The N-Dimensional City

Establishing a Vitality Driven Framework for Volumetric Building Networks Through Parametric Design

by

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AUTHOR'S DECLARATION

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

I understand that my thesis may be made electronically available to the public.

ABSTRACT

The architectural concept of a city within a city, or a three-dimensional urban realm, aims to engage the public and bring the vitality of the city into the building. This concept often manifests in the form of grade-separated pedestrian networks, promenades through buildings, roof terraces, sky-bridge connections between towers, and towers that morph together—creating the urban realm throughout volumetric space. *The N-Dimensional City* investigates a recurring theme of this "volumetric architecture" typology throughout architectural history from a critical perspective. While the type originated from the Soviet era social condenser as a means of creating social equity, volumetric architecture grew to the height of its popularity in capitalist North America with the construction of private building networks throughout the Modern era. Often initiated by the private sector and constructed piecemeal, without integration into the city's master plan or regulations, many of these volumetric cities experienced a desolated ground plane and the amplification of existing social and economic problems. Rather than producing the social equity envisioned by the building type's progenitors, the resultant profit-driven spatial organization reinforced segregation, inequality, and commercialism in these urban centres.

With a contemporary resurgence of interest in volumetric architecture, signaled by the World Trade Center redevelopment competition in which almost all finalists produced a variation of the type, the thesis aims to resolve the apparent shortcomings volumetric architecture has in achieving its goal of vitality and equity throughout the entirety of a three-dimensional public realm. The thesis adopts the values instilled into Jane Jacobs' work as its goal for volumetric architecture, including universal access to the city and its movement, inclusive communities, equitable economic opportunities, and a holistic increase to the city's land value. The City of Toronto is taken as an ideal site to test the building type, as a city with both a history of quasi-public volumetric architecture including the PATH and the Eaton Centre, as well as a recent resurgence of the type in private developments such as City Place and Pier 21. Undergoing a rapid period of construction, the unrestricted powers of the Ontario Municipal Board have undermined the municipality's ability to direct development in accordance with the Ontario Growth Plan—instead ruling a majority of cases in favour of the development industry against the

advisement of the city's planners. This regulatory vacuum produces a volatile environment for volumetric architecture, in which existing precedents have demonstrated the ability for a profit-driven building network to buttress the city's existing socio-economic problems through what effectively became a spatial oligopoly and the privatization of the commons.

In response to volumetric architecture's ambition to create an extension of the public realm throughout three-dimensional space, the work of Jane Jacobs is used to form an understanding of how physical qualities of the built environment, designated as *urban resources*, produce vitality by catalyzing informal uses of public space. Adapting her work from the planar public realm of the *old city*, Jacobs' sociological study is codified into a system of discrete actors and processes that can be replicated throughout the three-dimensional field, thus formulating a vitality-driven framework for the volumetric city. The thesis work takes a parametric approach, creating a custom tool written in Processing that simulates the development of the city over time and under a variety of regulatory and stylistic conditions by abstracting the city into a field of voxels with assignable properties.

Negotiating the territory between architectural design, urban regulations, and economic forces of the development industry, the parametric tool projects an image of how a vitality-driven model of the volumetric city compares to its profit-driven counterpart, and to the traditional planar city. *The N-Dimensional City* reveals a not too distant future, prompting a reflection on the qualities of the city that we collectively value as a society, and how these can be developed by the architecture we build today.

ACKNOWLEDGMENTS

I'd like to thank my co-supervisors Mona El Khafif, and Maya Przybylski for their invaluable guidance throughout the thesis process. Mona thank you for your incredible insights that were instrumental in the trajectory of the thesis and your continued commitment to the work. Maya, thank you for your encouragement and clear direction, and for sharing your expertise on a wide range of topics. To Val Rynnimeri, thanks for your enthusiasm for the parametric approach, an openness to radical ideas, and your valued feedback. To Ultan Byrne, thank you for joining the committee as the external reader—your professional experience with the subject matter as well as your personal interest helped create an insightful and enthusiastic dialogue. I'd also like to thank my family, without whom this degree would not have been possible; Rick Haldenby who has regularly offered support and inspiration throughout my undergraduate and graduate education; as well as the support of all of my peers at the University of Waterloo School of Architecture, especially Eveline Lam and Safira Lakhani.

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CHAPTER 01

VOLUMETRIC ARCHITECTURE IS RE-EMERGING AS A MULTI-NATIONAL PHENOMENON

This thesis comes about due to an observation of a growing trend of volumetric architecture projects that incorporate public programs throughout the volumetric space of private buildings. Despite the optimism of these projects have in their ability to create a lively and equitable public space, how this is accomplished under private ownership is unclear, prompting an investigation into the reality of the quality and character of the spaces this architecture produces, and its impact on the city.

01.01. "Volumetric architecture" is a distinct and identifiable building type that produces public program or infrastructure throughout a building's volumetric form

01.02. Many different forms of volumetric architecture have been proposed by contemporary architects

01.03. The entries into the World Trade Center competition signaled the return of volumetric architecture to the forefront of architectural design

01.04. Architects consistently envision volumetric architecture as new streets and public spaces at extra-grade levels

01.05. Developers tend to claim volumetric architecture creates exclusivity and luxury

01.06. Shared amenities were first implemented in condominiums to encourage investment and maintain marketability

01.07. Sky-bridges, double grounds, and roof terraces are an architectural formalization of extra-grade amenities

01.08. Volumetric architecture furthers the ability to maintain the marketability of condominiums

01.09. It is unclear how the architectural ambition for an extended public realm will be achieved by volumetric architecture

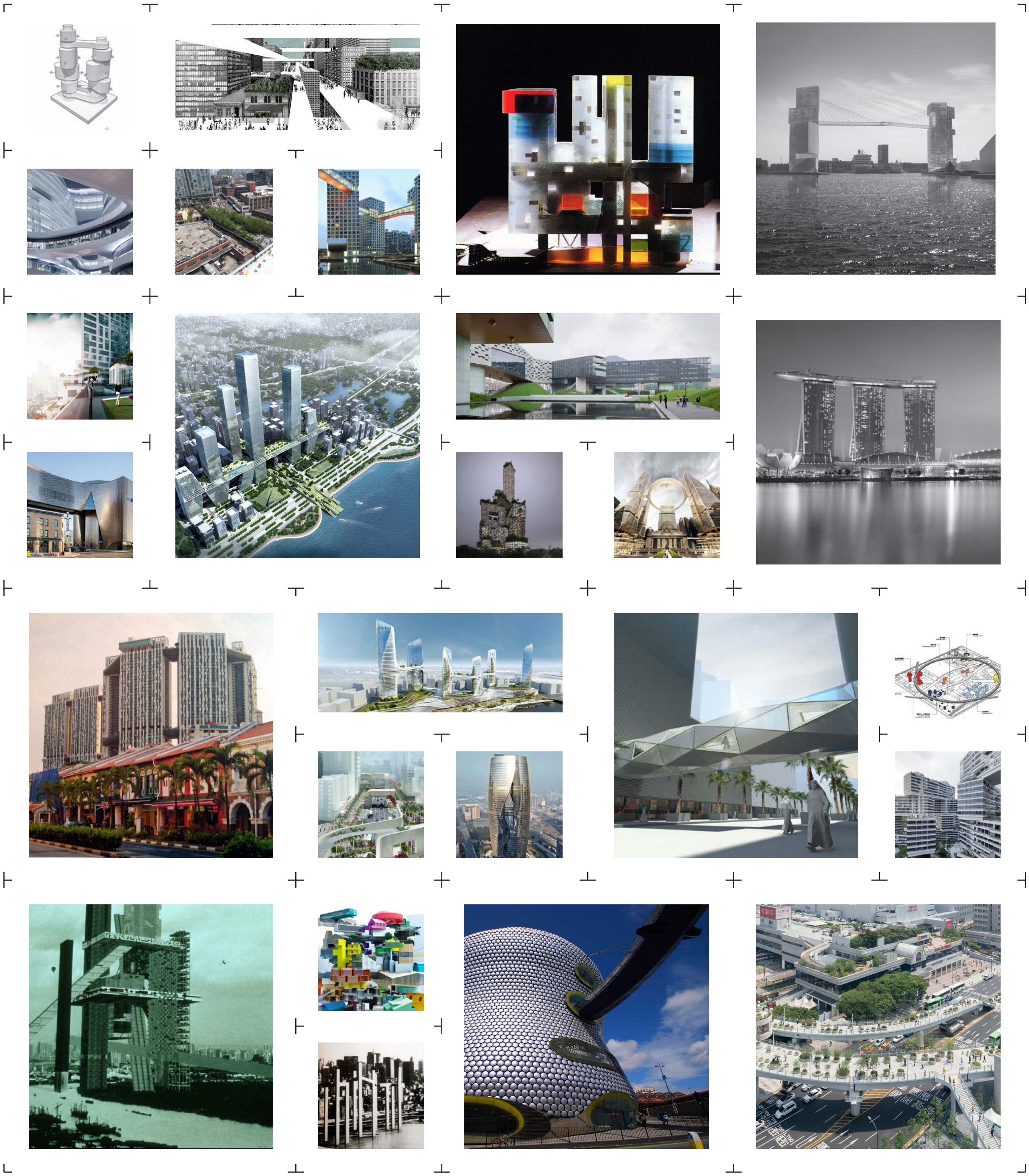


Figure 01.01.a-z: Samples of contemporary volumetric architecture proposals and projects including sky-bridges, building promenades, elevated pathways, extra-grade quasi-public space, and connected towers. [From left to right - a: Velo Towers, b: Galaxy Soho, c: NY City Vision, d: Highline, e: Linked Hybrid, f: Berlin Voids, g: Copenhagen Gateway, h: The Cloud, i: National Music Centre, j: Sky Street, k: Peruri 88, l: Vanke Center, m: Grand Central's Next 100, n: Marina Bay Sands, o: The Pinnacle@Duxton, p: The Linked Towers Tongzhou, q: Hua Qiang Bei Road, r: Leeza Soho, s: Riyadh Financial District Master Plan, t: Shenzhen Crystal Island, u: The Interlace, v: The Hyperbuilding w: Vertical Village x: Parallax Tower, y: Selfridges Birmingham, z: Seullo

01.01 *"Volumetric architecture" is a distinct and identifiable building type that produces public program or infrastructure throughout a building's volumetric form*

In a collection of volumetric architecture precedents to date, *Parallel Cities: The Multilevel Metropolis* by Minnesota based VJAA founders Jennifer Yoos (former John G. Williams Distinguished Professor at the University of Arkansas) and Vincent James, (Adjunct Professor at Harvard University's Graduate School of Design from 2000-2006 and Cass Gilbert Professor in Practice at the University of Minnesota School of Architecture) catalogue the history and construction of volumetric architecture around the world. The work suggests that volumetric architecture is a distinct building type that, when connected at a large scale, creates a *volumetric city.* Released last year in July of 2016, the work asserts that, despite a long history of architectural experimentation, volumetric architecture as a building type, was otherwise relatively undocumented,[1] self-proclaiming the work as, "the first of its kind."[2] Years earlier in 1998, this lack of research on volumetric cities was also noted by Jack Byers in the *Journal of Planning Education and Research* saying, "despite the proliferation of skyway and tunnel construction in cities across the continent, the literature specific to grade-separated cities is surprisingly scant."[3]

01.02 *Many different forms of volumetric architecture have been proposed by contemporary architects*

A variety of contemporary projects propose architecture that formalizes paths throughout buildings, amenity spaces at *extra-grade* levels above or below grade, and connections between buildings (*inter-building connections).* Projects such as Steven Holl's Linked Hybrid use pedestrian sky-bridges to connect towers of a residential project with an amenity level; MVRDV's Kissing Tower's forms connections between buildings without bridges by adapting the building's form; and the Diller Scofidio and Renfro High Line creates pedestrian urban infrastructure from an existing raised railway, that is later appended by BIG's Spiral Tower which extends the already extra-grade network vertically into the full height of the tower. This architecture interprets the occupant as a pedestrian moving through the building fabric as a three-dimensional public realm, re-framing the commons as not only planar space at grade level, but as an occupiable volume.

1 Vincent James and Jennifer Yoos, *Parallel Cities: The Multilevel Metropolis,* ed. Andrew Blauvelt, (New York: Distributed Art Publishers, 2016), back cover copy.
2 Ibid.
3 Jack Byers, "The privatization of downtown public space: The emerging grade-separated city in North America," in *The City: Land use, structure, and change in the Western city,* ed. Michael Pacione (London and New York: Taylor & Francis, 2002), 109.

01.03 *The entries into the World Trade Center competition signaled the return of volumetric architecture to the forefront of architectural design*

According to the authors of *Parallel Cities*, the entries for the competition to rebuild the World Trade Center site demonstrated that, "the multi-level metropolis was again en vogue,"[4] as nearly all finalists proposed extra-grade public space and interconnected buildings, including SANAA, Steven Holl, Richard Meier, Eisenman Architects, Norman Foster, Daniel Libeskind, Foreign Office Architects, Hariri and Hariri, United Architects, NOX, Zaha Hadid, and OMA.[5] Partially responsible for this revival is the influence of Rem Koolhaas' 1996 proposal of the Hyperbuilding, which became an icon for the "city within a building" concept.

4 James and Yoos, *Parallel Cities,* 161.
5 Ibid., 161.

Figure 01.03.a: Hariri & Hariri

Figure 01.03.b: Norman Foster

Figure 01.03.c: Zaha Hadid

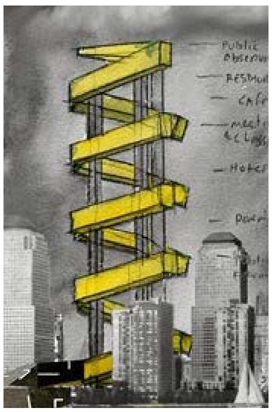


Figure 01.03.d: Steven Holl

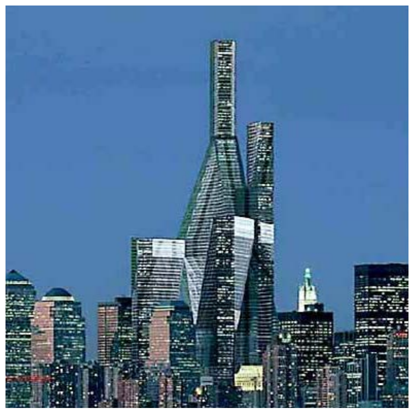


Figure 01.03.e: United Architects

Figure 01.03.f: Meier, Eisenman, Holl

Figure 01.03.g: NOX

Figure 01.03.a-g: The finalists for the World Trade Center design competition. The entries signalled the return of the volumetric architecture type, as almost all of the finalists displayed some form of interconnected towers in the proposal.

01.04 *Architects consistently envision volumetric architecture as new streets and public spaces at extra-grade levels*

Volumetric architecture offers new opportunities for architectural experimentation that deviates from simple point towers and identical floor slabs. Many projects view the type as a way of creating city space within a building—relieving the isolating and monotonous conditions throughout the height of a building tower by providing interruptions of amenities; including parks and shops, accessible through a traversable three-dimensional field of public space. Thus, the strategy is suggested as a method of densification that can relieve housing demands, reduce the strain on the city's existing amenities, and create communities.

The entire complex is ***a three-dimensional urban space*** *in which buildings on the ground, under the ground and over the ground are fused together.*

—Linked Hybrid , Steven Holl[a]

A hybrid structure with an abundance of real estate at the place of greatest value (and view), ***a second commercial and circulation zone above street level*** *. . . [Our building] creates a situation in which the largest floor plates—and the majority of the work spaces—are at the top of the building: a developer's dream diagram*

—World Trade Center, REX Architects[b]

*The Hyperbuilding – a self-contained city for 120,000 – is clearly the 'next step' . . . To achieve urban variety and complexity****, the building is structured as a metaphor of the city: towers constitute streets, horizontal elements are parks, volumes are districts, and diagonals are boulevards."***

—Hyperbuilding, OMA[c]

Mirador is ***a collection of mini neighbourhoods stacked vertically around a semi-public sky-plaza.*** *. . .This also provides outdoor space and community garden for the occupants of building, monumentalising public life and space.*

—Mirador, MVRDV[d]

01.05 *Developers tend to claim volumetric architecture creates exclusivity and luxury*

In contrast to the language of the architect, the rhetoric of developers selling units in buildings typically presents volumetric architecture as a symbol of luxury, and a way of creating exclusivity, rather than as an extension of the public realm. The disparity between the architectural concept and the marketing rhetoric indicates that the role of volumetric architecture in the city is highly plastic.

An urban landmark. A symbolic gateway to Canada's largest city. Directly facing the park, two 36-storey towers, joined by ***a two-storey bridge*** *at the 28th and 29th floors –* ***one level containing premium residences, the other exclusive amenity space.***

—*Parade, Concord City Place*[e]

An architectural masterpiece condominium residence, right at the water's edge in vibrant downtown Toronto. Situated at the foot of Yonge St., the stunning suites offer ***unparalleled, panoramic views, water and sky. Incredible amenities offer everything you'd expect from a world-class residence.***

—*Pier 27 , Fernbrook Homes*[f]

01.06 *Shared amenities were first implemented in condominiums to encourage investment and maintain marketability*

The development industry first incorporated shared amenities into condominiums to provide a marketable alternative to larger unit floor areas. In *Privatopia,* Evan McKenzie, Department Head of the Political Science Department of the University of Illinois at Chicago, argues that once land surrounding the city became built up and the middle-class of North America was unable to afford the land value of large lots, lot sizes became smaller.[6] Shared amenity spaces such as recreation centres, lakes, and other commonly owned amenities were introduced and designed, "to increase the cost of land by installing amenities, and then to effect housing prices which are even higher than those the costs necessitate."[7] This effectively convinced middle-class North Americans that smaller lots remained a stable investment—with the caveat that the amenities were controlled by a small private government, the homeowners association,[8]

6 Evan McKenzie, *Privatopia: Homeowner associations and the rise of residential private government* (New Haven: Yale University Press, 1994), 83.
7 Ibid., 97.
8 Ibid., 84

[a] Steven Holl, "Linked Hybrid," Steven Holl, accessed November 10, 2017, http://www.stevenholl.com/projects/beijing-linked-hybrid.
[b] REX, "Don't Rebuild. Reimagine.," REX, accessed November 10, 2017. http://www.rex-ny.com/world-trade-center/.
[c] OMA, "Hyperbuilding," OMA, accessed November 10, http://oma.eu/projects/hyperbuilding.
[d] MVRDV, "Mirador," MVRDV, accessed November 10, https://www.mvrdv.nl/projects/mirador.
[e] Concord, "Parade," Concord City Place, accessed November 10, http://www.cityplace.ca/parade/index.asp.
[f] Fernbrook Homes,"Pier 27," Fernbrook Homes, accessed November 10, https://www.fernbrookhomes.com/condos/pier-27-condos.

The apartment-condominium first saw a surge in Canada in the 1960s and continued to grow in the 1970s. After the recession of the 1990s, multi-family dwellings overtook single-family homes again, reaching the most number of units since 1977.[g]

From 2001 to 2011 the average condominium in the Greater Toronto Area (GTA) shrunk from 1,000 sq ft to 921, with the average downtown unit down to 749 sq ft. As of 2011 the smallest units under development were 270 sq ft in floor area.[h]

with strong exclusionary tendencies.[9] To meet changing market demands and stabilize investment with dwindling land resources, development responded with multi-family dwellings that maximized the number of units while providing an entry-level price-point,[10] creating a surge of condominium units in the 1990s.[11] Faced with the same issue of the shrinkage of saleable property, shared amenity spaces were again incorporated, this time into high-density developments. In Toronto, sales taxes combined with increasing land and building costs[12] have driven unit sizes down.[13] Despite this reduction in unit size, the successful marketing of shared services as luxury amenity spaces that supplement unit floor areas, coupled with supply and demand, have kept the shrinking condominium units marketable, while unit costs continue to rise.

01.07 *Sky-bridges, double grounds, and roof terraces are an architectural formalization of extra-grade amenities*

Architects have incorporated shared amenity spaces as architectural features, creating legible double-grounds, occupiable roof terraces, and sky-bridges between buildings, rendering shared amenities into architectural form. The architectural formalization of amenity levels creates spaces for collective activities and city life at extra-grade levels, bringing the urban life of the city from public space up into the *quasi-public space* (privately owned space that provides the program or infrastructure of the public realm) within high-rise towers.

01.08 *Volumetric architecture furthers the ability to maintain the marketability of condominiums*

Not only do the amenity spaces themselves provide added marketability to units, its formalization as volumetric architecture also provides new opportunities for high-end marketing, increasing density, achieving privileged views, and increasing land value;[14] creating a shared interest in the building type between architects and developers. Peter Clewes of architectsAlliance explains that in the case of Toronto's *Pier 27* condominiums,

9 Ibid., 88.
10 Ibid., 82.
11 Statistics Canada, "Evolution of housing in Canada, 1957 to 2014," *Statistics Canada,* last modified March 3, 2017, http://www.statcan.gc.ca/pub/11-630-x/11-630-x2015007-eng.htm.
12 David Wex, "Condominium Development in Toronto" (class lecture, Architectural Professional Practice: Ethics, Business, Legal Issues, and Contract Administration from University of Waterloo, Cambridge, ON, March 3, 2016).
13 Susan Pigg, "These tiny GTA condos smaller than hotel rooms," *The Star* (Toronto, ON), last modified September 26, 2011, https://www.thestar.com/business/real_estate/2011/09/26/these_tiny_gta_condos_smaller_than_hotel_rooms.html.
14 James and Yoos, *Parallel Cities,* 179.

[g]Statistics Canada, "Evolution of housing in Canada, 1957 to 2014," Statistics Canada.
[h]Susan Pigg, "These tiny GTA condos," The Star.

"the horizontal spans allowed for increased density while preserving views to the water,"[15] thus increasing the building's market value. In cities with an established skywalk network such as Calgary's +15, integration with the system can increase revenue by increasing the floor area ratio (FAR) permitted on the lot. While the benefits of volumetric architecture to developers creates an alignment of goals between investor and architect, the directed implementation of volumetric architecture as an investment tool has been met with the criticism of enabling gentrification. For example, John Robertson Architects' proposal for London in 2050 has been criticized as, "privatized enclaves to attract investors, not necessarily residents, using walkability and sustainability to increase investment value."[16]

01.09 *It is unclear how the architectural ambition for an extended public realm will be achieved by volumetric architecture*

Faced with a large population disassociated from grade and each other in high-density towers, an architectural discourse of creating a community within high-rise buildings has emerged. Volumetric architecture seemingly provides a possible solution through extra-grade amenity levels and inter-building connections that bring the movement of the city to the high-rise resident. However, the remnants of the last era of experimentation with the volumetric city are still operating in cities around the world, including Toronto's PATH, and other networks in Minneapolis, Baltimore, Bangkok, Calgary, Dallas, among others. In contrast to the contemporary idyllic vision of volumetric architecture, these precedents have been heavily criticized for their impact on the city caused by their ability to desolate the public street, their exclusivity, and their commercialism.[17] In light of these problems, contemporary volumetric architecture should respond with solutions which address these shortcomings; however, as Yoos and James note in *Parallel Cities*, the design profession has engaged in surprisingly little critical attention to the origins of the volumetric typology.[18]

15 Luke Simcoe, "Metro Explains: What are 'skybridges'?," *Metro News* (Toronto, ON), last modified August 10, 2015, http://www.metronews.ca/news/toronto/2015/08/10/the-rise-of-skybridges-in-toronto.html.
16 James and Yoos, *Parallel Cities,* 191.
17 Kim Ode, "Minneapolis skyway system is biggest in the world – and about to get bigger," *Star Tribune* (Minneapolis, MN), last modified January 23, 2016. http://www.startribune.com/biggest-skyway-system-in-the-world-minneapolis-is-about-to-get-bigger/366130581/.
18 James and Yoos, *Parallel Cities,* 16.

CHAPTER 02

TORONTO HAS A HISTORY OF VOLUMETRIC ARCHITECTURE AND REVIVED INTEREST IN THE TYPE

Now that a need to query the impact of volumetric architecture has been established, in order to observe its effect on the city, it must be viewed within context. Toronto is chosen as a city with a long history of ambitious volumetric architecture projects, as well as a renewed interest in the building type during a surge of unfettered development in the city. The following points show a continued interest in volumetric architecture and some of the impacts it has already had.

02.01. Toronto already has an abundance of volumetric architecture

02.02. The Eaton Centre is a commercial space rendered as a multi-level street that replaced diverse fabric urban fabric with a homogeneous commercial zone

02.03. Toronto's PATH network is an underground building network that removes the Financial District from participation in the public realm

02.04. The PATH demonstrates how large-scale building networks can begin from a single connection with a commercial motivation

02.05. "Double-ground" amenity levels are a common strategy to introduce variation into otherwise simple podium-tower buildings in Toronto

02.06. Toronto architects anticipate the construction of more sky-bridges in a competitive condominium market

02.07. A closer look at a proposal for a volumetric building in Toronto illustrates the discrepancy between the social goals and the real impact of the project

02.01 *Toronto already has an abundance of volumetric architecture*

There is already a substantial amount of significant projects of the volumetric architecture type constructed in Toronto, including: Nathan Phillips Square, the Eaton Centre, and the PATH network; and the contemporary resurgence of volumetric architecture in condominium design such as City Place Parade I and II, and Pier 21. Sky-bridges have already begun networking the city including the Toronto Skywalk and the Metro Convention Centre. Other less conspicuous examples throughout the city include the stacked interior mall of 10 Dundas East, and sky-bridges on the Ryerson and University of Toronto campuses, at 80 Gould, and at the Elizabeth McMaster Building (Figures 02.01.a-r). These subversions of the ground plane show a subtle, but increasing independence of large companies and institutions from grade.

02.02 *The Eaton Centre is a commercial space rendered as a multi-level street that replaced diverse fabric urban fabric with a homogeneous commercial zone*

The Eaton Centre serves as a suitable precedent for the three-dimensional city as an active machine, evocative of Antonio Sant'Elia's Città Nuova, which moves people up and down a multi-layered internal street connecting shops, restaurants, offices, and infrastructure; using stairs, elevators, and escalators expressed architecturally on the facade of the building's interior pathways. The building is indicative of common difficulties facing volumetric architecture, including: the private control of the interior street, favour towards corporate retail entities, and the replacement of diverse urban fabric with short blocks with long continuous street frontages.

02.03 *Toronto's PATH network is an underground building network that removes the Financial District from participation in the public realm*

The PATH, an underground network of inter-building connections between 50 Financial District office towers, redirects 200,000 commuters a day away from the street[1] into, "the largest mall in North America;"[2] where, "each segment of the walkway system is owned and controlled by the owner of the property through which it runs," which includes 35

1 Toronto Financial District Business Improvement Area, "PATH Map," *Toronto Path,* accessed October 15, 2017, http://torontopath.com/path-map/.

2 Toronto Financial District Business Improvement Area, "7 Little Known Facts about the Toronto PATH Underground Walkway," *Toronto Financial District,* accessed October 15, 2017, http://torontofinancialdistrict.com/7-little-known-facts-about-the-toronto-path-underground-walkway/.

Figure 02.01.a: The Eaton Centre

Figure 02.01.b: Metro Toronto Convention Centre

Figure 02.01.c: Grand Harbour

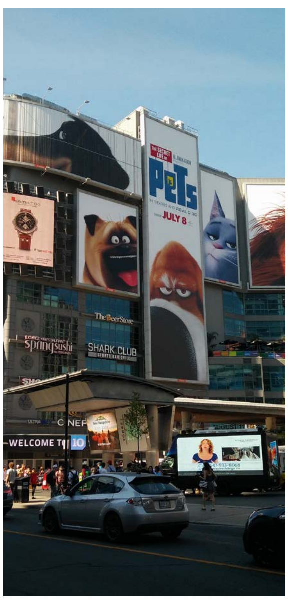


Figure 02.01.d: 10 Dundas East

Figure 02.01.e: OCAD

Figure 02.01.f: The Bay to Eaton Centre connection

Figure 02.01.g:Ontario Place

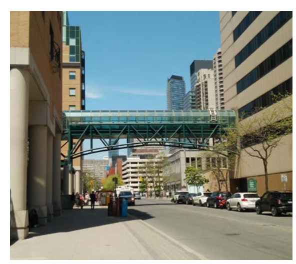


Figure 02.01.h: Elizabeth McMaster Building

Figure 02.01.a-r: Samples of constructed volumetric architecture throughout Toronto. The examples vary from sky-bridges, to underground tunnels, extensively vertical malls, and entire buildings placed on top of other buildings, each establishing their own significant datums that contribute to an increasingly volumetric public realm in the city.

Figure 02.01.i: 60 Richmond

Figure 02.01.j: The PATH

Figure 02.01.k: City Place

Figure 02.01.l: 1 Mount Pleasant Rd

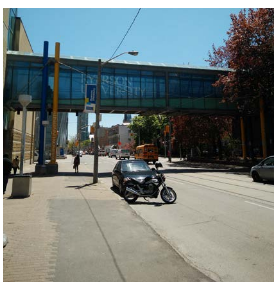


Figure 02.01.m: Ryerson University

Figure 02.01.n: Nathan Phillips Square

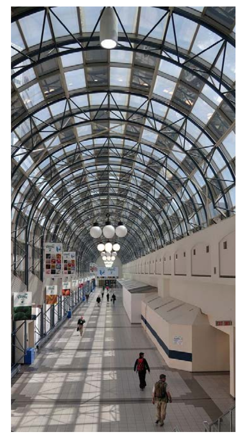


Figure 02.01.o: Toronto Skywalk

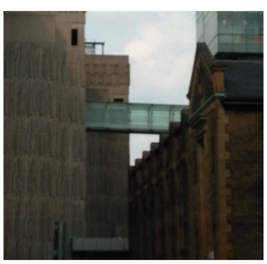


Figure 02.01.p: U of T Faculty of Medicine

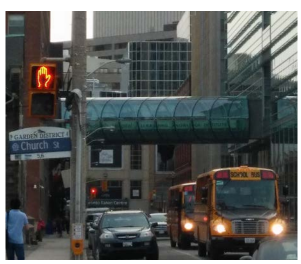
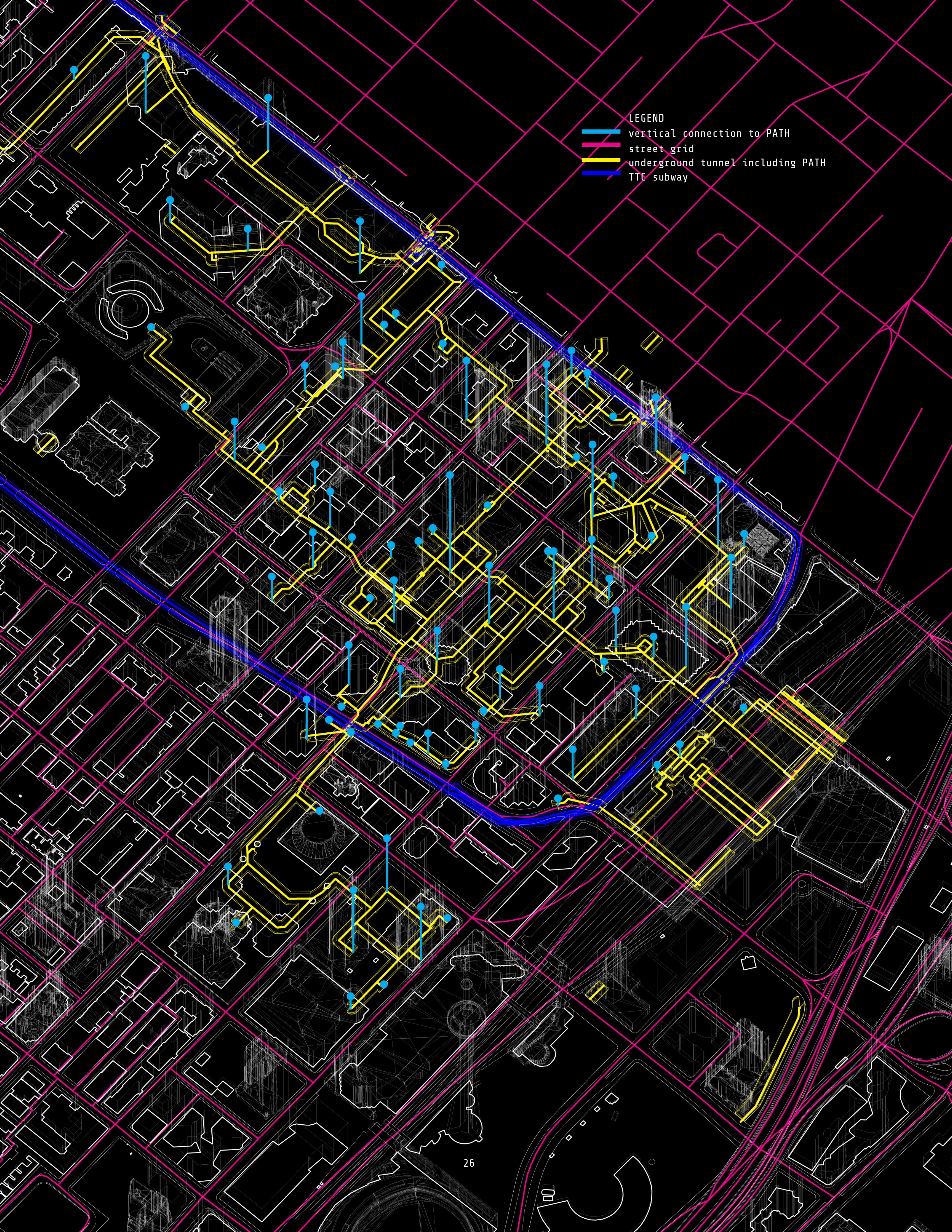


Figure 02.01.q: St. Michael's Hospital

Figure 02.01.r: Pier 27


LEGEND
vertical connection to PATH
street grid
underground tunnel including PATH
TTC subway

different corporations.[3] This means that a substantial amount of a specific demographic, including the city's wealthiest residents, is relocated from the public streets to a corporately controlled pedestrian walkway.

02.04 *The PATH demonstrates how large-scale building networks can begin from a single connection with a commercial motivation*

The PATH network is commonly attributed as the successor of Toronto's first pedestrian tunnel, created in 1900 by the Eaton company to join its locations at 178 Yonge Street and Eaton's Annex behind the old City Hall.[4] Seventeen years later, a total of five pedestrian tunnels were constructed in the downtown core, with another added in 1927 between Union Station and the Royal York Hotel.[5] The PATH network as it is known today took off in the 1970s with the connection between the Sheraton and Richmond-Adelaide Centres.[6] What began over a century ago as a single tunnel, has now evolved into a large-scale sub-grade network that alters the character of the downtown centre dramatically, connecting shopping centres and buildings in the Financial District directly with each other and transit, rather than the public realm.

02.05 *"Double-ground" amenity levels are a common strategy to introduce variation into otherwise simple podium-tower buildings in Toronto*

Double grounds are a common architectural device used to break up the mass of a high-rise building by visually indicating amenity levels, such as in Arquitectonica's proposal for 245 Queen Street East (Figure 02.05.b), and 8 Eglinton Avenue East by Varacalli Architects (Figure 02.05.a). Although not all new towers indicate amenity levels as clearly, as the private space of units continues to shrink, it has become a standard feature to integrate as many amenities as possible into new developments in order to provide residents with supplementary living space that can be used to increase unit value and marketability. In Toronto, most new residential towers have substantial amenity space in order to compete with other buildings on the market, and the double-ground is an effective means of indicating these common spaces without altering the floor plate substantially, keeping costs of this expression minimal.

Figure 02.03 (opposite): Toronto's existing three-dimensional network. The diagram shows how the integration of the PATH tunnel system and its connected building cores in relation to the underground subway can subvert the public street network at grade.

3 City of Toronto, "PATH – Toronto's Downtown Pedestrian Walkway," *City of Toronto*, accessed October 15, 2017, https://web.toronto.ca/explore-enjoy/visitor-services/path-torontos-downtown-pedestrian-walkway/.
4 Ibid.
5 Ibid.
6 Ibid.

Figure 02.05.a: E Condos at 8 Eglinton Avenue East by Varacalli Architects

Figure 02.05.b: 245 Queen Street East by Arquitectonica

Figure 02.06.a: The King Towers proposal at 254 King St East

Figure 02.06.b: 141 Bay Street by Wilkinson Eyre Architects and Adamson Associates

Figure 02.06.c: Patrick and Dundas by Hariri Pontarini

Figure 02.06.d: Qudarangle's proposal at Yonge and Gerrard

Figures 02.05.a-b: Current proposals for condominium amenity spaces formalized as double grounds
Figures 02.06.a-d: Sample of four proposals for new condominium sky-bridges in Toronto

02.06 *Toronto architects anticipate the construction of more sky-bridges in a competitive condominium market*

Sky-bridges are a costlier expression of extra-grade public space as they require additional structure and engineering, but their implementation allows for greater floor areas, and enhanced marketing potential. Peter Clewes of architectsAlliance believes sky-bridges will become more common in Toronto in spite of the additional costs, as developers try to stand out in a competitive condominium market. Clewes says, "they've become synonymous with trying to do something different."[7] Parade I & II and Pier 21 are a couple of recently constructed condominium sky-bridges that have already paved the way for numerous new proposals including 385 Yonge, 141 Bay Street, 254 King Street East, and Patrick and Dundas. (Figures 8.2.2a-d)

02.07 *A closer look at a proposal for a volumetric building in Toronto illustrates the discrepancy between the social goals and the real impact of the project*

Sited on the main stretch of Yonge Street, KingSett Capital's proposal for 385 Yonge is a podium tower development in Toronto, with the added flourish of a sky-bridge. The shared podium of the two towers actually forms a second inter-building connection, allowing residents to traverse between towers at shared amenity floors. The surrounding building fabric currently blends major tourist attractions closely with small businesses, retail chains, low-density, and high-density residences, making it a central area with an intensely active street, and one of the most enticing to build on.

