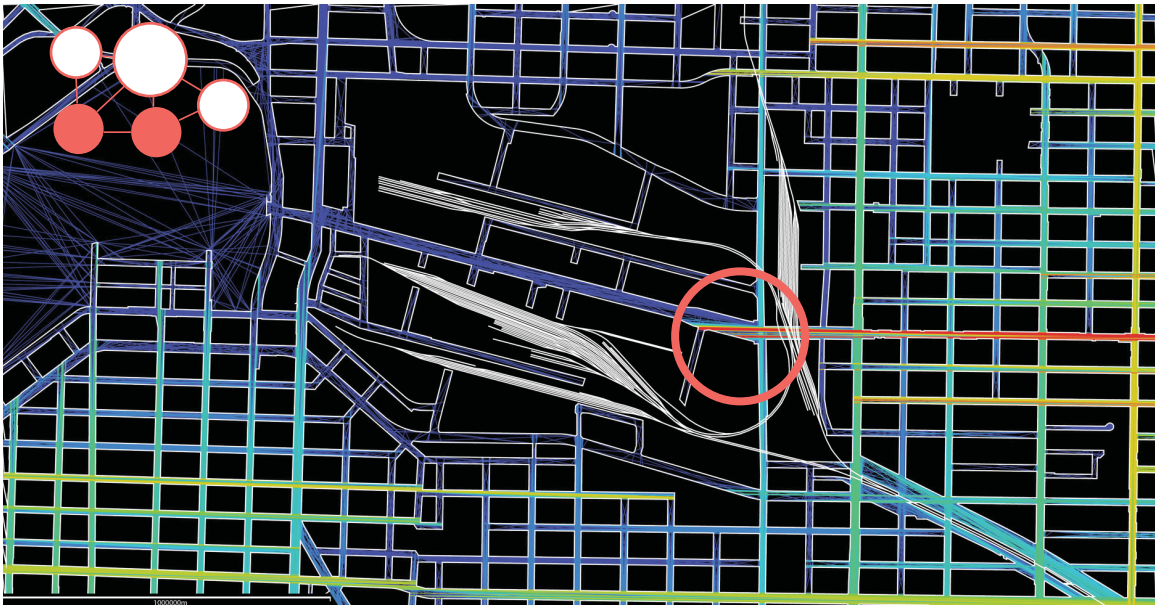


Commercial corridors in the city (outlined) correspond to high density volumes of traffic and a higher built environment. This pedestrian network of commercial activity helps provide for pedestrian connectivity through the city (Vancouver 2013).

The analogy comes into play by looking at the connective layers of the city. Main streets in Vancouver are normally comprised of ground-level commercial with residential on top in the tower-podium approach resulting in a higher building height. These streets also have a higher volume of traffic. The relationship between the two variables provides an opportunity to look at the lateral relationships between variables.

Analysis of Axial Connectivity

These main corridors in the city actually contain a structural difference in comparison to standard streets, coinciding with a wider road width and also a longer uninterrupted length. Analyzing the site using UCL DepthmapX reveals a strong axis travelling through the centre along Terminal Avenue that is impacted by the sudden rotation of the street grid.



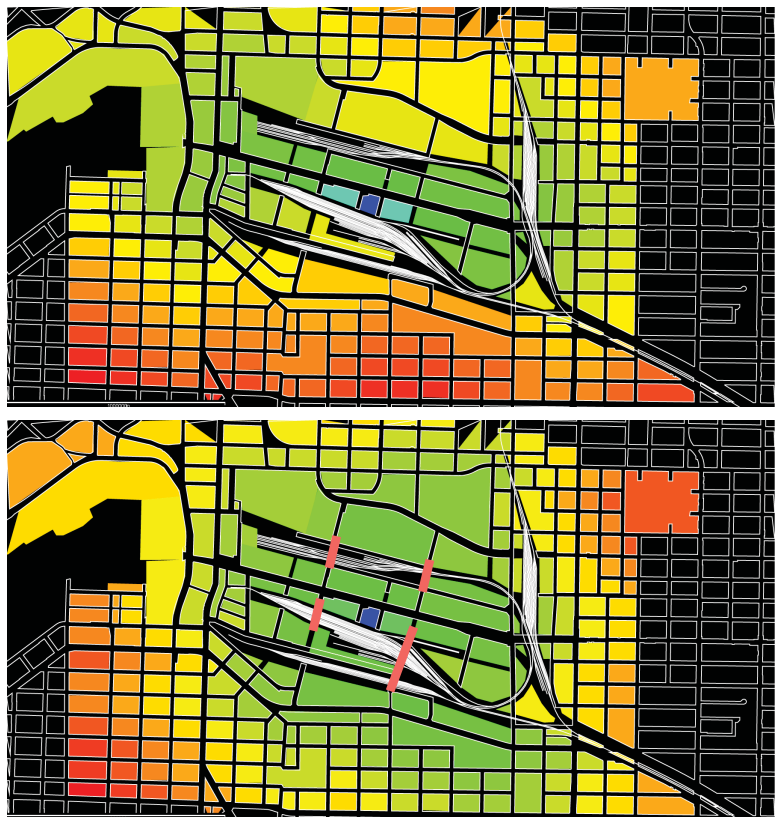
An axial analysis demonstrates the hierarchy of roads and streets based on an input of the street grid for continuity. The heavily red lines serve to represent the roads with the greatest “weight,” and correspond fortuitously to roads with heavy traffic and main thoroughfares. It is important to stress that this analysis looks solely at geometry, and so its ability to detect patterns is remarkable. This tool assisted in defining the boundaries of the district.

The ability of this tool to reveal the high traffic streets in the city is remarkable, and demonstrates how early design decisions on issues such as street width can help define a district for generations in very subtle ways. The rotation of the street grid thus contributes to the area's potential for the formation of a new district.

Connective Analysis

The order of the contemporary city is clearly that of a cloud, not of a clock. [...] Might some method for governing the relationship in forms of architectural expression between sharply defined parts and a fluctuating, cloudlike whole still be found? (Maki 2008, 236)

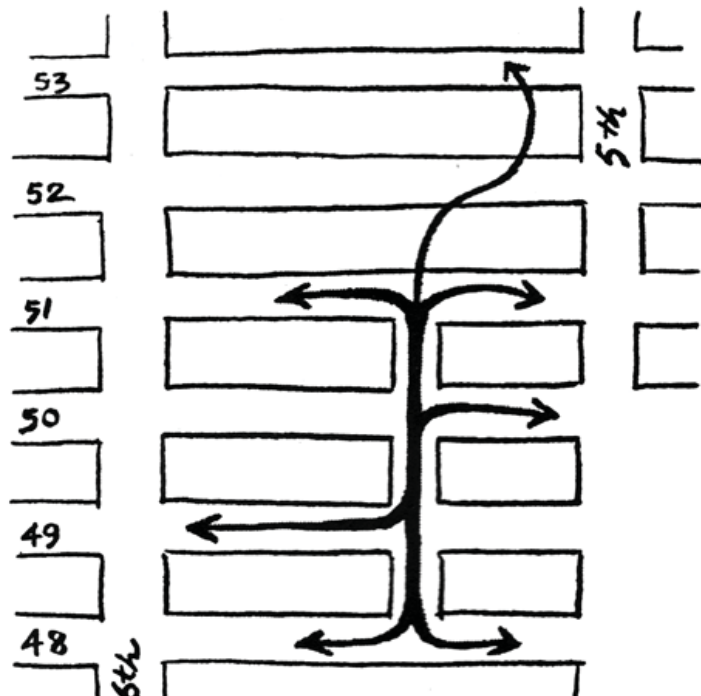
An important aspect of the digital process model is the differentiation between qualitative and quantitative variables. The interrelationship of objects can be viewed as a subjective experience viewed through the lens of human consciousness, but it can also be formalized into a more rigorous quantitative assessment. UCL DepthmapX allows for the user to create nodes that can be interconnected to form a network for connectivity analysis, showing the distance between any given points.



UCL DepthmapX "Step Depth" analysis of the site conditions demonstrates the discontinuity created by the railyards severing the site's connections. Above and below are before and after the proposed connection (in orange) is added.

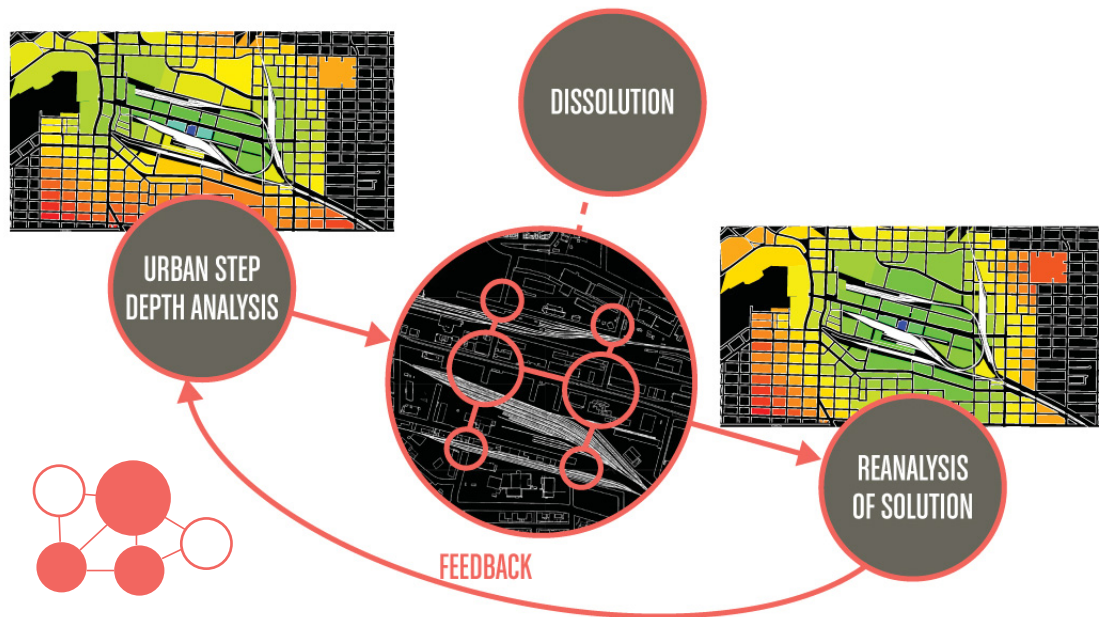


A demonstration of the linkages used for a typical step depth analysis reveals a mesh of blocks.



The units of the city from an urbanistic point of view are not the blocks, but rather the connections between them. This diagram illustrates the value of having smaller blocks to encourage multiple pathways for travel, reducing distances and improving active transit. (Jacobs 1961, 182).

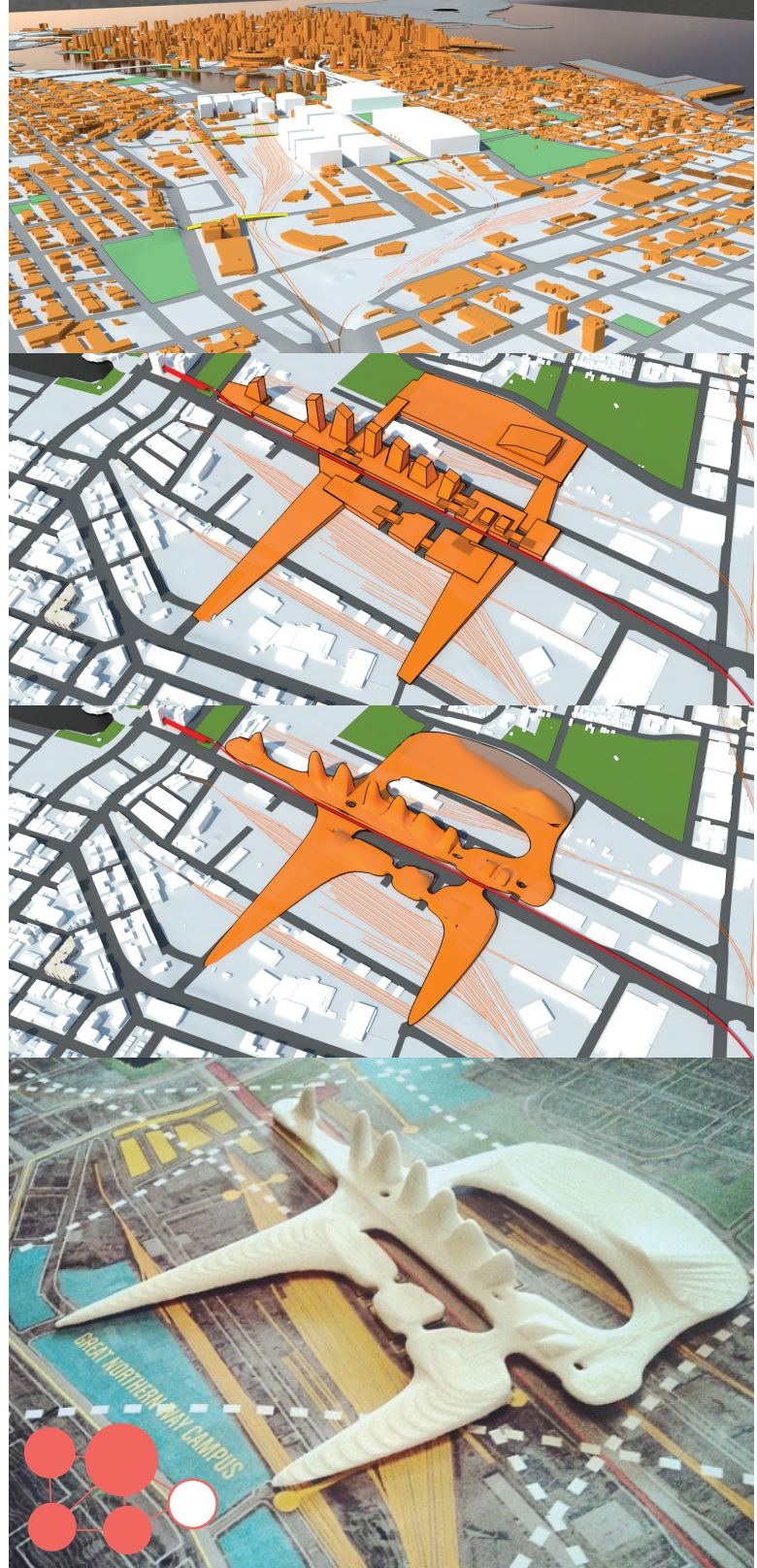
The data from the analysis reveals a sharp divide across the site, and the method of analysis makes it clear that by connecting over the railways a sense of urbanity can be realized through increased connections. This opens the door for a potential proposal to relink the urban fabric in a unique way while keeping the important railyards intact.



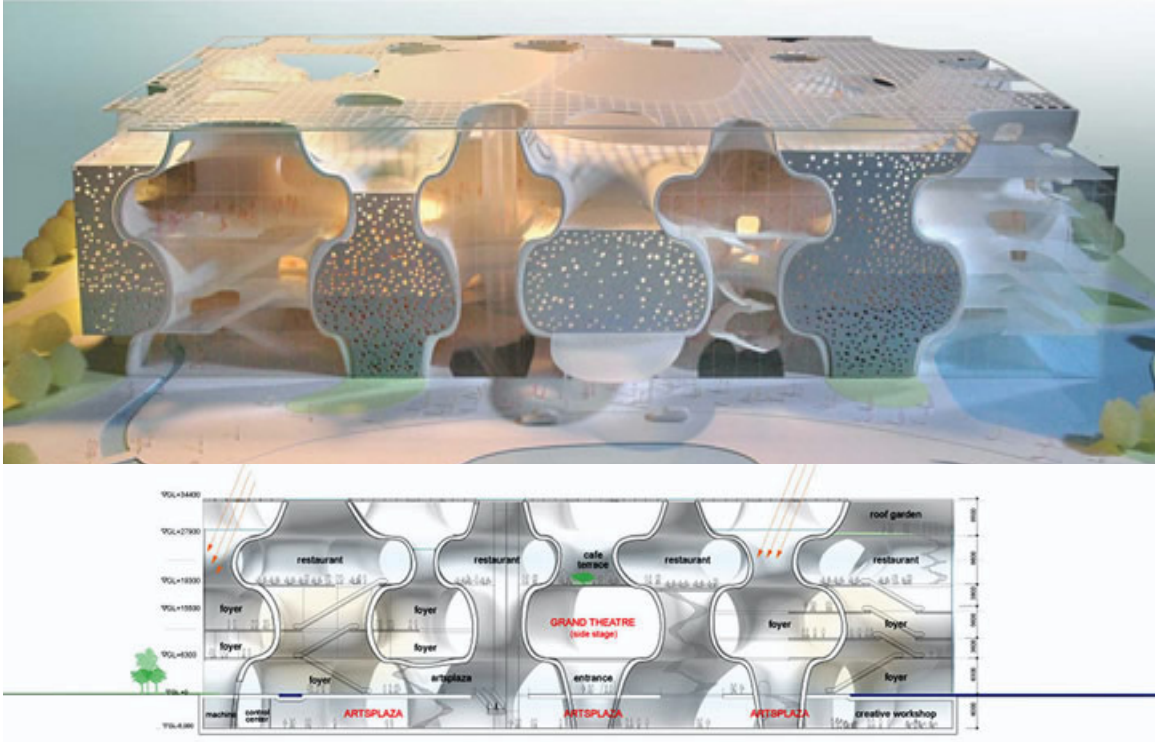
The analysis of urban connectivity is paired with a proposal and reanalysis to complete an interactive loop.

Subdivision Analysis

To begin to understand how the proposed connections can relate to built form, a combination of the two previous experiments and the existing typology of the city can be utilized to provide a sketch of how the city could function. However, the boundaries between objects need not necessarily be discrete. By beginning this next experiment with a prototypical urban form based on the tower-podium model, it is possible to begin to see how the relationships between adjacent forms can merge with one another. This provides a level of responsivity within the district while connecting built forms.



A hypothetical dissolution of an imaginary built-up form based on the previous traffic study shows that the boundaries between connection and building can be blurred.