While the architect's statement claims, "an activated streetscape incorporates existing heritage buildings and revitalizes a neglected stretch of Toronto's Yonge Street," the proposal supplants numerous small businesses including restaurants, a nightclub, retail stores and a mission, that all contribute to the street diversity that has already been dramatically altered by the adjacent Aura tower. Small businesses such as these need the reduced rent of older buildings in order to survive, and therefore, the existing businesses won't be incorporated into the new construction. Secondarily, the building specifically caters towards, "the working

7 Simcoe, "Metro Explains," *Metro News*.

professional,"[8] shifting the area closer towards a monoculture composed of a similar group that has, in part, already been established by the adjacent condominium developments. Although the historic frontage is preserved, the building operates differently from the historic buildings it replaces and reduces the fragile diversity offered by small businesses along an already heavily commercialized stretch. While the development may argue that the nightclubs on the street make it "neglected," night venues are also integral to creating safety by ensuring there are enough eyes on the street after dark. The development fails to conform to existing urban guidelines, with its full height still awaiting approval,[9] and the minimum requirement for outdoor amenity space (0.82m2/unit) unmet.[10] The building proposes sculptures and a terrace lounge[11] in order to supplement these shortcomings. However, the provision of public art to gain higher densities is a strategy heavily criticized in Rise and Sprawl[12] for its emphasis on aesthetics and lack of functionality, while the terrace lounge is an example of a proposal for quasi-public space being used to increase density and salable floor area, while potentially removing activity from the street.

8 Edvard Bruun, "Quadrangle Unveils New Renderings for Yonge and Gerrard Project," *Urban Toronto* (Toronto, ON), last modified July 3, 2015, http://urbantoronto.ca/news/2015/07/quadrangle-unveils-new-renderings-yonge-and-gerrard-project.
9 Derek Flack, "Yonge & Gerrard to get stunning bridge towers," *blogTO* (Toronto, ON), last modified July 6, 2015, http://www.blogto.com/city/2015/07/yonge_gerrard_to_get_stunning_bridged_towers/.
10 Bruun, "Quadrangle Unveils New Renderings," *Urban Toronto*.
11 Ibid.
12 Hans Ibelings and Partisans, *Rise and Sprawl*, (Montreal/Amsterdam: The Architecture Observer, 2016), 117.

CHAPTER 03

THE ENHANCED ABILITY FOR VOLUMETRIC ARCHITECTURE TO PROPAGATE AND THE STRENGTH OF ITS INFLUENCE NECESSITATES REGULATORY AND DESIGN INTERVENTIONS

Now that a trend of experimentation with the volumetric architecture type has been observed in Toronto, the following points highlight how building networks can easily propagate, and become highly influential in the development of the city, because they superimpose a private circulation network on top of the existing public street infrastructure. The result is a need to consider the planning of cities in three-dimensions as a volumetric urban realm.

03.01. The public realms of densifying cities are already becoming increasingly volumetric, shifting planar cities closer towards volumetric cities

03.02. City-wide building networks can begin as only a few, privately initiated connections

03.03. Market pressures make it difficult to opt out of the network once it is established

03.04. The most vibrant volumetric cities are initiated by the municipality and incorporated into their master plan

03.05. Cities that don't establish control over their building networks early lose their ability to plan the public realm that has been incorporated into private developments

03.06. The volumetric city, if privately developed, would significantly impact the city by creating a new disposition in the urban fabric

03.07. Volumetric cities require planning in three-dimensions to respond to their unique qualities and disposition

03.01 *The public realms of densifying cities are already becoming increasingly volumetric, shifting planar cities closer towards volumetric cities*

The scale and frequency of large-scale developments have increased in densifying cities, with large building complexes of three or more towers connected via podiums that function as sky-bridges by connecting building cores.[1] This building scale is sufficiently large enough that a single development can privatize portions of the urban realm by selecting a substantial portion of the residents and businesses within an area. As more extra-grade amenities and inter-building connections are constructed, cities become increasingly more volumetric in nature with uncoordinated disparate moments of three-dimensionality in the public realm. This means that even though many cities don't have extensive skyway networks yet, the urban fabric is transitioning from a distinctly planar city type to a more volumetric urban realm.

03.02 *City-wide building networks can begin as only a few, privately initiated connections*

Many existing volumetric cities have grown from a couple of small connections, initiated by a single developer, up to the scale of the downtown core, through the economic perpetuation of the network. Toronto's PATH network, now over thirty kilometres long,[2] began as only a single tunnel between Eaton's department store's two locations in 1900,[3] and the City of Toronto's Official Plan now encourages new development to connect to the system.[4] Cincinnati's initial plan for fifteen open-air sky-bridges was later amended by sixty-four additional bridges by private industry,[5] Hong Kong's small 1963 network grew to the most extensive building network to date, expedited by the Connaught Place development in 1970;[6] the Minneapolis Skyway System, begun in 1962 as a few sky-bridges, has since grown to eight miles under the direction of developers;[7] and Calgary's +15 network, so called because it establishes a new datum at fifteen feet above grade level, now has plans to expand to new strata at the +30 and +45 levels.[8]

1 Ibelings and Partisans, *Rise and Sprawl*, 70-71.
2 Toronto Financial District BIA, "7 Little Known Facts," *Toronto Financial District.*
3 Ibid.
4 City of Toronto, "Toronto Official Plan," (Toronto City Planning, Toronto, 2015) https://www1.toronto.ca/planning/chapters1-5.pdf, 17.
5 James and Yoos, *Parallel Cities,* 200.
6 Ibid., 212.
7 Ibid., 216.
8 Ibid., 198.

03.03 *Market pressures make it difficult to opt out of the network once it is established*

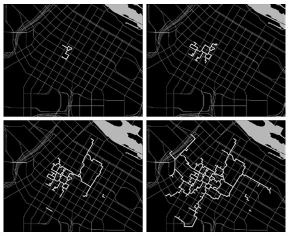


Figure 03.03: Phased growth of the Minneapolis Skyway. The evolution of the system over time demonstrates the viral nature of building networks and how only a few connections can spread to a city-wide network.

Once a building network has been established, the flow of traffic along the system attracts businesses to the skywalk level, developers pursue the opportunity to market its connection into the system, and businesses move to the skywalk in order to maintain a viable market.[9] The City of Toronto PATH master plan also states that the ability to connect to the network creates greater real estate value at network levels and "critical leasing advantage over those office buildings that are not PATH connected."[10] BIG's proposal for the Spiral Tower in New York City, which would directly integrate a vertically spiraling amenity path with the High Line sky-way is indicative of the viral nature of volumetric network growth. The economic power of the High Line, has already generated $900 million in tax revenue for the city, and $2 billion in economic activity.[11] Furthermore, potential density and height bonuses for integrating into the network such as those in place in Calgary, in addition to extra floor area available over city streets, allow buildings to increase their salable floor area.[12] This means that, once the precedent has been set to connect with a volumetric network, the economic incentive becomes incredibly high to continue to do so. Simultaneously, the increasing real-estate value of adjacent parcels establishes a new paradigm of higher lot values that can signal the beginning stages of gentrification. This means that even a few sky-bridges, or a single development, could initiate a city-wide building network that alters the circulation and socio-economic processes of the city.

> *What I hear from developers in the core of downtown is that if you have an opportunity to connect to the skyways, you do . . . It's hardly even a question anymore.*
>
> *—Minneapolis Downtown Council President Steve Cramer*[a]

03.04 *The most vibrant volumetric cities are initiated by the municipality and incorporated into their master plan*

Numerous building networks were also initiated by master planners that established municipal control over the design, regulation, and path of the building networks—creating the most responsive, and appropriate examples of building networks. Although Des Moines' skyway was

9 Ode, "Minneapolis skyway system" *Star Tribune*.
10 City of Toronto, "PATH Pedestrian Network Master Plan," (City of Toronto, City Planning Division, Toronto, 2012), 11.
11 John Rainey, "New York's High Line Park: An Example of Successful Economic Development," *The Leading Edge Newsletter,* Fall/Winter (2014): 3, accessed October 15, 2017, http://greenplayllc.com/wp-content/uploads/2014/11/Highline.pdf.
12 Vincent James and Jennifer Yoos, "The Multilevel Metropolis: On the radical origins — and mundane deployment — of the urban skyway," *Places Journal,* (2016), accessed October 15, 2017, https://doi.org/10.22269/160518.

[a] Ode, "Minneapolis skyway system," Star Tribune.

driven largely by development interests, the city planned and financed the network as a part of their master plan, and established clear rules at its inception—responding to the desolation of the ground plane with vertical connections to sidewalks and paths parallel to streets rather than perpendicular.[13] In Calgary, Harold Hanen developed the master plan for the +15—inspired by Team 10, Antonio Sant'Elia, and the social condenser—and as a result, the system is under public ownership and maintenance, with integration into public transit, and a 2.5-acre interior city park. One of the most recent examples of a volumetric city master plan, Riyadh, was designed by Henning Larsen, and uses the sky-bridges as an opportunity to generate solar power, create a unified design scheme, and include a mix of retail, residential, commercial, cultural, and recreational program.[14]

03.05 *Cities that don't establish control over their building networks early lose their ability to plan the public realm that has been incorporated into private developments*

In Minneapolis, the building network is overseen by the network's own occupants and building owners. This committee has been criticized for its lack of ability to, "ensure system continuity, uniform bridge design, consistent and convenient hours of operation, or a comprehensive, understandable way-finding system."[15] In Dallas, although the building network was a part of an integrated master plan, the private ownership and fragmented control of the network has created inconsistent access to the network, corporate plazas instead of public space, a lack of coherence, and the control over pedestrian flow by "task-oriented circulation" between work and retail.[16] In many cities, skywalks, "were built with a mix of public and private money and are now owned, maintained and guarded by the office towers through which they run."[17] Therefore, once skyways have been established by private industry without regulations, the municipality loses a substantial amount of its ability to influence or plan them.

13 James and Yoos, *Parallel Cities,* 220.
14 Ibid., 206.
15 Ibid., 216.
16 Ibid., 202.
17 Patrick O'Gilfoil Healy, "Rethinking Skyways and Tunnels," *The New York Times* (New York, NY), August 3 2005, http://www.nytimes.com/2005/08/03/realestate/rethinking-skyways-and-tunnels.html.

03.06 *The volumetric city, if privately developed, would significantly impact the city by creating a new disposition in the urban fabric*

In *Extrastatecraft*, Keller Easterling argues that the repetition of infrastructures, such as elevators, cell phones, malls, suburbs, and free trade zones, create a disposition with powerful economic and social conditions that affect citizens globally and create new forms of power beyond the government.[18] For instance, the introduction of elevators as infrastructure provided a new agency and disposition to the city, enabling the construction of high-rises,[19] and changing the investment potential of lots drastically by allowing greater densities. Volumetric architecture similarly provides a new agency due to the provision of increased density and value by floor area, as well as greater corporate control of downtown businesses and public circulation infrastructure. This new agency to influence the urban fabric raises the question of what disposition would be created by this dramatic shift in control, and how this would affect the city's inhabitants.

03.07 *Volumetric cities require planning in three-dimensions to respond to their unique qualities and disposition*

Considering the scale of contemporary building development creates a substantial amount of private city space and building networks function as public infrastructure but can exist under private control, unregulated building networks remove the city from its role of urban planning. Since *Parallel Cities* claims to be the first work to recognize and address volumetric cities as a distinct urban type, there are few established volumetric urban theories that extend beyond design concepts to discuss how these spaces work. As a result, volumetric cities that have already been built have little external guidance on the planning process, and the strategies and opinions about how to plan, regulate, or manage them vary drastically from city to city with little research to substantiate them. Despite the fact that volumetric cities function very differently from planar ones, the practice of planning is largely limited to two-dimensions, including its tools, such as GIS and zoning maps. If urban planning is to succeed in three-dimensions, it will ultimately need to establish new theories of volumetric urbanism, new tools capable of articulating the volumetric city, and new design and regulation strategies that support the interests of the public. Otherwise, what will eventually emerge is a volumetric city that redefines the city's public realm—designed not for living, but for profit.

18 Keller Easterling, *Extrastatecraft: The Power of Infrastructure Space,* (London/New York: Verso, 2014), 74.
19 Ibid., 74.

Like earlier examples of the multilevel city and its historical antecedents, the implicit utopianisms of many contemporary proposals may seem to offer panaceas for the myriad of problems facing the city in the twenty-first century. But is this optimism justified, or is it simply the seduction of the illusory urban spectacle of neoliberal economic development pursued obsessively without consideration for its societal impact?

—Vincent James and Jennifer Yoos, Parallel Cities[b]

[b] James and Yoos, Parallel Cities, 192.

CHAPTER 04

VOLUMETRIC ARCHITECTURE IS PROBLEMATIZED BY A HISTORY OF ENABLING SEGREGATION, INEQUITY, AND COMMERCIALISM

With the powerful influence of volumetric architecture on the commons established, and the potential for a wide-spread adoption of volumetric architecture in Toronto investigated, it is necessary to consider the effect an increase in volumetric architecture will have on the city. Querying past attempts at the building type reveal a surprisingly negative history of enabling segregation, inequity, and commercialism—due largely to the greater agency an unregulated building network provides to private industry to influence the city's commons.

04.01. The earliest examples of volumetric cities used stratification to intentionally segregate the city

04.02. In communist contexts, urbanists designed volumetric cities as a method of creating social equity

04.03. Capitalist cities first adopted the volumetric city for its functionality

04.04. Modernists such as the CIAM and the reactionary Team 10 groups proposed volumetric cities as socialist utopias

04.05. Diminishing commitment to the social principles of volumetric cities led to their failure

04.06. The private sector adopted the volumetric city to strengthen the commercial potential and corporate control of downtown cores

04.07. Private building networks were criticized for their support of commercialism by privatizing the commons and engendering inequality

04.08. The segregation of the population by volumetric architecture is problematic because spatial segregations have been exploited to increase the investment potential of land

04.09. In order to achieve the architectural vision of an extended public realm, the volumetric city must overcome its history of segregation, inequality, and commercialism as result of under-regulation and private ownership

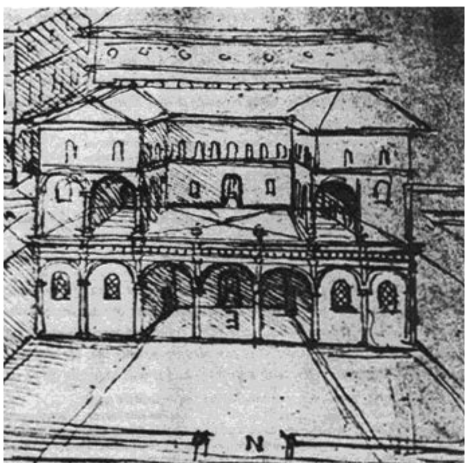
04.01 *The earliest examples of volumetric cities used stratification to intentionally segregate the city*

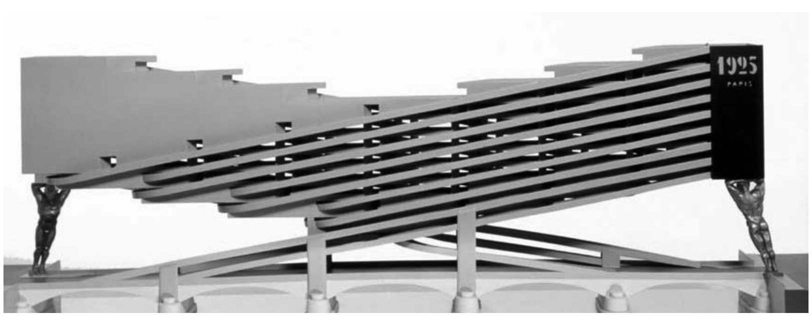
The earliest volumetric cities demonstrate that stratified circulation can be an effective tool of segregation by controlling access to the building network. In eighth-century Ghadames, Libya, a continuous two-level network segregated the city by gender.[1] In the fifteenth century, Da Vinci proposed stratified circulation of the city to separate nobility and commoners in his work *Paris Manuscript B, Folio 16*.[2] The Vasari Corridor, Florence, 1565, was constructed such that Duke Cosimo I de'Medici could move between his residence and the government palace without entering the public realm. Finally, the Adams brothers stratified circulation to separate social classes and commercial traffic in London at the Adelphi Terrace.[3]

04.02 *In communist contexts, urbanists designed volumetric cities as a method of creating social equity*

In the early twentieth century Soviet Union, the goals of the commune became adopted into the goals of its architecture and included: community interaction, social cohesion, Marxism, and redefining private as public.[4] This took the form of the *social condenser* which was designed as a way to radically restructure the productive, social, and personal aspects of human life[5] by encouraging collective living and social interaction,[6] and frequently emerged as concepts for a volumetric city. This ultimately took the form of projects such as El Lissitzky's Wolkenbügel, Konstantin Melnikov's Paris parking garage, and the Gosprum Building in Kharkov[7]—the connections between buildings seemingly making more equitable space by integrating building fabric further into one unified field.

1 Vincent James and Jennifer Yoos, "The 3-D City," *Architecture Magazine 93*, no. 5 (2004): 35.
2 Ibid.
3 Ibid.
4 James and Yoos, *Parallel Cities,* 30.
5 Richard Stites, *Revolutionary Dreams,* (New York: Oxford, 1989), 198.
6 James and Yoos, *Parallel Cities,* 38.
7 Ibid., 35-36.





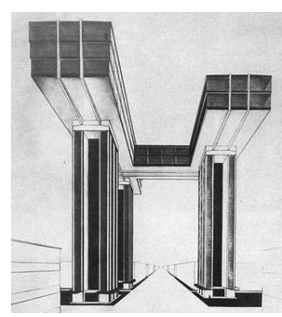


Figure 04.01.a: Aerial view of Ghadames, Libya. Vertically separated circulation pathways separated men from women.

Figure 04.01.b: The Florence Vasari Corridor. The raised path was constructed to allow the duke to move between his residence and the government building without entering the city commons.

Figure 04.01.c: Sketch from Da Vinci's Paris Manuscript B Folio 16. The drawing depicts an extra-grade network exclusively for nobility.

Figure 04.01.d: The Adams Brothers Adelphi Terrace. The second ground separated social classes from 1768-1774.

Figure 04.02.a: Konstantin Melnikov's Paris parking garage. The structure took inspiration from ideas such as Krutikov's Flying City and Khidekel's Aerial Cities.

Figure 04.02.b: El Lissitzky's Wolkenbügel. The design of the connected building towers were one of several manifestations of the social condensor concept.

04.03 *Capitalist countries first adopted the volumetric city for its functionality*

In capitalist contexts, the multi-level city first emerged with the functional and economic goals of relieving over-crowding and housing demands and separating the city by function to improve quality of life.[8] In 1910, Eugene Henard proposed separating vehicular traffic and pedestrian traffic. Antonio Sant'Elia's 1914, La Città Nuova, would later inspire a wave of investigations into multilevel cities, notably Harvey Wiley Corbett who proposed more radically stratified organizational systems in New York,[9] Hugh Ferriss' *Overhead Traffic Ways* and Raymond Hood's scheme for *skyscraper bridges* over the East River and Hudson River.[10] Corbusier's 1931 *Plan Obus* for Algiers adapted Henard's ideas into a traffic megastructure but has since been criticized for, "creating a sort of urban apartheid"[11] due to its pedestrian viaduct connection between Corbusier's new European suburbs and the business center, passing directly over the Muslim quarters of the city.[12]

04.04 *Modernists such as the CIAM and the reactionary Team 10 groups proposed volumetric cities as socialist utopias*

During the modern era, architects inspired by the social goals of Soviet volumetric cities began incorporating social utopias within a capitalist context, proposing increasing social contact and the mixing of social groups.[13] The multi-level deck system proposed by William Tatton-Brown and the MARS group, the UK representative of CIAM, became a recurring theme, adopted by a group of avant-gardists in the London County Council that standardized and realized the plans in a number of new towns.[14] Team 10 (later joined by Archigram and Archizoom), disenfranchised by the authoritarian control of the CIAM volumetric city, were inspired by historic and informal settlements to propose ideas for extra-grade streets with more reactive and organic forms.[15]

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8 Ibid., 23.
9 Ibid., 26.
10 Ibid., 29.
11 Hugh Pouliot, "'Machines for living': Reflections on Le Corbusier's Plan Obus (Algiers) & Unité d'Habitation (Marseilles)," *Shift Graduate Journal of Visual and Material Culture,* no. 4 (2011): 7.
12 Ibid., 7.
13 James and Yoos, *Parallel Cities,* 52.
14 Ibid., 75.
15 Nicolai Ouroussoff, "New Ideals for Building in the Face of Modernism," *The New York Times* (New York, NY), September 27, 2006, http://www.nytimes.com/2006/09/27/arts/design/27ten.html.

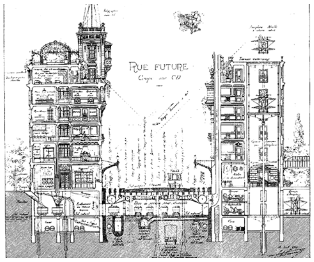


Figure 04.03.a: Henard's stratification of streets by traffic type

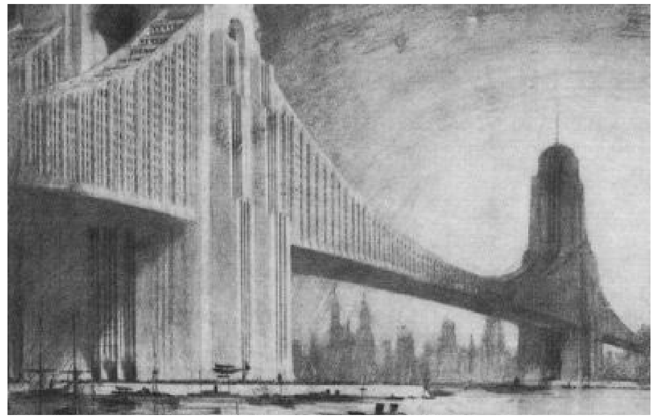


Figure 04.03.b: Raymond Hood's skyscraper bridges scheme illustrated by Hugh Ferriss

Figure 04.03.c: The New Tower of Babel in Fritz Lang's Metropolis

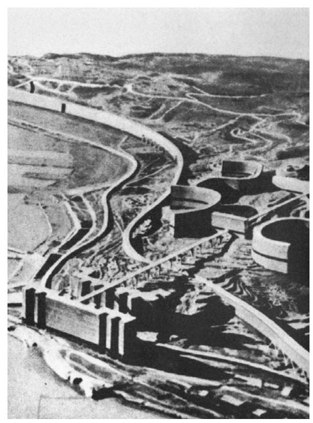


Figure 04.03.d: Le Corbusier's Plan Obus

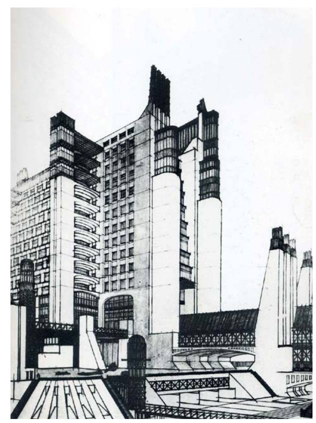


Figure 04.03.e: La Città Nuova by Antonio Sant'Elia

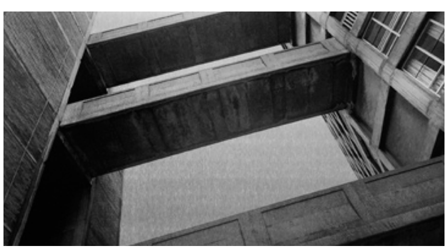
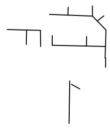


Figure 04.05.a: Park Hill, Sheffield by Jack Lynn and Ivor Smith

Figure 04.05.b: Balfron Tower, London, by Ernö Goldfinger

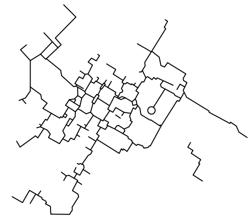
Figure 04.03.a-e: Early concepts of stratified cities in capitalist contexts ranged from practical isolations of street traffic, maximizations of floor area, and optimism in technology, to fears of the stratification of classes.
Figure 04.05.a-b: Projects built by governments in capitalist countries were often disappointing, attributed to poor construction quality, beauracratization, a lack of commitment to the projects social goals, and its authoritarian decisiveness of large building areas and circulation paths.

Figure 04.06: Scale comparison of various constructed volumetric building networks throughout North America

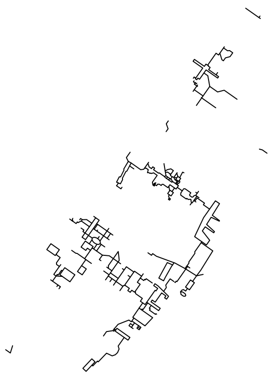


Indianapolis, Indiana

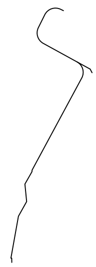
Louisville, Kentucky



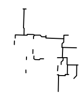
Minneapolis, Minnesota



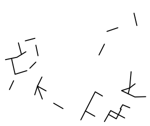
Montreal, Quebec



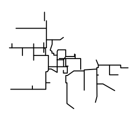
New York, New York



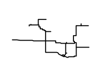
Oklahoma City, Oklahoma



Pittsburgh, Pennsylvania



Rochester, Minnesota



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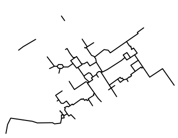

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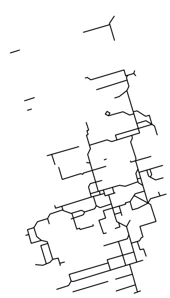
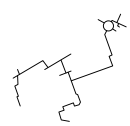
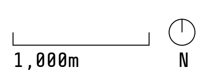


Toronto, Ontario



Winnipeg, Manitoba



04.05 *Diminishing commitment to the social principles of volumetric cities led to their failure*

Most of the concepts by the Soviet avant-gardists remained unbuilt,[16] and the Soviet experiment with the volumetric city largely ended with Stalin's withdrawal of support for constructivism and the modernists.[17] In capitalist cities, CIAM and their derivatives' projects failed due to the rationalist formalism of the designs, poor construction quality, and "bureaucratic interpretations"[18] of elevated walkways. Their work was criticized by their successors as a social instrument serving political authorities.[19] Despite the formal differences of Team 10's reactionary proposals, the rigid circulation systems of their designs were ultimately similarly denounced for inhibiting social and urban processes—demonstrating that changing the form of volumetric architecture to reflect social processes alone was not sufficient to create urban life in extra-grade walkways.[20] These factors, combined with the abandonment of government-led projects by the 1980s, would ultimately end the experiment with the volumetric city as a socialist utopia. The authors of *Parallel Cities* argue that, "the social idealism underlying so many proposals for elevated and interconnected urban space can be contrasted with the compartmentalized and segregated spaces that are more often created."[21]

04.06 *The private sector adopted the volumetric city to strengthen the commercial potential and corporate control of downtown cores*

After government-led megastructure plans fell out of favour, many path networks and inter-connected building developments emerged from the private sector in the 1960s and 1970s with the support of municipal authorities and pragmatically inclined planners.[22] Without the social agendas of previous volumetric cities, these volumetric cities emerged with the goals of reinforcing commercial urban centres with convenience, comfort, climate mitigation, and safety for urban shoppers and office workers,[23] as well as enhancing real estate prices by concentrating pedestrian traffic and commercial activity.[24]

16 Ibid., 33.
17 Ibid., 44.
18 Ibid., 75.
19 Ibid., 76.
20 Ibid., 79.
21 Ibid., 193.
22 Ibid., 94.
23 Ibid., 94.
24 Ibid., 95.

04.07 *Private building networks were criticized for their support of commercialism by privatizing the commons and engendering inequality*

Figure 04.07: The dismantling of the Baltimore skyway system. The skyway was torn down as a result of its commercialization of the downtown and desolation of the street.

The skyways constructed private development have been heavily criticized for their ability to remove people from the public street and introduce them into a privately controlled environment. The most immediate effects of this phenomenon include a reduction in street activity, reduction of property value at ground level, and the promotion of consumerism.[25] In regards to Cincinnati's walkways, *The New York Times* published that, "critics say the walkways are too antiseptic and too controlled and have transformed cities into places to pass through, not live in."[26] Building networks have also impacted cities socially because their domination of space and the ownership of publicly used circulation infrastructure creates a spatial oligopoly. For example, the Dallas skyway has been described as, "a segregated system divided by race and income with largely white, middle-class office workers above and lower-wage service and retail workers of color below."[27] The authors of *Parallel Cities* refer to this common condition of volumetric cities as *sectional demographics*, or the physical separation of social groups by architectural form into horizontal layers as a result of a building network. Outside of North America, sky-walks have also been criticized in Mumbai for not following the natural path of a commuter, increasing traffic jams at grade due to the interference of columns, and becoming unsafe, especially for women.[28] In spite of the added presence of security guards, this lack of safety can be explained as the result of two factors: an insufficient population within the sky-walks causing too few eyes on the street, and exits too far apart.[29] Both are related to Jacobs' passages on sidewalk safety—one demonstration that the concepts developed by Jacobs' sociological study of streets translates from traditional grade-based streets to elevated sky-walks. As a result of these problems, sky-ways in cities such as Baltimore and Cincinnati have already been largely dismantled.[30]

25 K.A. Robertson, "Pedestrian Skywalk Systems: Downtown's Great Hope Or Pathways To Ruin?," *Transportation Quarterly* 42 (1988): 457-484, 465.
26 Healy, "Rethinking Skyways and Tunnels," *The New York Times*.
27 James and Yoos, *Parallel Cities,* 202.
28 Menaka Rao, "Mumbai skywalks: are these elevated paths 'ugly caterpillars' or precious public space?," *The Guardian* (London, UK), last modified November 27, 2014, https://www.theguardian.com/cities/2014/nov/27/mumbai-skywalks-are-these-elevated-paths-ugly-caterpillars-or-precious-public-space.
29 Ibid.
30 Ode, "Minneapolis Skyway System," *Star Tribune*.

04.08 *The segregation of the population by volumetric architecture is problematic because spatial segregations have been exploited to increase the investment potential of land*

The history of segregation in volumetric architecture is problematic since it can be used to increase the value of real estate. *Privatopia* argues that the proliferation of suburban development in the mid-twentieth century was the result of the successful marketing campaign of a capital absorption plan to convince middle-class city dwellers to invest in land ownership. The work argues that this was done by implementing strict private local governments and racist land covenants that banned minorities to maintain an image of safety that would attract middle-class white Americans, while simultaneously intentionally inciting race tensions within inner-cities.[31] The capital absorption strategy was as influential in Canada, assisted by the 1944 National Housing Act, making Toronto the fastest growing city in North America by 1954.[32] The development of the suburbs, therefore, sets a precedent for capital absorption schemes to utilize tactics such as strategic spatial segregation in order to influence the real estate market in favour of corporate investors.

04.09 *In order to achieve the architectural vision of an extended public realm, the volumetric city must overcome its history of segregation, inequality, and commercialism as result of under-regulation and private ownership*

Although the rhetoric of contemporary volumetric architecture projects support the ambitions of the social condenser, community, and the freedom to use and adapt the building network as public space; the history of volumetric architecture has shown deep roots in segregation and inequality caused by: large areas of land developed and controlled by only a few groups of investors, and commercialism due to the transition of power from the city's inhabitants to private industry. Although the added cost of volumetric architecture requires extra incentive for development, so far, past precedents have demonstrated that the conditions necessary to create the volumetric city—either authoritarian implementation by a government body or the agency of ambitious private capital—are also the reason the projects cannot succeed in their social goals. Despite this overt history of social and economic problems, little attempt is made by contemporary volumetric architecture to rectify them. If future volumetric architecture is to succeed in creating a three-dimensional public realm against this history, it must find a way to overcome this obstacle.

31 McKenzie, *Privatopia,* 58.

32 CBC, "Birth of the Suburbs," *CBC,* accessed October 15, 2017, http://www.cbc.ca/history/EPISCONTENTSE1EP15CH3PA3LE.html.

CHAPTER 05 TORONTO'S UNDER-REGULATED BUILDING INDUSTRY MAKES THE CITY SUSCEPTIBLE TO THE EFFECTS OF PROFIT-DRIVEN VOLUMETRIC ARCHITECTURE

The failure of precedents of volumetric architecture to achieve their social goals presents a significant reason to question the validity of contemporary volumetric architecture's optimism in achieving vitality, communities, and equity. The following points demonstrate how Toronto is heavily influenced by the private sector, leading to large areas of the city being rapidly reshaped without proper oversight, regulation, or urban planning. This means that if volumetric architecture is developed in Toronto, it will be heavily influenced by the private sector and largely unregulated. This could lead to the same problems of inequality, segregation, and commercialism in Toronto as previous volumetric architecture projects have exhibited.

05.01. The Greater Toronto Area has a limited amount of space, bound on either side by the Greenbelt and Lake Ontario

05.02. Toronto's population growth allows for market pressures to support large scale development

05.03. Toronto is adding more skyscrapers than any other North American city

05.04. The densification of downtown Toronto has strong benefits for the city, but this density needs to be planned effectively

05.05. High-density housing in Toronto tends to form small clusters, centred around the downtown core

05.06. Housing in the downtown core is more accessible for high-income families

05.07. Foreign investment contributes to affordability problems in Toronto and feeds the luxury condominium development market

05.08. Condominium prices have doubled since 2008 and almost half of Torontonians have significant housing affordability problems

05.09. Development complexes rapidly reshape the local urban fabric

05.10. An urban planning power vacuum in the city means that planning control has shifted to an appeals board, the Ontario Municipal Board

05.11. The OMB compromises the public interest by overruling legislated zoning plans and yielding to developer interests

05.12. Allowed substitutions to guidelines and zoning don't respond to the city's needs

05.13. Stakeholders have been polarized to pro-condominium versus anti-condominium, while the appropriateness of specific developments is more significant

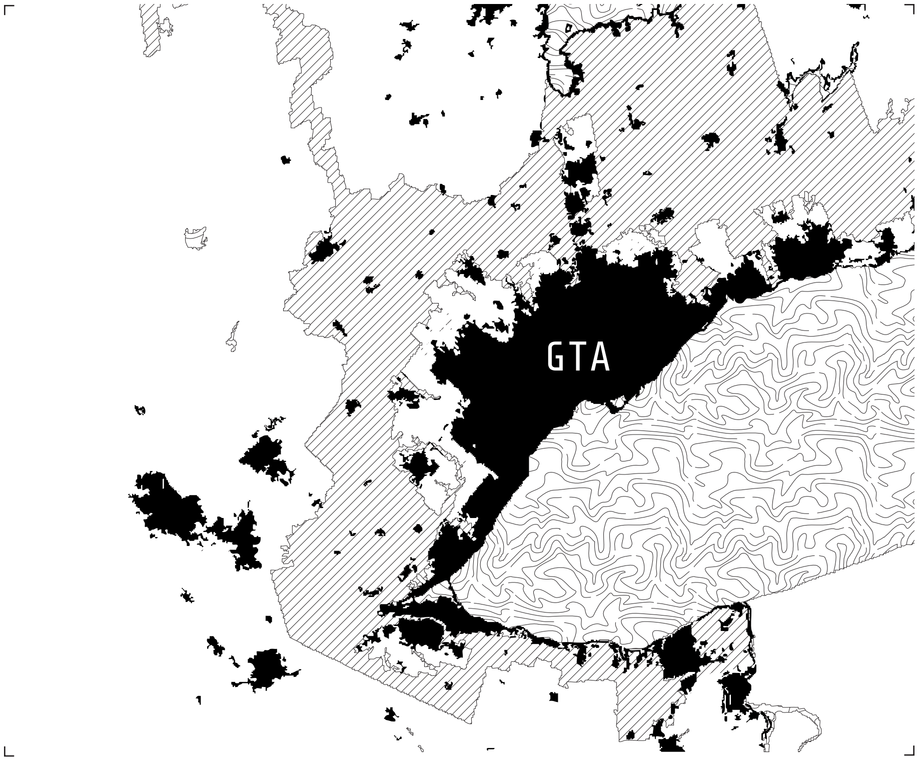
05.14. The OMB operates as an unelected body without oversight

05.15. Significant funding from the building industry has gone towards the political parties appointing OMB members

05.16. Reforms to the OMB have so far been unsuccessful, but a new reform is currently underway

05.17. The role of regulating development has been taken from the municipality and is not upheld by the OMB, creating a power vacuum that could be exploited further by the development of profit-driven volumetric architecture

Figure 05.01.a: Diagram of the Greater Toronto Area and its position between Lake Ontario and the protected Greenbelt lands. The boundaries on either side provide pressure on the GTA to intensify, rather than sprawl outwards.



LEGEND

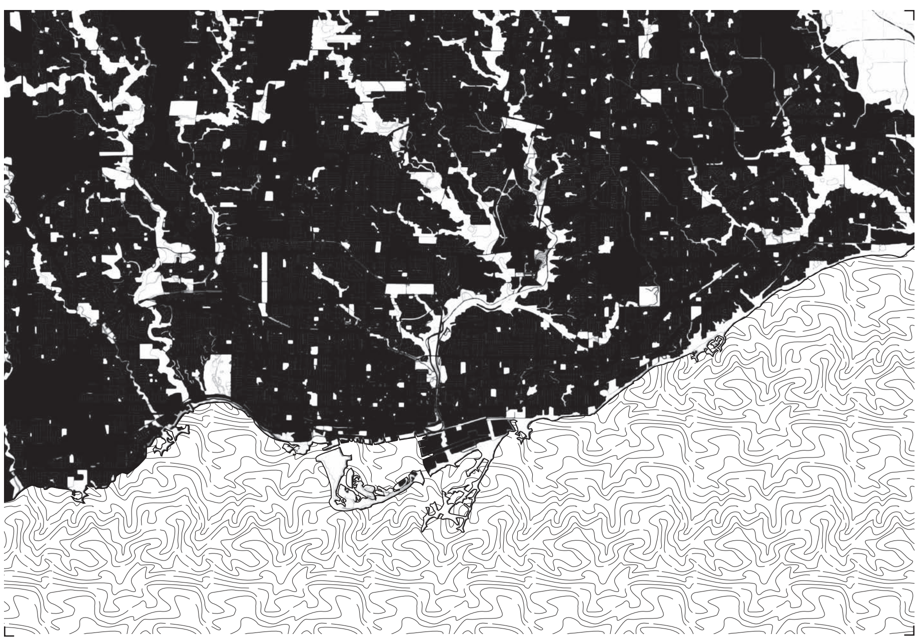
WATER

PROTECTED GREEN BELT

BUILT AREA

AVAILABLE AREA

Figure 05.01.b: Diagram of City of Toronto land uses reduced to a comparison of built fabric and unbuilt area. Most of the area that remains unbuilt is parks and valuable natural areas around waterways. As a result, Toronto must build up.



LEGEND

WATER

BUILT AREA

OPEN AREAS, PARKS, NATURAL AREAS

05.01 *The Greater Toronto Area has a limited amount of space, bound on either side by the Greenbelt and Lake Ontario*

The Greater Toronto Area's growth is constrained by Lake Ontario and the protected Greenbelt. The result is that any further expansion of Toronto must be densification rather than sprawl—Toronto must build up.[1] This is reflected in Ontario's Provincial Policy implemented 2005 which promotes intensification plans in the province and protects the Greenbelt as an important piece of environmental infrastructure. Most of the land within the boundaries of Toronto has already largely been constructed on, with much of the easily developed parking lots built up,[2] what remains is a small amount of unbuilt space largely around waterways, and public parks in the city that are important natural resources and amenities for the city.

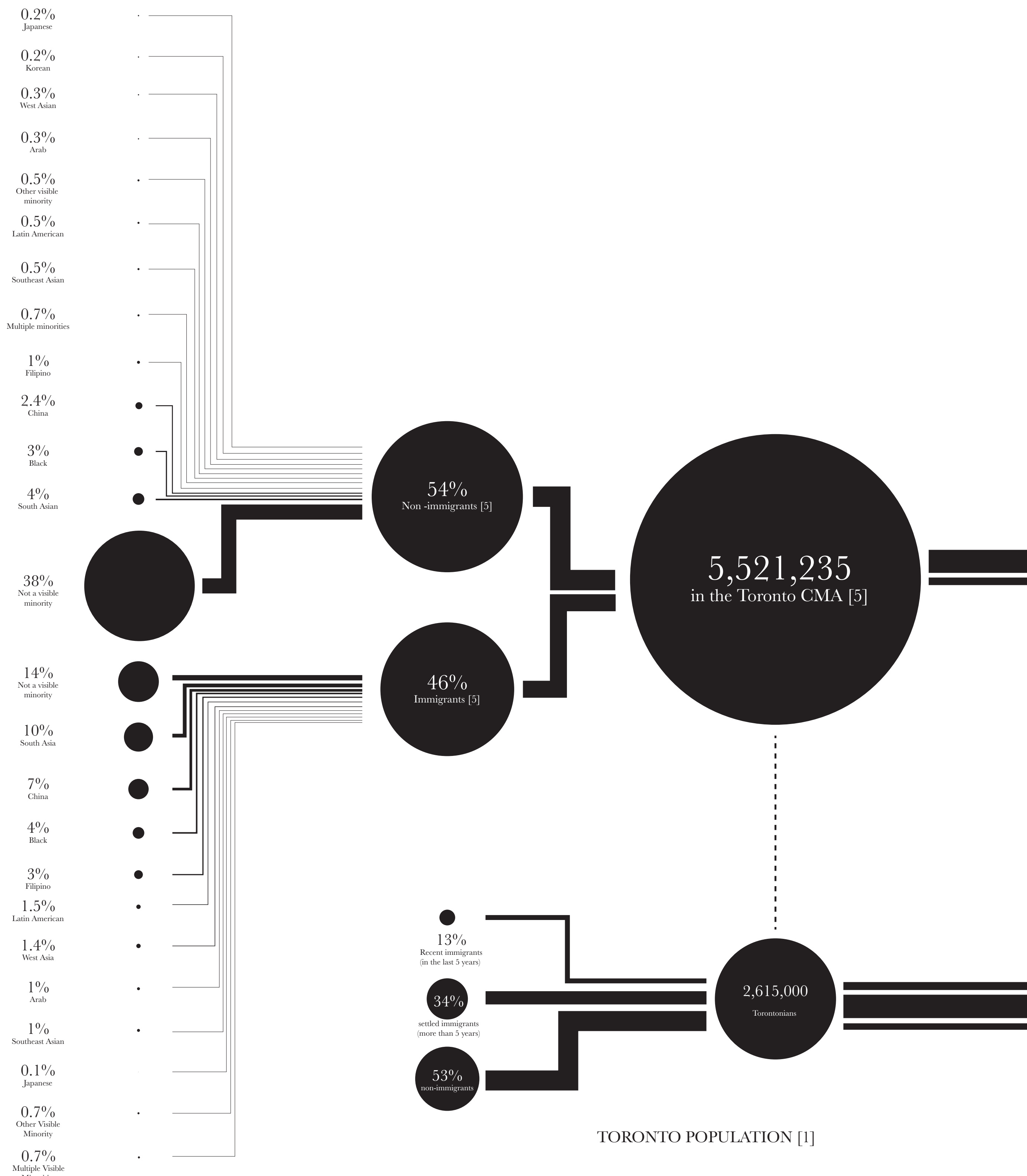
05.02 *Toronto's population growth allows for market pressures to support large-scale development*

By 2036, the Ministry of Finance projects the population of the GTA to grow by 49.5% to 9 million people.[3] This continual growth creates a large demand for housing. With the high market rate of housing in Toronto currently, few residents can afford low-density housing or new construction, while the rise of the *creative class* has also created a demand for housing near subway stations and Toronto night-life.[4]

05.03 *Toronto is adding more skyscrapers than any other North American city*

Toronto had 324 high-rises (buildings 12 floors and over) constructed or under construction between 2005 and 2017, and 318 high-rises proposed by 2027,[5] more high-rises than those planned in any other city in North America.[6] This new priority for high-rises makes the present one of the most formative moments in Toronto's urban fabric. The city will drastically change over the course of the next few decades, and the already apparent disconnect between residents and the ground plane, as well as other residents, can intensify. It also means that more daylight will

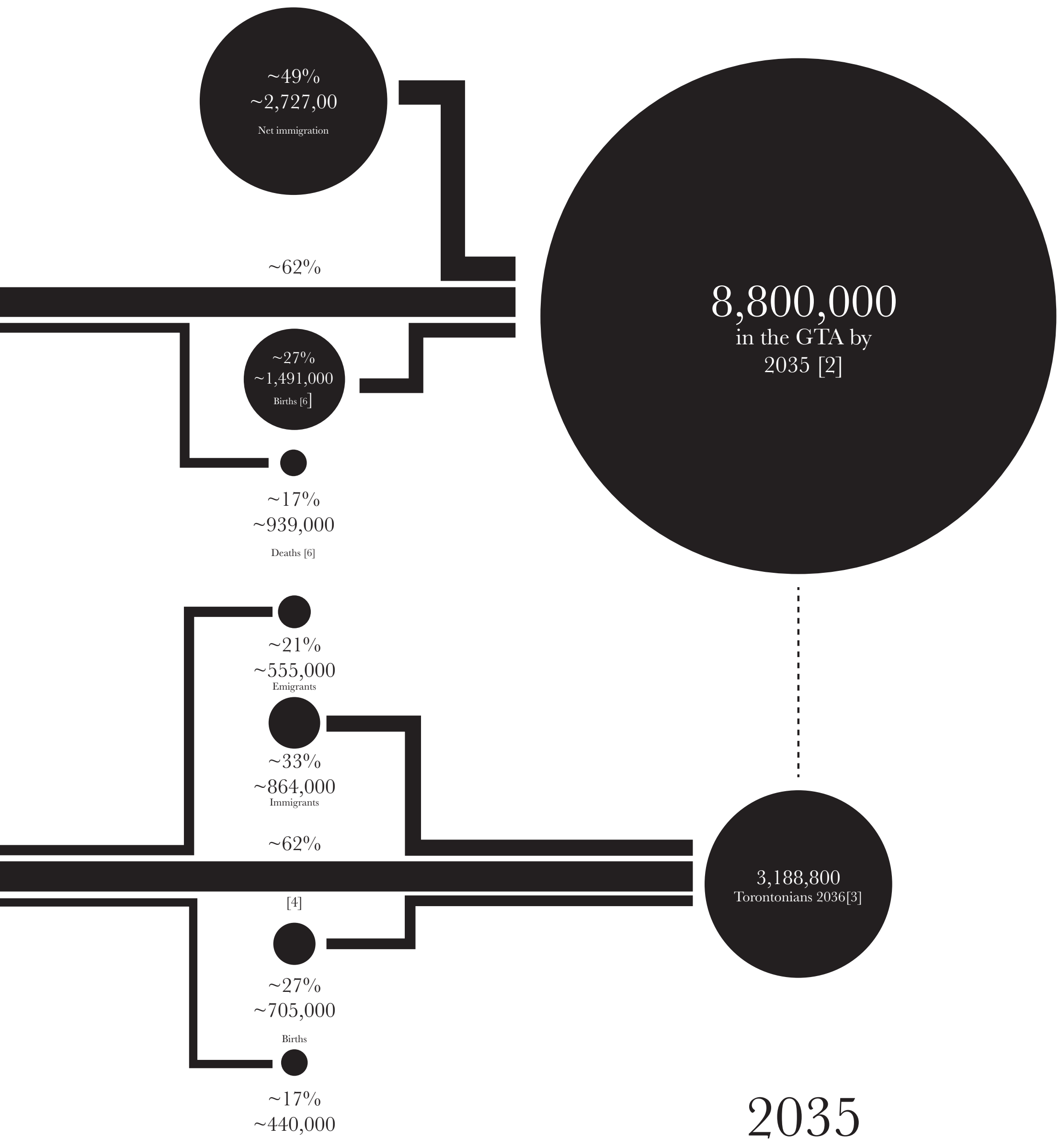
1 Wex, "Condominium Development in Toronto."
2 Ibelings and Partisans, *Rise and Sprawl,* 9.
3 Ontario Ministry of Finance, "Ontario Population Projections Update, 2016–2041," *Ontario Ministry of Finance*, accessed on October 15, 2017, http://www.fin.gov.on.ca/en/economy/demographics/projections/.
4 Maryam Sanati, "Neighbour vs. Neighbour: Cranky Empty Nesters, Party-Loving Hipsters and Screaming Babies are Living Cheek by Jowl in Downtown Condo Towers. How the Vertical City Became a Generational Combat Zone," *Toronto Life* (Toronto, ON), September 22, 2016, http://torontolife.com/real-estate/condos/condowars-neighbour-vs-neighbour/.
5 Urban Toronto, "Project Database," *Urban Toronto,* accessed October 15, 2017, http://urbantoronto.ca/database/.
6 Pete Evans, "130 highrise building projects in Toronto lead North America," *CBC News Business* (Ottawa, ON), last modified January 21, 2017, http://www.cbc.ca/news/business/130-highrise-building-projects-in-toronto-lead-north-america-1.2504776.



TORONTO POPULATION [1]

2011

Figure 05.02: Breakdown of Toronto's projected population growth from 2011 to 2035. The increasing population contributes to the rapid pace of the development industry, as development struggles to keep up with housing demand. The population growth is due, in large part, to immigration rather than the birth rate.



be blocked at grade level, more pedestrian street traffic will be absorbed into high rise amenities than before, and more of the city's urban realm will occur within private space. In their work, *Rise and Sprawl*, Partisans and Hans Ibelings call this form of rapid, financially driven urbanism, "spreadsheets in the sky," explaining, "a hierarchy emerges: first comes the spreadsheet, which subsequently determines the building structure, and then comes the packaging and the advertising. The architectural exercise that happens in between almost becomes irrelevant."[7]

05.04 *The densification of downtown Toronto has strong benefits for the city, but this density needs to be planned effectively*

Density is one of Jacobs' four generators for diversity, and Toronto can—and does—gain a substantial amount of street life from the increased density in the downtown core.[8] Both density and the podium tower type, do have a place in the city, and can provide: added people on the street, ground floor amenities, and aversion to sprawl. But these benefits are limited when treated as mutually exclusive from affordable housing, diversity, small businesses, universal accessibility, and design. Richard Florida provides commentary on this phenomenon in his latest book, *The New Urban Crisis: How Our Cities Are Increasing Inequality, Deepening Segregation, and Failing the Middle Class—and What We Can Do About It,* in which he notes that the optimism of his previous work, *The Rise of the Creative Class,* actually underestimated the drive of development in downtowns. Initially supportive of a wave of development revitalizing cities, Florida observed that the rate of centralized development exceeded his expectations, causing a large influx of people into city centres, while simultaneously driving out the existing population that could no longer afford the cost of living—deepening the social divide of North-American cities.[9]

7 Ibelings and Partisans, *Rise and Sprawl,* 25.
8 Ibid., 10.
9 Richard Florida, interview by Pater Leyden "Urbanism for All—Achieving a More Inclusive Prosperity through Cities," *The Future of Sharing,* podcast video, last modified July 25, 2017, http://reinvent.net/events/event/urbanism-for-all-envisioning-a-more-inclusive-prosperity-through-cities/.

Figure 05.05.a: Map of low-density housing in Toronto. The low-density construction is distributed throughout the city around environmental obstacles and zoning restrictions that have endured due to the political environment in the city.

Figure 05.05.b: Map of high-density housing in Toronto. The high-density construction forms clusters rather than an even dispersion, centred largely around the downtown core, especially subway stations; indicating areas of over-development and under-development.

05.05 *High-density housing in Toronto tends to form small clusters, centred around the downtown core*

A comparison of high-density (Figure 05.05.b) and low-density housing (Figure 05.05.a) shows high-density housing forming clusters of buildings throughout Toronto, focused particularly in the downtown area and subway stations. Clusters of high-density buildings indicate areas of standardized types or over-development during a single period, and centralization at the city's core shows a tendency for developments to be attracted to already vibrant and well-serviced areas, rather than those in need of the added density.

05.06 *Housing in the downtown core is more accessible for high-income families*

As explained by Jon Caulfield in *City Form And Everyday Life: Toronto's Gentrification And Critical Social Practice,* the middle-class resettlement of old downtown neighbourhoods is coupled with the rising incidence of low-income, immigrant, and working class households in high-density or public-housing projects resembling Regent Park or St. James Town. This is due in part to the rising cost of inner-city housing that, although once inhabited by these groups, is now priced beyond their means.[10] As a result, the city centre becomes more accessible by income, with most downtown residences having a household income of over $100,000 (Figure 05.06).

05.07 *Foreign investment contributes to affordability problems in Toronto and feeds the luxury condominium development market*

Critics argue that the numbers provided by the CMHC for the number of foreign investors are far too low, citing that the statistics were collected by only querying whether the owner had any Canadian address listed. Many resident housing investors speculate the amount of foreign investment is in fact higher, putting the market at risk of a panic sale in the future that could drastically depreciate condominium value.[a]

[a] Marr, "Foreign Money is Flowing into Canadian Condominiums," Financial Post.

A part of the economic momentum in Toronto is due to Canada's relative stability after the housing market crash of 2010, which gave it the reputation as a stable place to invest in real estate.[11] This has given skeptics reason to believe that foreign investment is causing an artificially inflated market in Toronto. In 2014, the CMHC published its first numbers on foreign investment in Toronto, at only 2.4% of all condominiums.[12] By 2016, the CMHC would report that the number of foreign investors had jumped to 10.1% of all condominiums, the majority of which were new condominium sales,[13] with some third-party estimates as high as

10 Jon Caulfield, *City form and everyday life: Toronto's gentrification and critical social practice* (Toronto: University of Toronto Press, 1994). 116.
11 Wex, "Condominium Development in Toronto."
12 Susan Pigg, "Percentage of Toronto condos owned by foreign investors is very low, CMHC says," *The Toronto Star* (Toronto, ON), last modified December 16, 2014, https://www.thestar.com/business/2014/12/16/percentage_of_toronto_condos_owned_by_foreign_investors_is_very_low_cmhc_says.html.
13 Garry Marr, "Foreign money is flowing into Canadian condominiums, raising concerns about market vulnerability," *Financial Post* (Toronto, ON), last modified April 7, 2016, http://business.financialpost.com/personal-finance/mortgages-real-estate/foreign-buyers-snapping-up-newer-condos-over-older-ones-in-toronto-vancouver-cmhc.

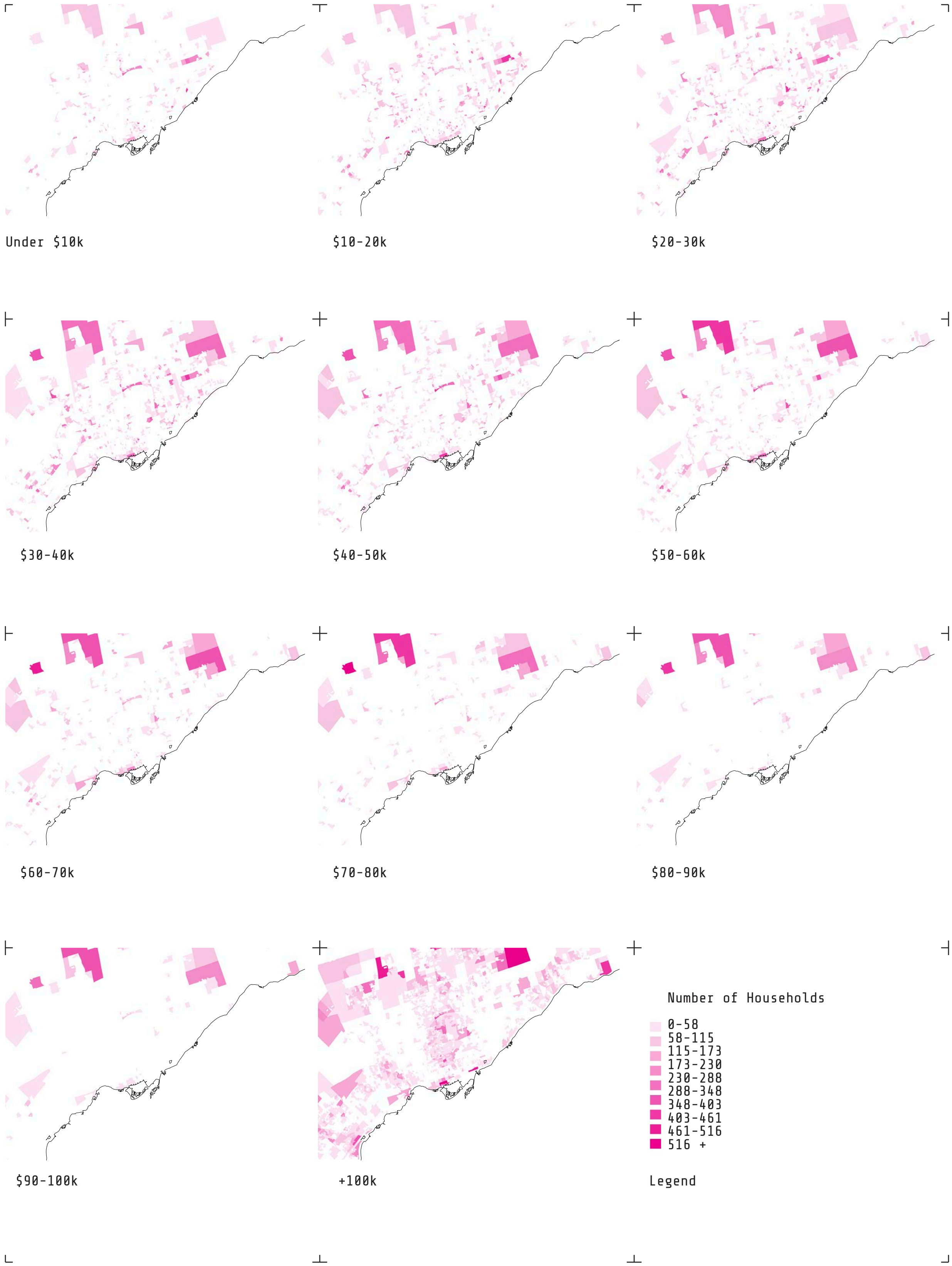


Figure 05.06: Number of households by annual income in the city of Toronto. The maps show the downtown core is largely only accessible with annual incomes above $100,000 in a city in which the median household income is $68,110, thereby excluding well over half of the population from residing in the downtown.

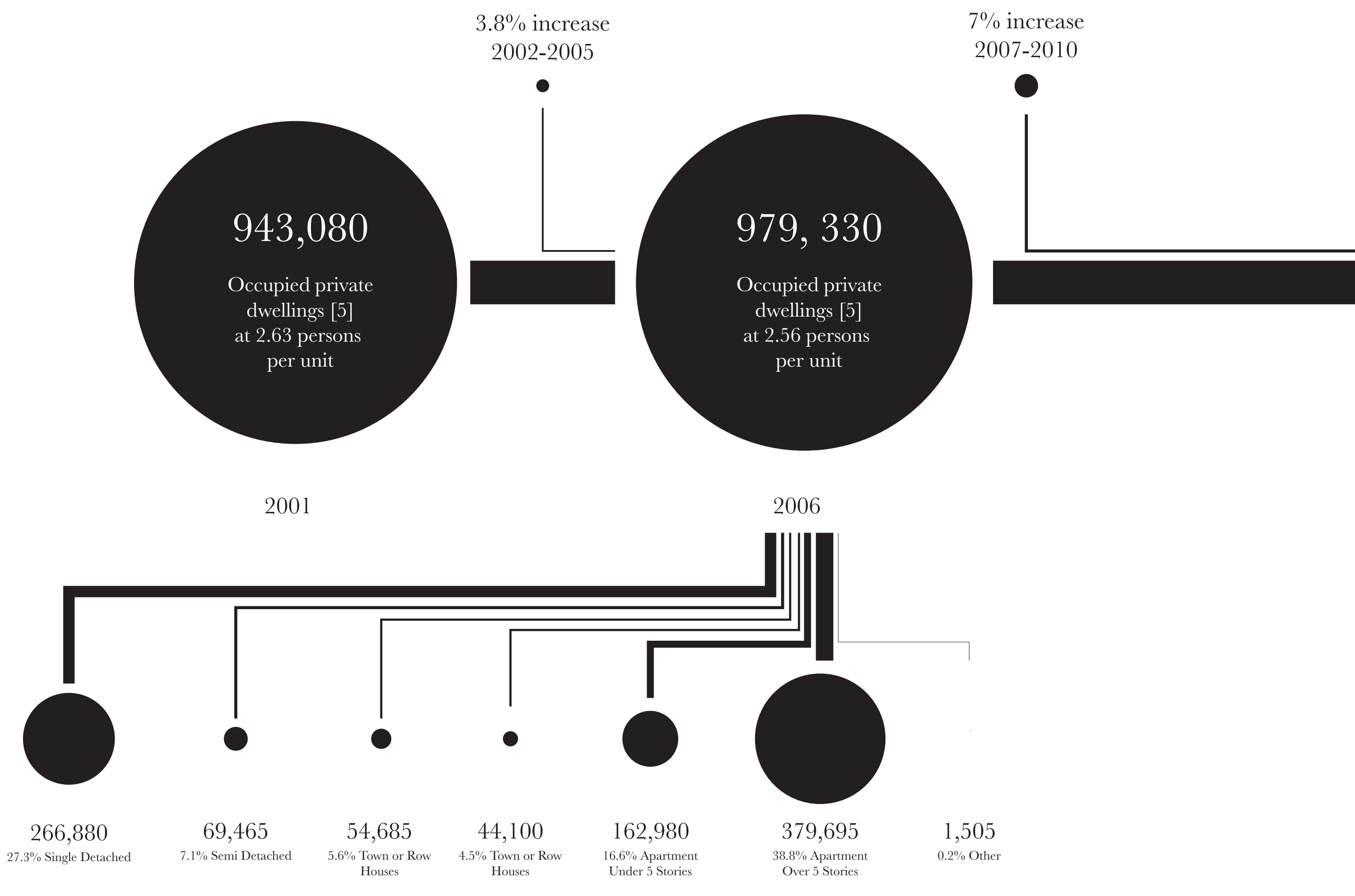
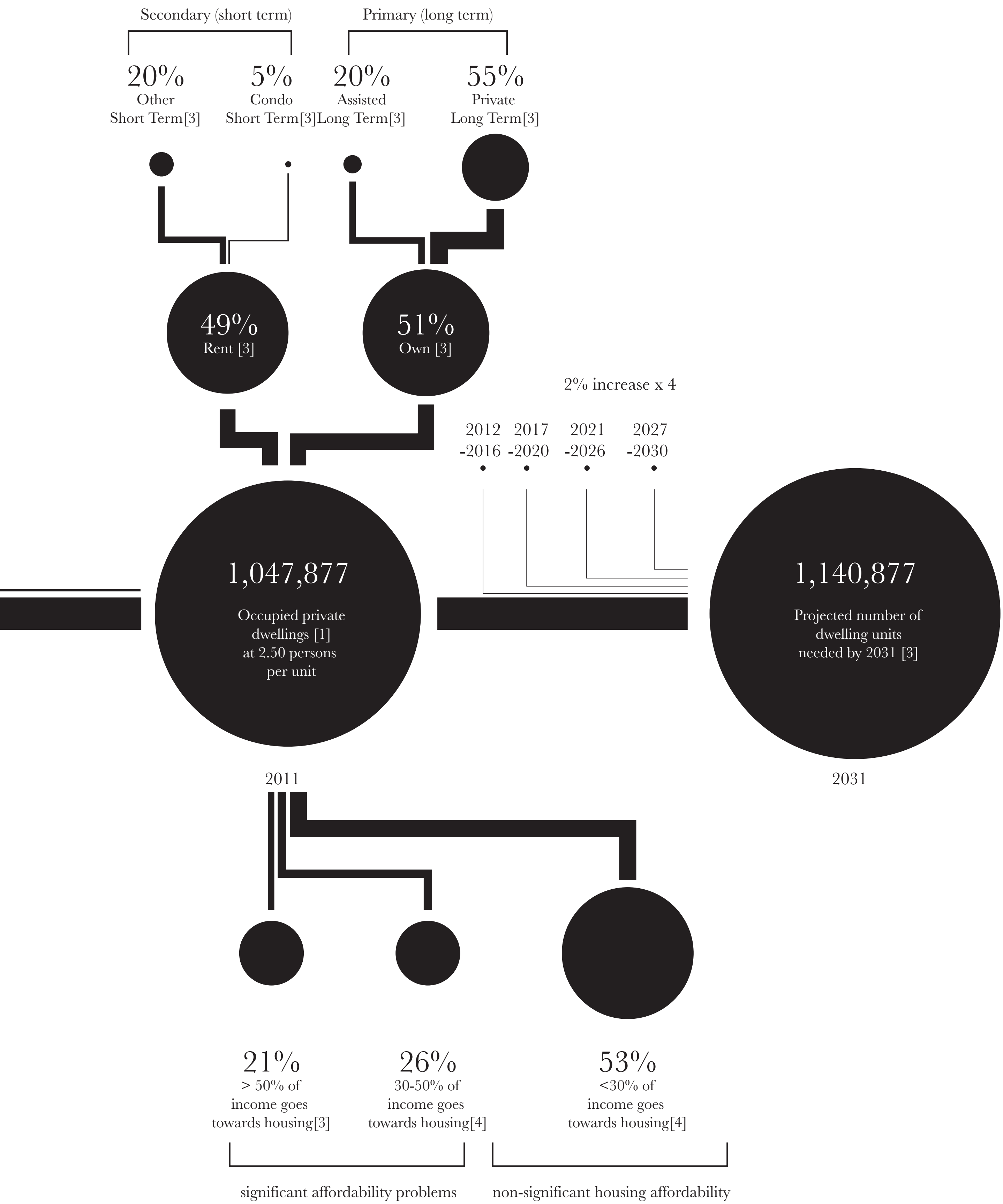


Figure 05.08.a: Diagram illustrating the projected increases in Toronto's housing demands from 2001 to 2031 and breakdowns of housing by type, ownership, and affordability. The diagram shows that 47% of Torontonians have significant housing affordability problems in a city in which condominium prices have doubled since 2008 and housing demand continues to increase.


Secondary (short term)
Primary (long term)
20%
Other
Short Term[3]
5%
Condo
Short Term[3]
20%
Assisted
Long Term[3]
55%
Private
Long Term[3]
49%
Rent [3]
51%
Own [3]
2% increase x 4
2012
-2016
2017
-2020
2021
-2026
2027
-2030
1,047,877
Occupied private
dwellings [1]
at 2.50 persons
per unit
1,140,877
Projected number of
dwelling units
needed by 2031 [3]
2011
2031
21%
> 50% of
income goes
towards housing[3]
26%
30-50% of
income goes
towards housing[4]
53%
<30% of
income goes
towards housing[4]
significant affordability problems
non-significant housing affordability

approximately 50%.[14] Additionally, David Wex of Urban Capital notes that development is also in part fueled by the low-risk created by Ontario's policies—explaining that foreign investors into development are heavily protected by Ontario legislation and banking policy, making investments into the building construction industry a particularly stable enterprise.[15]

05.08 *Condominium prices have doubled since 2008 and almost half of Torontonians have significant housing affordability problems*

In Toronto, 47% of residents have significant housing affordability problems: 26% spending over 30% of their income on housing, and 21% spending over 50% of their income on housing (Figure 05.08.a). While Toronto's downtown core is seeing the largest growth in high-rises, it remains largely inaccessible to household incomes below $100,000 a year, in a city in which the average household income is $98,174,[16] and the median household income is only $68,110.[17] Simultaneously, immigrants are the largest cause of population growth in the city, yet are settling primarily outside of Toronto's downtown core to the fringes of the city. (Figure 05.08.b) The combination of these factors suggests that the addition of high-rise condominiums downtown aren't necessarily meeting the needs of (both new and settled) Torontonians themselves, but are more a result of market forces, creating affordability problems in the downtown core, that are exacerbated by foreign investment, excessively polarizing the city's demographics.

A survey of 534 condominium buildings and 624 units available in downtown Toronto saw an average sale price of $978,438 and an average size of 1,088 square feet; while a survey of 934 rental listings saw an average price of $2,742 per month at an average size of 796 square feet. For unit ownership that rate has almost doubled from $438 per square foot in 2008 to $899 per square foot on April 15, 2017, when the survey was conducted.[18] While supply and demand of the market influence price greatly, this is due in part to the exemption of new construction on or after November 1, 1991, from the

14 Ibelings and Partisons, *Rise and Sprawl*, 15.
15 Wex, "Condominium Development in Toronto."
16 City of Toronto, "Economic Indicators," *City of Toronto*, accessed April 29, 2016, https://www1.toronto.ca/City%20Of%20Toronto/Economic%20Development%20&%20Culture/Business%20Pages/Reports%20&%20Data%20Centre/Economic%20Indicators/2016-march.pdf.
17 Statistics Canada, "Median total income, by family type, by census metropolitan area," *Statistics Canada*, last modified July 12, 2017, http://www.statcan.gc.ca/tables-tableaux/sum-som/l01/cst01/famil107a-eng.htm.
18 Condos.ca, "Condos For Sale in Downtown, Toronto," *Condos.ca*, accessed April 15, 2017, https://condos.ca/search?for=sale&search_by=Neighbourhood&buy_min=0&buy_max=99999999&rent_min=1500&rent_max=2000&unit_area_min=0&unit_area_max=99999999&type=0&beds_min=0&area_ids=1&polygon=&nh_ids%5B%5D=590&is_nearby=&view=0&user_search=1&sort=days_on_market.

Figure 05.08.b: Number of newly settled Canadians by decade and location in Toronto. Despite being one of the city's largest contributors to population growth, immigrants have largely been settling outside the downtown core, outside of new development areas. This is one factor that suggests the housing being constructed is more likely what is most profitable, rather than what provides the best fit, for the needs of Toronto's population.

annual rent increase guideline of The Residential Tenancies Act.[19] It is also worth noting that financial institutions control both the supply and demand of housing stock, providing both the financing for building development, as well as the financing for providing mortgages, as described by David Harvey in *Rebel Cities*.[20] As a result of this lack of affordable housing for half of the city, the province of Ontario passed the Rental Fairness Act of 2017 on May 18, introducing new regulations including rent increase controls and taxes on vacancy and non-resident ownership that would help prevent housing affordability from declining further.[21]

05.09 *Development complexes rapidly reshape the local urban fabric*

As a result of the current regulatory framework, large-scale building developments, especially development complexes, rapidly reshape the urban fabric, as demonstrated by the City Place condominium development (Figure 05.09). What began as industrial Railway Lands began its transformation in 2002 to a development complex that will ultimately contain over 7,500 units.

05.10 *An urban planning power vacuum in the city means that planning control has shifted to an appeals board, the Ontario Municipal Board*

The outdatedness of the zoning plan's height assignments and its broad generalizations has created a scenario in which the legal framework designed to protect the best interests of the public is considered so removed from the realistic demands of the Ontario Growth Plan, that it is recognized by all actors as effectively nullified.[22] Instead of a current zoning plan with a relevant, appropriate, substantiated, and legally enforceable urban strategy, this plan is continually modified for essentially every high-rise development in the city by either the city's own variances or by the Ontario Municipal Board.[23] Furthermore, the Tall Building Guidelines, one of the most crucial documents to high-rise development in the city, are a set of non-legally binding suggestions.[24] This means that neither of the measures designed to represent the best interests of Toronto citizens has any persuasive legal power.

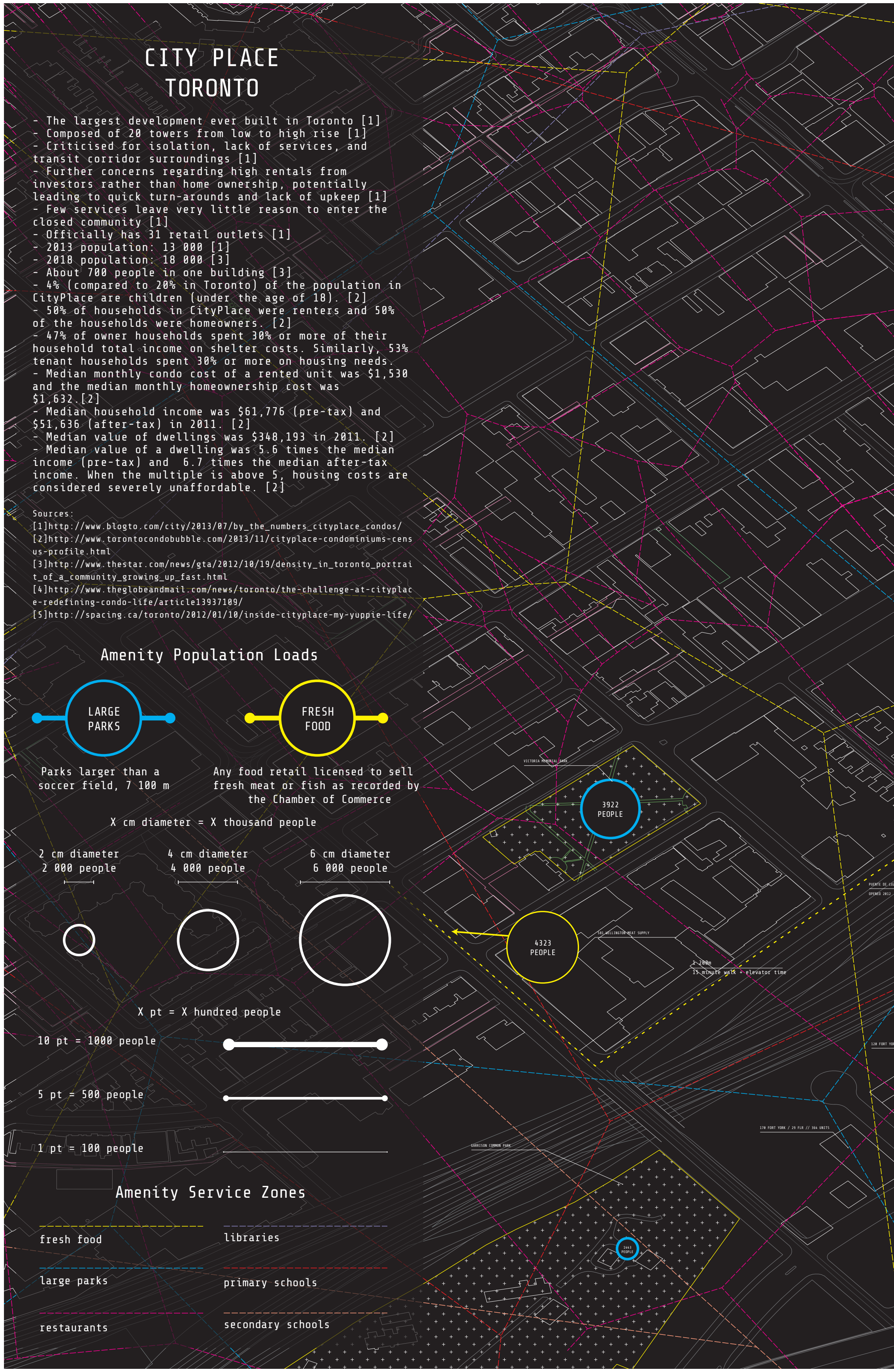
19 Ministry of Housing, "Ontario Introduces Bill to Protect Tenants from Unfair Rent Increases," *Ontario Newsroom,* last modified April 24, 2017, https://news.ontario.ca/mho/en/2017/04/ontario-introduces-bill-to-protect-tenants-from-unfair-rent-increases.html.
20 David Harvey, *Rebel Cities: From the Right to the City to the Urban Revolution,* (New York: Verso Books, 2012), 46.
21 Tom Cardoso and Evan Annett, "Ontario's Rent and Housing Reform: 16 Big Changes, Explained in Charts," *The Globe and Mail* (Toronto, ON), last modified April 20, 2017, https://www.theglobeandmail.com/real-estate/toronto/ontario-housing-16-big-changes-explained-in-charts/article34757648/.
22 Jennifer Pagliaro, "Contested Development," *Toronto Star* (Toronto, ON), last modified February 17, 2017, http://projects.thestar.com/ontario-municipal-board-reform/contested-development/.
23 Ibelings and Partisans, *Rise and Sprawl*, 117.
24 Ibid., 14.