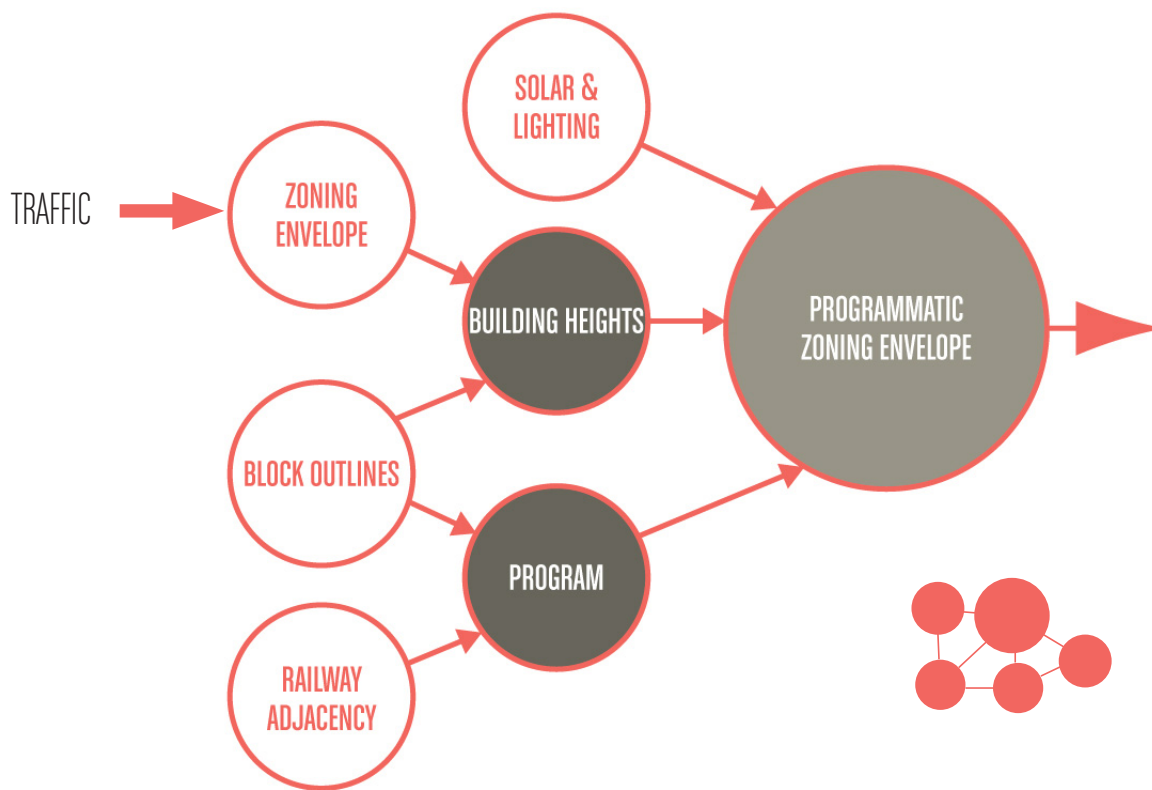
Toyo Ito's Taichung Metropolitan Opera House proposal uses subdivision and tension to dissolve the relationship between elements on the interior, creating a fluid path for users inside and the exterior urban fabric (Taichung Metropolitan Opera House 2005).

The dissolution of urban connectivity is an established mechanism, exemplified by Toyo Ito & Associates' 2005 proposal for the Taichung Opera House. Using imaginary tension between nodes of activity, the relationship between them is strengthened as the boundary is divided.

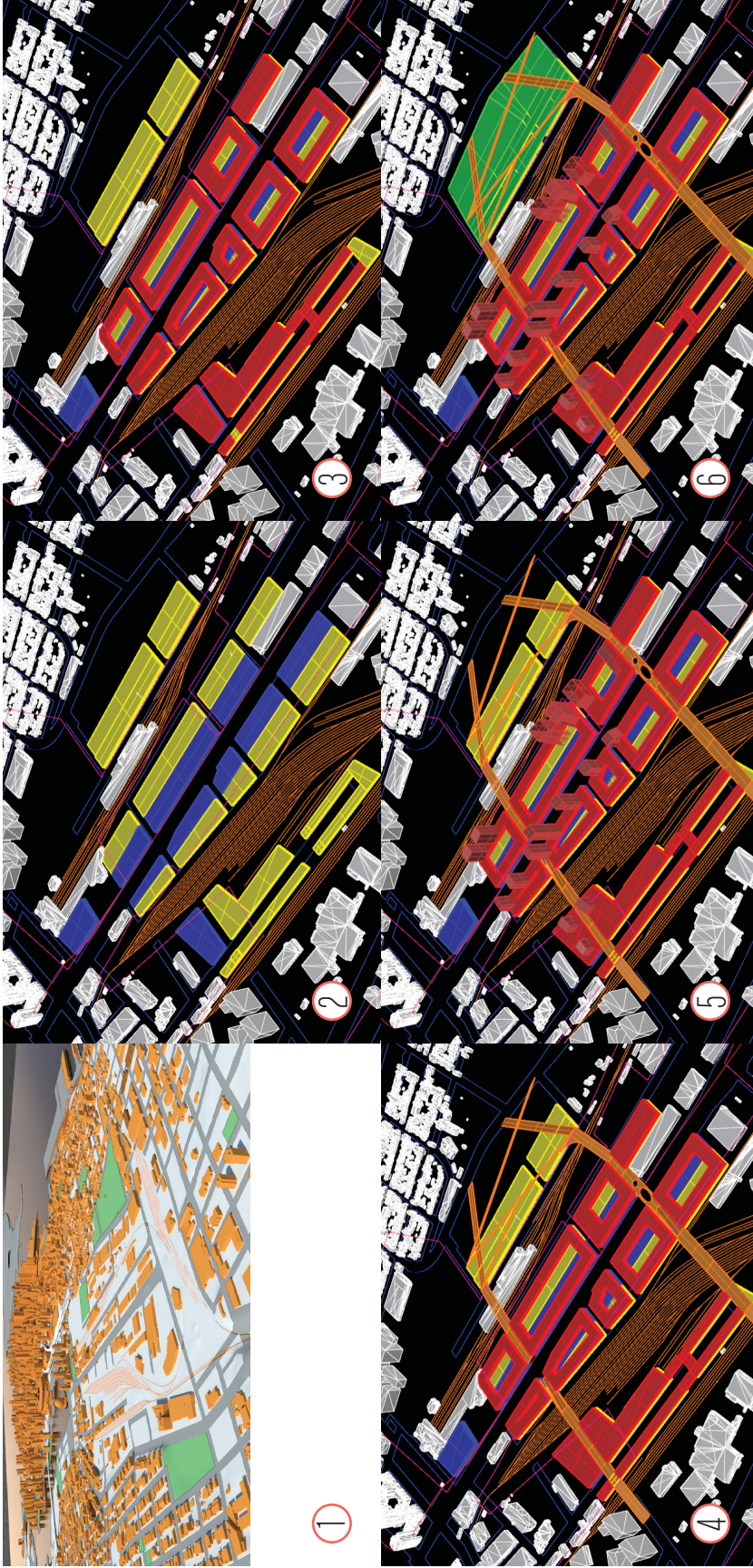
Using this level of analysis on the urban environment hints at the potential for connectivity to become not just about transport, but also a place in and of itself. The flow between nodes has an eroding effect. There is also great potential for building typologies to not be seen as discrete objects, but rather as culminations of formal requirements that are linked together in this way. The tower-podium typology of Vancouver is a prime target of this in the final analysis of this chapter.

Programmatic Analysis

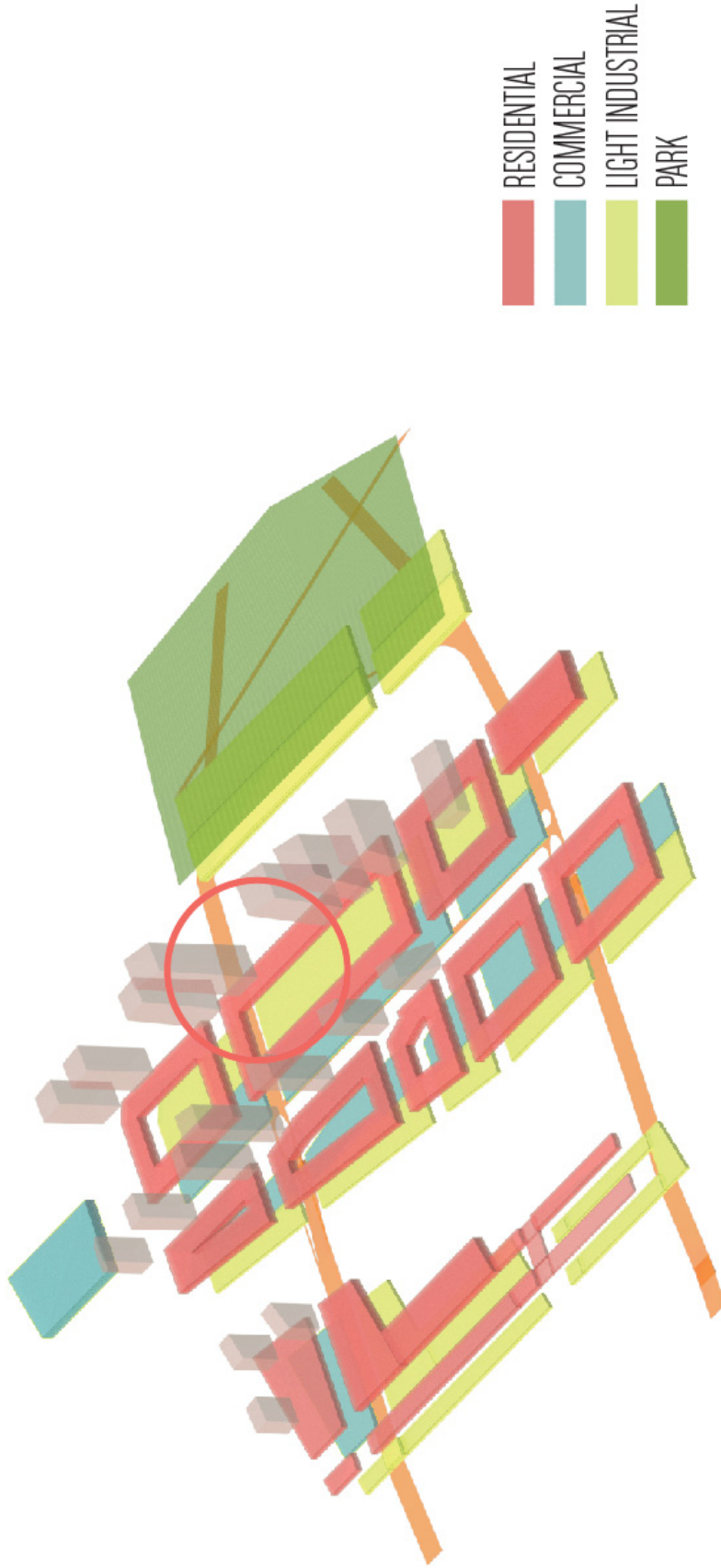
The relationship between elements studied in the previous experiment leads to a question of what those elements are. Based on the density corridors of the traffic analysis study, it is fair to say that program of built form can draw its focus from what it is adjacent to. Ground level commercial along main arterials is part of Vancouver's identity, and thus the cultural context of the city can inform our decision for what should go where. Just the same, the aforementioned necessity for light industry hints at the need for inclusion into the future district. The balance, then, is between commercial, industrial, and residential, and how they can all fit together to form district identity. The ideal outcome of this would be a rough concept of how to plan a district functionally.



The Blocker generates a proposal for program based on adjacencies and the input from the previous traffic analysis script.



The procedure by which the program massing was obtained. Beginning with block outlines, an assessment is made of adjacency to railyards (1). Using the cultural context, this space becomes light industrial due to noise and other environmental factors. The main axis becomes commercial at ground level keeping with the development trajectory of the city (2). Next, a perimeter block of residential is added above (3). The connections from the previous experiments are added manually (4), and an interpolation of towers is added based on the building heights from the traffic analysis (5). Finally, the dip towards Strathcona on the north side becomes a transitional park (6).

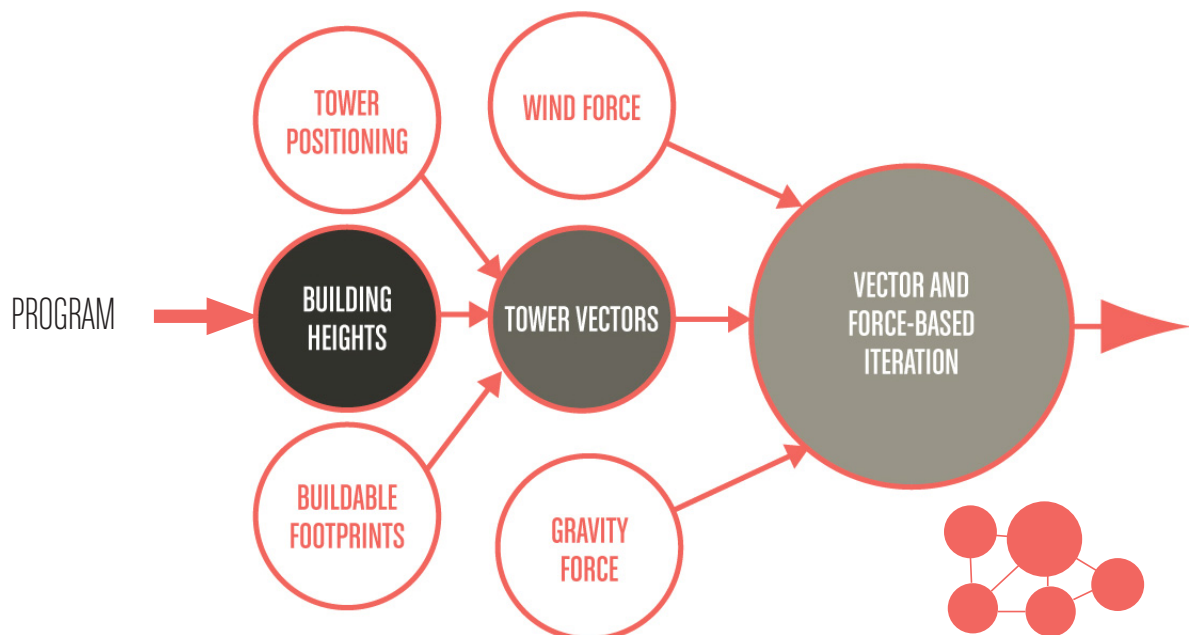


Program overview, showing the location of the tower to be pursued in the next section.

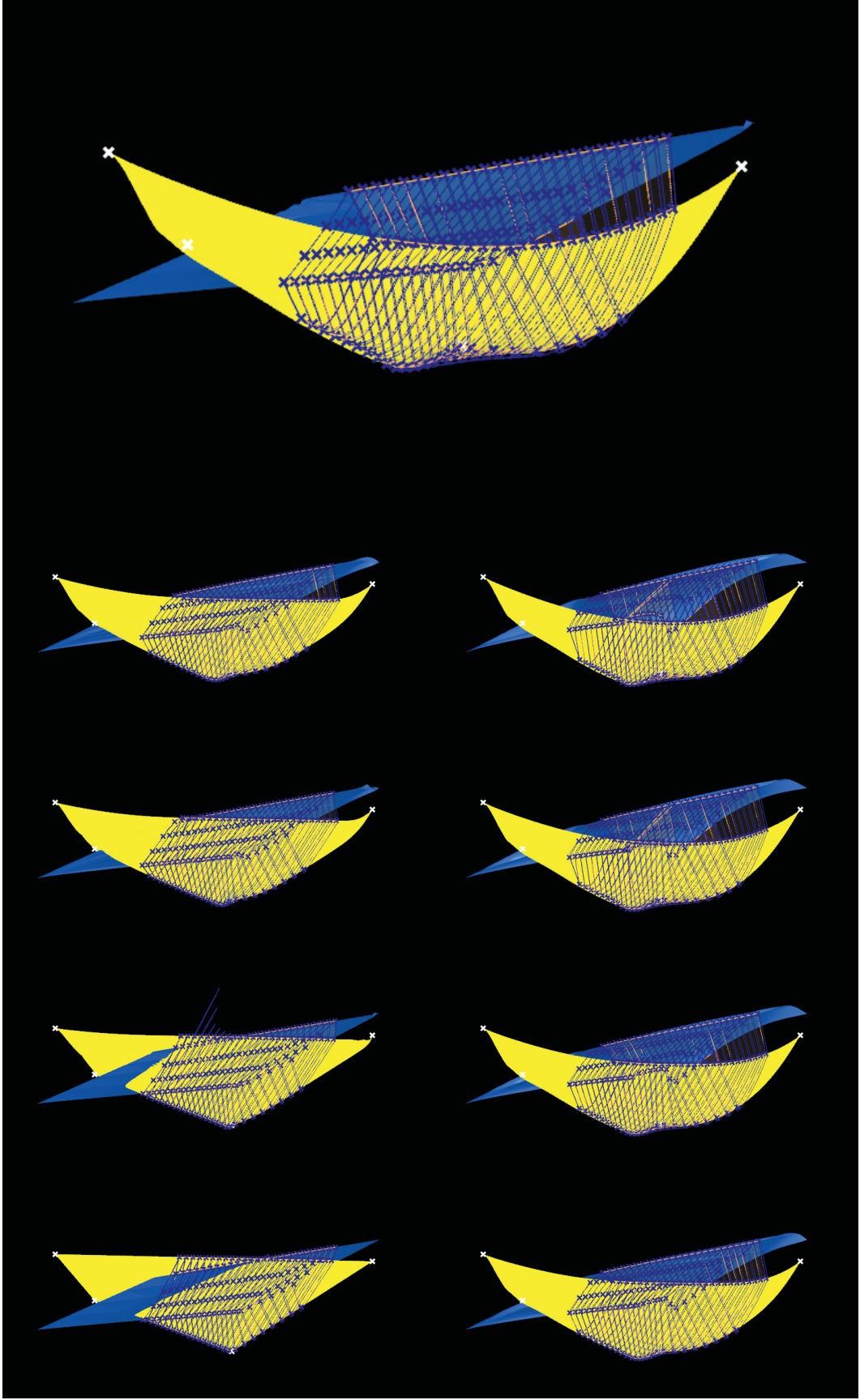
Physical and Social Force as Building

With a district defined by the mutually unifying forces of connectivity and responsiveness and a foundation of infrastructure, the next stage is to move onto the envelope of built form. Keeping in line with the dynamic nature of the city and responsive form, the form of the building envelope proposed is a response to environmental factors. Wind, solar gain, and gravity via structure are crucial to the performance success of any tall building.

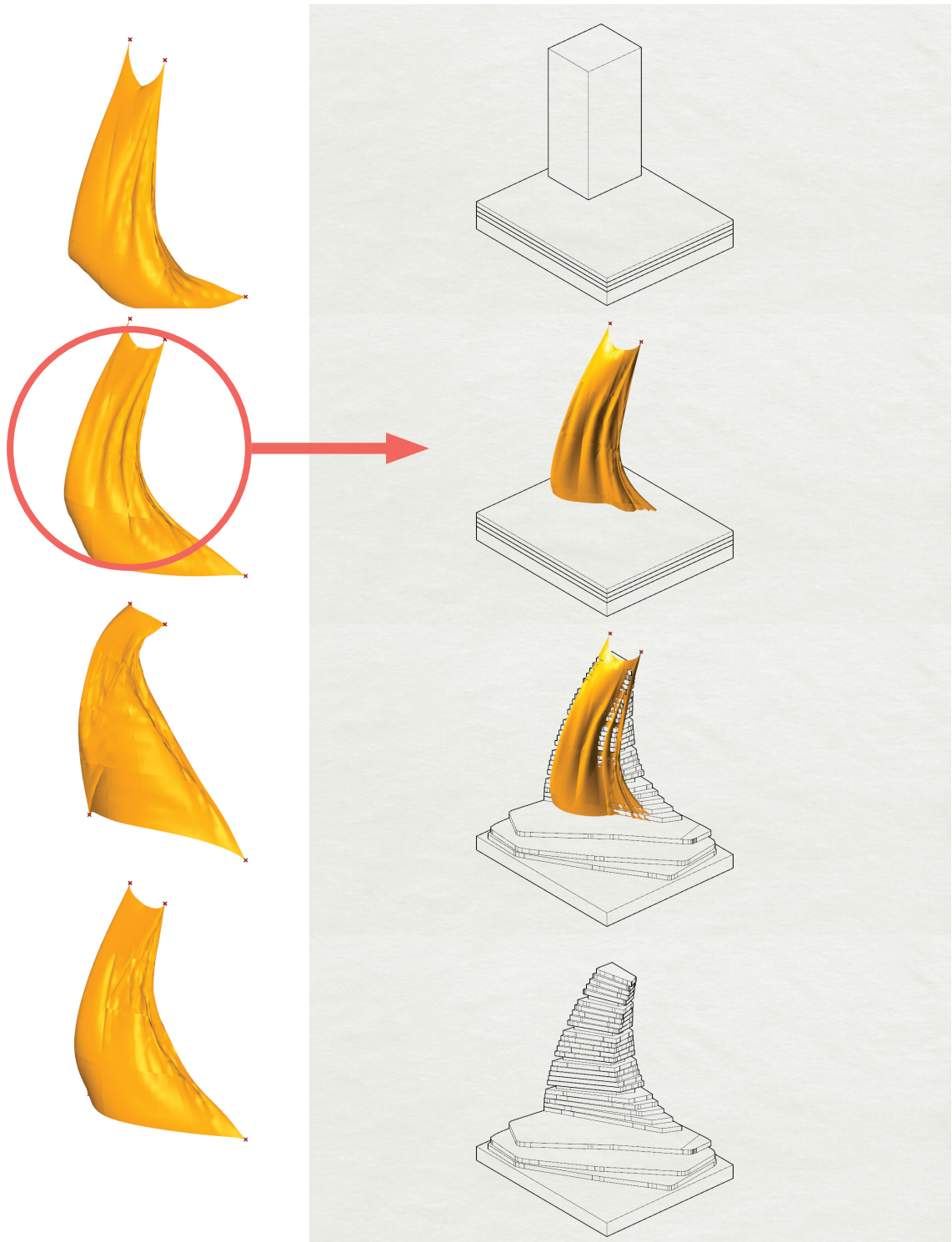
As opposed to traditional zoning with a static set of constraints, this method proposes that a building can fit within a range of options that satisfy site constraints. This approach generates more dynamic variation in the city, allowing for built form to optimize more variables simultaneously including environmental and social.



The proposal results in a dynamic zoning envelope with a range of possibilities for any given site.



Using contextual physical and social data the script generates a theoretical envelope for a building using the forces of wind and gravity acting on an abstraction of a tower into vectors. This method is used to generate an abstract, dynamic zoning envelope.

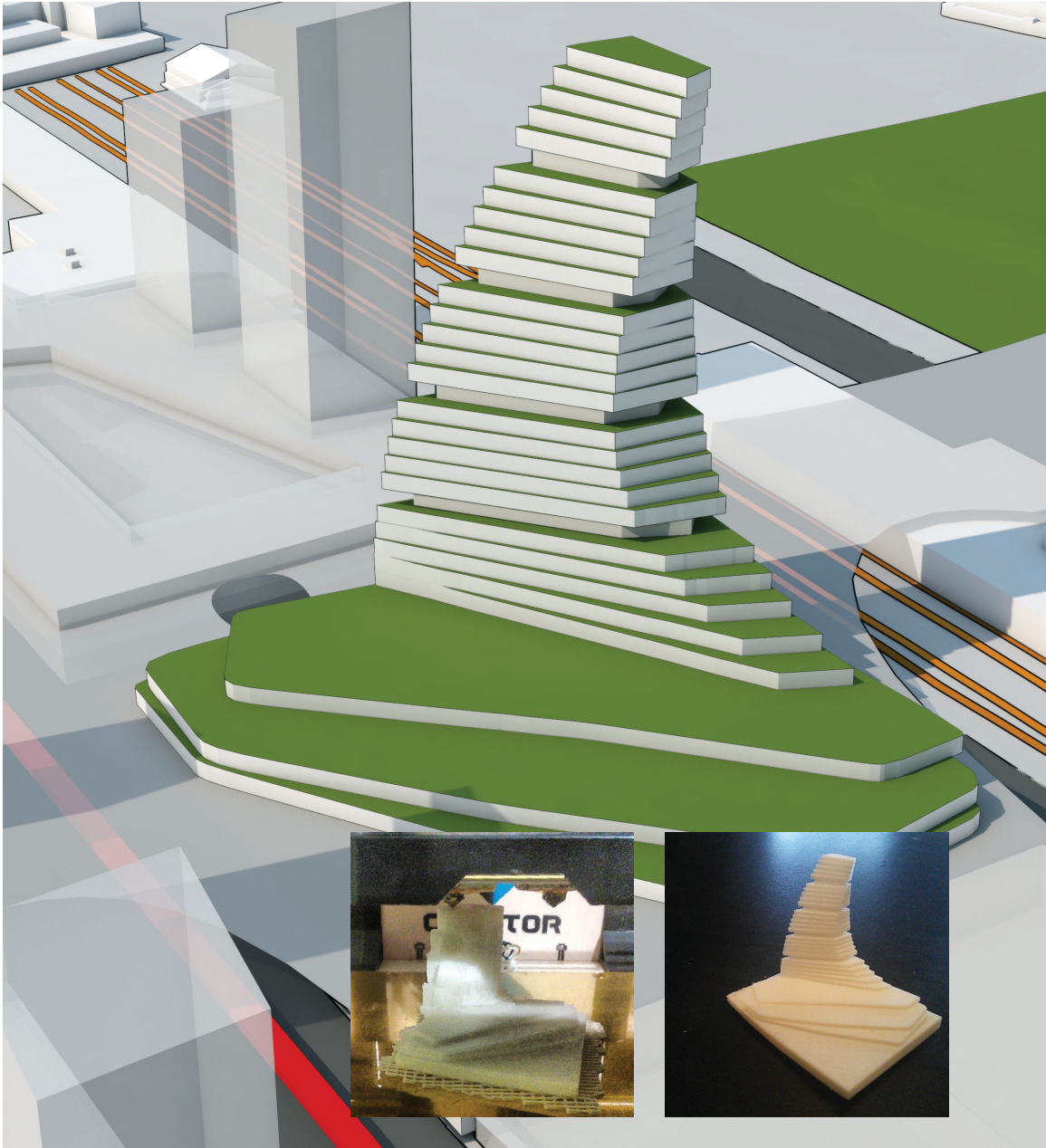


The use of force to dissolve a form produces numerous iterations that satisfy various conditions, creating a dynamic range of solutions for any given constraint. The standard typology of the Vancouver tower and podium is dissolved based on the needs of dynamic site parameters.



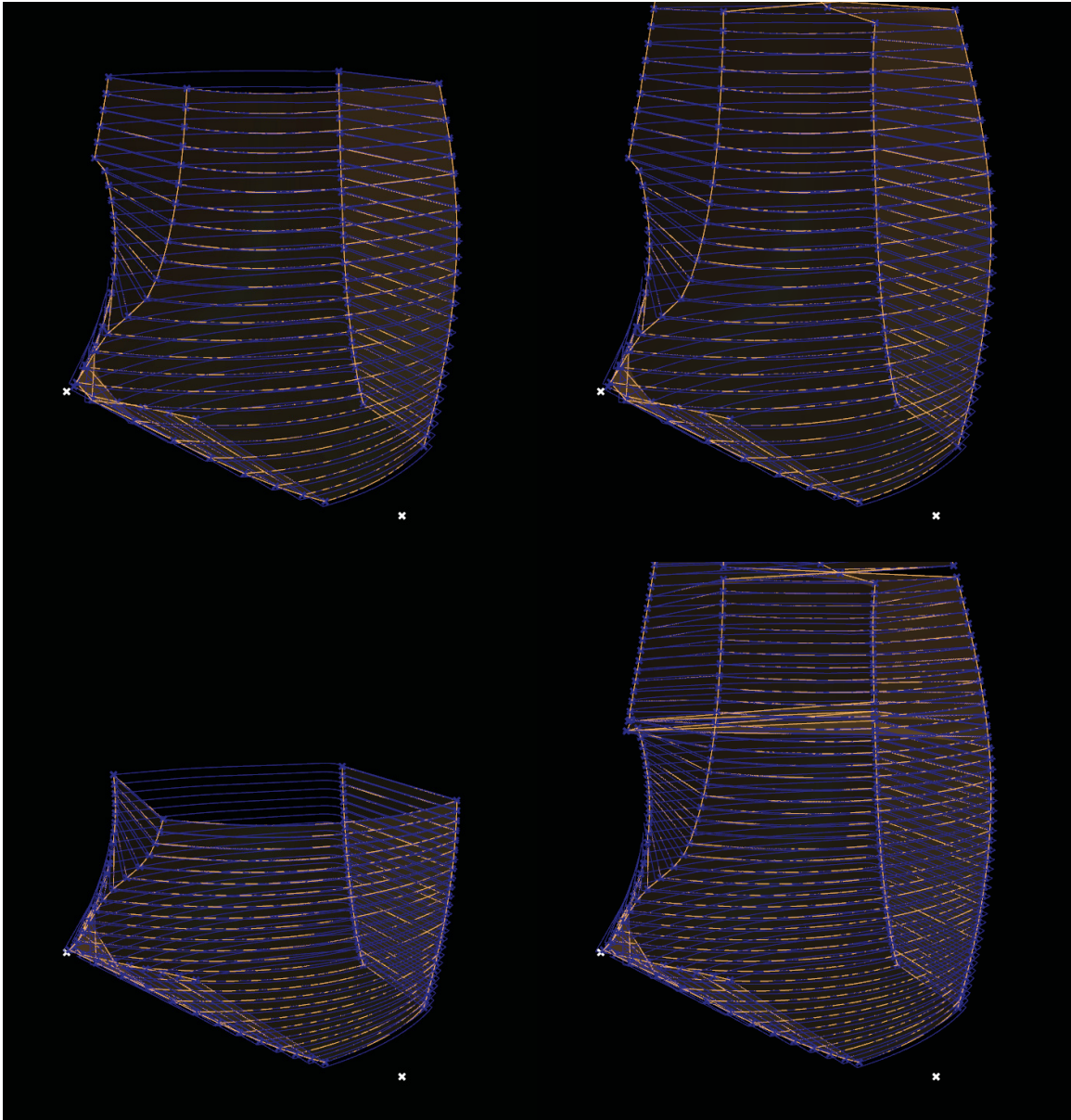
Morphosis' Phare Tower in La Defense is stated to respond to the forces of the site (Futagawa and Mayne 2010, 58).

A responsive building form that reads site contextual cues and physical constraints runs into the issue of balancing multiple variables for optimization. The key to handling this is to define a clear hierarchy of values. Morphosis' process for the Phare Tower in La Défense demonstrates that site forces of circulation and procession take precedence, after which the building's envelope is then optimized based on constraints identified at previous stages (Futagawa and Mayne 2010, 63).



This early iteration of the project demonstrates that the envelope of the tower can be interpreted into multiple heights, floor heights, slab depths, and floors.

Using the model of the Phare Tower and Ferriss' zoning envelopes as precedents, it is possible to begin populating our ultimate constraints into a buildable form. Floor plates and articulation of form in a dynamic response to the forces acting on the site allow for rapid iteration of concepts in situ.



The envelope of the tower can be interpreted into multiple heights, floor heights, slab depths, and floors.

Here, the traditional development model of floor slabs can collide with all the constraints that have been built up through experimentation to generate a transitional form between traditional developmental models. The next step is to synthesize the design of the broad strokes gleaned from experimentation into a cohesive built proposal.

CHAPTER 6: DESIGN SYNTHESIS

Using a divide-and-conquer strategy is to organize a parametric design into parts so that there are limited and understandable links from part to part. Directional of data flow assures a hierarchical model, with parts higher in the flow typically being assemblies – organizing concepts. Parts at the bottom of the flow usually correspond to physical parts of the design. (Woodbury 2010, 28)

Urban

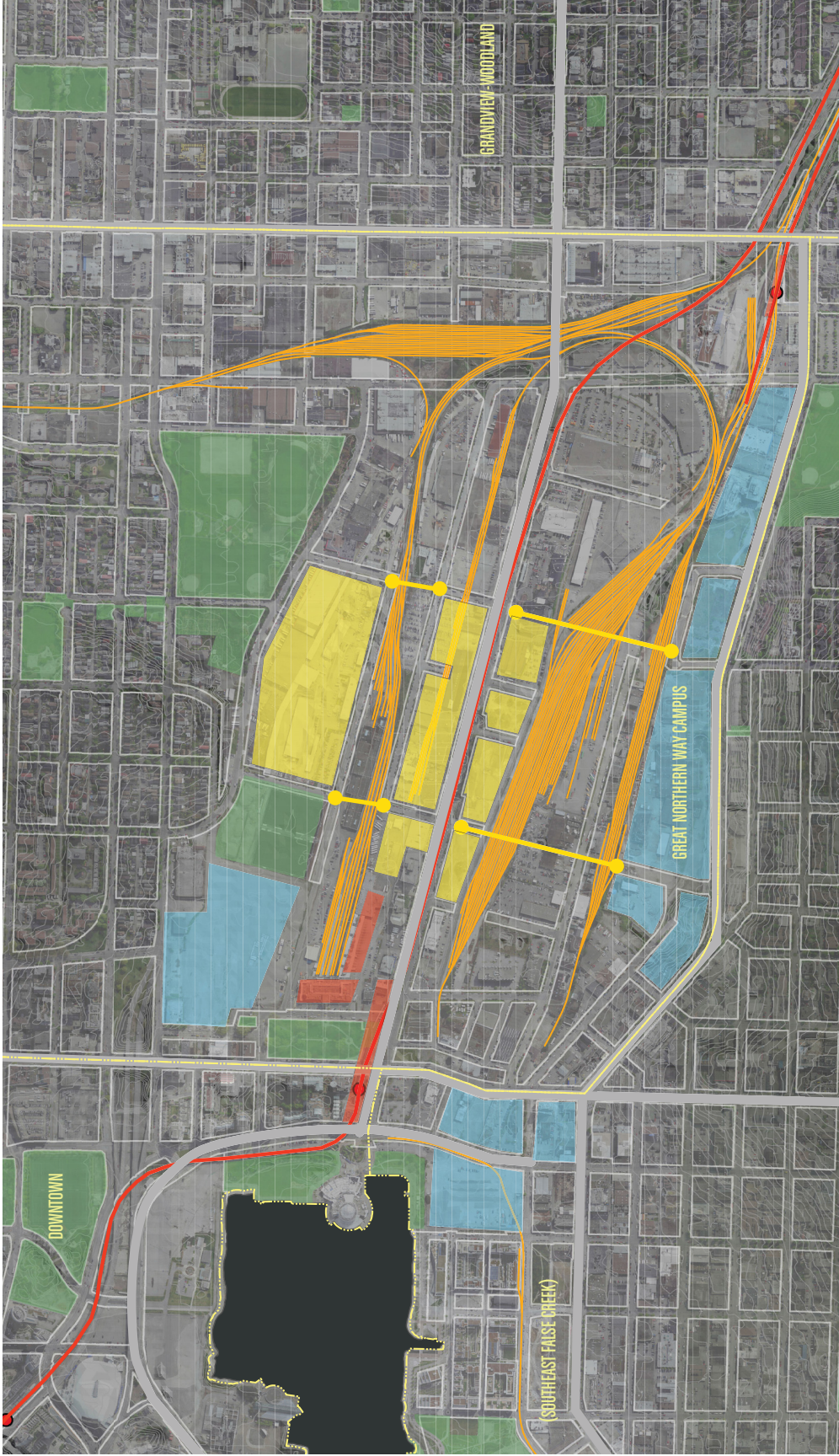
Overview

The urban analysis from the previous chapters has provided the design with a connective and responsive foundation to begin the process of synthesizing the experimental outcomes into a proposal of built form. Nodes have been established for a general urban strategy that create the connective infrastructure that bridges the urban environment and the new project site. We must work down in scale to generate reciprocal relationships between components. A loose interpretation of the urban forms the intent of the baseline for a building.