05.11 *The OMB compromises the public interest by overruling legislated zoning plans and yielding to developer interests*

The appointed council of the Ontario Municipal Board grants approvals without a coordinated urban plan or strategy, using instead one-off negotiations, of which 50-75% of high-density dispute decisions are made in favour of the developer.[25] These decisions are, "frequently made against the advice of professional staff and the will of an elected council."[26] This is problematic as the decisions made by the OMB are cumulatively shifting the standards for acceptable density, and clustering of development far outside of the city's plans. Toronto's Director of Community Planning says the appeals create their own context: one proposal is just above the city's allowed height, but after two or three consecutive increases in proposed height, a new precedent is set.[27] The city council has said that the planning professionals who represent the city's residents are overworked and struggling to keep pace with the number of hearings, and therefore, "can't always put their best work forward in protecting the city's interests."[28] When residents wish to defend themselves at OMB hearings, they must fund themselves against large companies with teams of lawyers, which requires fundraising to hire lawyers and planners.[29] Altogether this means that mechanisms have been established which allows development to legally operate outside of the intended legal framework of established laws and regulations, and without any form of an urban plan. This lack of representation for the public can be problematic for the city's residents, as, in Kevin Lynch's words, "when behaviour begins to escape any regulation and control groups lose their confidence," control will sometimes enter a, "self-destructive spiral."[30]

25 Jennifer Pagliaro, "Planning Power and Politics," *The Toronto Star* (Toronto, ON), last modified February 17, 2017, http://projects.thestar.com/ontario-municipal-board-reform/planning-power-politics/.
26 Pagliaro, "Contested Development," *The Toronto Star.*
27 Ibid.,
28 Jennifer Pagliaro, "Province plans to overhaul OMB and give more power to cities and citizens," *The Toronto Star* (Toronto, ON), last modified May 16, 2017, https://www.thestar.com/news/city_hall/2017/05/16/province-plans-to-overhaul-omb-and-give-more-power-to-cities-and-citizens.html.
29 Pagliaro, "Contested Development," *The Toronto Star.*
30 Kevin Lynch, *A Theory of Good City Form* (Cambridge: MIT Press, 1984), 212.

Figure 05.09: Diagram of new population loads on existing amenities caused by the City Place development complex. The diagram illustrates the dramatic and rapid change to a neighbourhood and increase in population load on existing amenities that is caused by the congregation of multiple high-rise buildings.



6 280 of 8 120 UNITS
aprx 10 440 of 13 500 PEOPLE
61 411 people per km²
414m X 414m = 0.17km²
ASSUMING EQUAL OCCUPATION OF UNITS BY 2013 POPULATION
2179 PEOPLE
800m
11 minute walk + elevator time
4545 PEOPLE
5370 PEOPLE
5 minute walk + elevator time
variable
12 249 PEOPLE
414 metres / 5 min walk
414 metres / 5 min walk
3251 PEOPLE

05.12 *Allowed substitutions to guidelines and zoning don't respond to the city's needs*

The substitutions which are approved by the OMB, and at times the city, both diminish the effectiveness of the zoning plan and fail to uphold the theories that produce quality public space according to authors such as Jane Jacobs. For instance, added height and density bonuses with the addition of amenities are intended to provide contributions to the city,[31] but when volumetric architecture is considered, private amenities added to large developments at extra-grade levels can potentially pull valuable street traffic away from grade level. Public art is commonly used in exchange for permission to exceed allowable heights.[32] While public art can at times be a meaningful contribution to the city, it doesn't replace the performance, functions, and value of diverse building fabric, and the aesthetic quality of the street should come primarily from the architecture itself.[33] In cases of over-development, this effectively allows greater densities to be purchased by aesthetic contributions that ultimately cannot make up for a poorly designed building or a lack of diversity. Similarly, preserving historic facades is also not a functional contribution that provides diversity. Although it may help retain some of the character of the original street, the underlying economic composition will have changed drastically with the new construction. As Jacobs explains, "superficial architectural variety may look like diversity, but only a genuine content of economic and social diversity has meaning."[34]

05.13 *Stakeholders have been polarized to pro-condominium versus anti-condominium, while the appropriateness of specific developments is more significant*

The decisions made by the OMB cite the 2006 Ontario Growth Plan which prescribes the intensification of urban centres to prevent urban sprawl into the Greenbelt.[35] Similarly, a 2016 public advertising campaign by the Building Industry and Land Development Association encourages the blanket support for all high-density proposals, citing the Ontario Growth Plan as well.[36] However, areas including Yonge-Eglinton, King-Spadina,[37] and North York Centre[38] have far exceeded their growth targets for 2041

31 Bruun, "Quadrangle Unveils New Renderings," *Urban Toronto.*
32 Ibelings and Partisans, *Rise and Sprawl,* 117.
33 Ibid., 123.
34 Jane Jacobs, *The Death and Life of Great American Cities* (New York: Random House, 1961), 103.
35 Pagliaro, "Contested Development," *The Toronto Star.*
36 Building Industry and Land Development Association, "From NIMBY to YIMBY - Full version," video, 03:26, September 28, 2016, https://www.youtube.com/watch?v=BJdJjHBK_W4.
37 Pagliaro, "Province plans to overhaul OMB," *The Toronto Star.*
38 Pagliaro, "Contested Development," *The Toronto Star.*

as of 2017. As a result, "city staff have raised serious concerns about most of the pending applications—that they represent substantial over-development, are poorly designed and that there is a lack of available community services to support new residents."[39] Josh Matlow, Councilor of Ward 22 identifies that the pro-condo versus anti-condo debate has dominated public discussion, but the real issue is not high-density buildings alone, but rather that their programmatic composition, selected locations, and magnitude of densities proposed don't build communities or quality of life, and the added services and infrastructure aren't enough to support new residents.[40] Ultimately, the decisions of an appointed board that frequently favour private investors cannot be as effective as a proper urban plan or design. As explained by Toronto's director of community planning, Gregg Lintern, "without sticking to a comprehensive plan," the risk is, "you wake up with a much-less livable situation, and that's not good planning."[41]

05.14 *The OMB operates as an unelected body without oversight*

The OMB is the most powerful body of its kind in North America and can overrule the city's decisions on most planning and land use disputes.[42] Ward 23 Councilor John Filion explains to his constituents that the OMB, "have more power than I do . . . they're the ones who make all the final decisions, not me, not the person you elected."[43] Although an oversight committee was installed to verify the legitimacy of the board's members, a regulation loophole prevents this committee from doing so, and twenty-four of the thirty-two members from the OMB—including the new chair—have not yet been reviewed.[44] Despite the, effectively authoritarian, planning powers of the board—of the thirty-two board members, only nine are professional planners, whereas seventeen are lawyers, three are former land economics or related consultants, two are former mayors, and one, spent "'considerable time in Europe' learning about environmental conservation and land use management."[45]

39 Ibid.
40 Ibid.
41 Ibid.
42 Ibid.
43 Ibid.
44 Pagliaro, "Planning Power and Politics," *The Toronto Star.*
45 Ibid.

05.15 *Significant funding from the building industry has gone towards the political parties appointing OMB members*

BILD is a homebuilder's association of 1,450 companies consisting of home builders land developers, renovators, financial and professional service organizations, trade contractors, and manufacturers and suppliers.

The development industry donated $17.5 million between 2004 and 2011 to the Ontario Liberal and Conservative parties, more than any other industry.[46] The GTA development industry alone contributed $1.7 million of that funding, provided directly by the BILD Association and the Ontario Home Builders' Association.[47] Since January 1, corporations and unions can no longer donate to political parties; however, the Toronto Star found over 1,400 individuals tied to the building industry who between 2014 and 2016 donated in their own name or under a numbered company.[48]

05.16 *Reforms to the OMB have so far been unsuccessful, but a new reform is currently underway*

Attempts to restrict the powers of the OMB to its intended role as an appeal board, rather than a planning authority, have so far been unsuccessful. Reforms in 2006 didn't have their intended effect according to Premier Kathleen Wynne.[49] The reforms were criticized by Aaron Moore, an associate professor at the University of Winnipeg who said, "the language that the OMB should 'have regard' to local decision-making was intentionally weak and the province knew it."[50] A new reform is currently underway, with a proposal to enforce the tribunal to only overturn city council decisions in cases where they are inconsistent with provincial policies,[51] as well as putting a two-year minimum on neighbourhood specific policies before appeals would be allowed,[52] thereby returning the dominant planning authority to the city. Whether or not the reforms will be successful is still to be determined.

46 Ibid.
47 Ibid.
48 Ibid.
49 Ibid.
50 Jennifer Pagliaro, "Onward and Upward," *The Toronto Star* (Toronto, ON), last modified February 17, 2017, http://projects.thestar.com/ontario-municipal-board-reform/onward-upward/.
51 Jennifer Pagliaro, "Omb Reform Praised as 'Bold' Boon to Local Democracy," *The Toronto Star* (Toronto, ON), last modified May 16, 2017, https://www.thestar.com/news/city_hall/2017/05/16/omb-reform-praised-as-bold-boon-to-local-democracy.html.
52 Pagliaro, "Province plans to overhaul OMB," *The Toronto Star.*

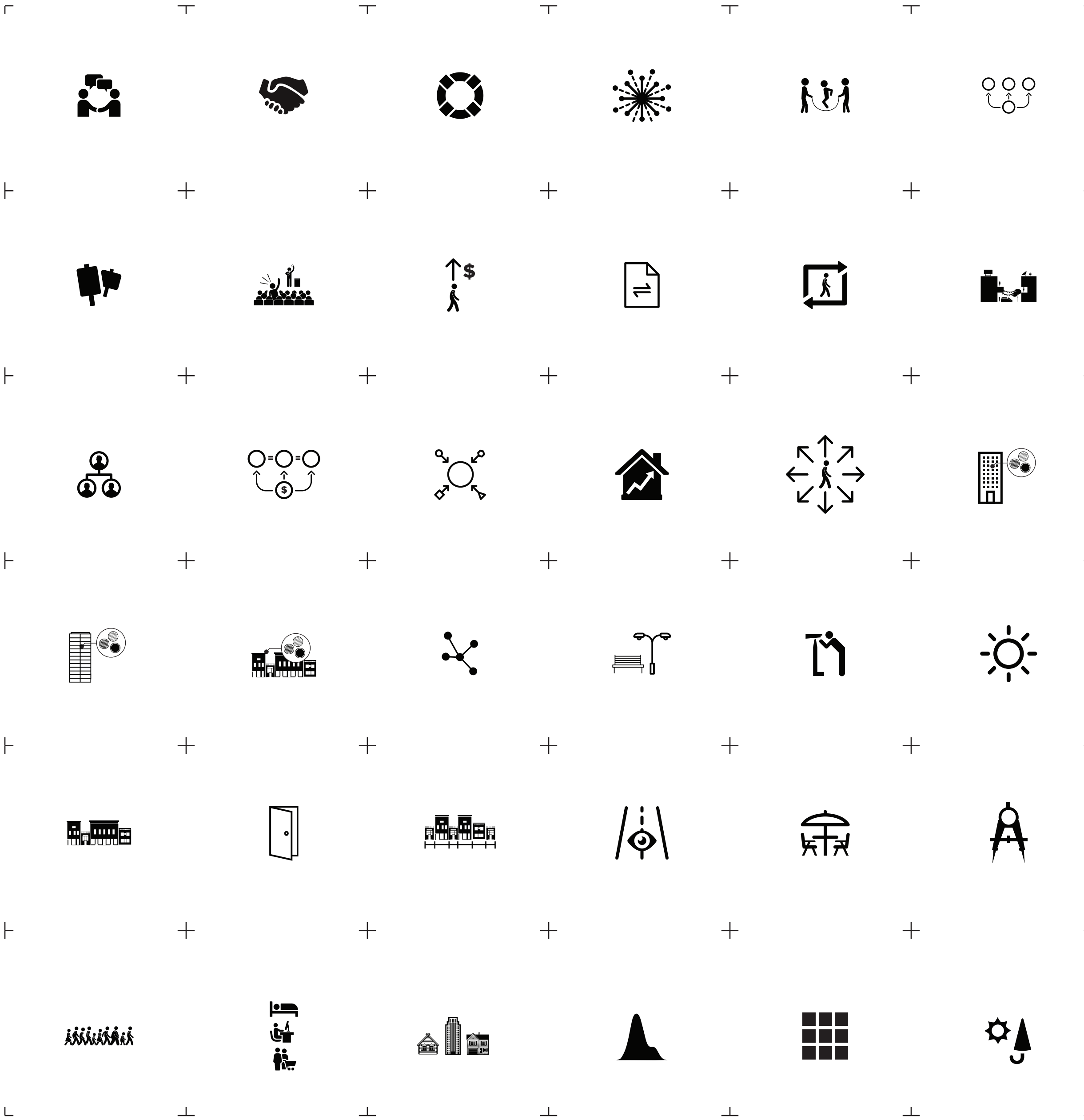
05.17 *The role of regulating development has been taken from the municipality and is not upheld by the OMB, creating a power vacuum that could be exploited further by the development of profit-driven volumetric architecture*

With the updates to the Official Plan since 2012, developers are required to submit a PATH feasibility study to demonstrate their adherence to the PATH master plan. The plan largely focuses on the connectivity aspects of the PATH alone and not the composition of the building fabric as a whole. Furthermore, although discouraging connectivity in areas identified that it could reduce street traffic, the master plan largely encourages new developments to integrate into the network without provision for diversity of residents, workers, reatil, or amenities. The master plan also applies only to developments specifically within the vicinity of the existing PATH and only regarding connections to the PATH itself—not additional inter-building connections at non-PATH levels. Therefore, there aren't regulations guiding volumetric architecture in general, and new sky-bridges are being erected largely without oversight in terms of their impact on the master plan of the city.

The power struggle between the city and the OMB has resulted in a scenario in which most of the planning decisions are being made by appointed businessmen without oversight, without a strategic urban plan, and with a high incidence of ruling in favour of the developer against the advisement of the city. The resultant growth has resulted in a disproportionate distribution of development that deviates from Ontario's official growth plan and is frequently refuted by both the city and the neighbourhoods affected due to its lack of contextual appropriateness. This has provided enhanced agency to influence the lives of residents, potentially escalating Toronto's existing problems of housing affordability and pockets of monocultural apartment blocks into an architecture of segregated urban enclaves and commercialism. This lack of regulatory power is especially significant to the volumetric city since precedents have already demonstrated that volumetric architecture has the ability to produce a spatial monopoly or oligopoly, and the privatization of the commons and public circulation infrastructure. This has already occurred in the case of Toronto's existing underground volumetric building network, the PATH, which up until January 2012 had no master plan.[53] As described by Jacobs in regards to the similarity of building types and ages constructed: "Monopoly planning can make financial success of such inherently inefficient and stagnant one-age operations. But it cannot thereby create, in some magical fashion, an equivalent to city diversity. Nor can it substitute for the inherent efficiency in cities, of mingled age and inherently varied overhead."[54]

53 Angela Kryhul, "Toronto Shines a light on underground PATH," *The Globe and Mail* (Toronto, ON), last modified March 26, 2017, https://www.theglobeandmail.com/report-on-business/toronto-shines-a-light-on-underground-path/article4189910/.
54 Jacobs, *The Death and Life*, 192.

IT HAS NOW BEEN ESTABLISHED THAT DUE TO MARKET PRESSURES AND CONTEMPORARY DESIGN STYLES, THERE IS THE POTENTIAL FOR A SURGE IN VOLUMETRIC ARCHITECTURE IN TORONTO TO CREATE THE BEGINNINGS OF A VOLUMETRIC CITY. WHILE THE DEVELOPER CENTRIC GROWTH OF THE CITY HAS ALREADY BEGUN TO NEGATIVELY IMPACT THE CITY BY FORCING OUT ITS POOREST RESIDENTS AND CREATING NEIGHBOURHOODS TARGETED TOWARDS ELITISM AND LUXURY, THE UNIQUE QUALITIES OF VOLUMETRIC ARCHITECTURE PRESENT NEW CHALLENGES AND OPPORTUNITIES THAT CAN INCREASE CONTROL OF PRIVATE INDUSTRY IN THE DOWNTOWN CORE AND EXACERBATE THE SOCIO-ECONOMIC DIVIDE. PART TWO WILL INVESTIGATE HOW THE FUNDAMENTAL DIFFERENCES BETWEEN PLANAR AND VOLUMETRIC ARCHITECTURE CAN PROVIDE THIS AGENCY.



PART TWO

UNDERSTANDING THE TENSION BETWEEN PROFIT-DRIVEN VOLUMETRIC ARCHITECTURE AND THE VITALITY OF THE CITY

VOLUMETRIC ARCHITECTURE'S FUNDAMENTAL AMBITION IS AN EXTENSION OF THE PUBLIC REALM INTO THREE-DIMENSIONAL SPACE. ALTHOUGH IT HAS NOT YET BEEN ESTABLISHED WHY, THE SHORTCOMINGS OF BUILT PRECEDENTS DEMONSTRATE THAT THE QUASI-PUBLIC BUILDING NETWORK FAILS TO ACHIEVE ALL OF THE QUALITIES OF PUBLIC SPACE THAT CREATE VITALITY. FOR THIS REASON, HOW PUBLIC SPACES WORK TO SERVE THEIR OCCUPANTS WILL NEED TO BE UNCOVERED FIRST, BEFORE IT CAN BE DETERMINED HOW VOLUMETRIC ARCHITECTURE FUNCTIONS DIFFERENTLY. THIS IS ACCOMPLISHED BY CODIFYING THE RELATIONSHIPS BETWEEN URBAN FORM AND VIBRANT STREET LIFE FROM THE WORK OF JANE JACOBS IN A SYSTEM THAT CAN LATER BE ADAPTED INTO THREE-DIMENSIONAL SPACE THOUGH A PARAMETRIC DESIGN. THE REASONS WHY VOLUMETRIC ARCHITECTURE HAS FAILED TO CREATE THE VITALITY OF PUBLIC SPACE CAN BE SUMMARIZED AS:

CHAPTER 06 VOLUMETRIC ARCHITECTURE NEEDS INFORMAL USES OF THE COMMONS TO CREATE VITALITY

07 INFORMAL USES CAN BE CATALYZED BY PHYSICAL QUALITIES OF THE BUILT FABRIC THAT FUNCTION AS URBAN RESOURCES

08 AN UNDER-REGULATED VOLUMETRIC CITY PERMITS PROFIT-DRIVEN ARCHITECTURE THAT CAN DIMINISH THE CITY'S URBAN RESOURCES

09 THE LOSS OF URBAN RESOURCES AS A RESULT OF PROFIT-DRIVEN VOLUMETRIC ARCHITECTURE CAN INHIBIT THE VITALITY OF THE CITY

CHAPTER 06

VOLUMETRIC ARCHITECTURE NEEDS INFORMAL USES OF THE COMMONS TO CREATE VITALITY

It has now been established that built volumetric architecture largely fails to fulfill its goal of an extended public realm because its private ownership and control have made their quasi-public spaces more places to shop or pass through than to live in. For this reason, the other, informal uses of public space must be incorporated as well, to allow occupants to use the space fully and generate street life within the building network. The work of Jane Jacobs is used to define what additional functions the quasi-public space must fulfill to achieve vitality and create an extension of the urban realm in volumetric space.

06.01 Volumetric architecture attempts to recreate the conditions of the street throughout three-dimensional space, but how it will accomplish this is unclear

06.02 In order to determine what qualities of the street volumetric architecture lacks, Jane Jacobs' *The Death and Life of Great American Cities* is used as the primary framework to understand how city streets function

06.03 Jacobs' explanation of the processes that create vitality will be codified into a system by defining the actors involved and categorizing them into four categories: *urban generators*, *urban resources*, *informal uses*, *and vitality*

06.04 Vibrant streets provide important informal uses, in addition to their formal purpose, that create the urban realm and its vitality

06.05 Public space has the capacity to be inclusive by distributing spatial control amongst its many stakeholders

06.06 Since informal uses of the commons create the urban realm of the city, including its vitality, they must be incorporated into volumetric architecture throughout the three-dimensional field

06.01 *Volumetric architecture attempts to recreate the conditions of the street throughout three-dimensional space, but how it will accomplish this is unclear*

The traditional parks, streets, and squares of the *old city*, as Jane Jacob calls it, have an embedded socio-economic structure that creates informal uses, giving them their vitality.[1] Recreating only the form of a street will not bring the character of the neighbourhood and the community to the high-rise. As explained in *The New Landscape* by Bart Lootsma, chair for architectural theory at the Leopold-Franzens University of Innsbruck:

> *The problem of public space is not about the architecture or the empty space itself. Architects, with their fixation on their own discipline and physical spatial solutions, tend to put the cart before the horse. The problem was—and is—that it remains completely unclear what exactly would take place in this empty space. Therefore, the hope that if one were to return to a specific kind of architecture with a specific kind of public space, the old sense of community would come back, is an illusion.*
>
> —*Bart Lootsma*[a]

This critique can similarly be applied to the quasi-public spaces of volumetric architecture. Despite the formal recreation of a street lined with shops in building networks such as the Toronto PATH or Calgary +15, how the quasi-public walkway space will be used beyond its commercial function remains unclear, and therefore the notion that connecting buildings together would alone generate a sense of community and vibrant urban life is misguided.

06.02 *In order to determine what qualities of the street volumetric architecture lacks, Jane Jacobs'* The Death and Life of Great American Cities *is used as the primary framework to understand how city streets function*

Due to the significance of the reproduction of the quality of the street as the quintessential proposal of the volumetric city, and Jacobs' authority on the topic of urban street life, the authors of *Parallel Cities* argue her work has ultimately become, "a critique of the emerging grade-separated pedestrian networks."[2] For this reason, Jane Jacobs' *The Death and Life of Great American Cities* has been selected as the primary framework to understand street life in the city, and how it can be created within volumetric architecture.

[a] Bart Lootsma, "The New Landscape," in Mutations 2000, ed. Rem Koolhaas et al., (Barcelona: ACTAR, 2000), 471.

1 Jacobs, *The Death and Life*, 50.
2 James and Yoos, *Parallel Cities*, 152.

This understanding of the mechanisms of urban street life can be built upon further by more recent, and scientific studies of the city; however, the significance of Jacobs' work makes it suitable as an initial point of departure.

"Under the seeming disorder of the old city, wherever the old city is working successfully, is a marvelous order for maintaining the safety of the streets and the freedom of the city. It is a complex order. Its essence is intricacy of sidewalk use, bringing with it a constant succession of eyes. This order is all composed of movement and change, and although it is life, not art, we may fancifully call it the art form of the city and liken it to the dance–not to a simple-minded precision dance with everyone kicking up at the same time, twirling in unison and bowing off en masse, but to an intricate ballet in which the individual dancers and ensembles all have distinctive parts which miraculously reinforce each other and compose an orderly whole. The ballet of the good city sidewalk never repeats itself from place to place, and in any one place is always replete with new improvisations."

—*Jane Jacobs*[b]

06.03 *Jacobs' explanation of the processes that create vitality will be codified into a system by defining the actors involved and categorizing them into four categories: urban generators, urban resources, informal uses, and vitality*

Jacobs work is especially useful as it connects the use of public space to explicit, observable and definable processes that can be catalyzed by the built environment. These processes can be codified into relationships that explain how street vitality can be created or inhibited, and applied not only to the two-dimensional street network, but the three-dimensional building network of volumetric cities. One of Jane Jacobs' key points in *The Death and Life of Great American Cities* is that high-level characteristics of the building fabric, what Jacobs refers to as *generators for diversity*, create spatial socio-economic qualities (what she refers to as *diversity*) and that this diversity enables the social functions of the old city that create street vitality (Figure 06.03). However, Jacobs work discusses many other factors that contribute to the city beyond diversity alone, and various aspects of the vitality created. Expanding on Jacobs' nomenclature of *generators, diversity*, and *vitality*, the actors in these processes that explain how the city work can be sorted into the following categories:

[b] Jacobs, The Death and Life, 50.

Generators:

Generators are high-level characteristics of the building fabric that describe a composition of buildings that create urban resources. These generators were naturally present in the *old city* due to its fine grain of parcels and streets. These generators include Jacobs' four *generators for diversity*.

Urban Resources:

Urban resources are *physical* and *quantifiable* characteristics of the building fabric that interact directly with the city's inhabitants to make the occupation and use of public space possible. Urban resources can be designed into buildings and public space, or emerge as a result of generators. Jacobs commonly uses the term diversity as short-hand to refer to some of these qualities, but actually describes several types of diversity as well as a range of other characteristics of the building fabric that also contribute to informal uses.

Informal Uses:

Informal uses are any of the activities, actions, and functions of public space that create urban life for its inhabitants beyond its formal functions for circulation and commercial space. Informal uses are catalyzed by urban resources: they are naturally created by the city's inhabitants in their daily lives but can be either encouraged, or suppressed, by a building fabric lacking in urban resources.

Vitality:

Qualities of the public realm Jacobs argues are beneficial to the city and its inhabitants that emerge because of frequent informal uses. The qualities selected by Jacobs are a value statement: Jacobs' principles prioritize creating community, equal economic opportunity, land value, and inclusiveness in the city, and are the goals she argues the city should work towards.


URBAN GENERATORS
HIGH LEVEL CHARACTERISTICS THAT CREATE LOCAL CONDITIONS
JANE JACOBS' GENERATORS FOR DIVERSITY
DENSITY
MULTIPLE PRIMARY USES
BUILDING AGE MIX
SHORT BLOCKS
UNIVERSAL ACCESS
DESIGN
URBAN RESOURCES
PHYSICAL LOCAL CONDITIONS THAT CREATE INFORMAL USES
DIVERSITY
RETAIL DIVERSITY
RESIDENTIAL DIVERSITY
COMMERCIAL DIVERSITY
PEDESTRIAN DISTRIBUTION
DIVERSE PEDESTRIAN TRAFFIC
SHORT FRONTAGE
DIVERSE AMENITY ACCESS
SUITABLE CLIMATE
DAYLIGHT
SIGNIFICANT LINES OF SIGHT
AESTHETIC QUALITY
PUBLIC INFRA-STRUCTURE
EYES ON THE STREET
CONNECTIVITY
FREQUENT STREET WALL OPENINGS
CONTINUOUS URBAN STREET WALL
STREET ACTIVATIONS
INFORMAL USES
UNPROGRAMMED USES OF SPACE THAT CREATE QUALITIES OF URBAN LIFE
SOCIAL ENCOUNTERS
ECONOMIC OPTIONS
ABILITY TO CONGREGATE
DISTRIBUTE INFORMATION
SPECTACLE
RESIDENT RETENTION
FREEDOM OF SPEECH
TRUST
SAFETY
CHILD REARING
UPWARDS CLASS MOBILITY
VITALITY
DESIRABLE ASPECTS OF URBAN LIVING THAT HAVE VALUE
VIBRANT STREET LIFE
COMMUNITY
EQUAL ECONOMIC OPPORTUNITY
INCLUSIVENESS
LAND VALUE
SPATIAL NEUTRALITY

06.04 *Vibrant streets provide important informal uses, in addition to their formal purpose, that create the urban realm and its vitality*

Figure 06.03 (opposite): Diagram depicting the hierarchy of actors in the generation of street vitality according to Jane Jacobs. The top most level are high-level descriptions of building fabric that produce vitality, herein called urban generators, and include Jacobs' four generators for diversity. The next level are the quantifiable qualities of the building fabric that result from these high-level characteristics and will be reffered to as, urban resources. These urban resources enable informal uses of public space to take place, which ultimately produces vitality. This hierarchy of actors and processes will be used to explain how qualities of the building fabric can either produce or hinder street vitality. Each category will be developed further on the following pages, and these characteristics will ultimately become those generated by a parametric design tool.

Throughout Jacobs work, she argues that it is the continuous frequent use of the street for all of its social and economic purposes desired by a diverse group of people that give the public space its vitality, moderated primarily by social contract and the distribution of control amongst its inhabitants. Lefebvre argues that the informal uses of the street create urban life itself, stating: “The street is where movement takes place, the interaction without which urban life would not exist, leaving only separation, a forced and fixed segregation.”[3] Koolhaas’ introduces the concept of the Generic City—a city defined by large-scale development spatial oligopolies creating a generic style and a culture of commercialization. He announces, “the street is dead,”[4] reduced to a place to move between stores,[5] “it is our own fault–we didn’t think of anything better to do.”[6]

In Jacobs’ *old city* the social functions of the street include: creating social encounters, trust, safety, a spectacle, a community, assimilating children, enabling upwards class mobility, congregation, resident retention, and distributing information, among many others. Equitable public space with control distributed among many groups also provides economic functions that include not only large enterprises, but also small businesses and the individual—becoming a place for retail transactions, advertising, and investing in land or housing units. Streets also are important political infrastructure by providing a platform for protest; the right to occupy and use city space and access amenities regardless of lifestyle or class; and by creating a clear (and potentially fair, as it is subject to public scrutiny and democratic intervention) governance structure in which public space is subject to municipal regulations and governed by social protocol and the municipal police.

3 Henri Lefebvre, *The Urban Revolution* (Minneapolis, The University of Minnesota Press, 2003), 18.
4 Rem Koolhaas, "The Generic City," in *SMLXL*, ed. OMA, Rem Koolhaas, and Bruce Mau, (Köln, Benedikt Taschen Verlag, 1997), 1253.
5 Ibid., 1260.
6 Ibid.

06.05 *Public space has the capacity to be inclusive by distributing spatial control amongst its many stakeholders*

Because the city street is public space governed by municipal laws, accountable to urban guidelines and rules and policed by the city, it can become a fair space for its citizens to occupy. This is because a diverse and vibrant street will have a variety of owners throughout its length, creating a variety of interests that don't allow a single stakeholder to become too dominant. Generally, different enterprises and individuals can temporarily appropriate public space of the street from time to time for use for specific activities, or non-intrusive activities such as sidewalk signage, or cafe chairs. In both cases, the social contract and public governance of the street restrict users from appropriating it to the detriment of others.[7] However, if one specific group becomes too influential and gains control of the space, the lack of diversity can bias the space and restrict informal uses by other groups with conflicting interests, even if the space is intended to be public.

Kevin Lynch identifies that control is an important property of space because it affects how urban society behaves. At a small scale, it can be considered the right to presence, use, appropriation, modification, and the right of disposal.[8] At a large scale, this control can create a continued influence that affects the daily life of its inhabitants and their resultant social, economic, and political decisions.[9] Control can exist both as the ownership of a space, or ownership of enough of the surrounding spaces to effectively influence the space itself or planning and regulations. While various groups have either a role and the right to influence the city,[10] control becomes problematic when one group becomes too dominant in either the amount of ownership of space, or the control of regulation.

06.06 *Since informal uses of the commons create the urban realm of the city, including its vitality, they must be incorporated into volumetric architecture throughout the three-dimensional field*

Informal uses of public space are the urban realm. They are what makes the city not just a place to move through and shop, but a place to inhabit.

7 Lynch, *Good City Form*, 205.
8 Ibid., 205.
9 Ibid., 35.
10 Ibid., 208.

They are how people use the city, and although they may differ from person to person, by selecting a wide range of informal uses and ensuring their generation and preservation, a wide range of people can be accommodated without infringing on any one person's right to the city. By selecting the values Jacobs perceives as good for a healthy city, Jacobs has provided a value statement that pursues an idealized city of specific ethical and moral values—namely community, land value, equal economic opportunities, and inclusiveness—that attempts encompass all walks of life. Different forms of urbanism choose to create unique conditions that value informal uses differently. However, Jacobs argues that plans such as the *Radiant City* and the *Garden City*, in destroying diversity and removing the balance of control, failed to create the basic functionality of the city, and therefore also lost the freedom of the city.[11] This critique of modern planning resulted in her work defending the ability for the traditional *old city* to generate informal uses on its own due to its fine grain of parcels and streets. Since the values Jacobs suggests work towards vitality, including quality of life, inclusiveness, and land value, the values Jacobs suggests will herein be adopted as the values of public space that the volumetric city should work towards in order to achieve a vibrant and inclusive building network.

Adopting Jacobs' values means that the volumetric city must find ways of incorporating these informal uses throughout a volume of quasi-public space, rather than simply at the ground plane as in Jacobs' old city. Jacobs argues that these informal uses of space can be produced by physical characteristics of the built environment which have been herein labeled as *urban resources*. In order to define how informal uses of space can be produced by the built fabric, her work has been codified into a system that defines and labels the informal uses of space, what they produce, and how they are created. Although these informal uses cannot be created through the composition of the urban fabric alone—requiring as well a variety of social, economic, and political conditions—when these other conditions are suitable, the built environment can stimulate their production, rather than inhibiting it.[12]

11 Jacobs, *The Death and Life*, 50.
12 Ibid., 139-141.

CODIFIED SUMMARY OF INFORMAL USES OF PUBLIC SPACE

Informal uses of public space are all the uses, functions, and roles public space plays to provide vitality, value, and inclusiveness for its occupants, beyond the street's formal commercial and circulatory functions. These informal uses create the urban realm because, without them, streets become places to move between private programs and shop. Although uses will differ between specific individuals, the following are some of the most significant uses that are inclusive and create vitality as identified by Jane Jacobs.