District

Districts are the medium-to-large sections of the city, conceived as having a two-dimensional extent, which the observer mentally enters “inside of,” and which are recognizable as having some common, identifying character. Always identifiable from the inside, they are also used for exterior reference if visible from the outside. (Lynch 1960, 47)

Based on the research in the previous chapters, we can now begin the process of synthesizing the design into a narrative. By breaking the project into components that coincide with the previous avenues of exploration, a form can begin to emerge based on three-dimensional site



In this urban plan, blue represents the encroaching development around the site. Yellow is the project site area with nodes added from the previous design analysis. The synthesis builds further upon the analysis from the previous chapter (Vancouver 2013).

constraints. One of the key design objectives of this process is the establishment of a new district to provide gravity to the site, and maintain its important cultural identity in the city as one of the last regions of light industrial programming.

Connectivity

The previous research into strategies for connecting a site to its context is manifested in the design proposal. A system of interconnected nodes forms a hierarchy for the site, with each node having its own function. There is a division between spaces for walking and places for staying (Gehl 1987, 131).

Nodes are points, the strategic spots in a city into which an observer can enter, and which are the intensive foci to and from which he is traveling. --- Or the nodes may be simply concentrations, which gain their importance from being the condensation of some use or physical character, as a street-corner hangout or an enclosed square. (Lynch 1960, 47).

Imagining the city as a series of pauses and movements reflects the notion of our world becoming increasingly about the “incessant movement of people, goods, and data,” and what remains as important is “the infrastructure that makes all of this motion possible” (Betsky 2007, 12). Laying the infrastructure for the movement within a city helps create the framework for what emerges there.

The use of connectivity also adds a level of robustness to city design, mimicking the redundancy in biological systems (Weinstock 2013, 21). Ken Yeang’s division of the “Four Strands of Ecoinfrastructures” as ecological, engineering, water, and human provide a suitable framework for beginning to understand the basics of connectivity on a systems scale (Hart and Littlefield 2011, 18).

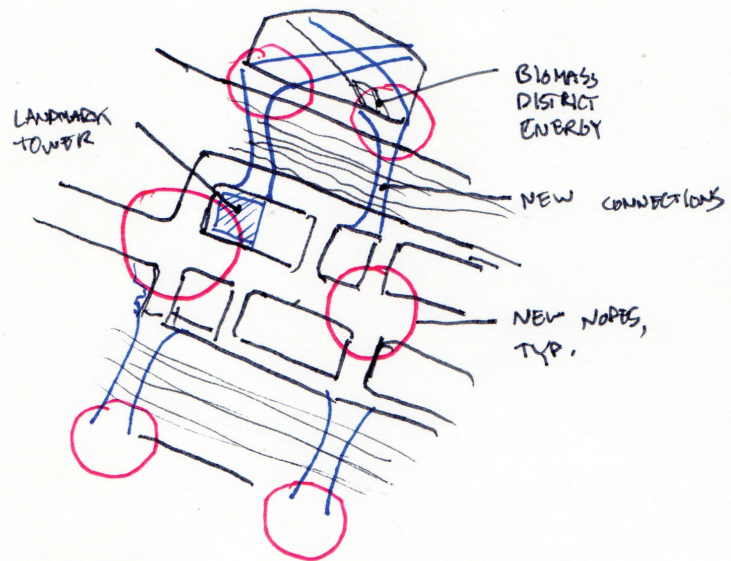
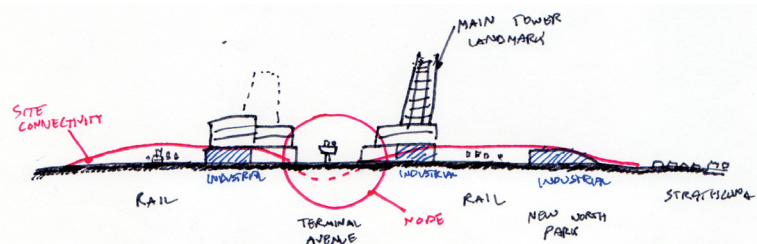


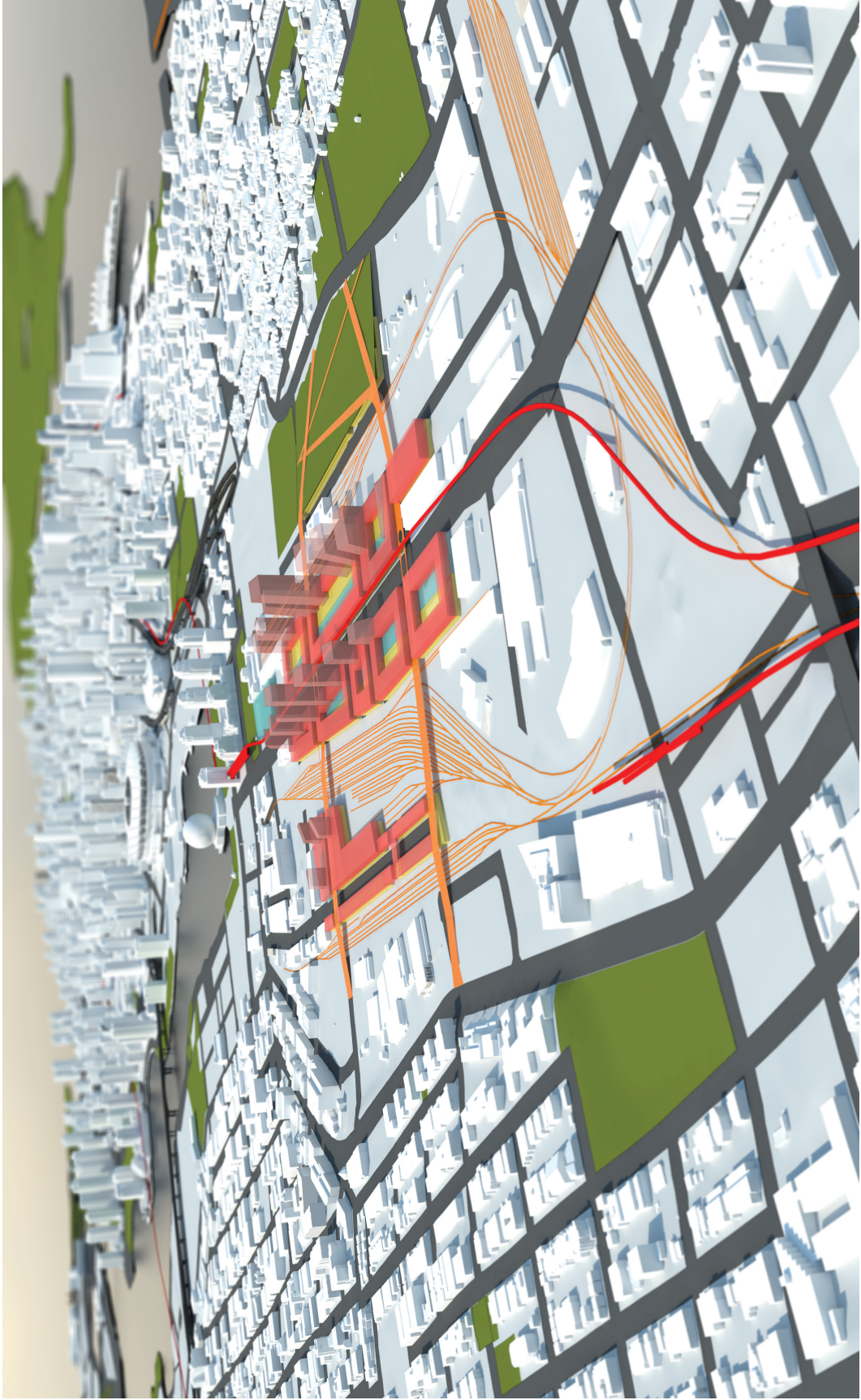
Diagram plan depicting the rhythm of nodes (in red) and connections over railyards. This language of anchors and flows works with Lynch's definition of node, and evokes the connectivity sought in the design objectives.

Program

The integration and retention of light industrial into the region is important to maintaining the industrial heritage of the site, and also for its continued functional capacity as the city's railyards by the port. The "Blocker" script in the previous chapter helped establish the site's stacked program, resulting in an interesting synergistic effect between the elements operating in three dimensions. The connective infrastructure unifies the whole and establishes district identity.



A north-south cross section through the site depicting the layering of industrial use on the ground floor by railyards. Other program is stacked up above and in front of it to form the other uses, all based on a synthesis of the Blocker script.



A southeast axonometric view depicting an idealized program massing obtained through data analysis. This forms the foundation for the infrastructural layer of the site, leading into the building scale that emerges from the constraints. The interaction of multiple layers of constraints in three dimensions makes for a unique interaction of program for analysis.

Traffic and Transit

A hierarchy and rhythm is established on the site based on what side of a block faces the railway and which faces public transit. The active railways which were the founding reason for the existence of the site and are still required by the local industry are incorporated holistically into the design.

Park

A park in the North bridges the density gradient between the single-family residential of Strathcona and the new high-density corridor of Terminal Avenue. It is envisioned that this park covers up the future Canada Post distribution garage use below, and simultaneously serves to bridge the height difference between the bridge over the railway and street level.

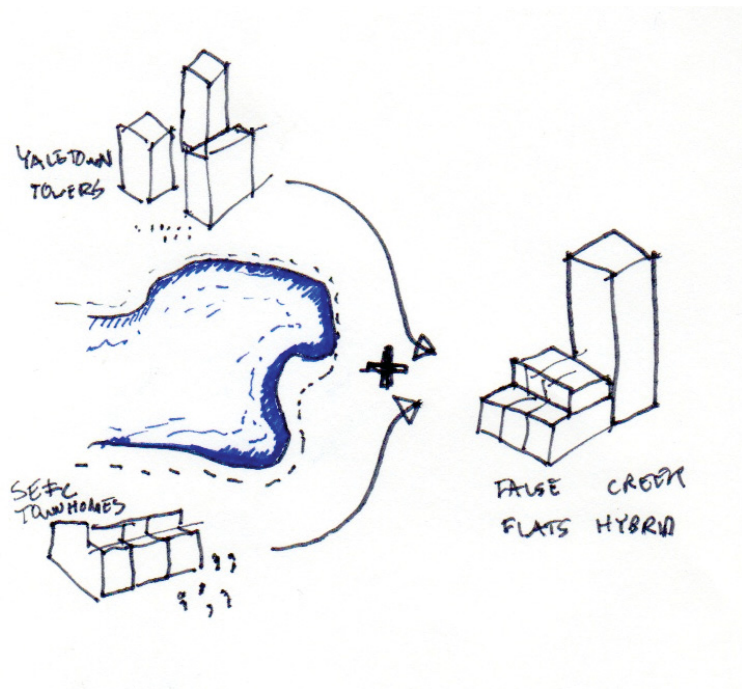
Layering

Below level produces intimacy, inferiority, enclosure and claustrophobia, above level gives exhilaration, command, superiority, exposure and vertigo; the act of descending implies going down into the known and the act of ascending implies going up into the unknown. There is a strange correspondence of similar levels across a deep gap, near but remote, or the functional use of levels to join or separate the activities of various road users. (Cullen 1961, 38)

Having a good visual connection between different uses is important in a city, and it is good to have demarcation of different areas without an actual separation (Gehl 1987, 63). The relationship between the elements of light industrial and commercial spaces proposes an interesting opportunity for the synergy of the two that can be explored in depth in the central tower of the district. The handling of these two juxtaposed programs is important for both the identity and environmental qualities of the site.

Massing

As Gehl notes, many smaller buildings is better for numerous variables including the handling of wind, acoustics, and solar gain (Gehl 1987, 178). The site is envisioned to have numerous towers that follow the tower-podium typology of the surrounding context, but merged with the urbanistic co-op housing of the adjacent areas to the southwest.

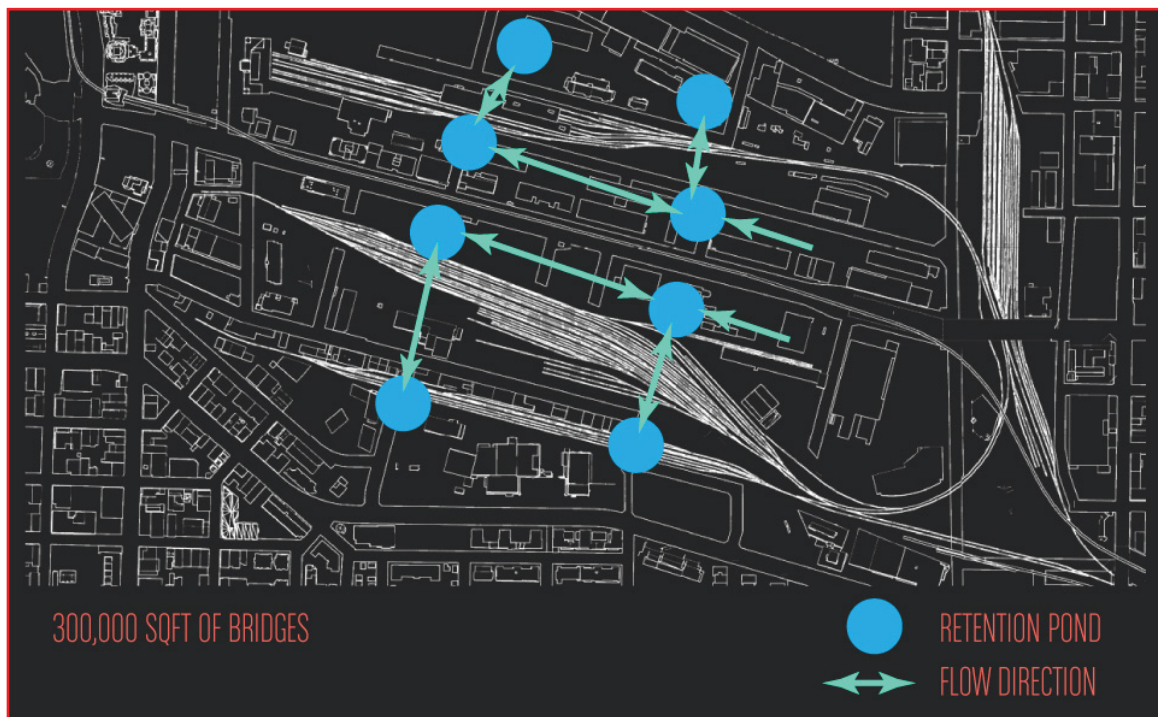


The low-rise co-op housing to the southwest of the site merges with the tower-podium morphology of Yaletown, connecting and responding to the surrounding urban environment.

Two “spines” of these towers run from west to east along the main corridor, Terminal Avenue. The heights are mandated by the City’s “dome shaped skyline” policy that indicates for the height of buildings to step down from the downtown core eastward. A central tower, studied in the next section, becomes the defining feature of the new district. Its position at the node closest to the downtown core makes it ideal for serving as a gateway to the new district, and its role in the connective tissue of the site

Stormwater

Echoing the system of nodes for pedestrian level activity, the nodes of the site can serve a dual function as stormwater collectors for the connectors. Given the site's low elevation and topography placing it in a bowl, this form of managing stormwater effects can make the difference between flooding and not.



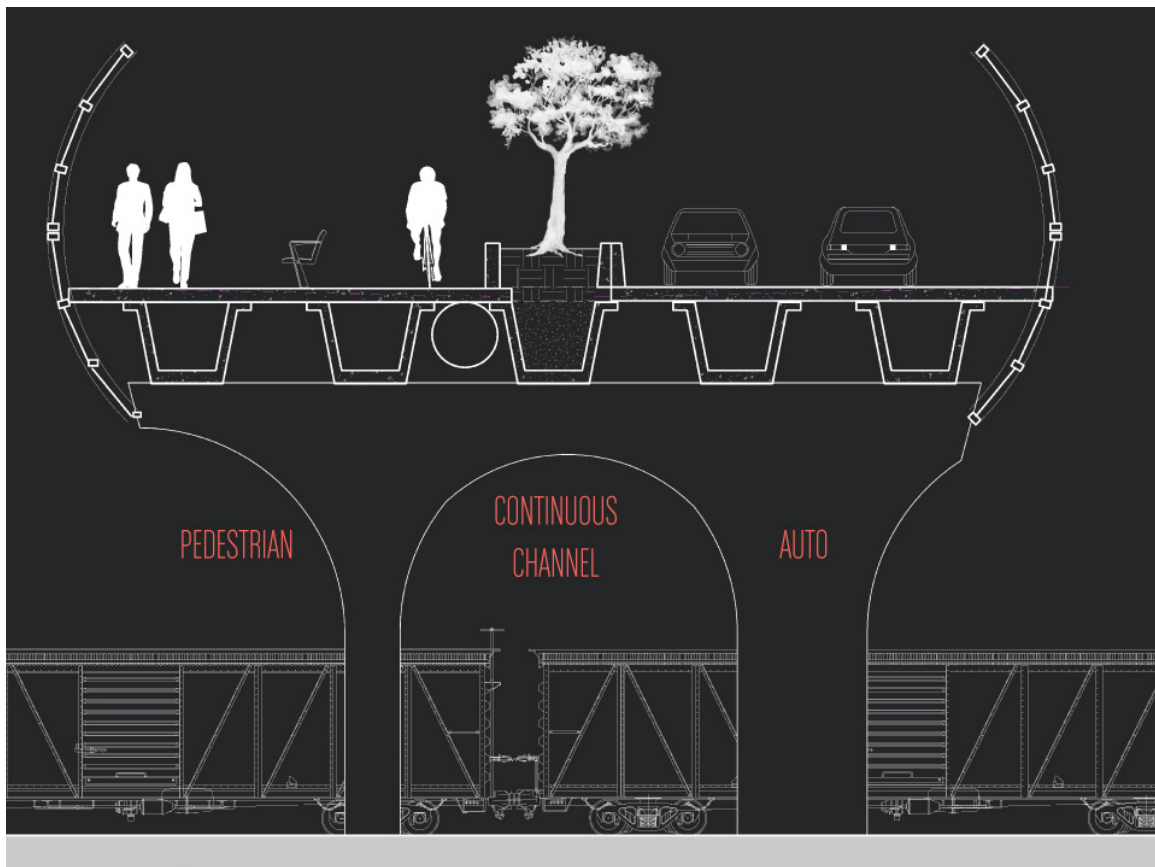
The new nodes in the site become nodes of pedestrian and stormwater activity (Vancouver 2013).