CREATING SOCIAL ENCOUNTERS

DESCRIPTION: A diverse street has a variety of people frequenting it throughout the day, and many different physical relationships such as openings and street activations from various enterprises that create different social scenarios for people to opt in or out of.
CREATED BY: Pedestrian traffic, pedestrian distribution, diverse amenity access, continuous urban street wall, frequent street openings, street activations
GENERATES: Community, trust, safety, spectacle, child rearing

CREATING TRUST

DESCRIPTION: Jacobs establishes the significance of trust between neighbours, built up through familiarity with each other through frequent social encounters, saying "the trust of a city street is formed over time from many, many little public sidewalk contacts."[1]
CREATED BY: Social encounters
GENERATES: Community, child rearing, inclusiveness

CREATING SAFETY

DESCRIPTION: Safety can be created by the presence of strangers on streets when enough street activity by diverse groups of people keeps the space moderated by social contract, with no periods of desolation, no ability to identify and scrutinize outsiders, and no group with complete control of the space.
CREATED BY: Social encounters, eyes on the street, continuous urban street wall
GENERATES: Community, child rearing, inclusiveness

CREATING A SPECTACLE

DESCRIPTION: Vibrant streets become an attraction themselves. When diversity creates continuous frequent street traffic, and the street provides various activations for social and economic activities, the vitality of the street draws more people to participate or become onlookers.
CREATED BY: Social encounters, street activations
GENERATES: Pedestrian traffic, eyes on the street

SUPPORTING CHILD REARING

DESCRIPTION: Jacobs argues that children are well assimilated into society on vibrant streets, since this gives children places to play, activating the streets themselves. In this manner, they join the community, and become familiar with a diverse number of local residents, all while protected by the safety of an active street of trusted individuals, rather than the danger of unseen, and therefore unmoderated spaces such as parks.
CREATED BY: Safety, social encounters, trust
GENERATES: Community

1 Ibid., 56.

PROVIDING ECONOMIC OPTIONS

DESCRIPTION: A diverse street has a variety of enterprises allowing residents to support whichever businesses suit them best and providing a range of affordable options, allowing different lifestyles and incomes to be accommodated.
CREATED BY: Diverse amenity access, residential diversity, commercial diversity
GENERATES: Equal economic opportunity, community, upwards class mobility, resident retention, freedom of speech, inclusiveness

FACILITATING FREEDOM OF SPEECH

DESCRIPTION: The street provides opportunities for self-expression through the shared right to occupy space, allowing the city's residents to express themselves through their presence, appearance, or actions (from organized public protests, to simply representing a unique lifestyle that contributes to the street's diversity).
CREATED BY: Universal accessibility, economic options, ability to congregate
GENERATES: Inclusiveness, upwards class mobility

ENABLING CONGREGATION

DESCRIPTION: The public space of streets allows people to congregate for a variety of reasons: from special events, to political protest, to informal performances. This both activates the street and provides opportunities for residents to pursue various means of expression and activities.
CREATED BY: Universal accessibility, pedestrian traffic, pedestrian distribution
GENERATES: Freedom of speech, inclusiveness

ENABLING UPWARDS CLASS MOBILITY

DESCRIPTION: A diversity of building ages, building types, and enterprises allows people to better find and retain jobs locally, and allows independent businesses to receive the foot traffic needed to succeed, providing more economic options and a greater variety of job opportunities that can include a range of promotions.
CREATED BY: Economic options, resident retention, freedom of speech
GENERATES: Community, equal economic options, inclusiveness

DISTRIBUTING INFORMATION

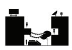
DESCRIPTION: The street is an important means of distributing information: through formal means such as wayfinding signage, or retail signage; as well as informal means such as flyers, congregations, public speaking, social interactions, and the occupation of the street by diverse social groups.
CREATED BY: Pedestrian traffic, pedestrian distribution, universal access
GENERATES: Equal economic opportunity, inclusiveness

ENABLING RESIDENT RETENTION

DESCRIPTION: The vitality of the street, development of a community, and local job opportunities give people reasons to stay in a neighbourhood, while diversity of accommodations gives them a variety of places to choose from, allowing residents to find new homes in a neighbourhood as their means change without wholly relocating. This retains people in the community, and can, therefore, enable Jacobs' concept of "unslumming," in which low-income areas, through the creation of a community, economic opportunities, and diverse living conditions by the built environment, can retain their residents as they improve their own means and gradually improve their own neighbourhood.
CREATED BY: Economic options
GENERATES: Community, upwards class mobility

CODIFIED SUMMARY OF VITALITY

These are the qualities of the city that Jacobs values in her writing. She argues that these qualities are the vitality of the street and are stimulated by the building fabric. Jacobs saw neighbourhoods of the old city that possessed these qualities as healthy parts of the city, and because she valued their presence, fought to protect the existing building fabric in order to preserve them. Like any values, their worth is subjective; however, since Jacobs argues that these values create street vitality and this is the objective of the volumetric city, they have herein been adopted as the values of the volumetric city. Jacobs argues that the informal uses of the street create vitality in the following forms:

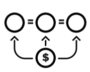


VIBRANT STREET LIFE

DESCRIPTION: Vibrant street life is one of the most explicit goals of Jacobs' writings. When the street becomes frequented and the public engages in a variety of informal uses, the street becomes a vibrant space of activity and movement that create's the city's urban life.
CREATED BY: Informal uses

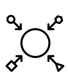
COMMUNITY

DESCRIPTION: A community is created by the people within an area, but Jacobs argues that communities need the building fabric to facilitate the interactions that produce these relationships and retain individuals long enough for these relationships to become meaningful.
CREATED BY: Social encounters, trust, safety, economic options, resident retention, child rearing, upwards class mobility



EQUAL ECONOMIC OPPORTUNITIES

DESCRIPTION: Without diversity, a neighbourhood can become catered towards supporting a specific type of business or lifestyle that doesn't provide the same amount of opportunities to individuals or businesses outside of the target group. A diverse street provides a variety of price tiers for businesses to be accommodated, as well as a variety of continual passersby with unique interests that could become customers, thereby including a range of businesses. The variety of retail options and residential rental price tiers allows the needs and interests of inhabitants from all economic classes to be supported and provides various employment options that can suit a range of people.
CREATED BY: Diverse amenity access, economic options, upwards class mobility, distribution of information



INCLUSIVENESS

DESCRIPTION: Inclusiveness refers to the ability for all of the city’s inhabitants to have access to the city’s circulation networks, amenities, businesses, and the uses and values of public space, without any formal or informal restrictions.
CREATED BY: Trust, safety, upwards class mobility, economic options, ability to congregate, freedom of speech, distribution of information, universal access

LAND VALUE

DESCRIPTION: Land value is largely determined by the demand for a location, which gains its desirability from the qualities such as vitality and centrality that the land grants access to. Land in vibrant areas with access to a wealth of services are in high demand. In turn, this high demand provides monetary value, as units, buildings or lots in highly desirable areas are valued over those in less desirable locations.
CREATED BY: All informal uses and urban resources

CHAPTER 07

INFORMAL USES CAN BE CATALYZED BY PHYSICAL QUALITIES OF THE BUILT FABRIC THAT FUNCTION AS URBAN RESOURCES

Now that it has been established what additional roles the quasi-public building network must play in order to extend the urban realm into volumetric architecture, it must be determined how this can be accomplished. An analysis of how Jacobs' *old city* produces these informal uses identifies several qualities of the built fabric that stimulate informal uses of public space and gives them the term *urban resources.*

07.01 Physical qualities of the built environment can catalyze or inhibit informal uses of space, and will be referred to as urban resources

07.02 One of the biggest contributors to the vitality of street life is the composition of the urban fabric surrounding it

07.03 The interaction between buildings creates a socio-economic "chessboard" that shapes the city

07.04 Diverse urban fabric generates pedestrian traffic continually throughout the day

07.05 Design can facilitate the informal use of public streets

07.06 Universal access is necessary for the equitable use of public streets

07.07 A diverse building fabric and continuous street traffic from diverse pedestrians can facilitate fair economic opportunities for a variety of businesses and residents

07.08 Communities can be formed when the building fabric facilitates the use of space through urban resources

07.09 Since urban resources generate vitality, their equitable distribution can create inclusive spaces

07.10 Due to the quality of life they produce and the land value of vibrant neighbourhoods, urban resources have quantifiable monetary value

07.01 *Physical qualities of the built environment can catalyze or inhibit informal uses of space, and will be referred to as urban resources*

Jacobs argues that the informal uses of public space can be supported by the built environment, and that the *old city* generated these physical conditions on its own—largely due to its fine grain of parcels and streets, which are responsible for her *generators for diversity*. Although Jacobs commonly refers to these characteristics using the short-hand *diversity*, she also describes many additional factors that contribute to informal uses of public space, and so the term *urban resources* has been adopted. The term comes from Harvey Perloff's *The Quality of the Urban Environment,* in which Perloff establishes the need to adapt the concept of resources to the urban environment in which, "natural resources are much more intimately tied in with the man-made features of the urban community,"[1] because, "there is conceptual value in seeing some man-made features as providing an important kind of environment."[2] The urban resources identified in Jacobs' work include: pedestrian traffic, pedestrian distribution, residential unit diversity, commercial unit diversity, retail unit diversity, connectivity, public infrastructure, significant lines of sight, daylight, a suitable micro-climate, aesthetic quality, eyes on the street, continuous urban street walls, street activations, frequent street wall openings, and short frontages.

Harvey S. Perloff was the dean of the Graduate School of Architecture and Urban Planning at the University of California at Los Angeles as well as an advisor to President Kennedy. Perloff's terminology, "new resources in an urban age," is abbreviated to simply, "urban resources," and his definition expanded upon.

07.02 *One of the biggest contributors to the vitality of street life is the composition of the urban fabric surrounding it*

Jacobs dispels the conception that public spaces such as parks or squares create vibrant street life on their own;[3] explaining that the people occupying this space must come from somewhere and that this is predominantly the surrounding urban fabric.[4] In many cases, people contribute most to the public realm either on their journey to a private space (such as on a daily route to work or to a specific retail location), or when exploring without any specific destination at all. Exceptions occur for areas that have become so popular and vibrant already, or are in high enough demand, that they become an attraction themselves. While this destination traffic can support some parts of the city, it cannot support an

1 Harvey Perloff, *The Quality of the Urban Environment: Essays on "New Resources" in an Urban Age* (Washington: Resources for the Future Inc., 1969), vi.
2 Ibid.
3 Jacobs, *The Death and Life.*, 90.
4 Ibid., 96.

entire city's businesses and public spaces, since not all areas can be so popular that they draw their own crowd. Therefore, the public spaces of the city largely rely on incidental traffic generated by diversity in order to have vitality.

07.03 *The interaction between buildings creates a socio-economic "chessboard" that shapes the city*

Jacobs argues that each building exerts a force on the surrounding fabric because of its specific make up of people, activities, and form. In this way, she compares the city to a chessboard in which buildings act as chess pieces.[5] The municipality has a limited number of its own buildings and should create and position them to create diversity and improve the city.[6] In contrast, the agency of developers, who are in the business of investing in real estate, position their buildings strategically to create a return on investment, restricted by regulations and laws. The way in which these pieces are positioned affects the building fabric not only formally, but also by altering it as a social, political, and economic landscape that in turn creates different conditions in public space. The municipality is able to represent the best interests of the public by defining the rules of the game—the city's laws, regulations, and design guidelines—influencing how the development industry can site and program its buildings. Therefore, the impact of a single building is more determined by its contribution to the composition of the whole of the local building fabric, than by its own contents and composition alone.

07.04 *Diverse urban fabric generates pedestrian traffic continually throughout the day*

Jacobs argues that diversity is the most effective method of creating activity on the street because people at different stages in life or with different types of jobs tend to have different schedules that will occupy the street at a variety of times, creating continuous foot traffic throughout the day that has many benefits for the neighbourhood (Figure 07.04.a).[7] Her four generators for diversity are: density, primary use mix, building age mix, and short block lengths.

5 Ibid., 167.
6 Ibid.
7 Ibid., 98.

Density:

Density is necessary because there needs to be enough people inhabiting an area in order to create a significant amount of street use once this traffic is spread throughout the day.[8] However, Jacobs also warns against achieving too high of a density for one area, explaining that very high densities create a standardization of building types, as point towers become the only building type in the area.[9] Jacobs also recommends high lot coverage in order to eliminate standardization of building types, as too low of lot coverage again forces standardization of type as well.[10] This has the benefit of creating a continuous urban street wall which concentrates people together, limits spaces obscured from view that could become unsafe, and provides the interactions with buildings that create social and economic transactions.

Building Age Mix:

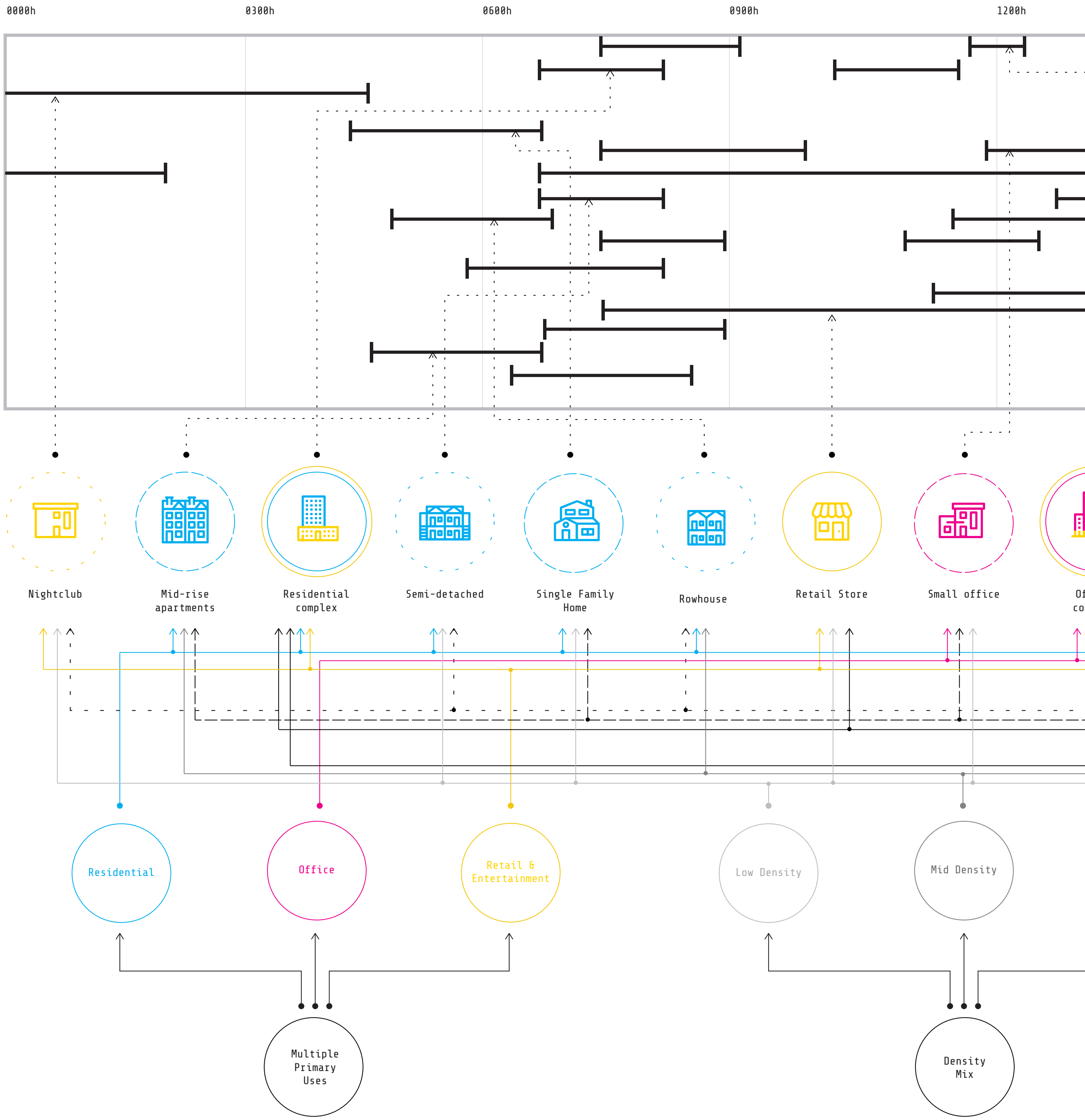
Building age mix provides a variety of building types, styles, states of upkeep, and rental or ownership costs.[11] This is because architectural styles change over time, and including a mix of building ages will tend to create a variety of building types and aesthetics. Additionally, new construction tends to have higher rental or ownership rates, restricting occupation to only the wealthiest of individuals or enterprises, and therefore a variety of building ages creates numerous price tiers such that a variety of people and businesses with different schedules and interests may occupy an area.[12] The diversity of building types has the added benefit of creating a varied urban street wall that can provide many different opportunities for interactions and events to take place.

Primary Use Mix:

Primary uses are the building programs that provide the main reason for an individual to be in a neighbourhood, such as a residence or office. Jacobs suggests at least two or three primary uses but recommends as many as possible.[13] While traditional planning attempts to sort different uses,[14] Jacobs argues that by having a variety of primary uses mixed

8 Ibid., 201.
9 Ibid., 212.
10 Ibid., 215.
11 Ibid., 188.
12 Ibid.
13 Ibid., 162.
14 Ibid., 177.

CONTINUOUS DIVERSE STREET ACTIVITY



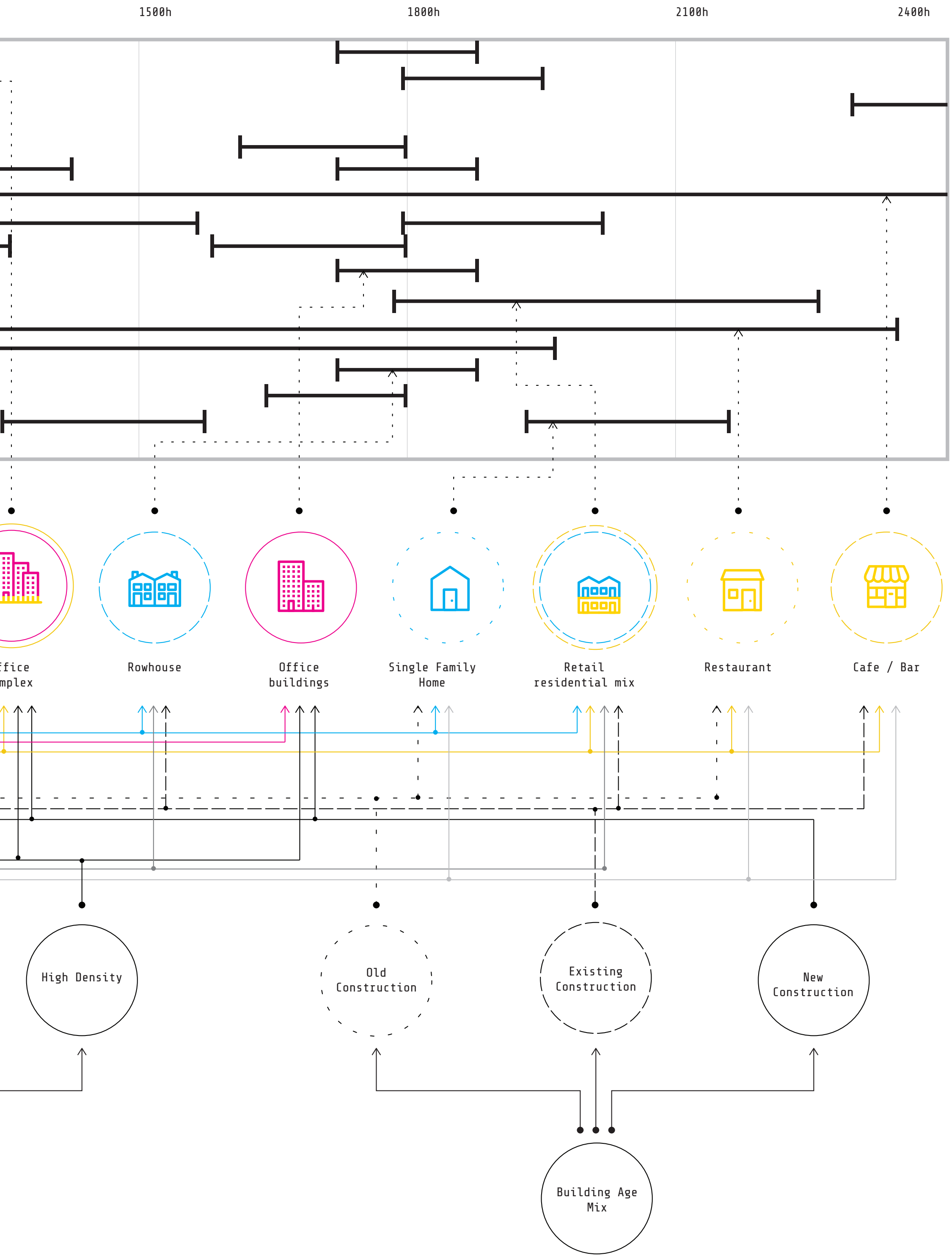


Figure 07.04.a: An idealized diagram demonstrating how diverse building fabric of multiple primary uses and building ages creates frequent, diverse street traffic throughout the entire day. The mix of building types and ages creates different rental and ownership price brackets, which are inhabited by a diverse group of the population with different professions or lifestyles. Their different schedules, puts them on the street at different times of the day. Similarly, the mix of primary uses and variety of shops or services gives people different reasons to visit the area throughout the day.

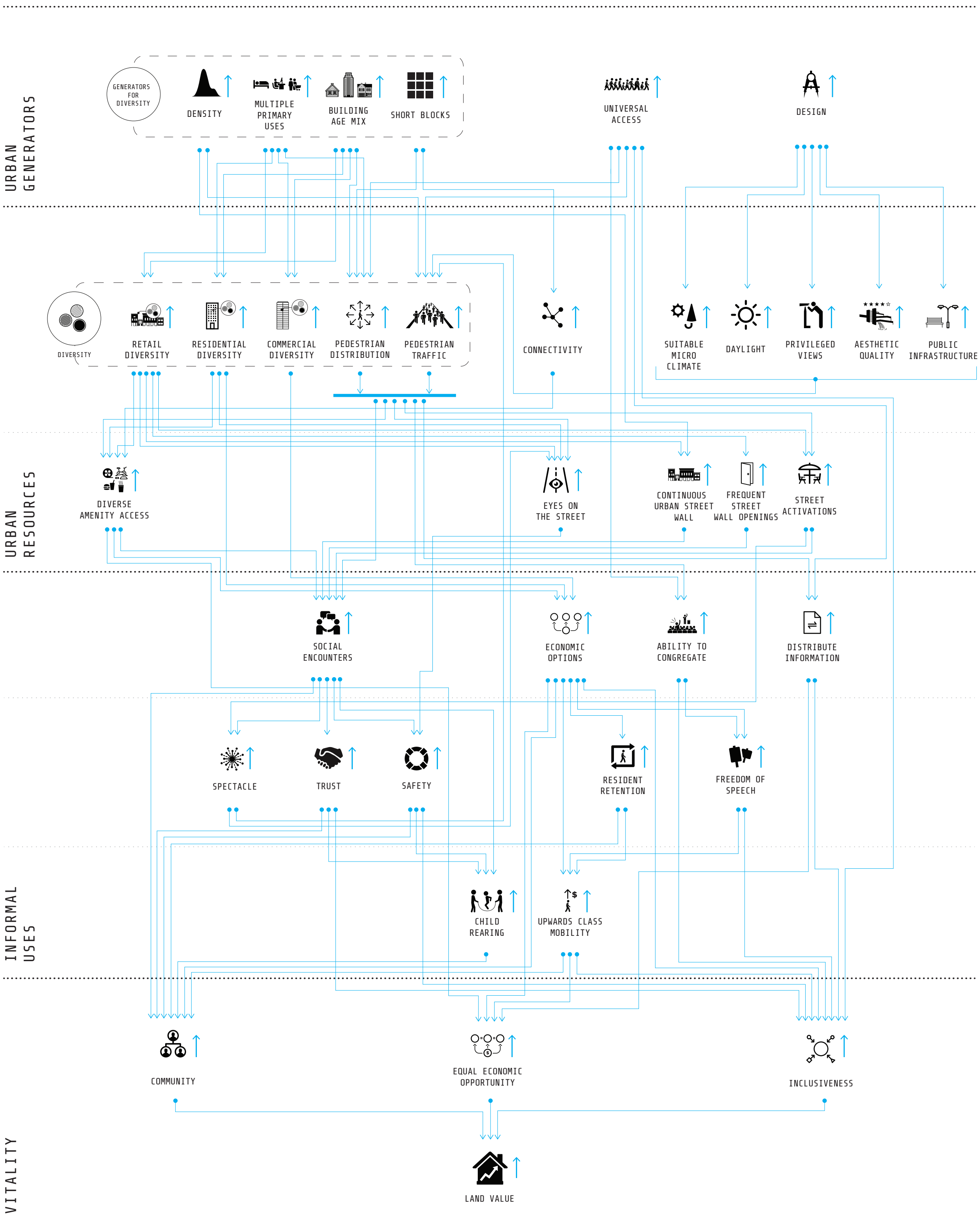
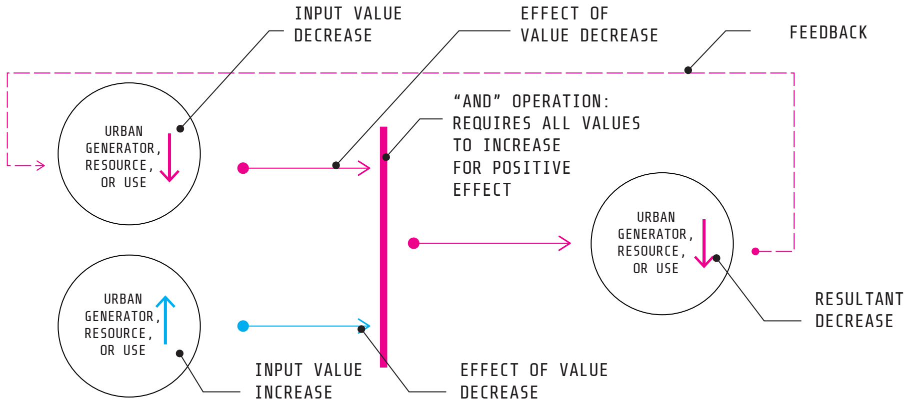


Figure 07.04.b: Diagram demonstrating the processes stimulated by the built environment which create street vitality in Jacobs' ideal old city as the interaction between discrete actors. The process begins with urban generators, high-level qualities of the building fabric that generate urban resources. The interaction between urban resources create informal uses of the street that provide value to the public sphere of the neighbourhood and ultimately result in its vitality.

LEGEND


INPUT VALUE DECREASE
EFFECT OF VALUE DECREASE
FEEDBACK
"AND" OPERATION: REQUIRES ALL VALUES TO INCREASE FOR POSITIVE EFFECT
URBAN GENERATOR, RESOURCE, OR USE
URBAN GENERATOR, RESOURCE, OR USE
URBAN GENERATOR, RESOURCE, OR USE
RESULTANT DECREASE
INPUT VALUE INCREASE
EFFECT OF VALUE DECREASE

together, a variety of people will be drawn to the area with various schedules that put them on the street at different times of the day.[15]

Short Block Length:

Short block lengths allow for a variety of routes to be taken to the same destination.[16] This both reduces congestion and distributes foot traffic more evenly, while also providing more breaks in the building fabric for events to occur. This means that the flow of foot traffic isn't restricted to a few routes and can flow freely past whichever enterprises people choose, rather than limiting their choices. Therefore, a greater potential is created for people to be mixed together, as individuals choose their own routes and have the option to pass by a greater range of people and businesses.

07.05 *Design can facilitate the informal use of public streets*

The design of buildings and public space can also help to facilitate the use of public streets. The design of buildings can increase street activity through aesthetics, and frequent and varied interactions with the street including: programmatic use adjacencies, visual connections, frequent entrances, programmed street activations, and short frontages per enterprise. Building designs can also be articulated to increase daylight to public space, preserve privileged views, and create a suitable micro-climate—improving the experience of public space that can increase foot traffic.[17] Making public space that can host a variety of activities by providing places to sit, lights for visibility at night, garbage cans that help keep streets clean, and other public infrastructure, work together to create a functional space that allows people to adopt it for their own use.[18]

07.06 *Universal access is necessary for the equitable use of public streets*

Universal access allows everyone in the city to access all of the enterprises and amenities the city has to offer, as well as the uses and values of public space. This increases pedestrian traffic by ensuring pedestrians can move through the city freely and not artificially reducing the distribution of pedestrian traffic by restricting access to some people by either formal or informal means.

15 Ibid., 162.
16 Ibid., 181.
17 Ibid., 103.
18 Anne Mikoleit, Moritz Pürckhauer, *Urban Code: 100 Lessons for Understanding the City* (Cambridge: MIT Press, 2011), 60.

07.07 *A diverse building fabric and continuous street traffic from diverse pedestrians can facilitate fair economic opportunities for a variety of businesses and residents*

Diverse building ages and building types create different rental and ownership price tiers that accommodate a variety of businesses, and therefore are necessary to include small businesses in an area that typically can't afford new construction.[19] Since many small businesses have larger overheads and less standardization than corporate enterprises, and can't be well-known enough to be supported exclusively by the crowd they draw, many businesses also require the frequent and even street traffic of a diverse building fabric to survive.[20] Therefore, continuous pedestrian street traffic allows for a variety of businesses in a neighbourhood to all be accommodated by the continuous flow of possible clients.

In return, a diverse selection of enterprises provides residents with various retail and other business options to choose from that best support their lifestyles. Diverse economic options for residences creates a variety of price tiers that allow residents of an area to move between different affordability levels without completely relocating as their means change. The diverse job opportunities from a variety of businesses can also contribute to upwards class mobility while retaining residents in a neighbourhood.[21]

07.08 *Communities can be formed when the building fabric facilitates the use of space through urban resources*

Communities are created primarily by the facilitation of social encounters after many small interactions build trust and relationships over time.[22] Social encounters can only occur when people are mixed together and have things to do, and therefore creating continuous, frequent street traffic throughout the day provides more opportunities for communities to form. Diverse building fabric with various amenities and businesses provides a variety of activities and social or economic options for inhabitants. It also creates a continuous building wall with activated areas of visual connections, entrances, and street activations such as patios and sidewalk sales that provide opportunities for neighbours to see each other,

19 Jacobs, *The Death and Life,* 156.
20 Ibid., 147.
21 Ibid., 212.
22 Ibid., 56.

for events to occur, and for social encounters to happen. Continuously inhabited streets provide little opportunity for crime to occur unnoticed and thus increase safety,[23] while simultaneously the safety of the area and the continued interaction of its occupants builds trust and familiarity that adds up over time due to the resident retention of a vibrant neighbourhood.[24] This can provide favourable conditions for raising children, in which the children benefit from the social contact with the diversity of people in the area, and are kept safe by the continuous street traffic, eyes on the street,[25] and known community members.[26] When residents are retained long enough, together these factors combine over time to create a community. With the vitality of street life, a spectacle is created[27] which can at times be heightened by the ability for people to congregate for performances or demonstration. A positive feedback loop forms as the spectacle puts more eyes on the street and residents watch events unfold, providing further safety, and making it more inviting for people to join the street.[28]

07.09 *Since urban resources can generate vitality, their equitable distribution creates inclusive spaces*

The quality of urban life is created by the combination of informal uses providing value to the city's inhabitants in the form of vitality—including a community, inclusiveness, equal economic opportunity, and land value. In *The Urban Revolution*, Lefebvre defines the right to the city as, "the right not to be excluded from centrality and its movement."[29] Therefore, the right to the city would include both the right to access city space and its intensity (centrality), as well as the right to participate in its functions through the use of space, and receive the benefits of its vitality (movement).

23 Ibid., 35.
24 Ibid., 56.
25 Ibid., 81.
26 Ibid., 61.
27 Ibid., 42.
28 Ibid., 40.
29 Lefebvre, *The Urban Revolution*,150.

According to Jacobs, the inclusion of all of the city's inhabitants is important to the creation of diversity which produces vitality of street life.[30] Lynch argues that not only is diversity necessary to create vitality, but the inclusion of the entire city's population is, "one fundamental characteristic of a good city,"[31] and an important freedom for its inhabitants.[32] Similarly, Lefebvre, in his *urban laws* calls for an, "end to separation, to the separation between people and things, which brings about multiform segregations."[33] For these reasons, in order to create an inclusive city, all residents need to have access to the city's vitality and informal uses. Since urban resources catalyze and support vitality, a good distribution of urban resources is a significant indicator of an equitable city.

In Jacobs' ideal scenario of the *old city*, diverse groups are brought together by the accommodation of many different types of businesses, residences, and amenities. The safety of the frequented and watched city streets and diversity of user groups allows strangers to contribute to the vitality of the street, without becoming an identifiable outsider.[34] The result is a neighbourhood which benefits from the presence of all social groups when mixed together by generating more activity on the street and more potential for local businesses and social encounters.

07.10 *Due to the quality of life they produce and the land value of vibrant neighbourhoods, urban resources have quantifiable monetary value*

The most significant way in which the vitality of a neighbourhood manifests in quantifiable value is in land value. Land value is influenced by supply, demand, and desirability. While supply and demand are influenced largely by population growth, investors, the amount of development allowed through regulations, and banks who finance both development and mortgages;[35] the value between neighbourhoods and parcels within these macro-scale trends is determined by the desirability of one area's quality of life compared to another.[36] People are willing to pay more for access to quality of life such as the vitality of a neighbourhood, its centrality, and connectivity.

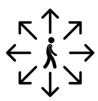
30 Jacobs, *The Death and Life*, 165.
31 Lynch, *Good City Form,* 229.
32 Ibid., 208.
33 Lefebvre, *The Urban Revolution,* 178.
34 Jacobs *The Death and Life,* 209.
35 Harvey, *Rebel Cities,* 46.
36 Lynch, *Good City Form*, 258.

One of the most overt ways in which access to quality of life affects land value is in proximity to subway stations. A study by real estate company Avison Young found that residences within 500 metres of a subway station in Toronto sold for a full 30% more than those farther away.[37] However, even more ephemeral qualities such as the amount of daylight have a quantitative value in the city. In *Three-dimensional City, Contained Urban Space*, former UT Dallas economics professor Dr. Irving Hoch demonstrates that the amount of daylight a condominium unit receives can be incorporated into an equation which represents the amount of monetary value added to an apartment unit.[38] Therefore, these qualities of the built fabric that produce vitality also have a monetary value due to the increased desirability of real estate. In this sense, the quality of city streets and the composition of the building fabric is commoditized by land value.

37 Garry Marr, "Toronto Property Near Public Transit Worth 30% More Than Other Buildings, Study Finds," *Financial Post* (Toronto, ON), last modified November 26, 2015, http://business.financialpost.com/news/property-post/toronto-property-near-public-transit-worth-30-more-than-other-buildings-study-finds
38 Irving Hoch, "The Three-Dimensional City: Contained Urban Space," in *The Quality of the Urban Environment: Essays on "New Resources" in an Urban Age*, ed. Harvey S. Perloff (Washington: Resources for the Future Inc., 1969), 90.

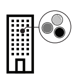
CODIFIED SUMMARY OF URBAN RESOURCES

Urban resources are the physical qualities of the building fabric that stimulate informal uses of public space. Jacobs argues that these characteristics existed intrinsically in the old city, but with modern planning techniques and development types, would need to be designed into the building fabric. Jacobs commonly referred to these characteristics simply as diversity. However, her descriptions of urban processes include many other qualities that also stimulate informal uses of public space beyond diversity alone. Since the qualities are measurable physical characteristics that can be created and destroyed, and have both qualitative and quantitative value, they are given the term urban resources.



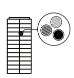
DIVERSE PEDESTRIAN TRAFFIC DISTRIBUTION

DESCRIPTION: The ability for the building fabric to distribute pedestrians in city space throughout the day. A good distribution is achieved when a diverse group of people have different schedules that put them on the street at different times, and universal accessibility and high connectivity allow them to move freely through space. People in public space create vibrancy as well as commercial opportunities that make pedestrian traffic incredibly valuable in the city.
CREATED BY: Multiple primary uses, building age mix, short blocks, universal access
GENERATES: Diverse amenity access, eyes on the street, social encounters, street activations, ability to congregate, distribute information



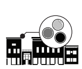
RESIDENTIAL UNIT DIVERSITY

DESCRIPTION: Residential unit diversity is the mix of housing types, unit types, and price tiers in an area. This is typically created when mixed primary uses add residential program to an area, and building age mix provides a variety of residence types that can accommodate a wide range of people and lifestyles.
CREATED BY: Multiple primary uses, building age mix
GENERATES: Economic options, eyes on the street, diverse amenity access



COMMERCIAL UNIT DIVERSITY

DESCRIPTION: Commercial unit diversity refers to the mix of spaces for businesses that allows for a variety of enterprises to be present in an area through differently sized and priced spaces that can provide for various business sizes and types.
CREATED BY: Multiple primary uses, building age mix
GENERATES: Economic options



AMENITY AND RETAIL DIVERSITY

DESCRIPTION: Amenity and retail diversity is the mix of building types and price brackets for spaces suited towards retail uses that allow for many different types and price brackets of retail amenities in an area. This gives inhabitants access to all of the services they need, as well as options to choose between different enterprises offering the same service. With this increased access, walkability is improved as people can reach more of the amenities they require on foot with a reasonable distance.
CREATED BY: Multiple primary uses, building age mix
GENERATES: Eyes on the street, continuous urban street wall, frequent street wall openings, street activations, continuous diverse pedestrian traffic

CONNECTIVITY

DESCRIPTION: Connectivity is the ability to access buildings, amenities, points of interest, and other parts of the building fabric. It refers to not only the proximity of things to access, but also the ease of access, access to transportation such as subway stops, and the diversity of destinations that are accessible, since being connected to twenty instances of the same enterprises provides less value to residents than access to twenty unique enterprises.
CREATED BY: Short blocks
GENERATES: Diverse amenity access

PUBLIC INFRASTRUCTURE

DESCRIPTION: In order for public space to be useful, pleasant, or accommodating, inhabitants also need equipment such as benches to sit, garbage cans to keep streets clean, public restrooms, wide sidewalks to accommodate a range of activities such as children playing, or streetlights to keep areas populated and safe. These features keep public space habitable by ensuring people don’t have to leave public space unnecessarily, keeping it maintained, and allowing people to enjoy using public space.
CREATED BY: Design
GENERATES: Pedestrian traffic

SIGNIFICANT LINES OF SIGHT

DESCRIPTION: Privileged views provide a spectacle for the city’s residents, can become an attraction of themselves, and improve quality of life by providing interesting sights in public space. A city which works towards privileged views for public spaces creates value for all of its inhabitants.
CREATED BY: Design
GENERATES: Pedestrian traffic

DAYLIGHT

DESCRIPTION: Jacobs describes shade as a street desolator, meaning that access to daylight is important to keeping people active and on the street. The building fabric should respond, avoiding unnecessarily shading public space.
CREATED BY: Design
GENERATES: Pedestrian traffic

CLIMATIC ENVIRONMENT

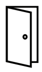
DESCRIPTION: The climatic environment includes all other environmental factors that would draw people to, or keep people from the street. Typically overly cold or hot weather, poor air quality, or excessive precipitation keep people from the street and are often a reason for the defence of sky-ways (such as escaping Toronto's winter in the PATH). It is also possible based on the environment to provide interventions in public space to keep people comfortable such as shade, protection from rain or wind, water features, or daylight.
CREATED BY: Design
GENERATES: Pedestrian traffic

AESTHETIC QUALITY

DESCRIPTION: Aesthetic quality refers to the ability for the public to enjoy the architecture of the neighbourhood, and can include both contemporary design as well as historic buildings. Streets that are interesting for the public make them popular and frequently visited, making them suitable to supporting businesses and influences the price of its buildings, land, and units.
CREATED BY: Design
GENERATES: Pedestrian traffic

CONTINUOUS URBAN STREET WALL

DESCRIPTION: A continuous urban street wall provides the substrate for interactions and events to occur. Without the programmed space provided by the street wall, little interactions and events unfold as large gaps in the urban street wall such as parking lots and parks can be street desolators. Although, when enough diversity and density is generated to fill them, parks can also create an added relief from the city and programmed public spaces (see "street activations") can draw some pedestrian traffic on their own accord, this would not be a suitable strategy to sustain the vitality of all city streets.
CREATED BY: Density, retail diversity
GENERATES: Social encounters



FREQUENT STREET WALL OPENINGS

DESCRIPTION: Street wall openings are the connections buildings make with the public realm. Without openings, the street would only be fronted on by a solid wall, providing little opportunity for anything to occur in the public realm (even if the wall is glass). Larger openings such as amenity program with garage doors that stay open are highly effective at creating cross-interactions between the building and the street, while regular doors provide effective, although less intense connections. Windows can provide visual connections but don’t tend to create social encounters.
CREATED BY: Diverse amenity access, design
GENERATES: Social encounters

SHORT FRONTAGE

DESCRIPTION: Short frontages provide access to a diverse array of enterprises, and create more frequent changes throughout the street that stimulate more events, social encounters, and economic opportunities than a single large frontage which creates only a single condition for a long stretch of the street.
CREATED BY: Design, mixed building age
GENERATES: Economic options, social encounters

EYES ON THE STREET

DESCRIPTION: “Eyes on the street” include not only the people on the street itself, but also people in their homes or businesses who monitor the street, either through their own self-interest of protecting their businesses or home, or because of the spectacle created by street vitality. Eyes on the street prevent crime from occurring by providing little opportunity for it to go unnoticed.
CREATED BY: Retail diversity, residential diversity, pedestrian distribution, pedestrian traffic, spectacle
GENERATES: Safety

STREET ACTIVATIONS

DESCRIPTION: Programmed outdoor spaces activate the street and include patios for eating and drinking or racks and shelves of retail items for street sales, as well as programmed park spaces for recreational activities. Both diversity and frequency of street activations are also important, as they provide a greater range and amount of social or economic scenarios that pedestrians can join.
CREATED BY: Retail diversity, pedestrian traffic, pedestrian distribution, design
GENERATES: Social encounters, spectacle

CODIFIED SUMMARY OF URBAN GENERATORS

Urban generators are high-level characteristics of the building fabric that produce urban resources. They are the conditions of Jacobs' old city that arose naturally due to the public access of the street network and the fine grain of parcels and streets allowing for distributed development, diversity of enterprises and people, and healthy competition for spatial control that kept streets equitable. Jacobs identifies these qualities because they are the qualities the modernist plans of the time lacked which she concluded would destroy the processes of the city that created vitality. Jacobs commonly referred to these as generators for diversity, but are herein called urban generators due to the additional criteria captured by the term urban resources.

PRIMARY USE MIX

DESCRIPTION: Primary use mix is one of Jacobs' four generators of diversity. It provides multiple reasons for people to be in an area, and therefore provides diversity by adding a new group to the area with different schedules that will populate the street at different times.
GENERATES: Retail diversity, residential diversity, commercial diversity, pedestrian distribution

BUILDING AGE MIX

DESCRIPTION: Building age mix is one of Jacobs' four generators of diversity. A mix of building ages creates a variety of building types due to changing architectural styles over time, as well as a variety of pricing tiers from different states of upkeep and the age of construction. This enables a variety of businesses and people to inhabit the area, as well as variety within the streetscape in which many openings or street activations create opportunities for the public to interact with enterprises or each other.
GENERATES: Retail diversity, residential diversity, commercial diversity, pedestrian distribution

DENSITY

DESCRIPTION: Density is one of Jacobs generators of diversity, and is necessary to create the intensity that produces continuous street traffic. In low-density areas, there aren't enough people to maintain traffic and eyes on the street throughout all times of day on all streets.
GENERATES: Pedestrian traffic

SHORT BLOCKS

DESCRIPTION: Short blocks are one of Jacobs' four generators of diversity. Short blocks allow for people to take a variety of routes to go to the same location. This allows for reduced congestion, better distribution of pedestrian traffic, and more interruptions in the street grid that create variety.
GENERATES: Pedestrian distribution, connectivity

DESIGN

DESCRIPTION: The aesthetic quality influences the places people decide to occupy and the design of the urban fabric works to create spaces people can use. Design can provide public infrastructure, privileged views, decrease or increase shade thrown from buildings appropriately, create visual and programmatic connections, and improve the local micro-climate.
GENERATES: Public infrastructure, aesthetic quality, privileged views, daylight, suitable climate

UNIVERSAL ACCESS

DESCRIPTION: Universal access is the open accessibility of the urban fabric to everyone in the city. This generator refers to formal controls, which include: security, identity checks, walls and fences, and rules and regulations. Informal controls (not included here) can vary from: convoluted wayfinding, to naming conventions, size or height as expressions of dominance, to a lack of safety, or making some individuals feel unwelcome. These informal controls are represented by the urban resources which work together to create a neutral space.
GENERATES: Pedestrian distribution, pedestrian traffic, ability to congregate, distribute information, inclusiveness

CHAPTER 08

AN UNDER-REGULATED VOLUMETRIC CITY PERMITS PROFIT-DRIVEN ARCHITECTURE THAT CAN DIMINISH THE CITY'S URBAN RESOURCES

Now that it has been determined how vibrant streets work and the physical qualities of the building fabric that can stimulate vitality, this understanding can be applied to the volumetric city to probe why this typology has typically failed to produce street vitality throughout volumetric space. The following points illustrate how economic factors have previously created a very coarse grain in the building fabric that introduced greater and monopolistic private control to volumetric cities. The result is that the urban resources needed to create vitality throughout the building network are depleted. The following points demonstrate the various ways in which this oligopoly of the infrastructure and commons of the city fails to produce urban resources because of a lack of competition and economic incentive to do so.

08.01 When appropriately sited, programmed, and designed, developments can contribute diversity and density to an area

08.02 The vitality created by the success of development in an area can lead to its own over-development by grouping new large-scale buildings together

08.03 Over-development can reduce the mix of primary uses, building ages, and price tiers that create diversity

08.04 Over-development can reduce connectivity that creates diversity

08.05 Reduced diversity and connectivity creates areas of identifiable monocultures that segregate the population

08.06 Monocultural urban fabric reduces street activity by producing intense spikes of public activity followed by long periods of desolation

08.07 Large-scale buildings provide fewer street activations due to longer street frontages

08.08 Large-scale buildings grouped together can reduce atmospheric qualities such as daylight and significant lines of sight

08.09 Contemporary volumetric cities tend to emerge from large-scale construction and inherit their inhibition of urban resources

08.10 A building network could spur a new wave of centralized development by drastically increasing the investment potential of adjacent lots

08.11 Building networks shift people from public space to privately controlled quasi-public space, privatizing the commons

08.12 Private control of a quasi-public building network gives the owner all the spatial rights of this urban realm

08.13 A quasi-public building network can be controlled through formal controls such as private rules, regulations, and policing

08.14 Private control of a building network removes this part of the commons from urban design guidelines and enables informal controls of space

08.15 The control of the city's commons should be scrutinized for inequity and incompetence

08.16 The privatization of the commons and segregation of the population would discard the functions of the city that create vitality

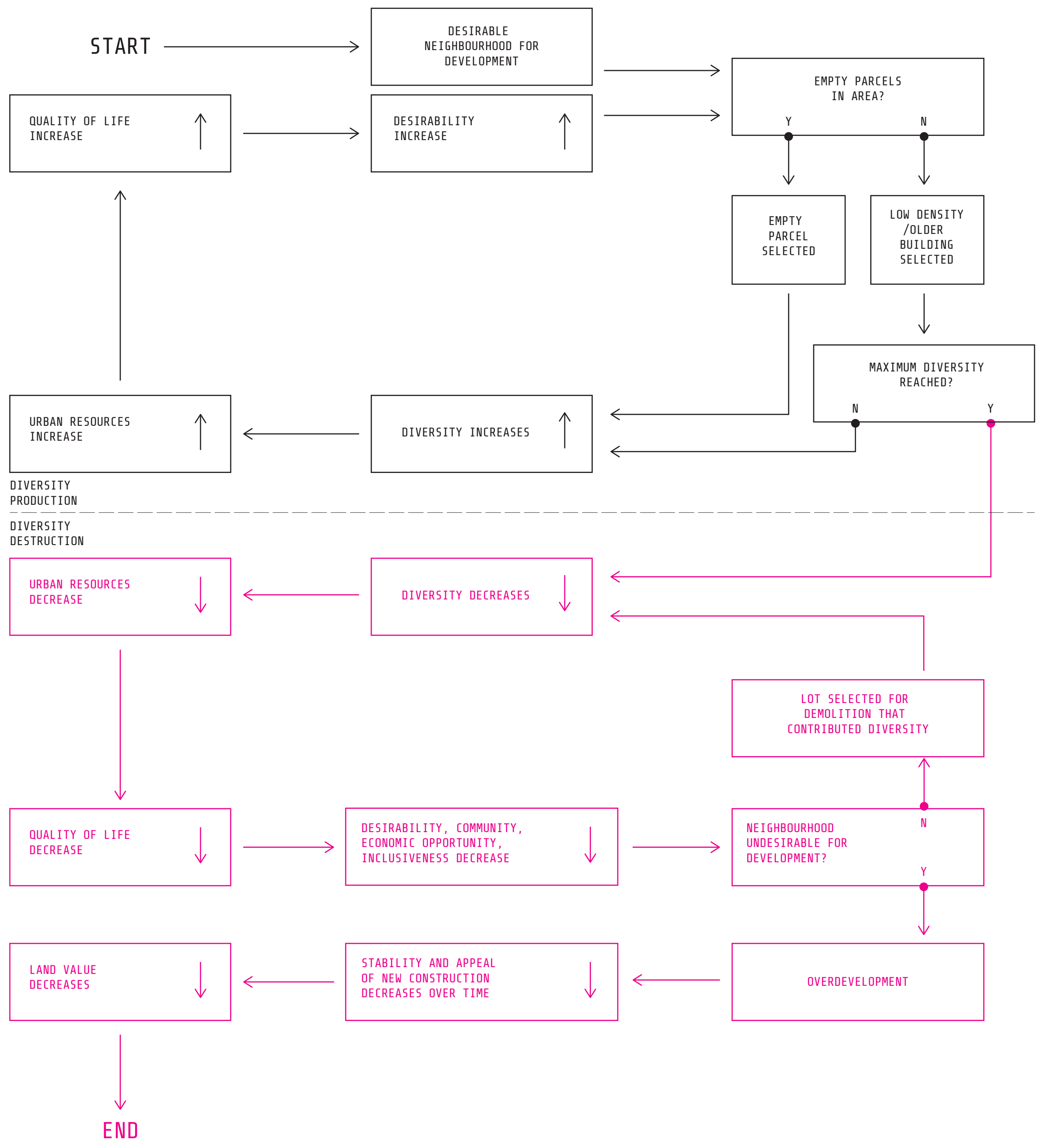


Figure 08.02: Diagram of Jane Jacobs' explanation of the self-destruction of diversity—how the success of an area's diversity creates vitality, making it a prime location for development that can occur quickly enough that the diversity of the urban fabric that made it popular in the first place is replaced by excessive duplications of the same type of new construction. Ultimately, once the appeal of the new construction wears off over the span of years, the neighbourhood's inability to generate street traffic, and therefore a community, economic oppoprtunity, street vitality, and inclusiveness, could result in the depreciation in the value of land as quality of life drops.

08.01 *When appropriately sited, programmed, and designed, developments can contribute diversity and density to an area*

New developments can help meet the high demand for housing and help bring diversity to an area by adding new social groups. Strategically designed developments can improve the urban fabric if the program they contain and their rate of introduction into an area are carefully considered, such that diversity and density are increased simultaneously throughout the city as a whole, rather than focusing development in one area.[1]

08.02 *The vitality created by the success of development in an area can lead to its own over-development by grouping new large-scale buildings together*

Jacobs' chapter on the self-destruction of diversity describes how the continuation of the processes that create diversity can ultimately lead to its own destruction due to the lack of a negative feedback mechanism that allows overcrowding of a single use or building type. A vibrant and central area has many urban resources and informal uses and can become so successful, that it becomes an ideal site for development, since highly desirable parcels provide the high demand that makes an investment stable.[2] The remaining parcels with lower densities and older buildings continue to provide needed diversity until the new construction has aged. However, these low-density parcels create a low-risk and high-reward opportunity in which the high demand created by the area's success makes the units more marketable, and the low density of existing construction makes it possible to increase the value of the lot by constructing a high-density building. At some point, the economic success of diversity in the area has proceeded so far that diversity is being destroyed rather than created, grouping the construction of numerous new large-scale buildings together and overwhelming the existing neighbourhood (Figure 08.02).[3]

In Toronto, the *Tall Building Guidelines* successfully identify this problem, stating: "Tall buildings are desirable in the right places but they don't belong everywhere. . . .When poorly located and designed, tall buildings can physically and visually overwhelm adjacent streets, parks, and neighbourhoods. They can block sunlight, views of the sky and create uncomfortable wind conditions in adjacent streets, parks and open space, and create traffic

1 Jacobs, *The Death and Life,* 214.
2 Harvey, *Rebel Cities,* 17.
3 Jacobs, *The Death and Life,* 251-252.

congestion."[4] However, the guidelines, unfortunately, do not offer any resolution to this significant problem, stating, "these city-wide Guidelines do not address where tall buildings should be located or how tall they should be on a specific site."[5]

08.03 *Over-development can reduce the mix of primary uses, building ages, and price tiers that create diversity*

New developments trend towards larger-scale buildings both because of a demand for higher densities and because, "large profits are possible from large-scale manipulations of land."[6] Large-scale buildings tend to increase the grain of the city by amalgamating smaller lots, reducing the mix of primary uses, building ages, and price tiers. Toronto's guidelines state that, "larger sites can offer certain planning and design advantages, including the ability to . . . provide a mix of open space and building types, and a diverse range of housing options and affordability."[7] However, this argument is actually the inverse of Jacobs' observations, in which small sites allow for a diversity of price points by allowing for buildings of different ages, types, and programs. Since, "mixed-use buildings are more expensive to design and build than single-use buildings,"[8] and it is easier to market and sell a building in an area known for a specific use—unless diversity is written into legally enforceable regulations, the only option that will be considered in practice will be the most profitable building type and program, and diversity will decrease.

Areas that are overdeveloped will have several buildings grouped together, erected within a short time frame, creating low building age and type mixes.[9] For large-scale buildings, this can mean a significant portion of the city has little variation in its unit pricing in comparison to the small grain of Jacobs' *old city*. Since new construction tends to be more expensive than existing construction, the result is that a wealthier section of the population is selected to reside in an area of new developments.[10] For these reasons, neighbourhoods can lose the diversity that brings a variety of people to

4 City of Toronto, "Tall Buildings," *City of Toronto,* accessed October 15, 2017, http://www1.toronto.ca/wps/portal/contentonly?vgnextoid=80a70621f3161410VgnVCM10000071d60f89RCRD, .
5 Ibid.
6 Lynch, *Good City Form*, 268.
7 City of Toronto, *Tall Building Guidelines*, 16.
8 Witold Rybczynski, "The Demand Side of Urbanism," in *Why place matters: Geography, identity, and civic life in modern America,* eds. Ted McAllister and Wilfred McClay (New York: Encounter Books, 2014), 128.
9 Jacobs, *The Death and Life,* 252.
10 Bengt Nyman, *Building Sector Regulations* (Copenhagen: Nordic Council of Ministers, 2004), 13.

an area. Toronto's Official Plan exacerbates building standardization by prescribing a single type, stating "a tall building should consist of three carefully integrated parts: a base building, middle, and top,"[11] promoting high-density podium-tower buildings. Zoning plans also decrease diversity, initially used to separate incompatible adjacencies such as industrial uses and residences, Jacobs criticizes the entire practice, suggesting, "we have to deal outright with combinations or mixtures of uses, not separate uses."[12]

08.04 *Over-development can reduce connectivity that creates diversity*

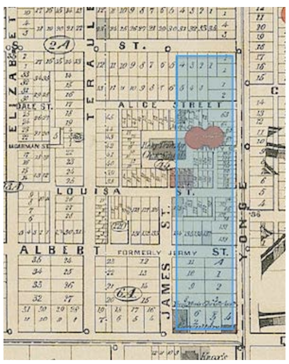


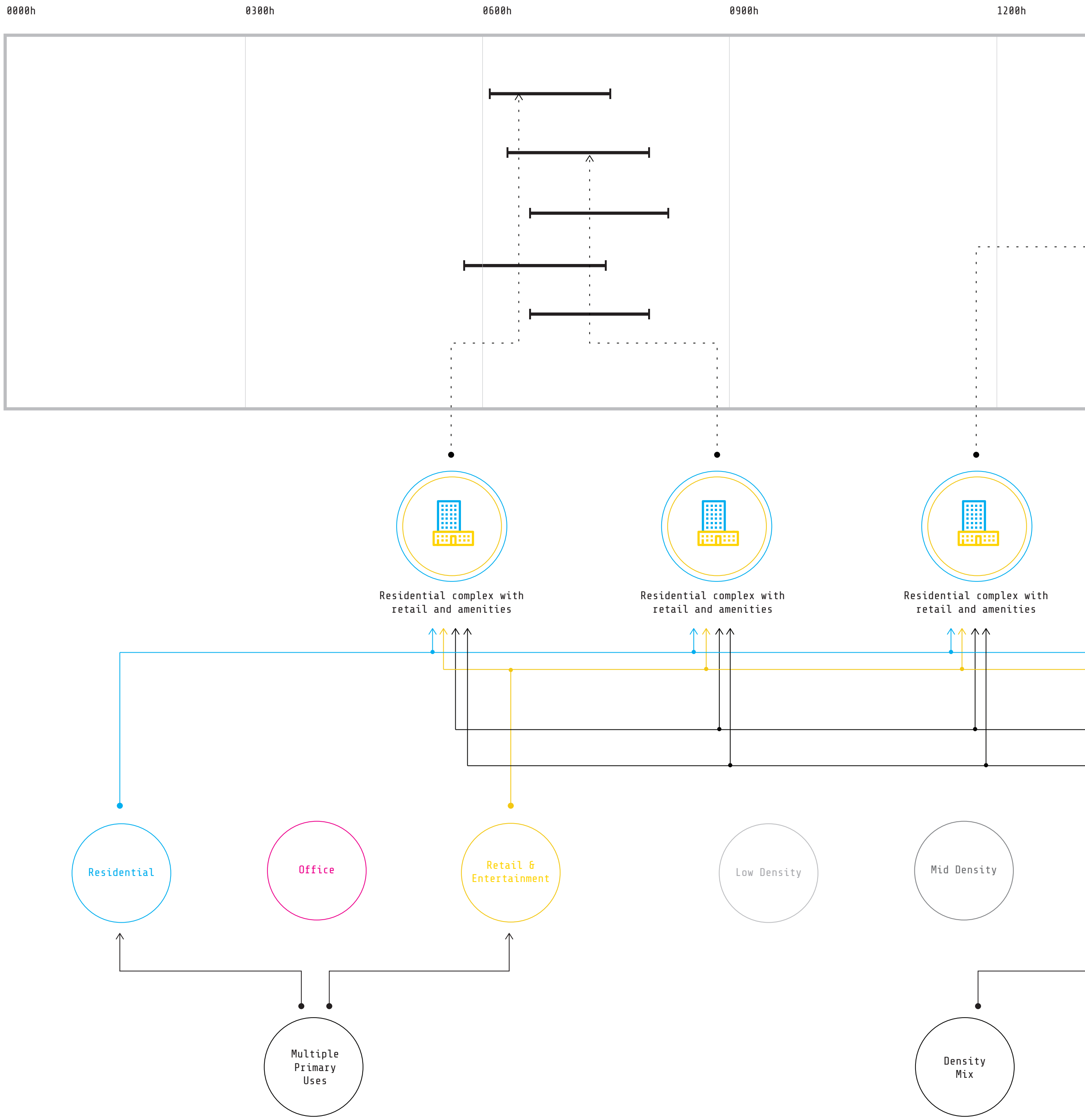
Figure 08.04: The footprint of the Eaton Centre overlaid on a historic map of Toronto showing the previously existing streets cut off by the new construction. This reduction in connectivity decreases the ability for people to mix, and creates long similar frontages without breaks that provide less social and economic opportunities.

If a large-scale development creates too few, or eliminates streets in the process of amalgamating parcels, for instance like the Eaton Centre terminating Alice Street, Louisa Street, and Albert Street between Bay and Yonge,[13] the block length is increased in opposition to Jacobs' suggestion for short blocks as a generator for diversity. Similarly, a development of multiple similar buildings may impede traffic flow through it due to the informal control of space, or an identifiable *turf* that dissuades outsiders. This constrains the path a pedestrian can take to only a few routes and doesn't allow people to change paths on different occasions. People's routes cannot vary to bring them past a greater variety of businesses, and people are forced to remain on separate paths unnecessarily, reducing the mix of pedestrians that could otherwise create social encounters.[14]

Long block length is further problematized in the volumetric city in which inter-building connections extend the street network. In this case the more connections to adjacent buildings and the more frequent the connections throughout the building's height, the greater the connectivity, and therefore the greater mix of people and better access. However, connections between buildings can be expensive and the ideal amount of connectivity might not be economically justifiable. Furthermore, the more connections created, the greater the risk of an incoherent network that is too complex in three-dimensional space to navigate effectively.

11 City of Toronto, *Tall Building Guidelines*, 36.
12 Jacobs, *The Death and Life*, 144.
13 Chris Bateman, "The Lost Street Names of Toronto," *blogTO* (Toronto, ON), last modified March 17, 2012, http://www.blogto.com/city/2012/03/the_lost_street_names_of_toronto/.
14 Jacobs, *The Death and Life*, 181.

HIGH TO LOW INTENSITY HOMOGENOUS STREET ACTIVITY



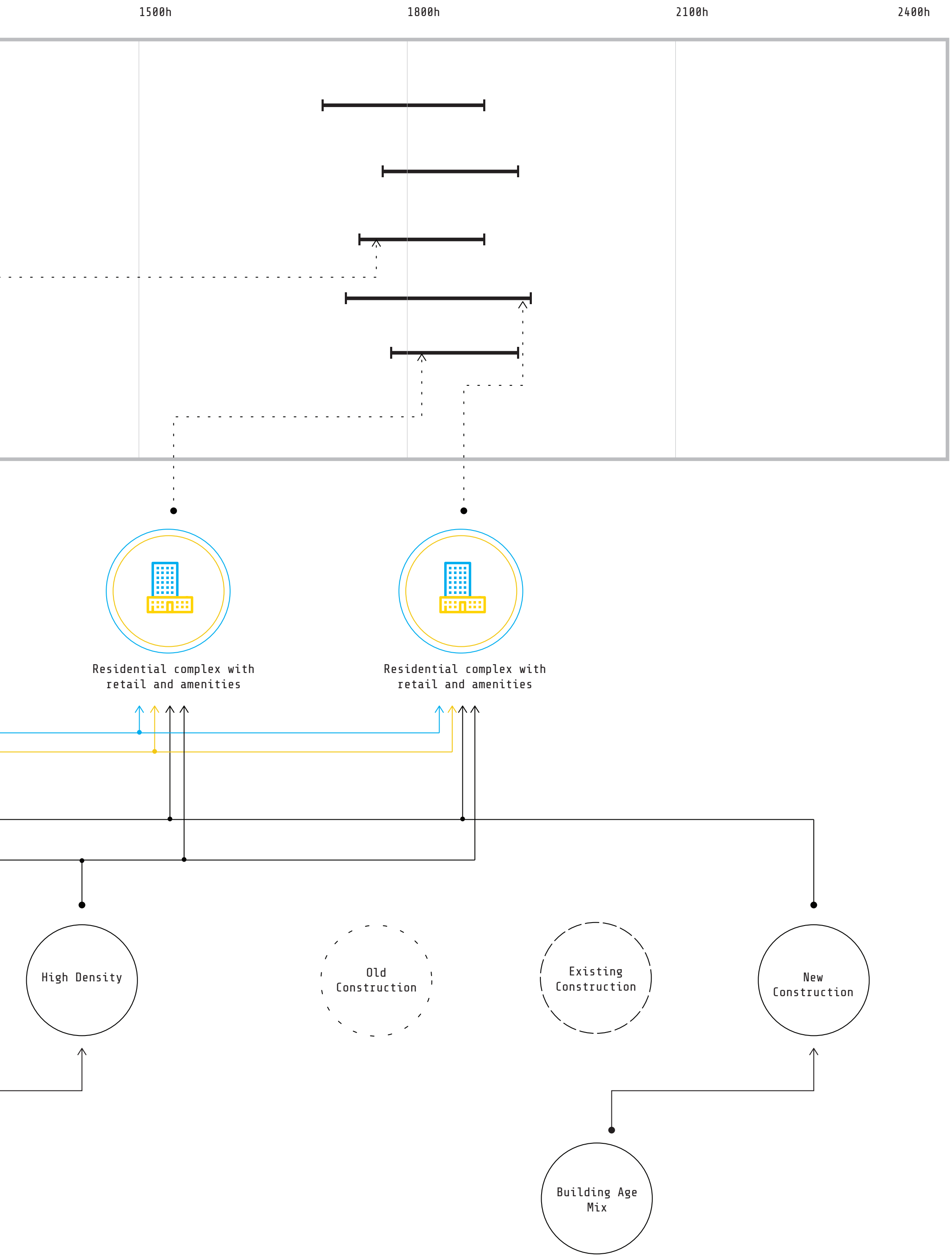


Figure 08.06: An idealized diagram demonstrating how the replication of a single building type within a short time frame can reduce street activity by hosting individuals with similar daily schedules. The similar building types, price points, and targeted marketing can create a neighbrouhood with a monocultural socio-economic group that is composed of people with similar budgets, lifestyles, and schedules. This puts the majority of residents on the street at the same time and fails to support a diversity of businesses. This means that density alone isn't sufficient to populate city streets, and too much density can result in standardization of the building fabric. The phenomenon also applies to other building types. For example a financial district has office workers on very similar schedules, creating bursts of activity before work, at lunch hour, and after work, but leaves the building fabric largely empty at other times and throughout the weekend.

08.05 *Reduced diversity and connectivity creates areas of identifiable monocultures that segregate the population*

Ultimately, without regulations constraining building siting, economic forces will trend development towards clusters of large-scale buildings that, through targeted marketing of a specific demographic and similar price points, can create pockets of monocultural neighbourhoods. Although new developments have the advantage of the higher-value of new construction and being able to locate in vibrant areas of the city, if the development displaces enough of the city's functions by destroying diversity, over time the quality of life can degrade and the value of real estate diminishes.[15] For example, this was the case for Toronto's St Jamestown, which began as a high-end residence, but due to the destruction of the city's functions, soon fell into the condition of a slum.[16]

08.06 *Monocultural urban fabric reduces street activity by producing intense spikes of public activity followed by long periods of desolation*

Jacobs argues that a lack of any of the four generators of diversity is enough to suppress the diversity needed for street vitality.[17] The diversity of a neighbourhood can become limited enough that its occupants have similar enough schedules that they use the streets within only a short window of time. This creates short periods of overwhelmingly high activity that at times can't be properly supported by the amenities or infrastructure, followed by long, desolate periods of inactivity (Figure 08.06).[18]

08.07 *Large-scale buildings provide fewer street activations due to longer street frontages*

Toronto's guidelines on street animation suggest to, "line the base building with a series of active commercial and retail uses,"[19] as "active street related commercial and retail uses are often the most desirable activity generators in the base building."[20] However, Jacobs' critique suggests the inverse relationship—that the diversity of the neighbourhood should generate the traffic to populate these amenities. Unless the retail spaces are all popular enough to draw crowds from across the city, the presence of retail itself doesn't generate activity; in contrast, bringing a diverse group of people together generates enough activity to support the retailers.

15 Jacobs, *The Death and Life,* 249.
16 Caulfield, *City Form*, 26.
17 Jacobs, *The Death and Life,* 151.
18 Ibid., 101.
19 City of Toronto, *Tall Building Guidelines,* 40.
20 Ibid.

Even when retail is present in large-scale developments, its relationship to the street isn't as strong as building fabric with a fine grain and a high amount of diversity. In comparing Toronto neighbourhoods known for their walkability with recent developments of a similar size (Figure 08.07), the street level of new developments have far fewer openings and entrances, fewer street activations like patios and outdoor merchandise stands, and longer frontages of the same program. This is problematic because street frontage provides the substrate for events to occur in public space: it creates a dialogue between the public realm and private space through visual and physical connections, and provides a variety of economic and social scenarios from the changes in program and usage of the street. Despite an equal amount of retail frontage, the streets of the new development can become desolated because very little can occur when long stretches[21] of the street have only a glass wall with few openings, street activations, program changes, or a variety of businesses.[22] The *Tall Building Guidelines* reinforce similar street frontages, rather than suggesting diversity along the urban street wall: "In locations where grand lobbies and foyers prevail. . . continue their use;"[23] "on streets with a mixed-use or commercial character, line the base building with a series of active commercial and retail uses;"[24] and "on streets with an exclusively residential character, line the base building with grade-related residential units."[25]

08.08 *Large-scale buildings grouped together can reduce atmospheric qualities such as daylight and significant lines of sight*

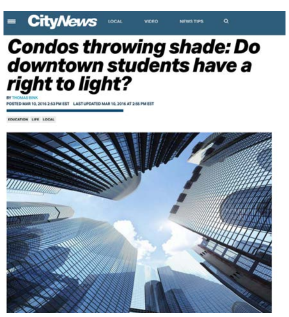
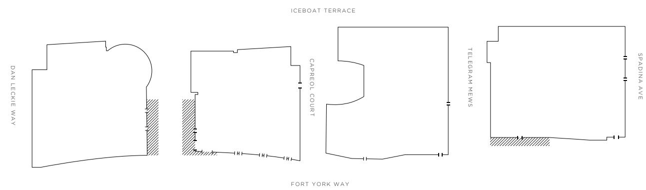
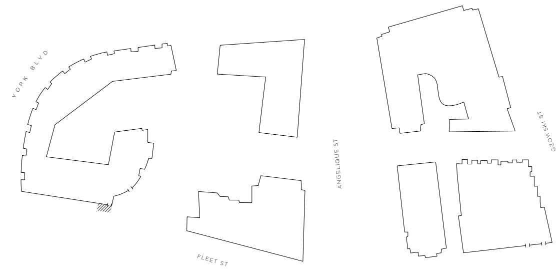


Figure 08.08: News headline discussing whether the city's residents have a right to daylight. Stories published about the clustering of condominium developments indicate that despite the podium tower type's response to setback rules, the allowed frequency and proximity of high-rises is negating the intent of the rules and creating an urban wall effect that shades the adjacent existing fabric.

Although the strict prescription of the podium-tower in the *Tall Building Guidelines* and the *Official Plan* are intended to preserve daylight at street level and reduce the urban wall effect, development in Toronto has become so focused in some areas that daylight is restricted regardless. This can be seen in complaints from residents about new development complexes in which multiple new towers surround existing properties and block sunlight throughout the day (Figure 08.08).[26] Rather than fulfilling the intent of preserving daylight with the podium tower type, because of the scale, frequency, and proximity of developments, an urban wall effect is created, unnecessarily diminishing the atmospheric quality to existing

21 Jacobs, *The Death and Life*, 182.
22 Jacobs, *The Death and Life*, 234.
23 City of Toronto, *Tall Building Guidelines*, 40.
24 Ibid.
25 Ibid.
26 Thomas Bink, "Condos Throwing Shade: Do Downtown Students Have a Right to Light?," *CityNews* (Toronto, ON), last modified on March 11, 2016, http://toronto.citynews.ca/2016/03/10/condos-throwing-shade-do-toronto-students-have-a-right-to-light/.



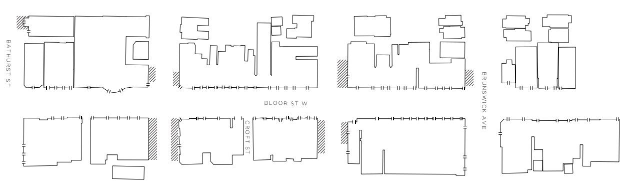


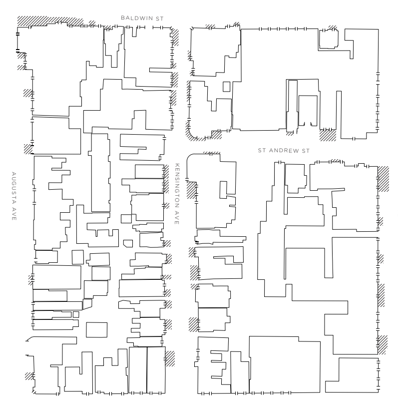
City Place

City Place shows few openings and programmed street activations creating engagements with the public. Although several of the podiums were lined with potential retail space, the units were vacant as of November 2016, despite the development complex being completed 3 years earlier in 2013—indicating that the urban fabric may be creating conditions that are unsuitable for potential businesses. The restaurants did have patios that could activate the street, but even these were largely fenced off and inwardly focused, rather than engaging the perimeter of the development.

Waterpark City

The Waterpark City Condos completed in 2007 showed little centrality, bound on either side by Lake Shore Boulevard and the Gardiner Expressway. This isolation could be one of the reasons for little public engagement at the ground floor, which was mostly private spaces, including residential units, except for a couple of independent shops. Ultimately this means the buildings provided very little for the general public and there is not much reason for an outsider to visit, or things for an outsider to do, creating an urban enclave.





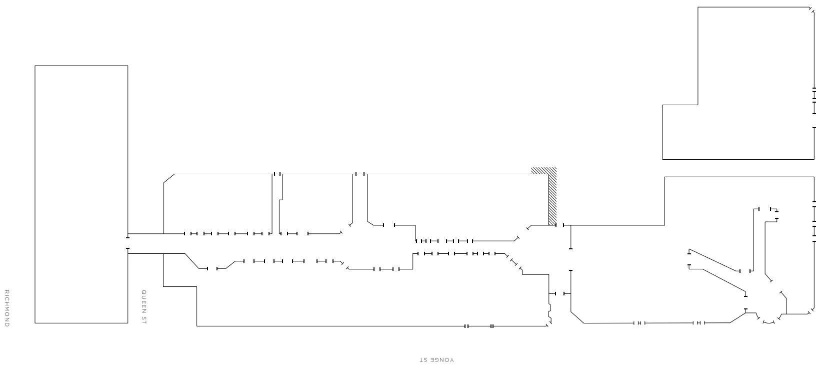
The Annex

The Annex is a popular Toronto neighbourhood, and home to Jane Jacobs upon her immigration to Canada.[2] With many small shops in historic urban fabric, the neighbourhood provides lots of opportunities for interaction with the street, with numerous patio spaces, short frontages, and frequent openings which provide a suitable substrate for the animation of the street.

Kensington Market

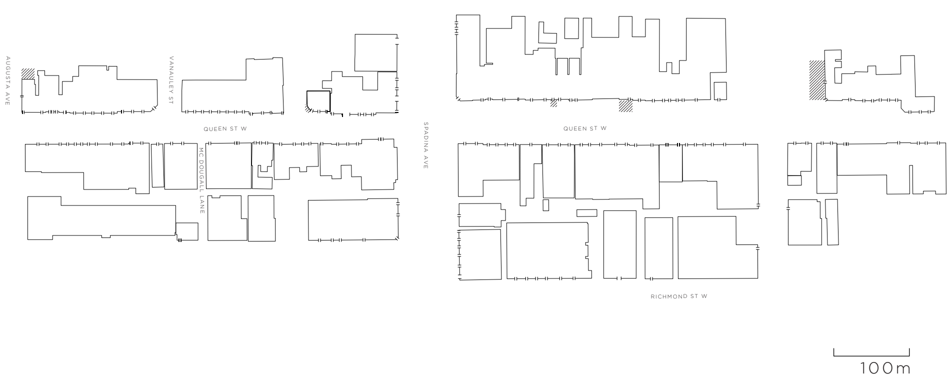
Kensington Market is well known in Toronto as a pedestrian neighbourhood with many small retailers that provide an alternative lifestyle to a niche market across the city. The informal nature of the neighbourhood creates a lot of variation with many openings in the urban street wall, and a wealth of exterior patios and shop spaces activating the street.

Figure 08.07: Case study comparing street activations and public engagements of three large-scale development complexes to the building fabric of three Toronto neighbourhoods known for their street life. The openings and street activations of each show that the diverse fabric engages the street more than the large-scale building developments, providing more animation on the street with increased visual and programmatic connections, more programmed spaces, and providing opportunities for more social encounters or economic exchanges. Therefore, although new developments may include retail spaces, this demonstrates that not all retail spaces provide the same amount of value to the city.