Neighborhood Energy Utility

A neighbourhood energy utility provides and heat for a district, providing energy savings by reducing conveyance times for waste and heat and also reducing the inefficiency of individual heating equipment for buildings, and also making more space for green roofs. This feature works off the northeastern node in the North Park area, serving as an indication of the district's energy usage. This has a direct precedent for the Southeast False Creek Neighbourhood Energy Utility, below the nearby Cambie Street Bridge.

Pedestrian Realm

A green corridor provides a channel for the some 300,000 square feet of bridges to drain to retention ponds at the end, while providing an acoustic and visual buffer between pedestrians and automobiles. The continuity of plantings also serves to give a sense of continuity to the path itself as part of a greater network (Lynch 1960, 52).



A section through one of the stormwater carrying bridges on the south side of the site. The use of vegetation provides a differentiation between pedestrian usage and that of automobiles.

The paths could terminate in forms that mimic a river estuary, dissolving between path and node and avoiding the feeling of disconnection generated by sharp separations (Lynch 1960, 56). The connective flow could be maintained through the building itself, akin to Ito's Taichung Opera.

Flood Construction Level

As part of its Climate Change Action Plan (Vancouver 2010), the City of Vancouver has increased its flood construction level (the minimum height at which habitable space can be built) to 4.5 metres from 3.5 metres above sea level. As a result, some of the pedestrian network is under this imaginary line within the project site. This will affect building massing, forcing habitable areas above the flood levels. While in this study flood construction level played no role in the previous urban analysis, it would most certainly play a role in future iterations. For this case, it will be considered manually in the design process as a designer override.



The effect of a 4 metre sea level rise on the False Creek Flats renders it under water. The updated 4.5 metre flood construction level for habitable spaces assists in mitigating the effect of this damage (Keenan and Yan 2011, 11).

Landmark Placement

The act of siting betrays to us the tenor of human aspiration, the shape of God and the worth of man. (Erickson 1975, 21)

Keeping step with the work of Kevin Lynch and precedents of visual connectivity through landmarks in Paris, Rome, and Barcelona, it was determined that defining a district could occur. By lining up placement of the building at one of the nodes of the site and view planes from two of Vancouver's main outbound arterial roads, an ideal location for the defining tower of the district is chosen.



The placement of the tower coincides with the main visual axes leaving Vancouver along Hastings and Cordova (Vancouver 2013).



The Torre Agbar in Barcelona defines a district by being placed at the intersection of prominent views through the city.

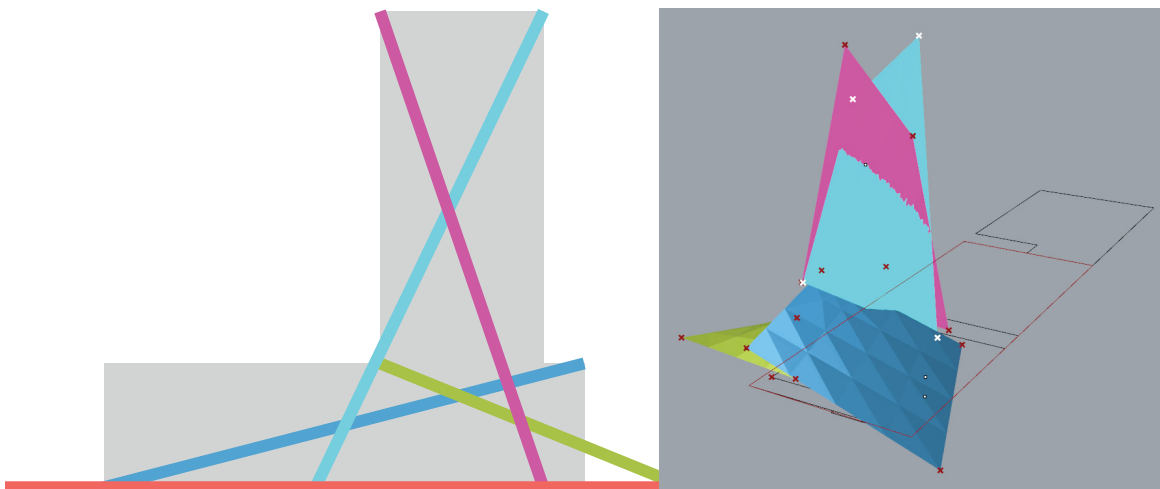
Building

The city - a block. A little steam rising from one of the flat-topped high buildings - monolith style - modern. But nothing else moving. There across the inlet. (I looked to see if the trees on this side were moving, to give a contrast.) I imagine winter - the city in the mind - the trees, the branches, waving, blowing all around, & the rain blowing, but the city still there, dark, in the mind. So non-existent, that way. There when you don't see it, as you wake in it. (Stanley 2008)

Form

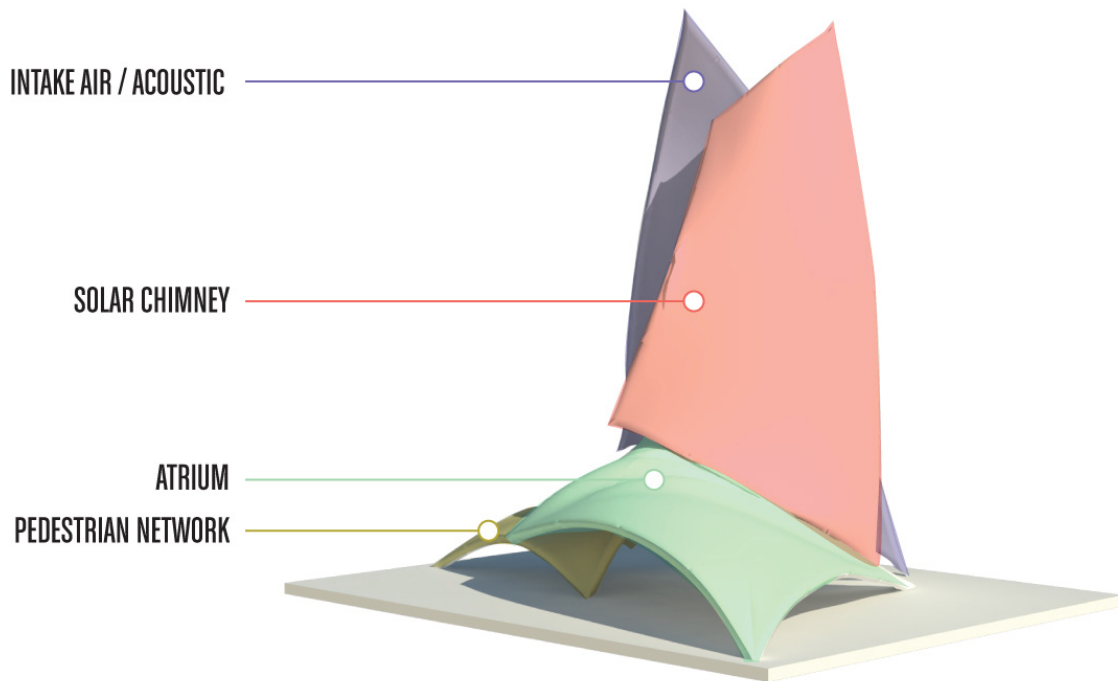
The effect of the previous studies of urban strategy and infrastructure culminate in the building strategy. Layering of unique constraints collides to generate a new form and dissolved typology. The form of the building emerges from the constraints placed upon it by social, environmental, and physical forces. At this scale, it can be seen as a diagram of four separate forces. In architecture, there is precedent in the Baroque era for the dynamic movement of forces becoming expressed in the built form:

The skin is no longer merely an accurate mural envelope; it is quivering under the thrust of internal reliefs that seek to come up into space and revel in the light and that are the evidence of a mass convulsed to its very depths by hidden movements. (Focillon 1948, 80)



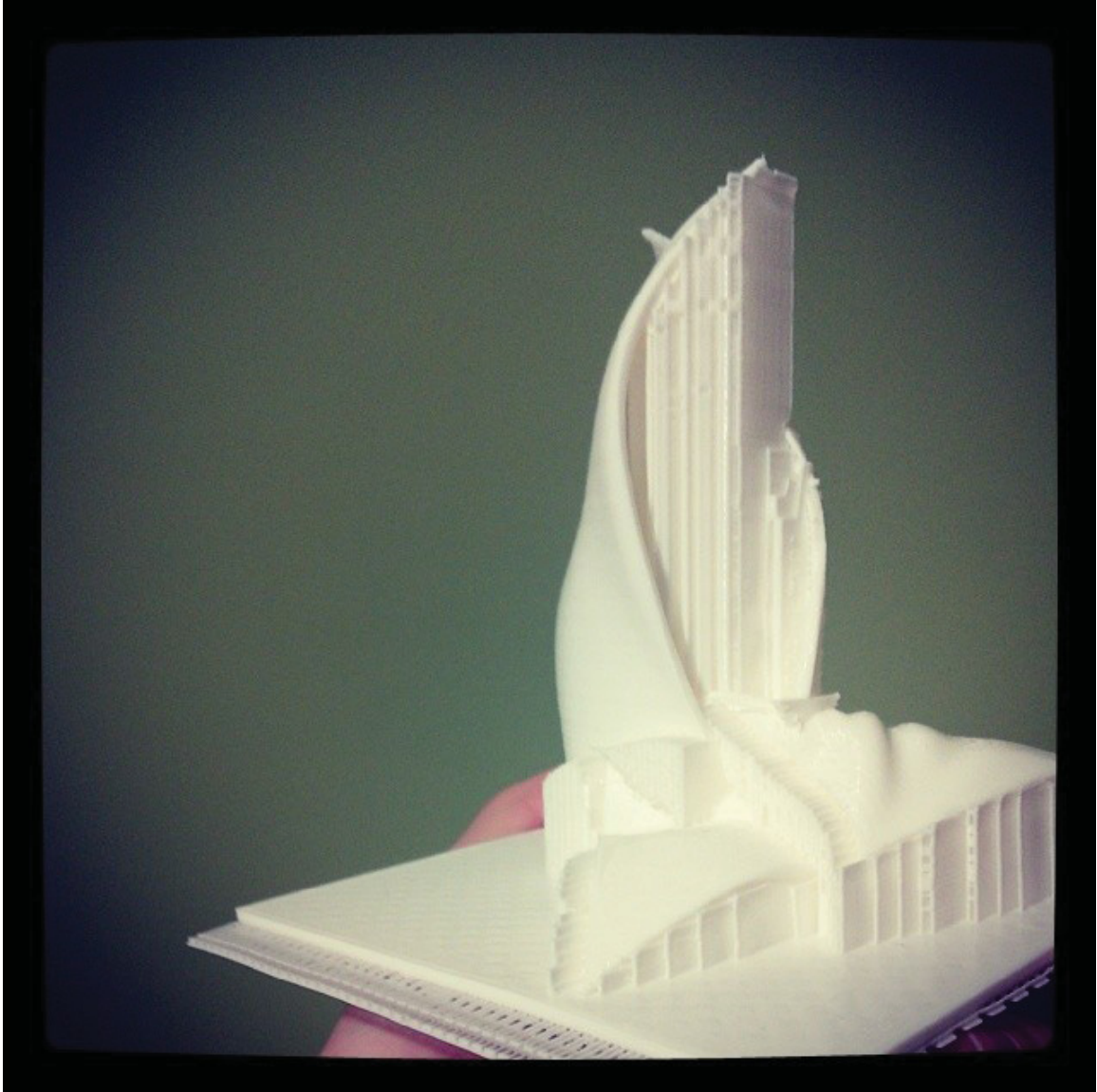
The forces that create the tower are a result of converting the standard mass into vectors with a dynamic range of possibilities for form that satisfy the constraints.

The establishment of vectors is assessed in three dimensions based on the forces that are acting upon them, akin to the studies in the previous chapter on wind and gravity. This study provides a range of possible solutions, of which it is up to the designer to choose the solution. The criteria for this is not firmly established, but in future models it could incorporate floor plate sizes and other constraints.



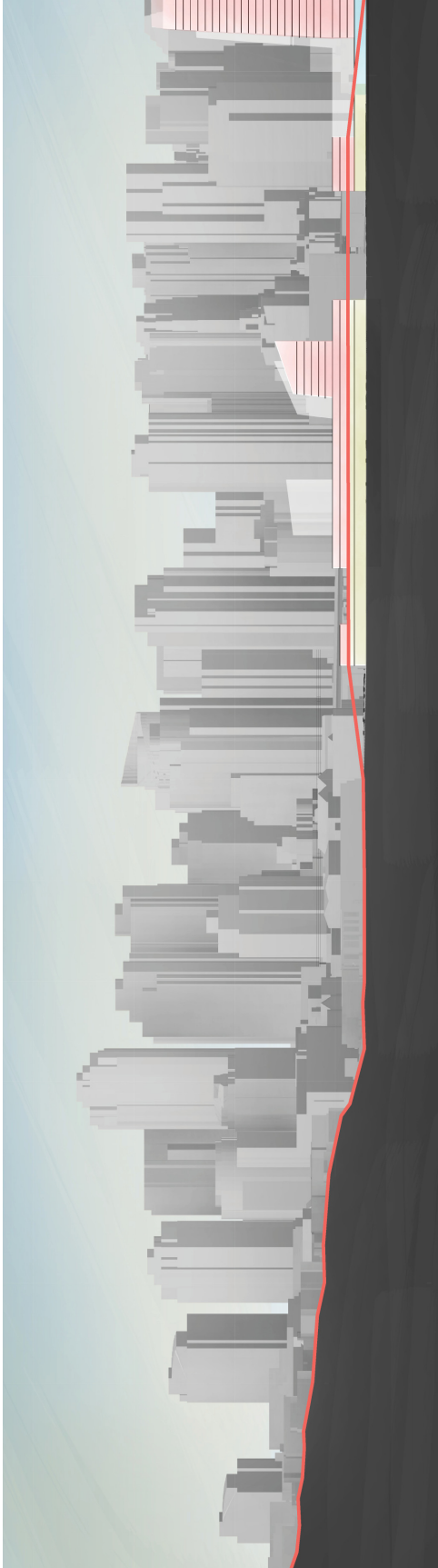
A diagram of forces comprising built form parti, obtained using physical modeling of gravity, vectors, and fabric simulated in digital space. The selection of forces is up to the designer in this iteration. A dynamic form to define the district is chosen for its properties of converging forces creating a tower, satisfying the programmatic constraints.

The selection of forces can be interpreted to drive considerations to satisfy the social and physical variables of the built form. The atrium and pedestrian network emerge from the horizontal vectors, and environmental considerations emerge from the unique massing created by the collision of the two vertical forms. The emergent form informs the design intent, working back from constraint.

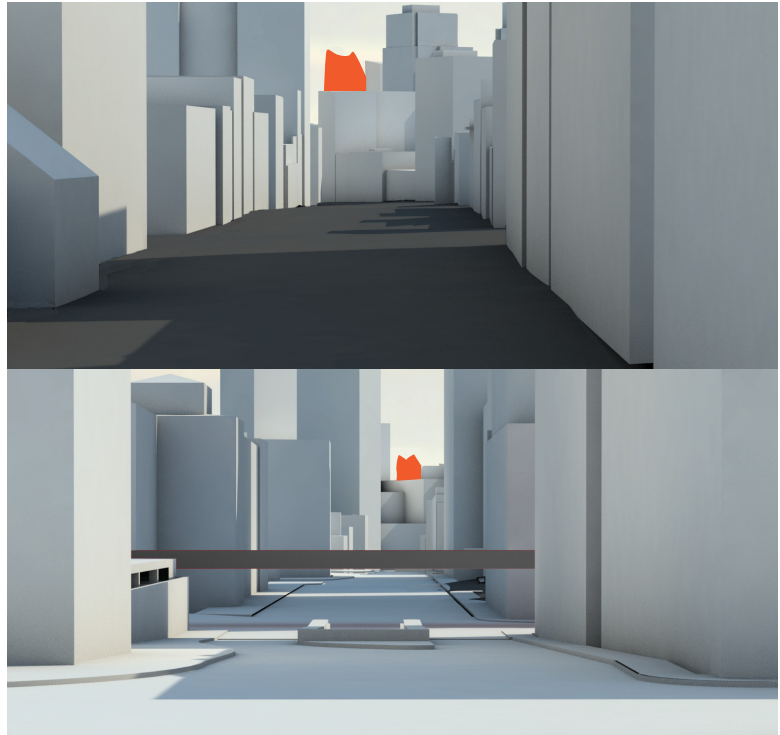


A 3D print of the forces requires scaffolding to support it, creating a language of structure emerging from necessity. The support material becomes the vertical circulation cores of the mass.

The establishment of vectors is assessed in three dimensions based on the forces that are acting upon them, akin to the studies in the previous chapter on wind and gravity. This study provides a range of possible solutions, of which it is up to the designer to choose the solution. The criteria for this is not firmly established, but in future models it could incorporate floor plate sizes and other constraints. These forces form the envelope for the building.



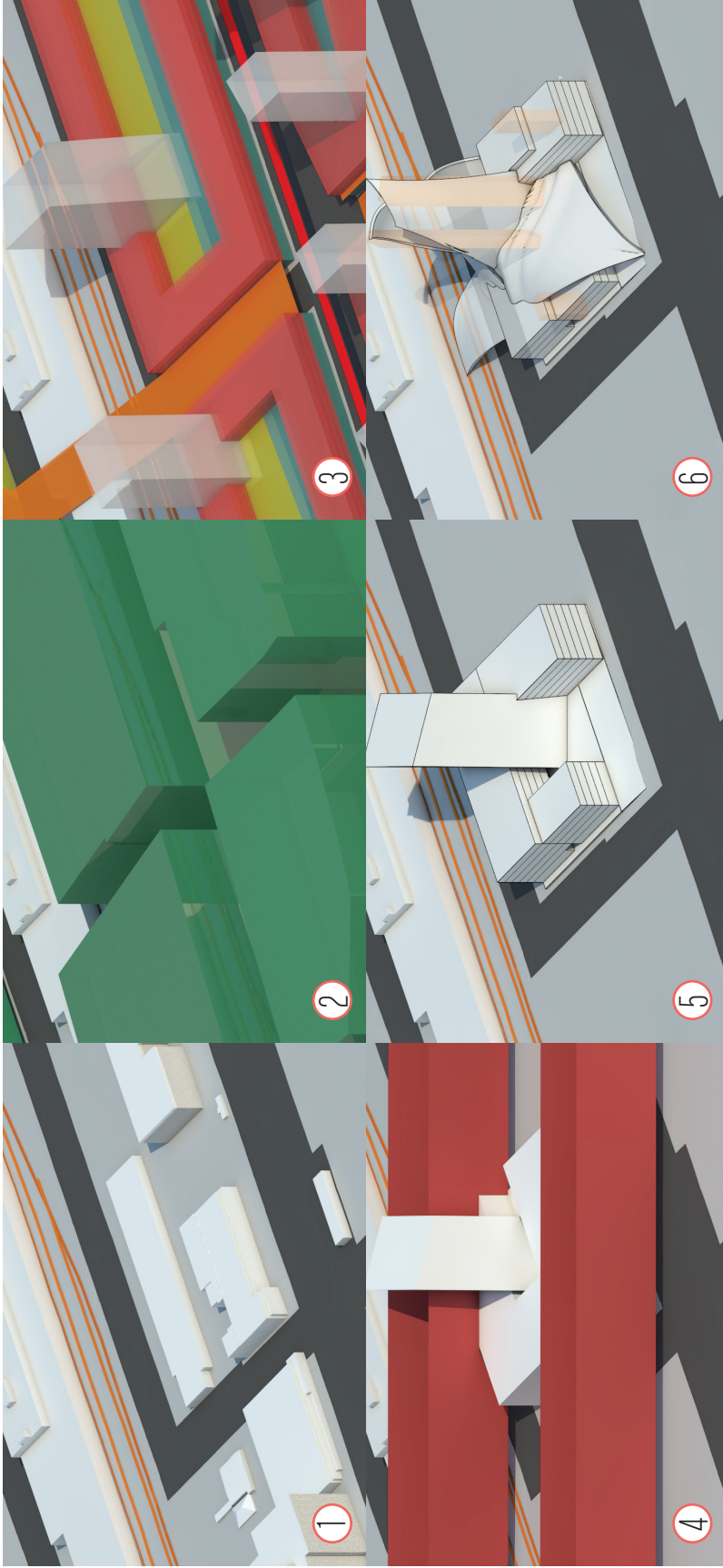
A north/south section through the site depicting the height of the buildings in the downtown core to which this district transitions. The tower is of greater size than all others in the district to establish its importance at a connective node.



The effect of the tower at the end of the previously identified axis streets hints at the new district and provides visual continuity. The district has an identity that is visible from other portions of the greater region, due to the relatively low building heights of the surrounding context.

Program

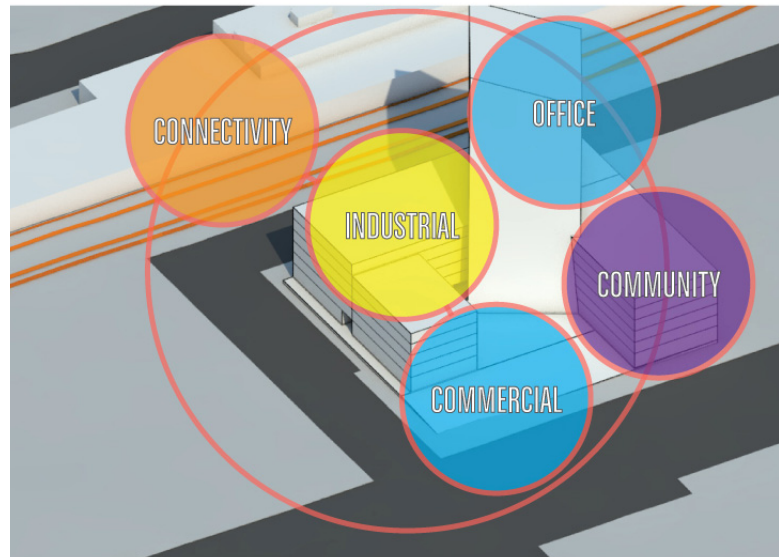
The form of the building is the outcome of the convergence of forces identified in the urban analysis section, and is a continuation of the scale and breaking the design decisions into separate components. The industrial side facing the railyards offers potential for a different modality of inhabitation, and this interacts with the retail along the main street in front. The goods that are made in the workshops can be warehoused and retailed in the same building. Fabrication space becomes a community amenity, and opportunities for education and skills training emerge. The juxtaposition of programmatic elements makes this approach to design appealing, in its ability to generate unexpected combinations.



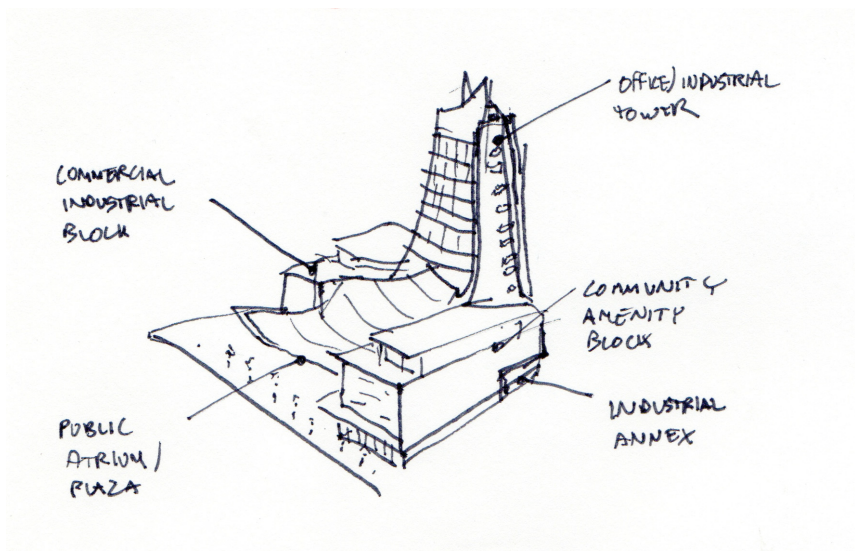
The cumulative effect of the process takes its form on the site resulting in the built form using a combination of analysis, generation, and manual designer control. The site in its current state (1) gets its height restrictions defined by traffic analysis (2). Program and unique juxtapositions are developed based on site metrics and cultural history (3). The movement of the tower is manual, placing it in position for a landmark (4). The flood construction level, also a manual decision, dissolves the southwest corner of program to make a transition in height for habitable space (5). Finally, the forces dissolve this form and cores are developed based on structural and programmatic constraints (6).

Massing

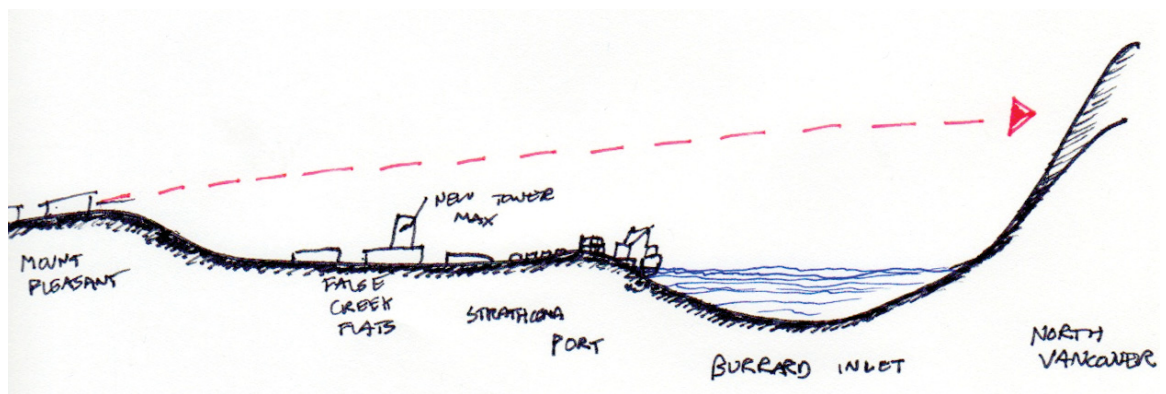
The building becomes a literal transition between the two eras of design, morphing from a modernist tower to a responsive one. Interaction between programmatic elements provokes a unique dynamic of industrial and retail in the community, suggesting a system of operation or manufacturing.



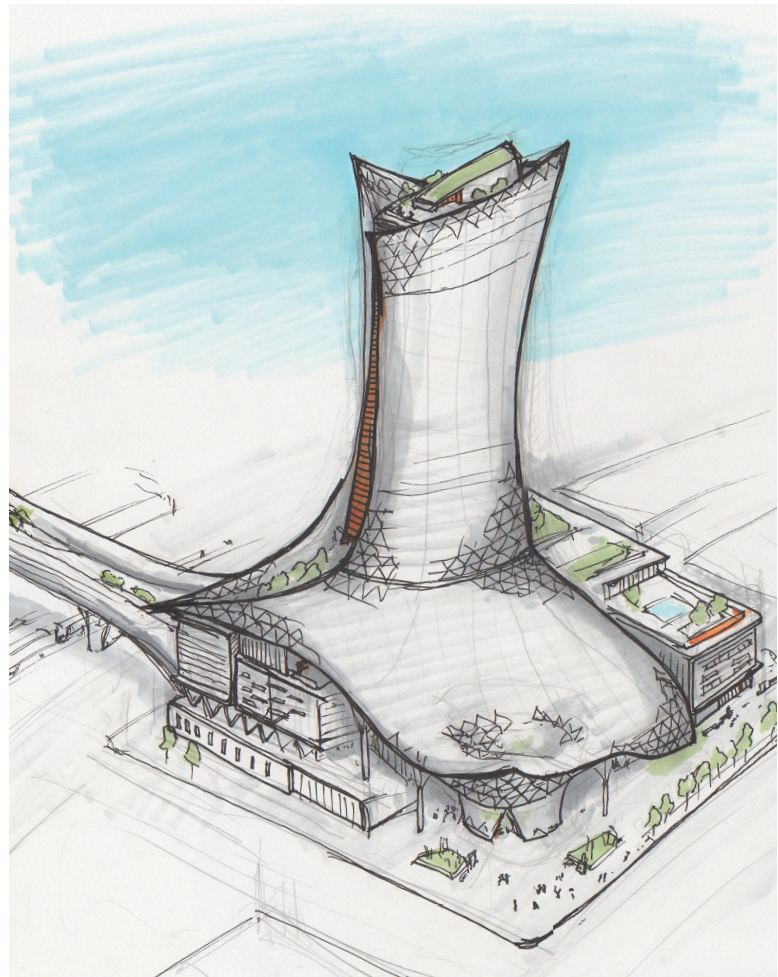
The collision of unique programmatic elements is the driving force of the building typology.



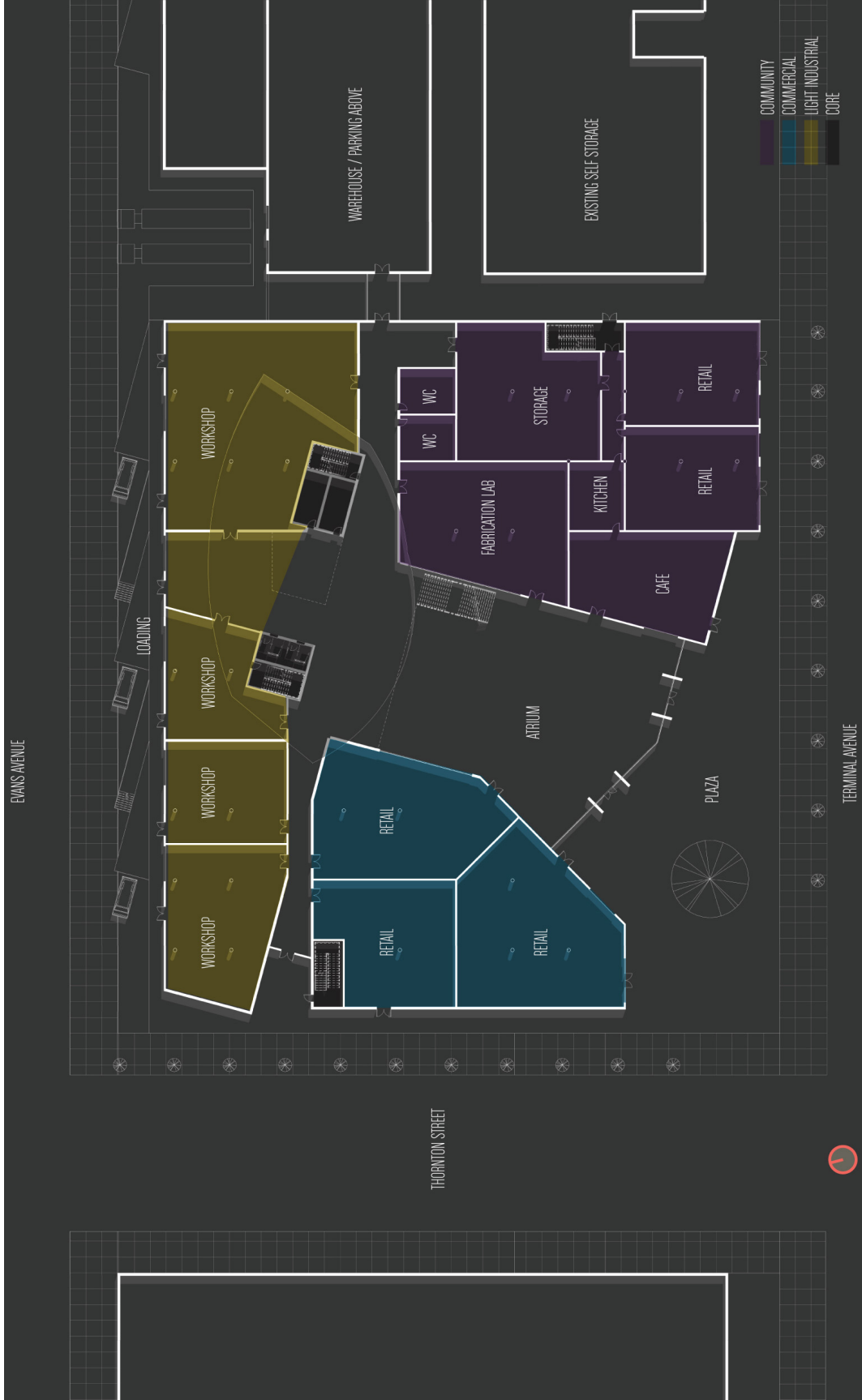
A southeast axonometric diagram depicting the program of the tower. A strip of light industrial use runs along the back side, and a three dimensional public space unifies the disparate programs on the southwest corner of the site.



An exaggerated north-south cross-sectional diagram depicting that the relatively wide east-west floor plate of the central tower does not interfere with views to North Vancouver from the south, due to the topography.



An axonometric sketch of how the constraints could be interpreted to generate built form. This is just one possible interpretation of what is implied by the constraints generated by urban analysis, an instance of a solution set that satisfies the constraints.



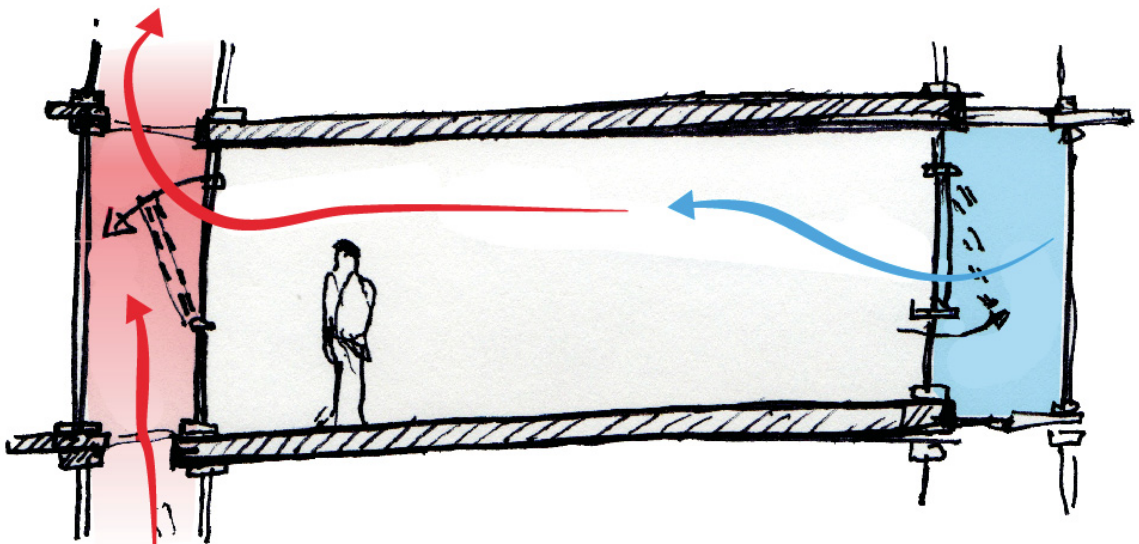
Level 1 floorplan demonstrating integration of industrial workshops and community fabrication amenities. The retail spaces are for the outcome of these processes, creating a complete system.