Eaton Centre

Designed as a three-level mall connecting office towers with the Toronto sub-grade PATH network, the Eaton Centre is designed as a multi-leveled covered street, modeled after the Galleria Vittorio Emanuele II in Milan.[1] The connection with the existing building network, the PATH, and the elevator, stair, bridge, and escalator connections throughout the volume make the mall one of the most explicit manifestations of volumetric architecture in the city. The interior arcade has, therefore, been considered a part of the urban "street" grid. Shown here, the third level of the mall engages the exterior street on the north end, while the slope of grade allows for only a bridge connection to the adjacent building on the south end. The interior interactions are noticeably frequent with openings for each shop, creating many opportunities for public interaction with the urban street wall. However, the formal nature of the street restricts any internal public street activations such as patios and external retail spaces, although corporate events do frequently appropriate the walkways.



Queen West

Legend

PUBLIC STREET ACTIVATION

URBAN STREET WALL OPENING

Queen west, another popular pedestrian neighbourhood, also utilizes the historic fabric to create many different openings in the urban street wall. With buildings coming directly to the lot line, the street edge is held with enough permeations to create opportunities for public interaction, allowing for different economic and social exchanges to become possible. The neighbourhood does have notably less patio spaces or exterior retail spaces activating the street than the Annex or Kensington Market, but food and beverage retail on street corners tend to take advantage of side streets with a large patio space.

construction. More adaptable solutions, such as Zürich's regulation in which a high-rise building is limited to throwing a two-hour shadow on an adjacent residential building,[27] create the possibility for a variety of formal solutions to resolve the same problem. This means there are opportunities for fulfilling the intent of guidelines without homogenization of the city through performance regulations, rather than prescriptive regulations.

Super-block projects are apt to have all the disabilities of long blocks, frequently in exaggerated form, and this is true even when they are laced with promenades and malls, and thus, in theory, possess streets at reasonable intervals through which people can make their way. These streets are meaningless because there is seldom any active reason for a good cross-section of people to use them. Even in passive terms, simply as various alternative changes of scene in getting from here to yonder, these paths are meaningless because all their scenes are essentially the same

—Jane Jacobs[a]

08.09 *Contemporary volumetric cities tend to emerge from large-scale construction and inherit their inhibition of urban resources*

The earliest volumetric city schemes were government-led construction projects and competitions that created building developments large enough to accommodate a building network under the direction of the state.[28] However, the contemporary city, distanced from these authoritarian plans, sees the volumetric city constructed by the private sector.

Connections between buildings inherently tend to occur in large developments rather than small ones because of the economic, programmatic, and structural requirements necessary to create them. Small enterprises would generally not be able to afford the expensive construction of the additional structure, and bridge connections between small-scale buildings are less necessary because of their close grain and strong connection to the ground plane—yet inter-building connections are more practical and in some cases economically beneficial in large-scale buildings. In the case of residential buildings, inter-building connections can materialize as a method of creating new floor areas of high-value real estate, creating shared amenities, or to give the building a marketable identity.[29] In a commercial context, inter-building

27 Alex Lehnerer, *Grand Urban Rules* (Rotterdam: 010 Publishers, 2009), 149.
28 James and Yoos, *Parallel Cities,* 76.
29 Luke Simcoe, "Developers Turning to Skybridges to Add Creativity to New Developments," *The Toronto Star* (Toronto, ON), last modified August 14, 2015, https://www.thestar.com/news/gta/2015/08/14/toronto-developers-turning-to-skybridges-to-add-creativity-to-new-developments.html.

[a] Jacobs, The Death and Life, 186.

connections tend to occur to strengthen the relationship between stores[30] or office locations by optimizing some routes[31] (while obscuring the wayfinding for others), and circumventing an unfavourable local climate[32] in order to retain customers and employees longer.[33]

As downtown development trends towards an increasingly larger scale, the size of contemporary high-density buildings, coupled with shared amenity spaces, already begins to define quasi-public space within a single tower. The podium connection between towers of multi-tower developments furthers this volumetric quality by connecting vertical cores of multiple buildings constructed around the same time. This connection can be strengthened at higher levels by bridge connections between towers, or the design of towers that intersect. As large-scale buildings begin to group together from economic pressure, connections between separate building developments become possible. Together, these factors mean that a building network would most likely be defined by the connection of large-scale buildings in close proximity to each other, built successively within a narrow time frame. Therefore, the problems of generating diversity and urban resources facing large-scale construction will also be inherited by the volumetric city.

08.10 *A building network could spur a new wave of centralized development by drastically increasing the investment potential of adjacent lots*

The formation of a building network could allow for higher density targets to be achieved, both due to the benefits of a network of added amenities making it possible to house more people, as well the possibility for cities to provide height bonuses to buildings which integrate into the network, as exemplified in Calgary.[34] This change could be a paradigm shift which drastically alters the value of lots that can integrate into the network compared to those which cannot, potentially increasing the likelihood for lots occupied by existing diverse urban fabric to be acquired for development and grouping new developments more intensively.

30 Toronto Financial District BIA, "7 Little Known Facts," *Toronto Financial District*.
31 Ode, "Minneapolis Skyway System," *Star Tribune*.
32 City of Toronto, *PATH Pedestrian Network Master Plan*, 33.
33 Shawn Micallef, "Aura: Toronto's most visible and invisible building," *The Toronto Star* (Toronto, ON), last modified January 16, 2016, https://www.thestar.com/life/2016/01/16/aura-torontos-most-visible-and-invisible-building.html.
34 James and Yoos, *Parallel Cities,* 198.

08.11 *Building networks shift people from public space to privately controlled quasi-public space, privatizing the commons*

The addition of amenities at extra-grade levels has become a common element in architectural design, as well as the marketing of a development. While high-density towers can contribute a needed population to street traffic, they can only do so if the inhabitants use the streets. With gyms, outdoor parks, pools, music, dance, art, photography, and yoga studios, restaurants, and grocery stores in new developments, the need for inhabitants to leave a building complex can become greatly diminished.

Got artistic flair? A favourite hobby? Indulge your everyday whims at the Prisma Club, with creative studios for music, dance, art, photography, yoga and more.

—Exchange Condos[b]

Picasso's 10th floor is amenity heaven, with a chic party lounge featuring floor-to-ceiling windows that provide an ever-changing seasonal display as a background.

—Century 21 on Picasso Condos[c]

Incredible amenities include a rooftop terrace, 40,000 sq ft Hard Candy fitness facility, founded by Madonna.

—Aura, College Park Condos[d]

From up here, things are looking good.

—Selene Metrogate condominiums by Tridel[e]

Toronto's guidelines encourage private open space at extra-grade levels[35] and extra-grade connections,[36] and Lisa Rapoport of PLANT Architect argues that cities such as Toronto are informally encouraging the addition of quasi-public amenity space into private buildings in order to meet the needs of neighbourhoods rapidly reshaped by development.[37] With the adoption of large-scale private development as the solution to all the amenity needs of the urban resident, this means that even before connections between building cores are made, residents of high-density cities will already spend more time away from the public commons at grade level.

[b] Concord, "Amenities," Exchange, accessed November 10, 2017, http://exchangecondos.ca/content/amenities/.
[c] Pace Condos, "Picasso Condos," Pace Condos, accessed November 10, 2017, http://www.pacecondo.ca/picasso.
[d] Canderal Residential, "Reshaping The Toronto Skyline," Aura, accessed November 10, 2017, http://www.collegeparkcondos.com/mobile/.
[e] Tridel Corporation, "Amenities & Lifestyle," Tridel Built for Life, accessed on November 10, 2017, https://www.tridel.com/selene/amenities-lifestyle/.

35 City of Toronto, *Tall Building Guidelines,* 32.
36 Ibid., 33.
37 Lisa Rapoport, "Spaces of (Im)possibility" (presentation at the University of Waterloo School of Architecture Hyper City symposium, Cambridge, ON, March 3, 2016), https://www.youtube.com/watch?v=GywpPDiU_u8&t=3.

With the increased accessibility provided by a building network, pedestrian traffic can be redirected by providing access to more amenities and the ability to move between buildings uninhibited by weather or vehicular traffic. Unless the municipality legislates ownership and control of building networks during their inception, guidelines and rules established within quasi-public space are set by the private establishment. They can vary from building to building, and without necessarily research or training in urbanism guiding them, can even be somewhat arbitrary. This diminishes the efficacy of the municipality's urban plan and the ability for city space to be managed for the benefit of its citizens.

08.12 *Private control of a quasi-public building network gives the owner all the spatial rights of this urban realm*

In the quasi-public space of the building network, even though the space functions as public infrastructure, when the network is privately owned, the building owner has full control of the area's spatial rights as defined by Lynch: presence, use and action, appropriation, modification, and disposition.[38] The owner has the means to use the space to the detriment of others, alter the space to its own benefits, and control how the space will be sold.[39] Controls that affect the network's occupants may take many different forms, but some that Lynch describes include: the expression of power and control of resources;[40] spatial separations, selective views, formality, cleanliness, standardization, naming and marking, fixing things in time and place, and the regulation of spatial behaviour;[41] access and exclusion of spaces and activities and their creation, modification, and management;[42] and control of the dissemination of information.[43] These spatial controls can have, "strong psychological consequences: feelings of anxiety, satisfactions, pride, or submission," and ultimately mean that, "social status is buttressed, or at least expressed, by spatial dominance."[44]

38 Lynch, *Good City Form*, 205.
39 Ibid.
40 Ibid., 36.
41 Ibid., 21.
42 Ibid., 118.
43 Ibid., 193.
44 Ibid., 205.

08.13 *A quasi-public building network can be controlled through formal controls such as private rules, regulations, and policing*

In the case of office buildings and shopping malls, rules can be enforced by security to include or exclude any individuals in order to protect the best interests of the businesses they contain. In the case of residential buildings with integrated amenities, access is typically restricted to residents by security at the ground floor. Both Evan McKenzie in *Privatopia*, and Jennifer Bell of Placet Dispute Mediation company have referred to condominium boards, which are effectively multi million-dollar not-for-profit companies,[45] as essentially a fourth level of government.[46] This is because they are able to create their own unique rules and have an established governance structure.[47] These private governments are designed to protect their own financial investment in the value of their lots and units through regulations established by the developer, and furthered by the board.[48] Therefore, they are tasked with maintaining and advancing their lifestyle image. The intended appreciation of the investment in new construction creates a trend towards luxury and exclusivity, often to the detriment of the residents' own freedoms, through restrictive rules.[49] These motivations can at times impede directly on private lifestyle choices in order to maintain a marketable image of stability and uniformity,[50] create conflict between user groups that utilize amenities,[51] or regulating everything from drapery colours, personal relationships, and child safety, among other lifestyle choices.[52] Although condominium boards theoretically allow residents to represent themselves, because, "friends recruit friends to run for positions, pushing through rules that benefit the most vocal constituents rather than the population at large,"[53] boards are often generationally homogeneous and create a, "ruling bias against other groups."[54] Therefore, even under self-governance, the control of all spatial rights by a single group is able to create a bias that infringes upon the rights of the collective whole.

45 Maryam Sanati, "Neighbour vs. Neighbour," *Toronto Life*.
46 McKenzie, *Privatopia*, 148.
47 Maryam Sanati, "Neighbour vs. Neighbour," *Toronto Life*.
48 McKenzie, *Privatopia,* 41.
49 Ibid., 144.
50 Ibid., 78.
51 Maryam Sanati, "Neighbour vs. Neighbour," *Toronto Life*.
52 McKenzie, *Privatopia,* 18.
53 Maryam Sanati, "Neighbour vs. Neighbour," *Toronto Life*.
54 Ibid.

08.14 *Private control of a building network removes this part of the commons from urban design guidelines and enables informal controls of space*

When building networks aren't established as publicly owned and regulated infrastructure, they aren't required to follow the city's design standards for streets or public space, despite the fact that they serve as a public right of way. Control over the design, route, services, and upkeep of the walkways are left to the individual owners of the buildings. In contrast, public space is designed and governed through guidelines, laws, and regulations that provide public infrastructure to support informal uses of streets and other public spaces. This governance provides utilities such as benches, lights, bike stands, restrooms, waste and recycling bins, bollards, outdoor amphitheatres, greenery, and other pieces of public infrastructure that make it possible to inhabit public space for a variety of uses. However, in quasi-public space, the private governance allows the control of space by altering, removing, or adding public infrastructure in order to constrain public activities in what is known as "defensive architecture." Other urban guidelines that can improve street vitality may include street frontage requirements that can be used to create variety and opportunities for social and economic interactions, yet in quasi-public space, regulations pertaining to street frontage won't apply to frontage on the public right-of-way because the pathway is outside of municipal regulation. This brings the city's commons outside of the influence of the municipality, removing its ability to ensure that public uses of space are accommodated.

08.15 *The control of the city's commons should be scrutinized for inequity and incompetence*

In an inclusive city, Kevin Lynch argues the equitable distribution of access and control of space by all stakeholders is necessary, and cannot be held by one body alone.[55] However, the more quasi-public space grows in the city, the more space falls outside of direct public control, and therefore the greater the ability to deprive groups of access to the movement of the city and the qualities of urban life when it becomes unprofitable to the building's owners. Lynch identifies the power this control of the city's circulation infrastructure may hold: "At larger scale, control of the access system is essential to maintaining economic or political hegemony. Mapping who controls the main communication channels, and the extent to which they can exclude certain people from the use of these channels,

55 Lynch, *Good City Form*, 200.

is, therefore, a significant analysis of a place."[56] This could be a significant shift in control in the city, and Lynch warns that, "these changes must be monitored to detect undesirable shifts: a growing inequity or incongruence, rising exclusion, or increasing incompetence."[57] Because the control of space is essential to obtaining political or economic dominance,[58] Lynch identifies that it is, therefore, necessary to consider who is in control and their responsibility: "those who control a place should have the motives, information, and power to do it well, a commitment to the place and to the needs of other persons and creatures in it."[59]

08.16 *The privatization of the commons and segregation of the population would discard the functions of the city that create vitality*

The result of the privatization of the commons and the segregation of the population will be explored in the following chapter, which explains how the destruction of diversity and depletion of urban resources suppresses the processes of the city that create vitality and equity. Jacobs similarly criticizes the *Rebuilt American City* and the *Radiant City* strategies as fundamentally divisive; that by discarding the functions of the city street, they have, therefore, eliminated the freedom of the city.[60] Ultimately this results in the lack of informal uses of space that give the city vitality and potential for commercialism and inequity to flourish. At times, without the presence of informal uses to provide the city's vitality, they can be purchased. Safety can be procured through private security, walls and fences, and security cameras; and foot traffic is replaced by vehicles which travel to more vibrant locations. However, this excludes neighbourhoods without the economic power to provide these services, and although they can temporarily fix some problems that may arise, they can't replace the vitality of a healthy neighbourhood that provides an adequate environment for its inhabitants. For this reason, it will be valuable to understand how the privatization of the commons and loss of diversity that would result from a privately developed volumetric city will affect how the city functions and its effect on the people who inhabit it.

56 Ibid., 193.
57 Ibid., 212.
58 Ibid., 193.
59 Ibid., 211.
60 Jacobs, *The Death and Life*, 44.

CHAPTER 09

THE LOSS OF URBAN RESOURCES AS A RESULT OF PROFIT-DRIVEN VOLUMETRIC ARCHITECTURE CAN INHIBIT THE VITALITY OF THE CITY

Now that it has been established how private control of the building network would fail to produce the urban resources necessary for vitality, what impact will this have on the city? Without urban resources, informal uses of the quasi-public space will become inhibited and the liveliness of these "raised streets" diminished. The following points show some speculations of how the private circulation network and segregation of the population into monocultural neighbourhoods could, and in some cities, already has, resulted in more severe socio-economic consequences for the volumetric city.

09.01 Social encounters, events, and assemblies could be curated to benefit the building network owners

09.02 Large clusters of identifiable groups could form exclusionary *turfs* that limit access to serve each group's own interests

09.03 Private ownership of the building network can permit design to exclude specific social groups from the quasi-public space

09.04 Targeted marketing could exploit the socio-economic divide in order to increase revenue potential

09.05 The strata of a building network could buttress the social status of higher floor levels

09.06 Without enough diversity, density, and connectivity within the building network, the existing planar city could suffer from a loss of street vitality

09.07 The safety of monocultural neighbourhoods could be undermined by a lack of continuous street activity and visual connections

09.08 The vision of high-rise communities used to promote volumetric architecture projects could fail to be realized

09.09 Building network pathways can become even more commercialized than city streets due to their private control

09.10 Building network owners could favour corporate retail chains, excluding small local businesses and narrowing options for consumers

09.11 The conditions of building networks could fail to support what local or small businesses are selected for tenancy in the building network

09.12 Control of the building network could ultimately substantially redirect economic flows

09.13 A spatial oligopoly over the building network could be used to drive business to enterprises invested in by the owners and force out competition

09.14 Bottle-necked access points could be used to close building networks and prevent public protest

09.15 Combined, the privatization of the commons shows potential to empower commercialism and inequality in the building fabric

09.16 Economic criteria driving development are already designing spaces for profit

09.17 To produce vitality, informal uses of space must be designed and regulated into the volumetric city

09.01 *Social encounters, events, and assemblies could be curated to benefit the building network owner*

It has already been established that city streets are spaces for informal activities to occur, groups to gather and meet, and other institutions to create situations for interaction between inhabitants. A diversity of enterprises and short frontages can create many different social scenarios to choose from, areas of street activation, and dispersion of control amongst the numerous stakeholders of a street. Without this balance of control or variety of social scenarios, the use of the space can be controlled. For example, while on the public street network, Yonge and Dundas just outside the Eaton Centre is home to many informal music and dance performances, and political oration. However, inside the volumetric architecture of the mall's extended quasi-public realm, congregations are strictly corporate and are typically formalized events that advertise products. In many building networks, artists are prohibited from performing, a point which indicates that the public use of the space is limited.[1] The curation of social events can at times take the form of codes of conduct, such as, St Paul's Code of Ordinances which have a, "highly detailed" section on skyway conduct that regulates behaviour in the skyway system.[2]

09.02 *Large clusters of identifiable groups could form exclusionary* turfs *that limit access to serve each group's own interests*

The loss of diversity can create an identifiable *turf* in which the exclusion of social groups can be intentional by the city's individual inhabitants or businesses—either by condominium boards to maintain an image of safety and luxury that protects the resident's investment values,[3] to maintain the clientele of a business,[4] or because of a lack of street safety due to inactivity.[5] For instance, Jacobs cites an example in which an area dominated by high-end retail chains, in an effort to maintain their customer base, will fight to maintain their luxury image within the city to the detriment of individuals.[6]

An Islington Avenue condominium in Etobicoke was, "originally marketed as an adults-only complex, and many owners had bought their units because they were promised the quiet comforts of empty nesters." However, when new tenants weren't accommodated for, a grievance was filed with the Ontario Human Rights Commission, "on the grounds that the condo's rules discriminated against people with kids." After strong opposition from the other tenants, the human rights tribunal ultimately determined the condominium's regulations were discriminatory.[a]

[a] Sanati, "Neighbour vs Neighbour," Toronto Life.

1 Jianqiang Cuia, Andrew Allan and Dong Lin, "Assessing grade separation pedestrian systems: Planning, design and operation," *Urban Design International* 20, no. 3 (2015): 250.
2 James and Yoos, *Parallel Cities,* 208.
3 McKenzie, *Privatopia,* 104.
4 Jacobs, *The Death and Life*, 244.
5 Ibid., 41.
6 Ibid., 245.

Even though public streets formally have universal access, without diversity, the unbalanced control of space can allow individuals, companies, homeowner associations, and condominium boards to control access through informal means. Some examples include intimidation or exclusion from social events and restrictions on the uses of space,[7] convoluted way-finding or naming conventions,[8] formality,[9] aesthetic choices, or rules which target specific users but don't outright ban them.[10] These informal controls of public space can be limited when the diversity of the urban fabric ensures that a single group doesn't become too dominant in an area.

09.03 *Private ownership of the building network can permit design to exclude specific social groups from the quasi-public space*

Kevin Lynch takes the possibility of limiting access to the extreme and wonders, "could we add toll bikeways and sidewalks? . . . The disadvantage is that access will be graduated even more sharply by income, and that basic requirements may be beyond the reach of some."[b]

In quasi-public building networks, the space is privately owned and controlled and can be designed to exclude specific social groups that may be bad for business or an inconvenience. An extreme example of this is the installation of anti-homeless spikes and anti-homeless benches.[11] This is known as *defensive architecture* and in public space can be disputed by elected officials, planners, or the public. However, regulation of defensive architecture outside of the public domain in quasi-public space would be much more difficult, especially because not all cases of defensive architecture are as overt. For instance, confusing wayfinding as a method of access control can be seen in the Minneapolis skyway: "Minneapolis may be known for its skyways, but they weren't designed for visitors, but for 9-to-5 office workers."[12] The Star Tribune continues: "as with honeybees, office tenants just know where they're going,"[13] outsiders find the system, "challenging to navigate and access, meaning they mostly get used by people who know the area well and work there—less by tourists or visitors."[14]

7 Maryam Sanati, "Neighbour vs. Neighbour," *Toronto Life*.
8 Ode, "Minneapolis skyway system," *Star Tribune*.
9 Lynch, *Good City Form*, 21.
10 Byers, "The Privatization of Downtown Public Space," *Journal of Planning and Research*, 116.
11 Vickie Cooper, "Homelessness and Victimisation," *A Companion to Crime, Harm and Victimisation*, eds. Karen Corteen et al. (Bristol: Policy Press, 2016), 97.
12 Ode, "Minneapolis skyway system," *Star Tribune*.
13 Ibid.
14 Rachel Quednau, "Skyways: Helping Or Hurting Downtown?," *Strong Towns*, last modified June 28, 2016, http://www.strongtowns.org/journal/2016/6/27/skyways.

[b] Lynch, Good City Form, 198.

09.04 *Targeted marketing could exploit the socio-economic divide in order to increase revenue potential*

Targeted marketing of new developments, ensure the viability of the project by strategically selling to a marketable demographic.[15] Currently, the condominium expansion in Toronto is characterized by, "many buildings targeting young professionals looking for a starter home near the TTC, nightlife and the Financial District."[16] This establishes a narrow initial demographic; however, even if the unit rates lower over time and new, diverse groups of tenants move in, the condominium regulations may not be suited for the new tenants, driving them out.[17] New buildings cost more than their older counterparts, and therefore create a higher entry point for possible tenants,[18] meaning that the construction of a new building network would have a higher price point than the surrounding, unconnected building fabric, therefore, allowing the wealthiest classes to adopt the network first.

The authors of *Parallel Cities* argue that the new proposals from architects working first in the Middle East and Asia, and now Western cities, are creating, "circumscribed and defensible spaces of the new economic elite defined by interlinked tower clusters sharing amenities, recreational spaces, and privately accessed sky gardens."[19] For example, in London recent projects such as the Fenchurch Street Tower have negotiated a higher density (and larger profits) for new buildings by offering extra-grade amenities advertised to be public—however, "these new forms of quasi-public space have been heavily criticized for their exclusionary tendencies,"[20] meaning that higher revenues were negotiated on the basis of providing a service to the city, which in reality was designed to serve only the wealthiest individuals.

15 McKenzie, *Privatopia,* 97.
16 Sanati, "Neighbour vs. Neighbour," *Toronto Life*.
17 Ibid.
18 Bengt Nyman, *Building Sector Regulations: A Background to Increased Exchange Between Countries in the Baltic Sea Region*, (Copenhagen: Nordic Council of Ministers, 2004), 13.
19 James and Yoos, *Parallel Cities,* 190-191.
20 Ibid., 191.

09.05 *The strata of a building network could buttress the social status of higher floor levels*

Within the narrow band of the population selected for a new condominium, market rates of different units are priced primarily by the unit's floor area and the floor level in the building, stratifying the diversity that does exist within the development. This stratification interfaces with feelings of superiority that arise at higher floor levels. As explained by a New York development consultant, Nancy Packes, in an interview with *The Journal*, "people are paying for the status and the exclusivity of living on that next higher floor . . . there's a psychological component to living on high floors in a building."[21] In the case of the volumetric city, the formalization of amenity spaces into strata could create a legible hierarchy rendered into the architecture that intensifies this phenomenon as *sectional demographics*.

09.06 *Without enough diversity, density, and connectivity within the building network, the existing planar city could suffer from a loss of street vitality*

A strong argument in support of the high-density buildings favoured by development is that they contribute needed vitality to the street by adding foot traffic and support for local businesses. However, if a building network moves people from the public street to a private network, this impact can be diminished at the ground plane. When the increased density isn't sufficient to maintain circulation at grade and in the building network, or the development's contribution to diversity isn't enough to maintain regularly dispersed foot traffic, this could actually detract from the street traffic that creates vitality. The result would deprive businesses accessible from grade of a market that may be necessary for them to thrive and reduce the social sphere of the planar city—a condition already documented in Houston, Minneapolis, and Toronto, among others.[22]

09.07 *The safety of monocultural neighbourhoods could be undermined by a lack of continuous street activity and visual connections*

Vibrant streets are typically moderated by social contract when they are frequented by a variety of people, and diverse businesses and residences with strong visual connections to the street keep eyes on the street throughout the day. If the connected buildings have a monocultural

21 Kim Velsey, "Higher Than Thou: The Headaches That Come With Living on Top of the World," *The Observer* (New York, NY), last modified August 17, 2012, http://observer.com/2012/08/skyscraper-living/.
22 Byers, "The Privatization of Downtown Public Space," 113.

composition, intense swings of pedestrian traffic and the simultaneous closure of shops and offices would make paths desolate at some times throughout the day, reducing the safety of the building network. This condition has already been documented in existing building networks, in which compromised safety at night has been attributed to a lack of activities taking place in the system at this time of day.[23] Designs which limit the amount of visual connectivity between the private realm and the quasi-public street network can also reduce the number of eyes on the street that also provide safety. A lack of diversity would also make it easy to identify outsiders, and without the formation of a community, the relationships and trust between individuals haven't built up enough for members to watch out for each other, or to find comfort in their presence. Ultimately these conditions cause people to seek alternative security measures that might otherwise be unnecessary, such as private security guards, formal access controls, and CCTV cameras. However, these solutions have also been criticized for only responding to a problem, not resolving it.[24]

09.08 *The vision of high-rise communities used to promote volumetric architecture projects could fail to be realized*

"Building communities" is one of the strongest arguments in favour of the volumetric city, which attempts to respond to the disconnect between individual units of high-density towers and public space. However, Jacobs argues that communities aren't formed out of the presence of the street or amenities alone, but through a diverse building fabric creating continual pedestrian traffic, frequent social contact between inhabitants, as well as eyes on the street, safety, trust, and resident retention. In the building network it could be more difficult to provide eyes on the street from the surrounding private space which may not front onto the enclosed walkway or have direct line of sight; the commercialization of pathways could make them more places to pass through rather than to stay and engage in social encounters; and in residential scenarios which haven't been designed and regulated for diversity, the conflict between different user groups in amenity spaces can be polarizing.[25] With a loss of diversity and the resultant reduction in continuous street traffic and fewer varieties

23 Cuia, Allan and Lin, "Assessing Grade Separation Pedestrian Systems," 247.
24 Ibid., 123.
25 Sanati, "Neighbour vs. Neighbour," *Toronto Life*.

of businesses or amenities, the use of the streets can become limited. Streets that aren't frequently inhabited make it easier for crimes to occur as they are unmoderated by social contract.[26] The lack of social contact between inhabitants fails to establish trust,[27] and the role of streets in assimilating children can become unfavourable as the streets become unsafe.[28] Without local vitality and a variety of businesses that support upwards class mobility, resident retention can drop. Over time this means that a community struggles to develop and the social functions of the street can be unfulfilled.

09.09 *Building network pathways can become even more commercialized than city streets due to their private control*

Parallel Cities identifies that the capital structure of public streets already interferes with its uses: "with its proliferation into many capital-intensive infrastructural layers, the street as 'free space' has been problematized."[29] Lefebvre, too, discusses the loss of the informal uses of city streets to commercialization:

> *The street became a network organized for and by consumption. The rate of pedestrian circulation, although still tolerated, was determined and measured by the ability to perceive store windows and buy the objects displayed in them. Time became "merchandise time" (time for buying and selling, time bought and sold). The street regulated time outside of work; it subjected it to the same system, the system of yield and profit. It was nothing more than the necessary transition between forced labor, programmed leisure, and habitation as a place of consumption.*
>
> —*Henri Lefebvre*[c]

While the city's public streets are already entangled with their commercial function, the public right-of-way of a privately owned building network provides even more control over the commons that would commercialize the space further.

[c] Lefebvre, The Urban Revolution, 19.

26 Jacobs, *The Death and Life*, 35.
27 Ibid., 56.
28 Ibid., 75.
29 James and Yoos, *Parallel Cities*, 14.

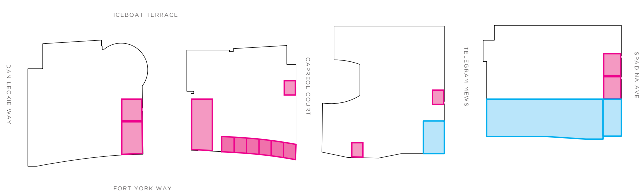
09.10 *Building network owners could favour corporate retail chains, excluding small local businesses and narrowing options for consumers*

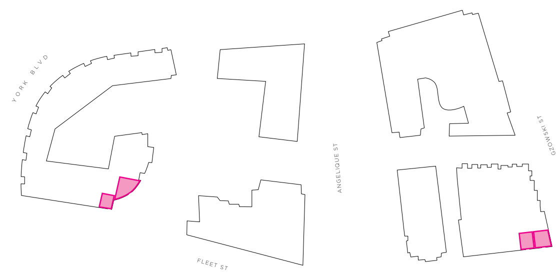
A large commercial development such as a mall is different from commercial stretches of Jacobs *old city* because the units are all owned by the same investor, even though formally they may appear to be similar public pathways lined with a variety of shops. The owner can dictate the type of shops allowed, the aesthetic, the appropriation and alteration of space, and to an extent the clientele as well (by maintaining a specific image, informal spatial controls, and behaviour rules). Lynch explains the result of this control in the case of regional shopping centres, in which a single investor will, "usually exclude uses of low rent-paying ability, and most institutional occupants."[30] He goes on to say, "while profitable, the new shopping centres thus lose many of the functions and advantages of the traditional city centre."[31] Ultimately this means that unless small businesses are intentionally accommodated for, large-scale construction will tend to support major corporations rather than local businesses, narrowing the selection of retail and amenities for the city's inhabitants (Figure 9.10). When large-scale buildings dominate a neighbourhood, it can effectively force out small businesses from this portion of the building fabric.

09.11 *The conditions of building networks could fail to support what local or small businesses are selected for tenancy in the building network*

In cases where the building fabric isn't diverse enough, the resultant street traffic that swings between short overpopulated periods, and long sparse periods, gives corporate enterprises a better ability to survive. The similarly priced units in the same development can only accommodate businesses of a similar economic status.[32] Lower overheads and standardization makes it easier for these businesses to handle higher fluctuations in traffic throughout the day than local operations.[33] In some cases with low enough diversity or density, this can result in the closure or relocation of businesses, further reducing the reasons for people to use the street. Both reduce the number of businesses and amenities people have access to, reducing socio-economic options for inhabitants, and

30 Lynch, *Good City Form,* 393.
31 Ibid.
32 Jacobs, *The Death and Life,* 188.
33 Ibid., 156.



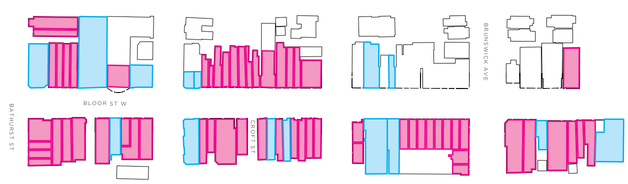


City Place

The City Place condominium developments do an impressive job of including independent enterprises despite the new, large-scale construction, with banks and the grocery store as the only corporate enterprises. However, many of the retail units are still vacant at City Place, possibly indicating that the socio-economic environment is unsustainable for businesses who are isolated from the urban fabric and must depend on the residents of the development alone.

Waterpark City

Waterpark City shows has very few retail spaces, but those that it does have are also independent, including a Toronto-based cafe, pizzeria, dental office, and market. The development's intense isolation from the building fabric would mean these businesses would largely be sustained by the residents of the development itself, as there would be little foot traffic from outsiders in the area.



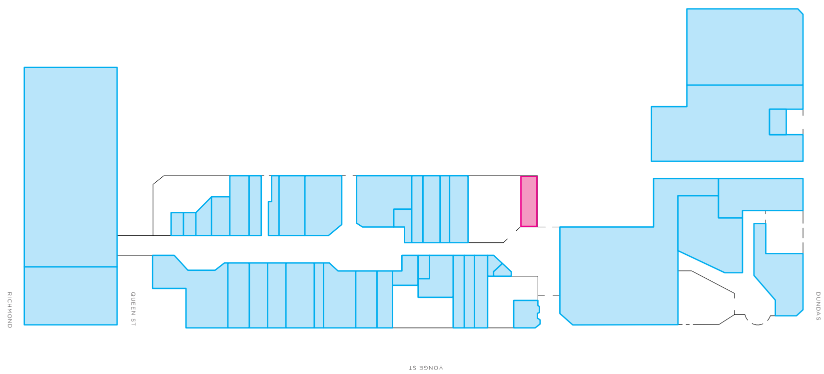
The Annex

The Annex can be characterized by a variety of popular Toronto cafes, bars, and restaurants that make it a popular destination for outings. A few corporate retailers have capitalized on the area's popularity, but much of the character of the neighbourhood remains intact.

Kensington Market

With a reputation as a "Bohemian" neighbourhood, Kensington Market expectedly has very little visible corporate presence. The only exceptions are two banks on site.

Figure 09.10: Case study comparing the independent and corporate retail ownership of three large-scale development complexes to the building fabric of three Toronto neighbourhoods known for their street life. The distribution of independent and corporate enterprises illustrates how the conditions of large-scale development complexes lead to the exclusion of local businesses and favour corporate enterprises. This exclusionary disposition effectively designs out different types of business and lifestyles, and the opportunity for inhabitants to start their own enterprises is constrained to other areas of the city. Ultimately if these large-scale developments dominate the city, the building fabric will only support corporate enterprises, and would result in the flow of capital out of the city.



Eaton Centre

The Eaton Centre mall has many different businesses; however, typical of many malls, the large-scale development focuses on large retail chains, with only a single locally-owned restaurant amidst many global corporate enterprises. The Eaton Centre is exemplary of how volumetric architecture can contribute to the urban fabric of the city, while simultaneously demonstrating how this urban fabric creates a shift from local independent businesses to corporate retailers due to the nature of large-scale development and private ownership of large swathes of the building fabric.

Queen West

Queen West has a characteristic combination of local bars and restaurants mixed among popular corporate retail chains, producing a lively street during the day as destination shoppers seek out popular retail chains. This creates incidental traffic for independent retailers, restaurants, and cafes. The area also has a good mix of program to fill the street at various times of day with a night life generated from numerous bars hosting live music.

Legend

INDEPENDENT TORONTO BUSINESS

NATIONAL/INTERNATIONAL RETAIL CHAIN

reducing the diversity of job opportunities that enable upwards class mobility and resident retention.[34] The isolation of enterprises within a building network with controlled access could also limit their clientele, cutting them off from the wider audience of the entire city that can be necessary to support niche enterprises.[35] Already, skyways have shown that they aren't capable of sustaining a diverse array of businesses as a result of a monocultural composition. For example, a critique of the Minneapolis skyway in the *Star Tribune* said: "Think of the system as a hive for worker bees, with more restaurants than clothing stores, more shops to buy flowers than shoes, more places to make copies, buy a snack, grab some coffee or deposit a check."[36]

This accommodation for large enterprises can dramatically reduce activity in the building network when businesses with long street frontages are established. The urban street wall becomes less active as long store frontages of similar content, with fewer entrance-ways programmed street activations reduce social encounters.[37] As a result, social encounters, trust, and the sense of community diminish as well.

09.12 *Control of the building network could ultimately substantially redirect economic flows*

The Toronto Financial District Business Improvement Area (BIA) consists of all businesses in the Financial District including, "Canada's five major banks and most prominent firms."[d]

Lynch identifies that control over circulation networks can influence human behaviour, saying that, "if barriers to movement are erected, or if people are directed to shop in one place and work in another, or to use a particular service, then access and adaptability decline."[38] This has been put into practice in the case of Toronto's PATH network as explained by its representation, the Toronto Financial District BIA themselves: "If you're an employer who wants your workers to never have an excuse to leave the office building, you'll appreciate this one, too. Many of the Financial District's office towers have clothing stores, pharmacies, shopping markets, gyms, dentists, and doctors."[39] Their message is explicit: through the complete spatial control of the building network, the decisions of over 200,000 occupants who use the PATH every day can be redirected towards decisions that benefit the companies in control of the building network.

[d] Toronto Financial District Business Improvement Area, "About our BIA," Toronto Financial District, accessed on November 10, 2017, http://torontofinancialdistrict.com/toronto-financial-district-bia/.

34 Ibid., 276.
35 Byers, "The Privatization of Downtown Public Space," 113.
36 Ode, "Minneapolis Skyway System," *Star Tribune*.
37 Jacobs, *The Death and Life,* 234.
38 Lynch, *Good City Form*, 244.
39 Toronto Financial District BIA, "7 Little Known Facts," *Toronto Financial District*.