Flood Construction Level

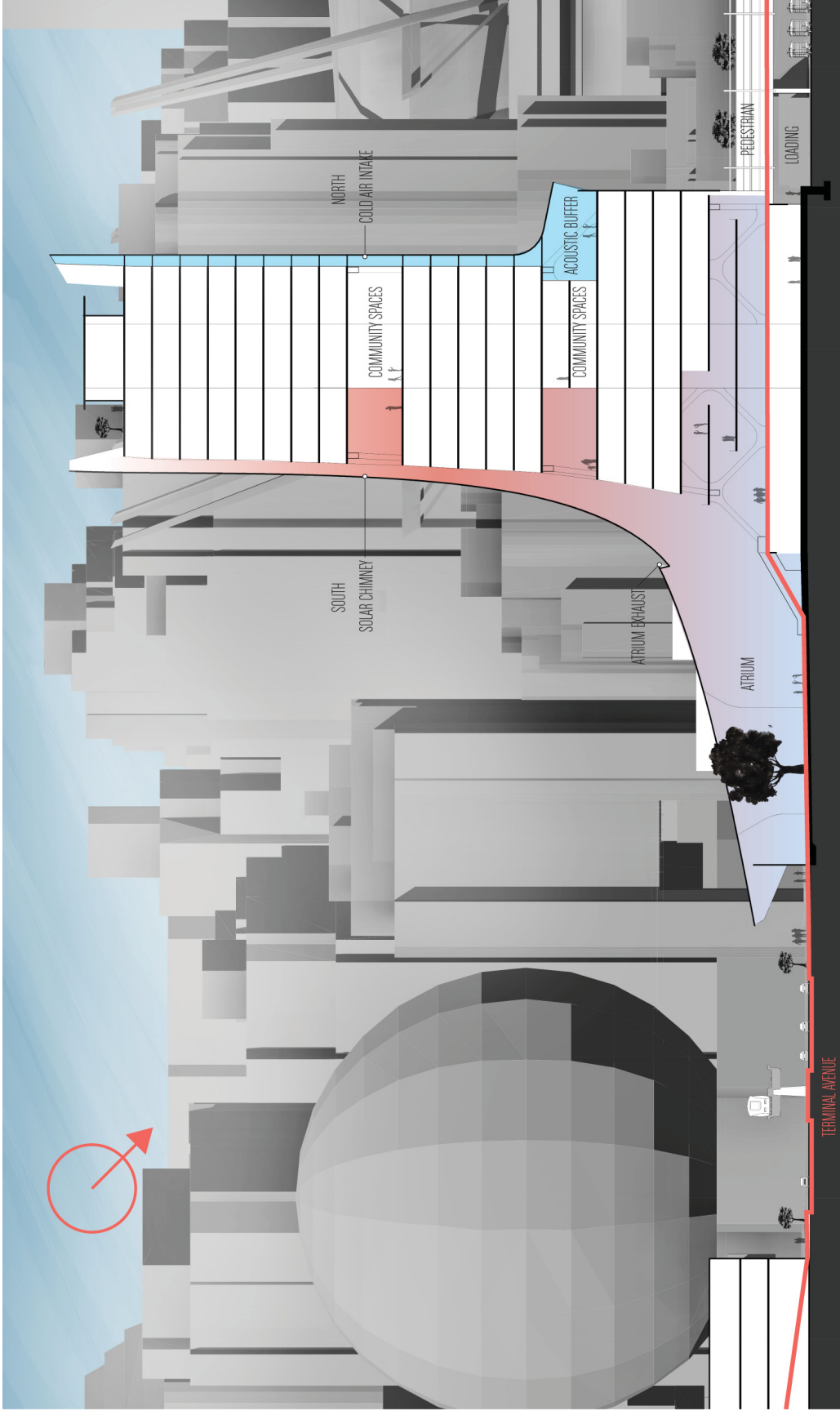
The City of Vancouver's Climate Change Action Plan cites a need for an increased flood construction level. Given the site's location in an infilled area, it was a prerequisite to have all habitable spaces above this elevation. A previous iteration of the building had below ground parking, which had to be removed and replaced with a parking structure in the urban plan. The atrium becomes a mediator between the increased building height requirements and the pedestrian realm at Terminal Avenue.

Environmental Systems

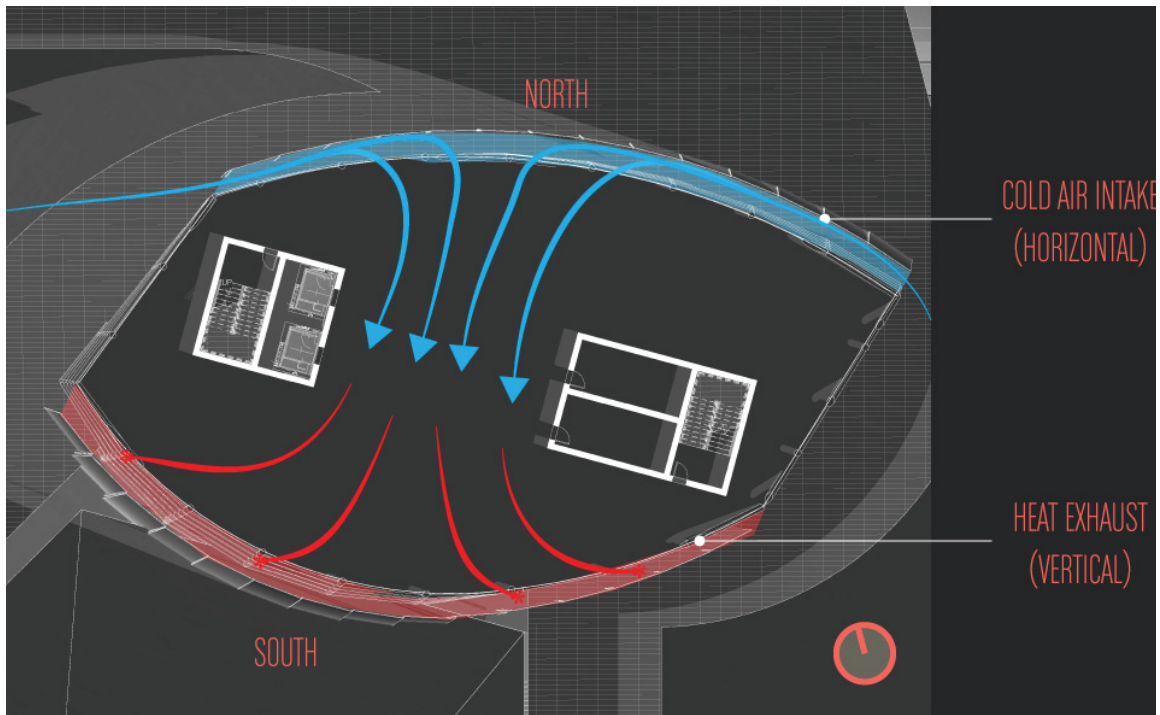
The unique form factor of the envelope provides an opportunity for advanced environmental constraints. Just as the precedent of Morphosis' Phare Tower undergoes a process of refinement based on the constraints identified at previous stages towards refinement of environmental variables.



A detail section of an individual floor showing the air flow working with the solar chimney on the south façade. The double façade is an opportunity gained from the unique form factor.



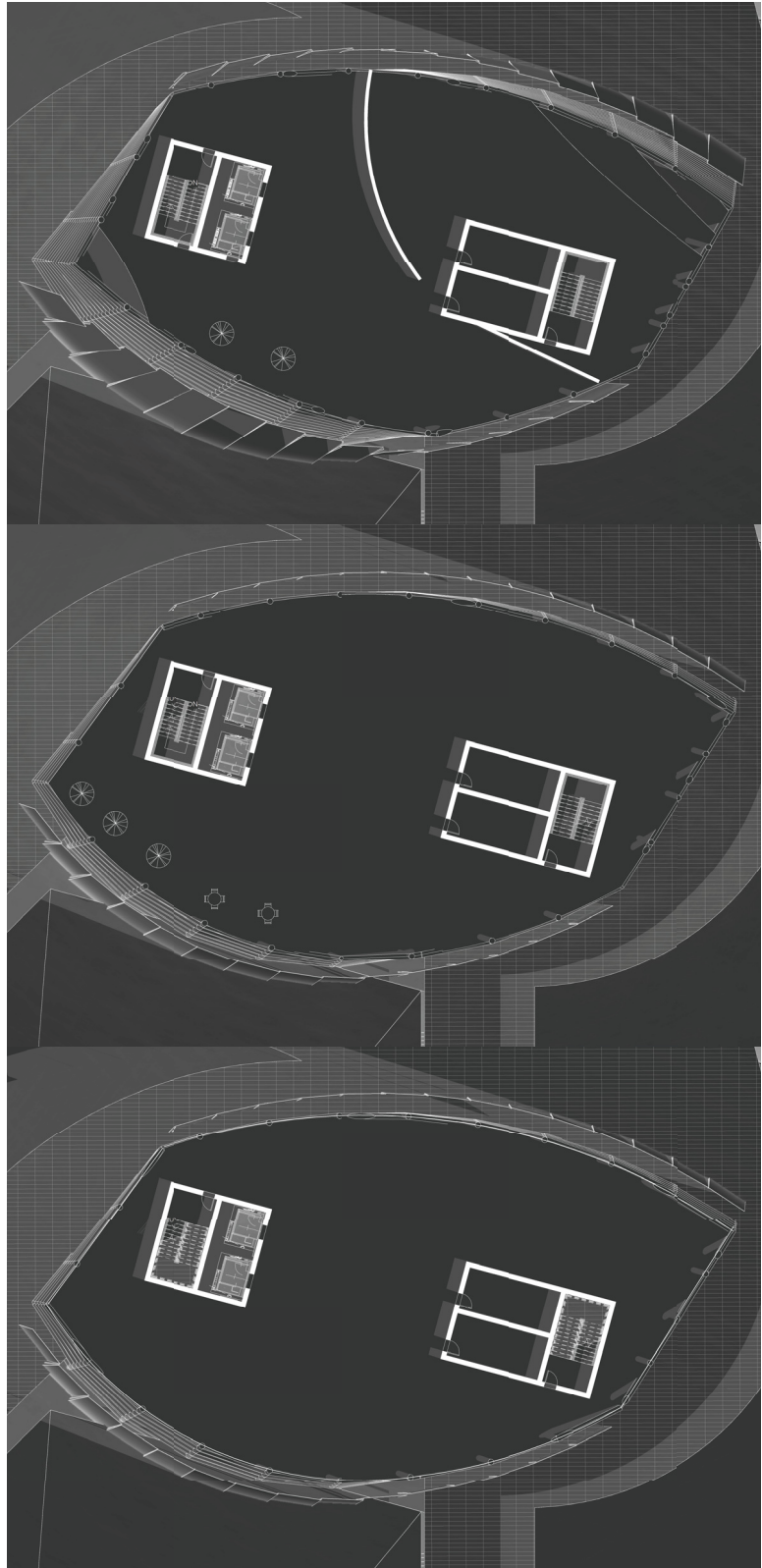
A north/south section through the site depicting the height of the buildings in the downtown core to which this district transitions. The tower is of greater size than all others in the district. The double facade on the south side utilizes its solar gain to drive a stack effect that pulls cool air via negative pressure from the north side through the office floor slab. This public space unifies disparate program



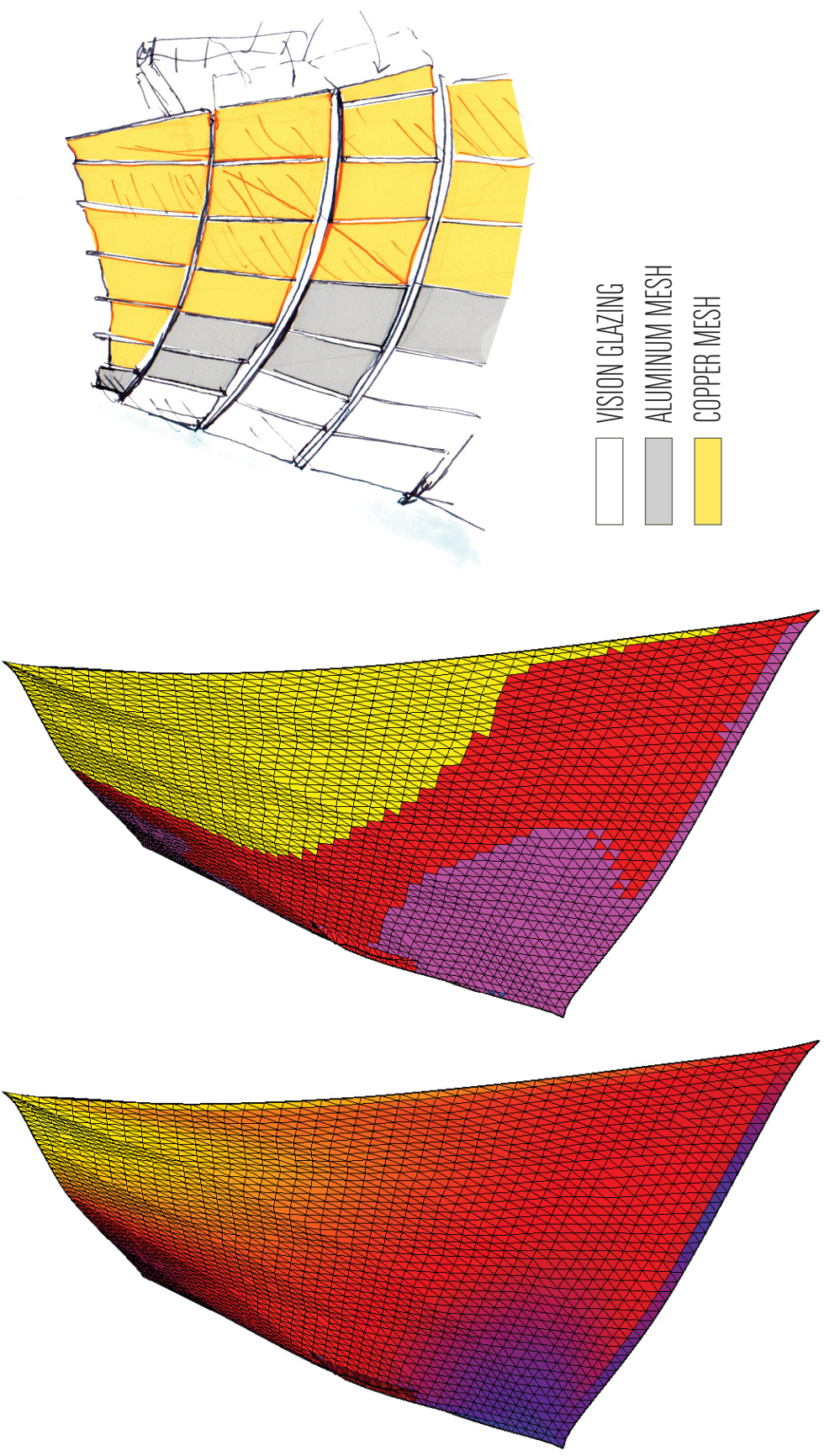
The plan of the tower illustrates how the split cores allow for airflow through the centre to the floor plate aligned with the prevailing east-west winds on the site that drove the form of the envelope to begin with.

An environmental constraint further helps to define the formal envelope of the building, specifically for a tower in the placement of the cores. Using advanced ventilation methods further identifies the constraints of a tower, and also confirms the program as office due to the necessity for operational windows in residential floorplates.

The tower also sets the baseline material palette for the district, providing it with a coherent identity through the use of a common character (Lynch 1960, 66). By having the landmark tower follow a particular approach to materiality and environmental treatment, the hope is that future developments follow suit to create a unified district.



Plans of the tower illustrating the double facade and separated cores for environmental purposes and how the cores interact. From top to bottom: roof level 26, sky atrium level 13, typical office level 12.



Solar gain analysis drives the material palette for the south facade, articulating the environmental forces that drive the stack effect into a visual depiction of the constraints operating on the building. Two different densities of extruded mesh inserted in the insulated glazing unit coupled with vision glazing provide legibility and environmental control to the building.



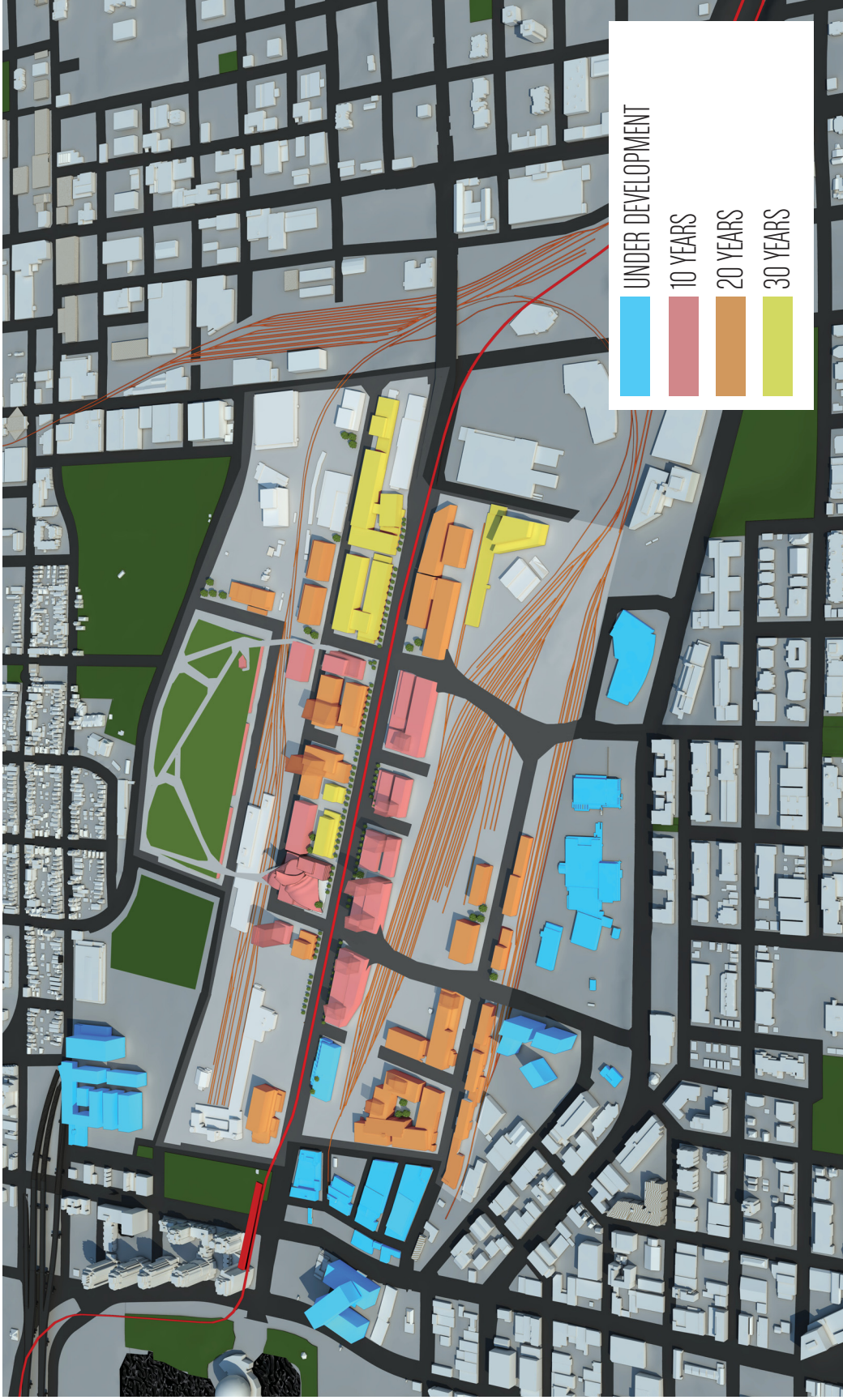
A view from one of the tower levels through the facade demonstrates the effect of the layered environmental treatment.

Future Development

Things will endure less than us. Every generation must build its own city. This constant renewal of the architectural environment will contribute to the victory of Futurism... (Sant'Elia 1914)

The infrastructure of the site now in place, and an emergent identity generated based on site constraints, the neighbourhood should begin to develop from the inside-out, as opposed to from the outside-in as was happening with development prior to the intervention. There is no attempt to simulate what will happen at this point, because the layers of what will be weaved through decades of development do not exist, and there is nothing to extrapolate on. The cultural and technological upheaval in which we live is the environment in which this seed grows.

Predicting the future requires a perhaps impossible level of analysis. The process identified in this research needs to be applied recursively and continuously to define the developmental path of a district, as it continually reacts to its changing surroundings and reassesses levels of connectivity



The zoning envelope proposed allows for a gradual infill on the site based on economic and political considerations as time progresses. This aerial view depicts one possible outcome with phasing. The encroachment of projects under development is evident, stressing the importance of having a plan.

CHAPTER 7: CONCLUSION

A blueprint does not predict the cracks that will develop in the future; it describes an ideal state that can only be approximated. (Koolhaas 1991, 11)

Synthesis

This is a preliminary simulation based on a proof of concept on emergent form from the layering of contextual cues. In a true holistic application, a more collaborative approach and much more data is needed to create more realistic models and hit the study's goal of a more representative architecture. We are beginning to see this process in practice with the trend towards increased collaboration and construction methodologies that place the architect as an intermediary "prime consultant" to wrangle with sets of data, opinions of the public, and consultants. The role of the designer is to synthesize the data and problems available to them, but the study of the city also has begun to transcend unexpected boundaries into different disciplines beyond those traditionally associated with it (Weinstock 2013, 18).

This digital framework is an attempt for a more representative and urbanistic city, and a response to integrating computational tools into architectural practice and discourse in a more beneficial way than has been done already. As Richard Sennett writes in *The Craftsman*:

The seduction of CAD lies in its speed, the fact it never tires, and indeed in the reality that its capacities to compute are superior to those of anyone working out a drawing by hand. Yet people can pay a personal price for mechanization; misuse of CAD programming diminished the mental understanding of its users. (Sennett 2008, 81)

The key word in the above quotation is misuse, which could be interpreted to imply that there is indeed a proper usage for CAD if its abilities are understood correctly by

users. The choice to terminate this research in loose, hand drawn sketches was intentional in this respect. Following along the framework of using the BIM model as a tool for assisting in the design process, it is evident that it is not the final stage in the process by any means. While it can be used to produce drawings, it does not need to for the framework to be complete. The tools are an amplification of our understanding of a problem at hand, and even a partner with us in this process. While Sennett laments the potential for invasion of "intelligent machines" into the realm prior reserved for human judgment, the use of the tools correctly allows for our judgement to be improved (Sennett 2008, 81).

This is needed desperately in contemporary practice, where there is an economic disincentive to architects and the construction industry on a whole to do anything other than fall back on rules of thumb with, for example, traditional structural grids and material usage. For massive projects with tight commissioning fees and construction budgets, in addition to the litigious nature of the profession, this tendency is no doubt justified. The research thus proposes the solutions of simulation, analysis, and designer synthesis as a potential future remedy for the constraints that economics and expediency place upon practitioners. Complexities of building code and zoning can begin to be elucidated through tools that take these issues into account, and the theoretical end result is a performance-based code that operates in three-dimensions.

Allowing for layers of constraints to drive the design process also enables a greater level of citizen engagement on two fronts. Firstly, the problem space in which a design must inhabit becomes apparent to the public in a clearer way,

as opposed to being obfuscated through a complex chain of information flow. The second is the speed at which iteration times can increase using an emergent approach, as new layers can be added, removed, and weighted as the project develops. The construction or planning of any project requires certain decisions to be made for the sake of expediency, and being able to readjust rapidly to changing parameters makes this an appealing proposition. Interest taken out on loans means that there are "points of no return" at which decisions need to be made, and are unable to be taken back.

As a word of caution, the race to embrace technology may supersede our ability to handle its impacts. In Huxley's *A Brave New World* the reader is presented with a world in which things have been "figured out," and the end result is a society in which innovation and the human spirit are consequently stifled (Huxley 1946). It may be possible to eventually design a script that maximizes the profit for developers on a site, and this becomes the de facto standard for the building industry. Just as a logical syllogism can be a valid argument even though its principles are false, we should be wary of allowing for this corruption to take place.

The key to cultural advancement through built form lies in which forces we allow to take precedence. A city needs to be more than just well organized, it also needs to have poetic and symbolic characteristics as well (Lynch 1960, 119). This is why the interaction between algorithmic architecture, computational tools, and the innovative forces of designer questioning and stakeholder feedback are essential for the process to work.

Future Research

With these caveats in mind, the potential for emergent urban design is tantalizing with its possibilities. Design has always been a movement to capture the elusive (Terzidis 2006, 1), and the visibility of the forces that shape our city promises to allow us insight into the way our city works like never before. The use of “big data” and networked buildings provides an insight into the patterns of the city hitherto untapped. Improvements in fabrication and the potential for full scale 3D printing of buildings in the near future leads to civilization’s abilities to respond to issues rapidly when they are identified.

The use of anchors to generate nodes of activity in the urban fabric and connective flows between them creates a dynamic outcome where variables overlap. The facade system of the design proposal was completely unexpected, and was an encouraging outcome of a new language of design spawned from intersections of variables. This is an example of the digital design framework successfully achieving its intent of defining new design methodologies for a new era of problem solving.

Simultaneously, the issues that are handled by this research are by design specific and hermetically defined akin to the rules governing an experiment. Understanding how to approach this problem in the real world requires going beyond a handful of urbanistic design variables, and instead to take a holistic approach including more advanced approaches to structural and mechanical engineering. The intersection of the more technical variables with urbanistic goals would truly achieve the intent of this building's public space as a seamless integration of building and the urban

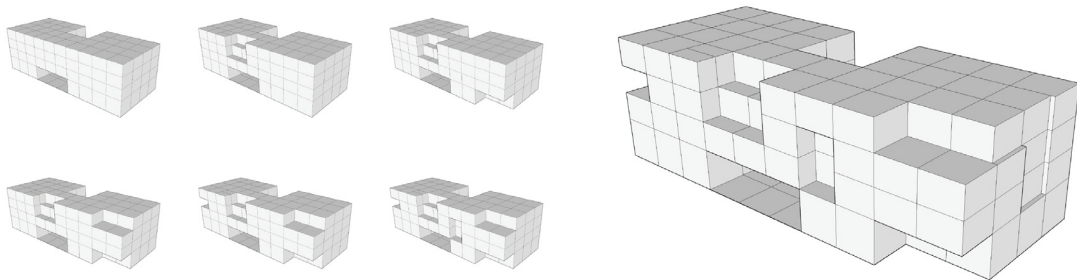
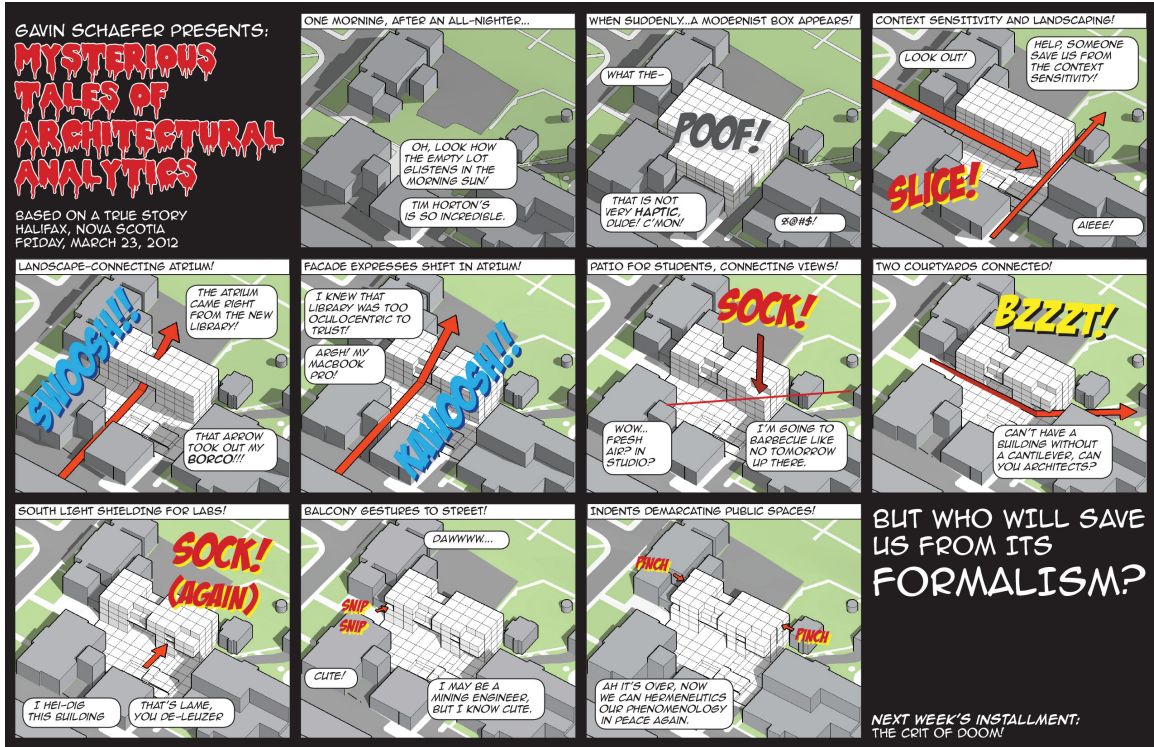
fabric. It would also inform a level of design that could more likely be put into practice.

It is indeed the ultimate goal of this process to balance conflicting demands created by overlapping systems. The confluence of these systems is where interesting design outcomes arise that also manage to balance the problems at hand. But while the formal design language may have an aesthetic component as a result, the intent is an altruistic one in anticipation of the problems our cities have caused and will create in the future.

Indeed, the ability to manage and assess the complicated demands we place on our cities and our buildings can also lead to an improved ability to face the challenges of the future by improving the efficiency with which we operate. Just as we once had emergent cities because we had no alternative, it may seem that we now need to return to emergent design because we have no other choice.

APPENDIX: PREVIOUS STUDIES

IDEA Building (2012)



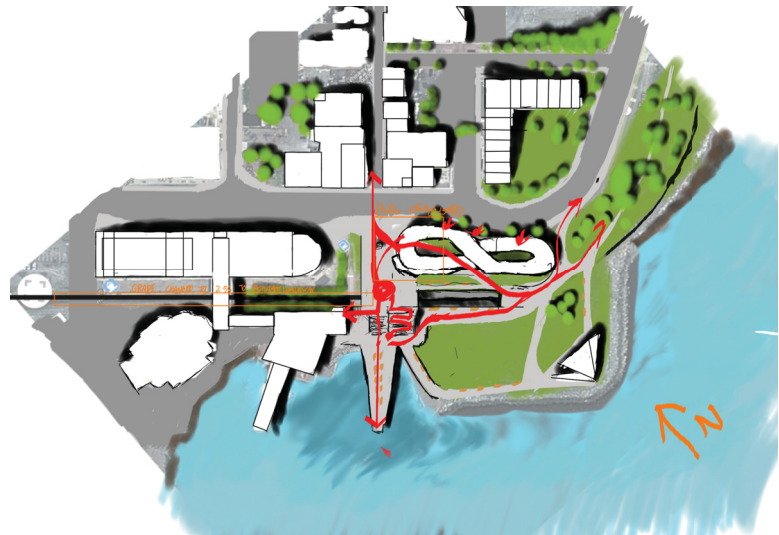
The massing process reinterprets the traditional structural grid based on urban contextual cues.

The IDEA building proposal begins as an abstraction of a commonly used structural grid for institutional buildings, and then reinterprets it based on the surrounding urban condition. This initial foray into responsive urbanity saw the forces acting to dissolve the boundaries between internal and external, using public space as the mediator between the two.



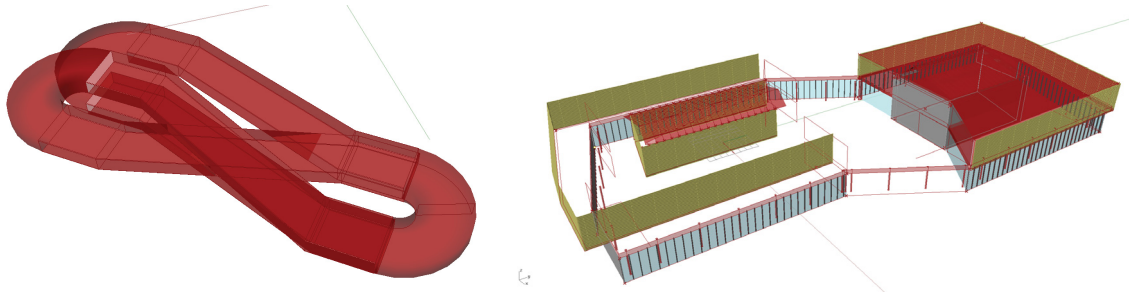
The public space is an emergent form based on the forces acting on the traditional structural grid. It acts as a mediator between the internal and external, and the public and private spaces.

LOOP Gallery (2012)

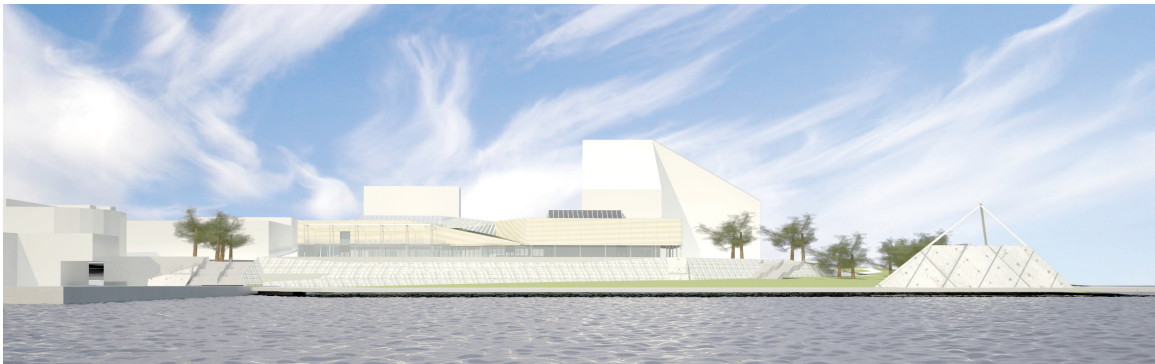
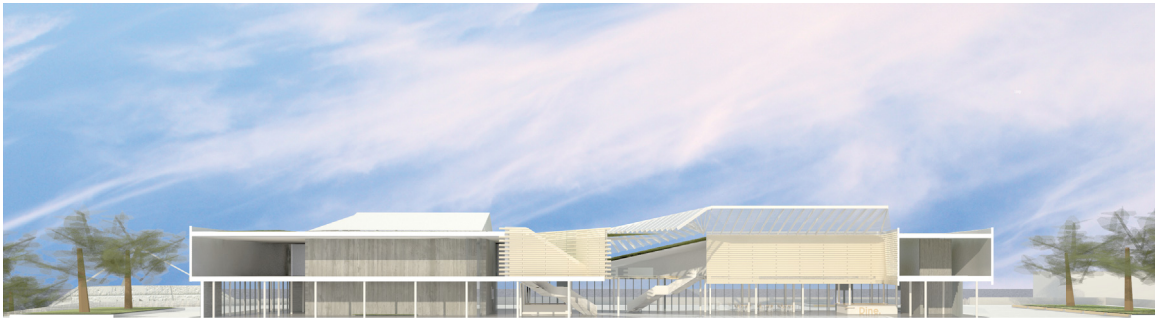


The LOOP gallery began as a study in tapping the pedestrian flows along the waterfront in downtown Dartmouth, NS.

The flows of pedestrians and patrons of an art gallery drove the formal decisionmaking process for the LOOP Gallery. A rapidly developing waterfront and busy ferry terminal saw the construction as part of the natural urban flow, and the forces it created helped drive the loop form.



A parametric process allowed for the testing of many iterations, along with rapid visualization and material testing.



The gallery taps into the urban flows and uses public space as a mediator between internal and external, public and private.

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