Some argue that informal means are also used to increase revenue in the PATH, speculating that way-finding, “is difficult to negotiate because, so the lore goes, each property owner wanted people to stay and shop in their part of the system.”[40] Ultimately, the control over the urban planning of the area has resulted in the power to influence the $1.5 billion in annual sales revenue[41] of the PATH network. This ability for skyways to redirect economic potential was substantiated in court when a group of businesses sued the city of Cincinnati for $1,000 per day due to reduced pedestrian traffic that reduced sales when the city dismantled the skywalk system.[42] Combined with the tendency for large-scale developments to select corporate enterprises, this could substantially bring capital out of the city’s local economy and redirect it towards multi-national corporations.

09.13 <u>*A spatial oligopoly over the building network could be used to drive business to enterprises invested in by the owners and force out competition*</u>

As complete control over building network infrastructure would allow for the large-scale acquisition of the urban commons by only a handful of owners or ownership groups (such as the Financial District BIA), in an extreme scenario this control could then be used to manipulate transactions towards the owner’s investments. This could be accomplished by replacing all amenities and retail with either the owner’s own enterprises, those that they have invested in, or those that have signed an exclusive license with them. While independent businesses would potentially still be free to use other parts of the city, this would effectively cut them off from a substantial market. This practice exceeds the fair competition of businesses and creates an architecture of spatial and economic oligopoly.

09.14 <u>*Bottle-necked access points could be used to close building networks and prevent public protest*</u>

When spaces of the city become privately controlled, they are granted all of its spatial rights. Anything harming the best interests of the governing body can be subject to discrimination, including: specific demographics using the space, acts of protest, the inclusion of people with lifestyles that conflict with the occupants or businesses, and informal appropriations of space. Lefebvre notes, “whenever threatened, the first thing power

40 Micallef, "Aura," *The Toronto Star.*
41 City of Toronto, *PATH Pedestrian Network Master Plan*, 11.
42 James and Yoos, *Parallel Cities,* 200.

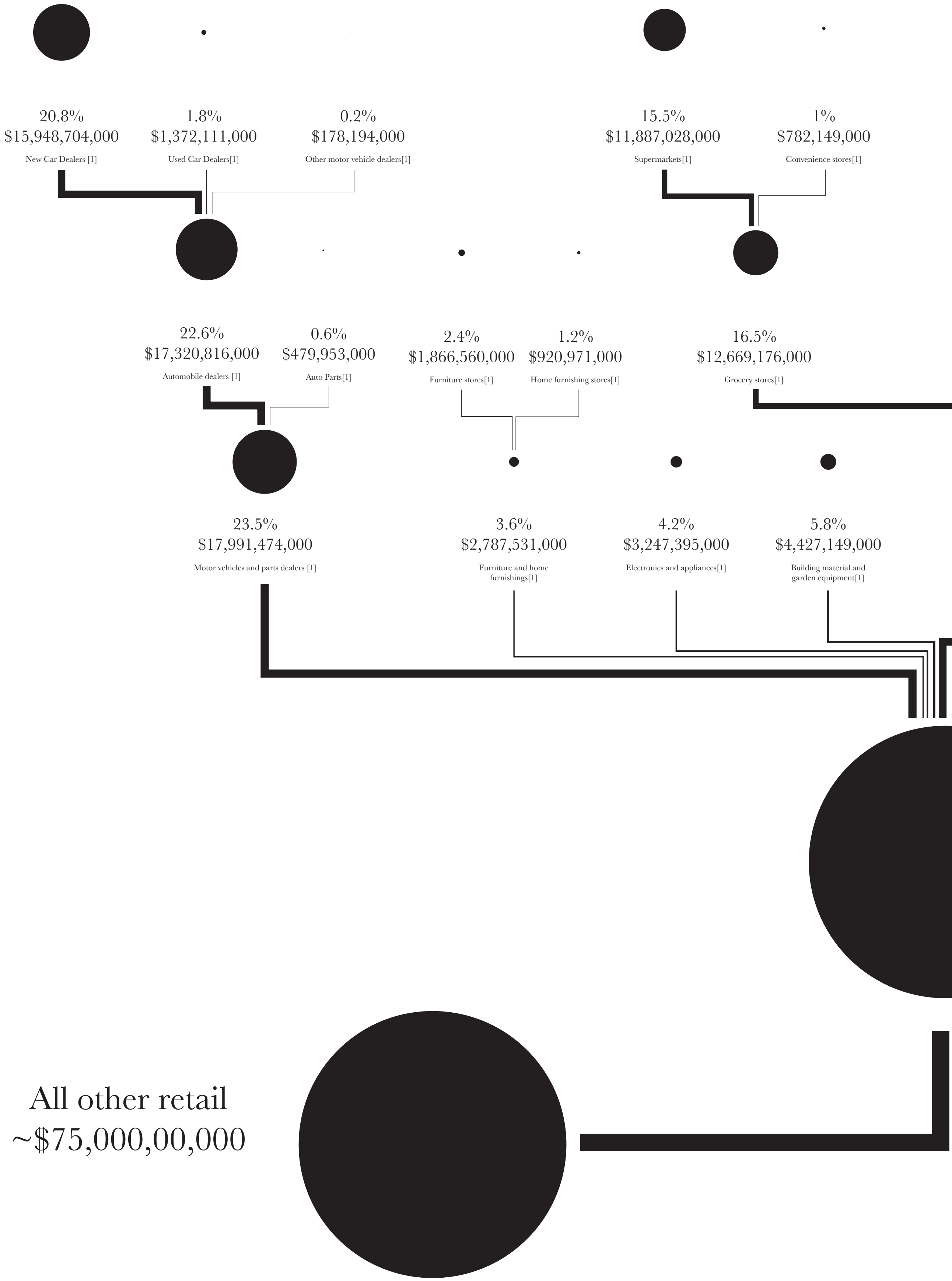
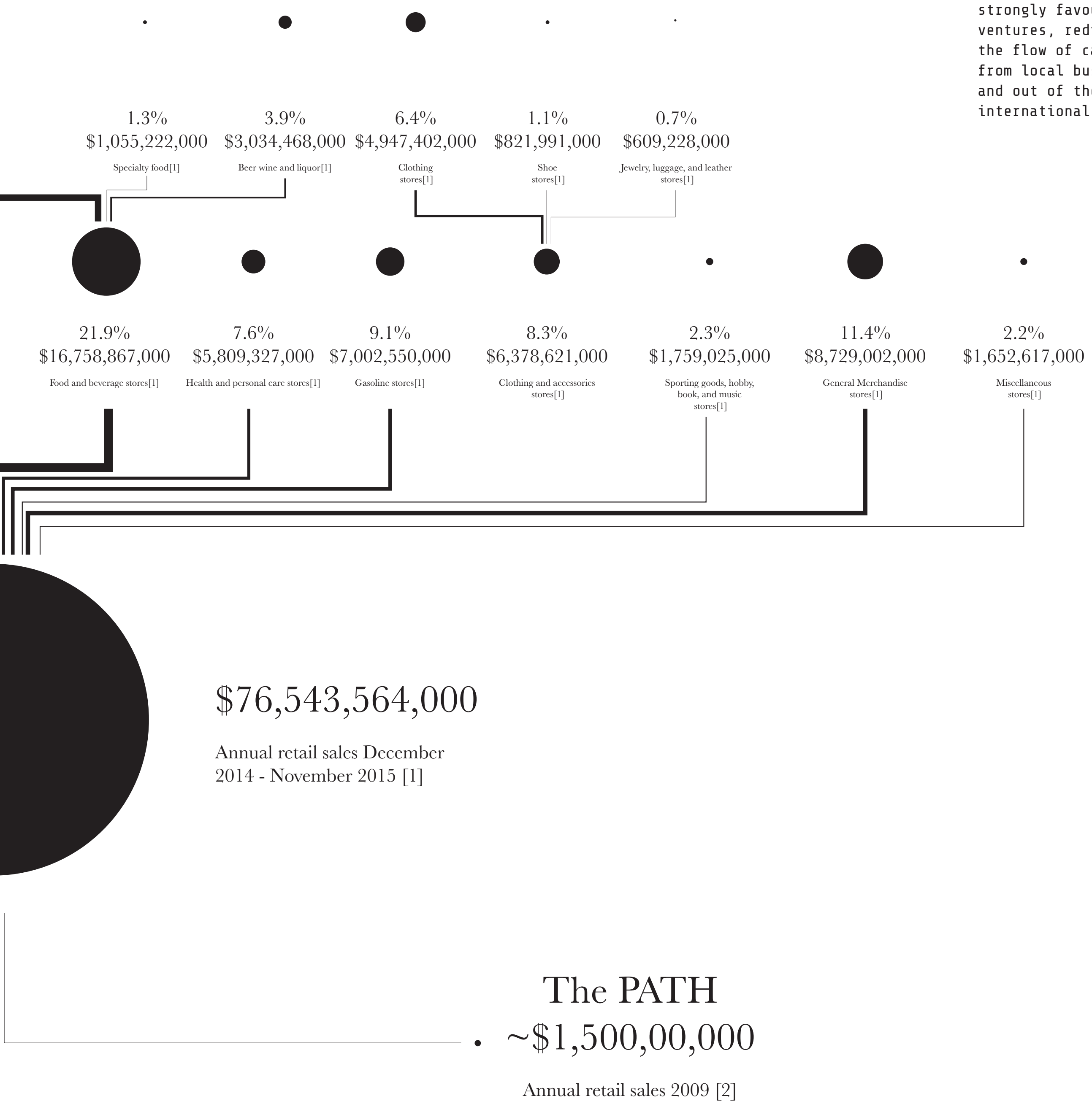

20.8%
$15,948,704,000
New Car Dealers [1]
1.8%
$1,372,111,000
Used Car Dealers[1]
0.2%
$178,194,000
Other motor vehicle dealers[1]
15.5%
$11,887,028,000
Supermarkets[1]
1%
$782,149,000
Convenience stores[1]
22.6%
$17,320,816,000
Automobile dealers [1]
0.6%
$479,953,000
Auto Parts[1]
2.4%
$1,866,560,000
Furniture stores[1]
1.2%
$920,971,000
Home furnishing stores[1]
16.5%
$12,669,176,000
Grocery stores[1]
23.5%
$17,991,474,000
Motor vehicles and parts dealers [1]
3.6%
$2,787,531,000
Furniture and home furnishings[1]
4.2%
$3,247,395,000
Electronics and appliances[1]
5.8%
$4,427,149,000
Building material and garden equipment[1]
All other retail
~$75,000,00,000

Figure 09.12: Breakdown of annual retail sales in Toronto, of which the corporately dominated PATH network comprises about 2% of the city's annual sales revenue. Expanding the downtown building network without inclusion for independent businesses would have the unintended side effect of constructing an urban fabric that strongly favours corporate ventures, redirecting the flow of capital away from local businesses, and out of the city to international enterprises.



restricts is the ability to linger or assemble in the street."[43] The introduction of building networks provides a more efficient means with which to control the street. For example, during the G8 summit in Calgary, the police force closed the +15's public right-of-way to the public in order to protect the interests of private companies from protests, most notably the protection of the Alberta petroleum industry.[44] This sets a precedent of how the increased control of public circulation and its bottle-necked access points can be used to suppress political activism and protect major corporations.

09.15 *Combined, the privatization of the commons shows potential to empower commercialism and inequality in the building fabric*

In an extreme scenario, the combined impact of the spatial oligopoly and privatization of the commons can reach a critical point in which sectional demographics become formalized in the building fabric: the city's wealthiest citizens inhabiting the highest strata of the volumetric city with all of its amenities, views, and daylight; the middle-upper class in the lower strata of the volumetric city; and the city's lower classes excluded from the volumetric city entirely, relegated to the older pre-building-network construction of the planar city. Formal and informal controls can prevent undesired groups from accessing the building network and its more luxurious amenities and views, while urban enclaves of disparate monocultures, or separate building owners, fragment the building network. The isolation of social groups fails to support local businesses, and the corporate tenants of the building network use the street to further their commercial agenda, while discouraging uses that might dissuade sales. Despite the destruction of the functions of the city, the building industry can continue, erecting new developments that attract owners who can afford the new construction through narratives of safety and affluence which are maintained for a time, until the destruction of the functions of the city have gone too far and older neighbourhoods begin to experience the loss of the city's vitality. While this architecture of inequality may at first appear unlikely, recalling the criticism of the Dallas skyway, and Corbusier's *Plan Obus*, they begin to appear startlingly plausible: the Dallas skyway was described as, "a segregated system divided by race and income with largely white, middle-class office workers above and lower-wage service and retail workers of color below,"[45] and the *Plan Obus* for Algiers, was

43 Lefebvre, *The Urban Revolution*, 19
44 James and Yoos, *Parallel Cities*, 152.
45 Ibid., 202.

criticized as an urban apartheid,[46] “due to its pedestrian viaduct connection between Corbusier’s new European suburbs and the business center, passing directly over the Muslim quarters of the city.[47]

09.16 *Economic criteria driving development are already designing spaces for profit*

Figure 09.16.a: The grounds of the Linked Hybrid in contrast with the neglected rubble of its surrounding context only metres away.

Figure 09.16.b: Decaying infrastructure surrounding the project in contrast to the new construction of Linked Hybrid in the distance.

When economic forces are able to dominate the composition of the building fabric without the intervention of design or regulation, the city begins to be designed to support its commercial functions alone, while its other social and informal uses are designed out, having not generated a profit to substantiate their place. The volumetric city can give builders and companies greater control to shape the processes of the city by succeeding the city’s circulation infrastructure, and therefore its commons. This explains how the volumetric cities sprung from private industry in the late twentieth century failed to offer the vitality of city life proposed by its planners, and instead have largely served to reinforce the companies which influence them. While the architects of projects from Linked Hybrid to the World Trade Centre proposals offer similar visions of a vibrant volumetric public realm, the projects occur in largely the same context of a single developer initiating a network of connections between its own buildings that creates a fortified space under company control, ultimately subverting the intentions of the architect. Given the example set by previous precedents, the potential for volumetric architecture to reinforce segregation, inequality, and commercialism should be anticipated—most significantly when the scale and context of the project enable the privatization of the commons or a dominant control of space in the city.

This can be exemplified by the Linked Hybrid project, which proposes the project as a social condenser[48] explicitly aspiring to the Soviet avant-gardists’ socialist utopia, suggesting a, “porous urban space, inviting and open to the public from every side… a ‘city within a city.’”[49] Instead, in spite of the country’s socialist market economy, the local context and private development industry have resulted in the project housing only high-end retail rather than the urban marketplace envisioned,[50] and the building

46 Hugh Pouliot, "‘Machines for Living," *Shift Graduate Journal of Visual and Material Culture,* 7.
47 Ibid.
48 Steven Holl, *Urbanisms: Working with Doubt* (New York: Princeton Architectural Press, 2009) 137.
49 Ibid.
50 Dan Hill, "Journal: Linked Hybrid by Steven Holl Architects, and designing for the occupation of space in contemporary Beijing,"

has been marked by guards armed with guns at every entrance turning away visitors.[51] While these factors are outside of the architect's control, the reality of the contrast of the high-end building design with, "the surrounding context of rubble, half-finished infrastructure, patrolling armed guards and rapid social change,"[52] means that the volumetric architecture type—which provides greater agency to control space than planar architecture—may not have been the best choice in this specific context.

09.17 *To produce vitality, informal uses of space must be designed and regulated into the volumetric city*

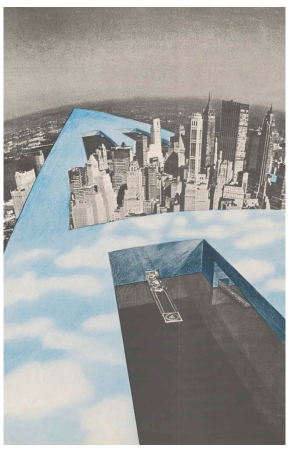
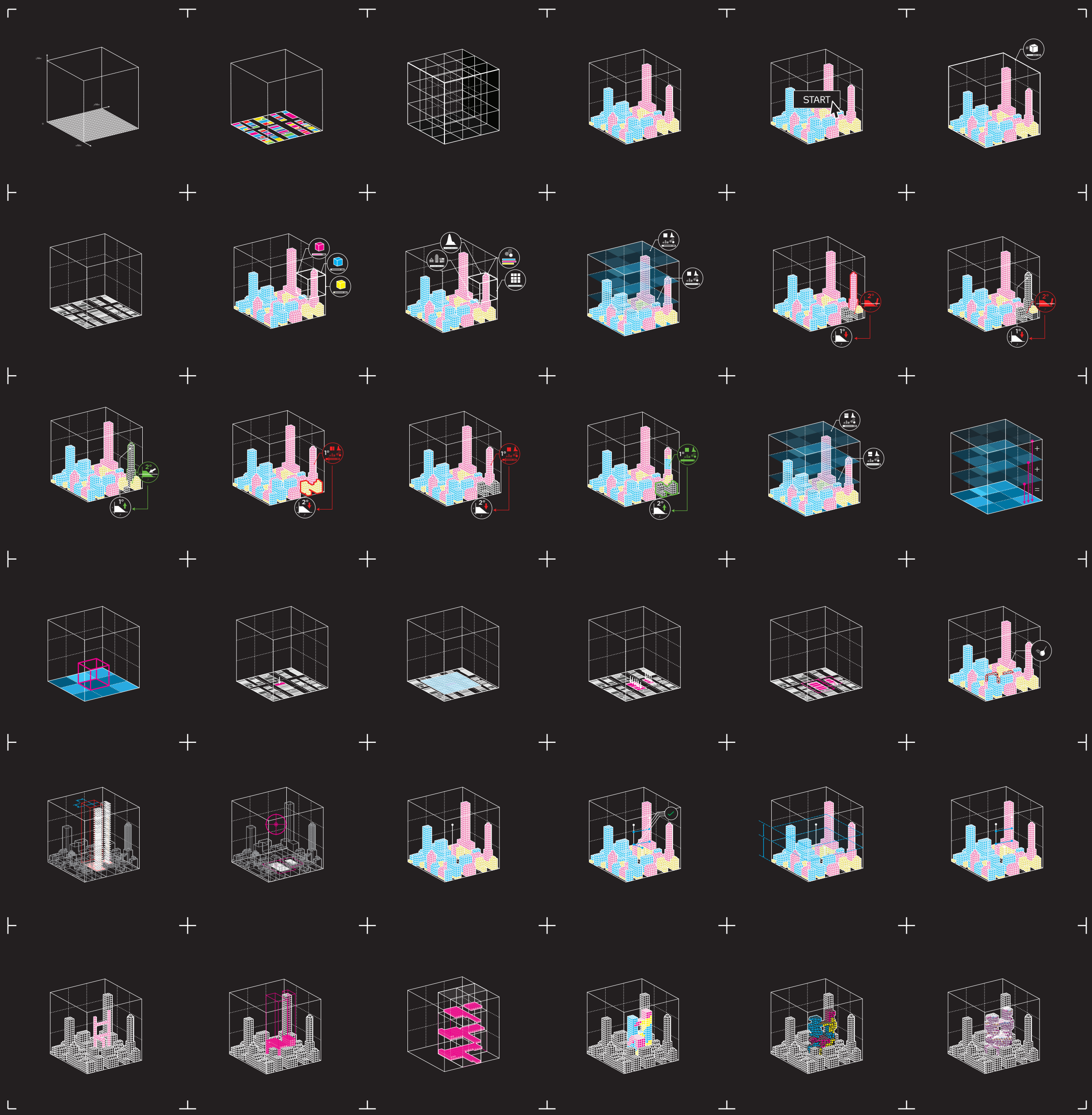


Figure 09.17: The Continuous Monument by Superstudio illustrates the ultimate privatization and commercialization of space as a continuous, generic interior dominating cities around the world.

The Continuous Monument by Superstudio (Figure 09.17) takes the commercialized urban interior to its extreme: by projecting urbanism forwards to an endless, monotonous building of corporate space, the group critique the generic architecture style and the privatization of the city.[53] Recalling Jacobs' argument that modern plans such as the Radiant City and the Garden City dismantled the functions of a healthy city that produced vitality, the volumetric city should learn from the shortcomings of these strategies and incorporate the functions of public space into its architecture. Since profit-driven development is already selecting out the informal uses of the city, in order to design for vitality, volumetric architecture needs to design informal uses of public space back into the architecture of a volumetric city.

City of Sound, last modified April 11, 2011, http://www.cityofsound.com/blog/2011/04/linked-hybrid-beijing-steven-holl.html.
51 Ibid.
52 Ibid.
53 James and Yoos, *Parallel Cities*, 123.

AFTER ESTABLISHING THE POTENTIAL FOR AN INCREASE IN UNREGULATED VOLUMETRIC ARCHITECTURE PROJECTS IN TORONTO, IT HAS NOW BEEN SHOWN THAT WITHOUT INTERVENTION, THIS WOULD LIKELY EXACERBATE EXISTING SOCIAL AND ECONOMIC ISSUES FACING THE CITY'S RESIDENTS. SINCE THE VITALITY OF SUCCESSFUL NEIGHBOURHOODS COMES FROM ITS INFORMAL USES OF PUBLIC SPACE, THESE USES SHOULD BE STIMULATED BY THE BUILDING FABRIC BY THE PRODUCTION OF URBAN RESOURCES. HOWEVER, THE ECONOMIC FORCES SHAPING THE DEVELOPMENT OF A VOLUMETRIC CITY FAIL TO PRODUCE THESE BENEFICIAL QUALITIES OF THE BUILDING FABRIC ON THEIR OWN, WHICH ULTIMATELY WOULD REDUCE THE PUBLIC USE OF THE VOLUMETRIC CITY TO PURELY CIRCULATION AND COMMERCIALISM. THEREFORE, TO CREATE A VIBRANT VOLUMETRIC CITY, THE PROPOSAL IS TO DESIGN AN BUILDING FABRIC THAT ENABLES INFORMAL USES OF PUBLIC SPACE.



PART THREE

ESTABLISHING A NEW VITALITY-DRIVEN FRAMEWORK TO ADDRESS THE TENSION BETWEEN PROFIT-DRIVEN VOLUMETRIC ARCHITECTURE AND THE VITALITY OF THE CITY

IN ORDER TO COUNTERACT THE HEIGHTENED COMMERCIALISM AND INEQUITY OF PRIVATELY DEVELOPED VOLUMETRIC ARCHITECTURE, THE PROPOSAL IS TO TARGET THE GENERATION OF URBAN RESOURCES THAT STIMULATE INFORMAL USES OF SPACE. HOWEVER, UNLIKE JACOBS' OLD CITY, IN THE VOLUMETRIC CITY, THIS MUST BE DONE THROUGHOUT THE THREE-DIMENSIONAL FIELD. IN ORDER TO RAPIDLY TEST DIFFERENT IDEAS AT THE URBAN SCALE, A CUSTOM PARAMETRIC DESIGN TOOL WILL BE PRODUCED THAT SIMULATES THE GROWTH OF THE CITY OVER LONG TIME FRAMES. THIS TOOL WILL BE USED TO CRAFT DIFFERENT SCENARIOS THAT IMAGINE HOW THE FUTURE CITY WILL BE SHAPED BY VOLUMETRIC ARCHITECTURE UNDER A VARIETY OF REGULATORY CONDITIONS. A COMPARISON OF THESE SCENARIOS AT THIS LARGE SCALE WILL HELP TO EVALUATE THE EFFICACY OF DESIGNING INDIVIDUAL BUILDINGS FOR VITALITY THROUGH THE GENERATION OF URBAN RESOURCES.

CHAPTER 10 THE PROPOSAL IS TO DEVELOP A FRAMEWORK TO DESIGN FOR VITALITY BY COMPARING POSSIBLE SCENARIOS OF THE FUTURE CITY

11 THE UNDER-REGULATED VOLUMETRIC CITY CAN BE STUDIED THROUGH A PROFIT-DRIVEN SCENARIO

12 THE IDEAL VOLUMETRIC CITY CAN BE STUDIED THROUGH A VITALITY-DRIVEN SCENARIO

13 A PARAMETRIC DESIGN TOOL IS PRODUCED TO SIMULATE THE GROWTH OF THE CITY BY ABSTRACTING THE BUILT ENVIRONMENT

14 THE PARAMETRIC DESIGN TOOL IS DESIGNED TO SIMULATE DIFFERENT URBAN SCENARIOS BY USING ADJUSTABLE PARAMETERS

15 THE PARAMETRIC DESIGN TOOL SIMULATES THE GROWTH OF THE CITY BY ALGORITHMICALLY REPLICATING THE STAGES OF DEVELOPMENT

CHAPTER 10 THE PROPOSAL IS TO DEVELOP A FRAMEWORK TO DESIGN FOR VITALITY BY COMPARING POSSIBLE SCENARIOS OF THE FUTURE CITY

Now that the difficulties facing volumetric architecture have been identified, the following points explain why the possible benefits of a volumetric city may be worth confronting these difficulties. It is proposed that in order to overcome the commercialism and inequity created by unregulated volumetric cities, vitality must be introduced throughout the city's three-dimensional building network by generating urban resources throughout the three-dimensional field. In order to test the validity of this strategy, this vitality-driven volumetric city will be investigated at the urban scale and compared to alternative scenarios. A profit-driven volumetric city will test how effective the vitality-driven strategy is in improving the volumetric city, and a vitality-driven planar city will test the value of the volumetric city's advantages.

POTENTIAL SUCCESSES OF THE VOLUMETRIC CITY:

10.01 The volumetric city could improve high-density living conditions by creating a vibrant three-dimensional public realm

10.02 The volumetric city could relieve high amenity demand and improve walkability by creating more frequent amenity zones

10.03 Affordability could be improved by meeting the high demand for housing

10.04 Sprawl into the valuable Greenbelt could be reduced by enabling greater densities

10.05 The land value of sites could be raised by new economic potential near the building network, and throughout the city through competitive diversion

10.06 The volumetric city could take better advantage of rooftops and provided additional exterior spaces for sustainable uses

10.07 Volumetric architecture could permit greater architectural exploration

10.08 Its continual reemergence and the current need for densification increasingly push the volumetric city closer towards inevitability

10.09 The goal will be to develop a new theory of volumetric architecture that can recreate the vitality of the public realm throughout volumetric space

THIS GOAL OF VITALITY IN THE VOLUMETRIC CITY RAISES 3 QUESTIONS:

10.10 Question 1: Can the mechanisms of vibrant public streets be integrated into the volumetric city's pathways by designing for vitality?

10.11 Question 2: How effective can designing for vitality be in the volumetric city?

10.12 Question 3: Do the benefits of volumetric architecture outweigh the difficulties of designing for vitality and the risk of reinforcing existing socio-economic struggles in the city?

THE VOLUMETRIC CITY WILL BE STUDIED BY PARAMETRICALLY DESIGNING SCENARIOS:

10.13 Future scenarios will be used to probe the possibilities of a volumetric city

10.14 Volumetric architecture entangles architecture and urbanism, necessitating the study of the building in relation to the city through time

10.15 Parametric design will be used to rapidly test a variety of different ideas at scale to seek an optimal solution to the problematic of the volumetric city

10.16 The algorithm used in the parametric design will focus on the generation and depletion of urban resources that create vitality

10.17 The three questions will be answered by comparing a vitality-driven scenario of the volumetric city to a profit-driven scenario, and comparing the volumetric city to the planar city

THREE SCENARIOS WILL BE COMPARED:

10.18 Scenario 1: The Profit-Driven Volumetric City Scenario

10.19 Scenario 2: The Vitality-Driven Volumetric City Scenario

10.20 Scenario 3: The Vitality-Driven Planar City Scenario

POTENTIAL SUCCESSES OF THE VOLUMETRIC CITY

10.01 *The volumetric city could improve high-density living conditions by creating a vibrant three-dimensional public realm*

If the social and economic functions of the *old city* can be recreated within the volumetric city, the creation of a vibrant public realm within high-density towers could drastically improve quality of life in new developments by creating social encounters, trust, safety, a spectacle, and new economic opportunities. A new form of urban living can emerge as residents inhabit the traversable three-dimensional space, creating moments of engagement that bring people out of the isolation of a condominium unit and out into the extended public realm where communities can be formed.

10.02 *The volumetric city could relieve high amenity demand and improve walkability by creating more frequent amenity zones*

The city's services and amenities can become strained by the introduction of a large new population to an area if important services aren't added. The incorporation of public parks, schools, medical facilities, shops, cafés, restaurants, and other facilities throughout the entire volume of the urban fabric of high-density buildings could relieve the demand for services placed on the existing building fabric. The building network could increase connectivity in the city, while providing a greater variety of amenities, services, and retail within walking distance, making it easier and more practical to access everything to carry out one's daily life on foot.

10.03 *Affordability could be improved by meeting the high demand for housing*

The improved living conditions of high-density developments could allow higher densities to be constructed without compromising quality of life. This increased density could relieve housing demand in the city and help improve the affordability of housing, increasing diversity by creating a mix of affordable housing throughout the building fabric.

10.04 *Sprawl into the valuable Greenbelt could be reduced by enabling greater densities*

Improving the quality of life in high-density construction could allow densification to continue and remain marketable. This could help prevent the city from sprawling outwards into the Greenbelt if the living conditions of high-density towers would otherwise have become unfavourable enough to pressure the market to expand outside of the city. This market pressure can already be observed in campaigns by the building industry to permit development in some parts of the Greenbelt.[1]

10.05 *The land value of sites could be raised by new economic potential near the building network, and throughout the city through competitive diversion*

The increased economic potential from connecting into the building network, coupled with the increased densities possible, could raise the land value of areas connected by the building network. If development is spread throughout the city, targeting the areas that could benefit most from the added density through competitive diversion, the land value of the entire city can be raised by producing greater vitality and density throughout the city as a whole. This would both boost the local economy and the municipality's tax base, and therefore, the municipality's ability to provide public infrastructure.

10.06 *The volumetric city could take better advantage of rooftops and provided additional exterior spaces for sustainable uses*

The rooftops of the city already provide a sizable unused area. With Toronto's recent bylaws mandating new construction incorporate green-roofs, there will be an increasing amount of untapped landscape throughout the city that could be integrated into a building network to provide public access. The added roofs of horizontal connections could provide new exterior spaces to be used for public parks, small-scale agricultural operations, or sustainable energy production.

10.07 *Volumetric architecture could permit greater architectural exploration*

The new urban typology of the volumetric city could provide new possibilities for architectural exploration by embracing connections between buildings, performance responsive building forms, and a traversable

1 Gill Shochat, "How developers are trying to build on Ontario's protected Greenbelt land," *Global News* (Vancouver, BC), last modified December 14, 2016, https://globalnews.ca/news/3117212/how-developers-are-trying-to-build-on-ontarios-protected-greenbelt-land/.

three-dimensional field. If the public realm of the city can truly be extended throughout the volume of the building fabric, architects can realize their concept for "a city within a city" and fulfill the ambitions of a new volumetric urban realm with a wealth of creativity and radical ideas for living in the city.

10.08 *Its continual reemergence and the current need for densification increasingly push the volumetric city closer towards inevitability*

Whether or not these possible benefits are worthwhile in the endeavor for a volumetric city, the ubiquity of volumetric architecture may soon prove to be inevitable for densifying cities, making resolving the past socio-economic problems of volumetric architecture crucial to the future city. In *Investigations in Collective Form*, 1964, Fumihiko Maki suggests that, "a wholly new concept of three-dimensional linkage [is] necessary because we will be building more high buildings as land in our cities become scarcer."[2] Similarly, Moshe Safdie asserts that extra-grade public space is inevitable for dense cities, stating, "when you build in the densities of China, you cannot provide public green areas on a reasonable scale on the ground, and so you have to raise them upward."[3] Between the renewed architectural interest in volumetric cities, its recurring presence throughout architectural history as the future of urbanism, and the possible windfall of economic prosperity that it would create for the development industry, Jennifer Yoos and Vincent James argue that, "the next stage of three-dimensional urbanization is imminent."[4]

10.09 *The goal will be to develop a new theory of volumetric architecture that can recreate the vitality of the public realm throughout volumetric space*

Given the aspirations of contemporary architects, the potential for volumetric architecture to improve quality of life, and its potential inevitability, if new strategies are developed to design and regulate volumetric architecture that can overcome its history of negative socio-economic effects, then the architect will have a greater ability to influence the project for its success. The goal will be to develop a new theory of volumetric architecture that could overcome the struggles of past iterations of the building type to achieve the vibrant urban realm throughout

2 James and Yoos, *Parallel Cities*, 157.
3 Ibid.,188.
4 Ibid.,192.

three-dimensional space envisioned by today's architects. It is hypothesized that if the quasi-public walkways of the volumetric city are able to incorporate the same mechanisms of Jacobs' *old city*, despite its significant formal differences, the volumetric city could provide new and equitable opportunities to introduce walk-ability into high-density cities, relieve the demand for housing and amenity spaces, create communities, and provide new economic opportunities.

THIS GOAL OF VITALITY IN THE VOLUMETRIC CITY RAISES 3 QUESTIONS

10.10 *Can the mechanisms of vibrant public streets be integrated into the volumetric city's pathways by designing for vitality?*

What can be learned from Jacobs' understanding of the street that can be applied to the volumetric city? If the conditions of the street which create vitality cannot emerge on their own in a large-scale development, can they be programmed in through design and regulation?

10.11 *How effective can designing for vitality be in the volumetric city?*

Will designing for vitality provide a substantial enough impact to counter the potential for commercialism and inequality in the building network? How would the city be affected by volumetric architecture if design and regulation don't adapt for vitality, and instead is driven largely by economic forces? What cost to urban life will a volumetric city designed for profit come at?

10.12 *Do the benefits of volumetric architecture outweigh the difficulties of designing for vitality and the risk of reinforcing existing socio-economic struggles in the city?*

The building network, even if originally public, may always be under pressure of privatization with lobbying from private industry. Given the potential for this privatization to reinforce existing socio-economic problems, the added cost of creating building connections such as sky-bridges, and the added difficulty of generating vitality in the building network, will the added vitality of a volumetric city compared to the planar city justify these costs? If the same techniques of generating vitality in the volumetric city are applied to the ground plane alone, can they generate enough vitality in the existing public realm instead?

THE VOLUMETRIC CITY WILL BE STUDIED BY PARAMETRICALLY DESIGNING SCENARIOS

The computer has made it possible to explore still another view of the city, one long held as an intuitive descriptive image, but whose consequences could not previously be analyzed. This is the idea that a settlement does not grow of itself, like a biological organism, but is the cumulative product of the repeated decisions of many persons and agencies—actors who have diverse goals and resources, and who are continuously being influenced by each other's actions. . . . These linkages are the multifarious decisions of persons, firms, and agencies. If one can specify the classes of significant actors, with their motives and resources and how their decisions are affected by the state of the system, and if one can also define the significant elements of the system, their present state, and how each state is modified by the flow of decisions, then one can make an abstract machine out of these elements and links. Once set in motion, this machine will replicate the succession of forms that a real settlement takes on.

— *Kevin Lynch*[a]

10.13 *Future scenarios will be used to probe the possibilities of a volumetric city*

In order to probe the uncertainty of the volumetric city, a strategy proposed by Bernardo Secchi, professor emeritus of Universitario di Architettura di Venezia, will be used. Secchi proposes the use of scenarios, "attempts at inquiring 'what would happen if . . .',"[1] in order to, "clarify the path between constraints and the conquest of the possible."[2] Secchi argues that this strategy illuminates the intents and effects of planning schemes in an otherwise highly uncertain discipline and, "forces every project to move out of the enclosure that is well-protected by an ineffable private wisdom to declare which aspects of urban transformation, of social and economic transformations, and which actors and recipients it intends to face and how it will concretely attempt to meet them."[3] By creating scenarios which embody a set of values carried out to their fullest extent, we can confront the reality of what these values propose and their impact on the city and question what values drive our current designs and regulations. According to Secchi, if "some aspects are isolated and we ask what would happen if these phenomena reached their extreme or probable consequences, we obtain images of the future."[4]

1 Bernardo Secchi, "Three Words," *Planum Magazine*, accessed June 18, 2017, http://www.planum.net/these-words.
2 Ibid.
3 Bernardo Secchi, "Scenarios," *Planum Magazine*, accessed June 18, 2017, http://www.planum.net/scenarios.
4 Ibid.

[a] Lynch, "Good City Form," 337-338.

10.14 *Volumetric architecture entangles architecture and urbanism, necessitating the study of the building in relation to the city through time*

Volumetric architecture intrinsically suggests buildings as not only discrete objects, but a linked network of buildings that all work together in a much more interrelated manner than buildings connected by the ground plane alone. Studying this interaction between buildings becomes even further problematized by the fact that most city-wide building networks start, not as a unified urban plan, but by a single innocuous connection between buildings or a volumetric quasi-public space. Since the repetition of infrastructure creates the strength of its disposition,[5] when applied at the urban scale, volumetric architecture replicated across the city in a city-wide building network would substantially alter the urban fabric—therefore adding the complication that the impact of volumetric architecture evolves drastically through the dimension of time.

In the investigation of Jacobs' theories on street vitality, it was also found that one of the most significant contributors to street vitality is the composition of the building fabric, especially its diversity and the grain of that diversity. Her theories suggest that the socio-economic and programmatic composition of the building in relation to the composition of the building fabric is more significant than the composition of the building alone in the creation of vitality. This also means that the surrounding building fabric can offset the impact of volumetric architecture by making up for its lack of urban resources such as diversity, making the study of a single piece of volumetric architecture in isolation less informative.

Volumetric architecture also intentionally blurs the line between architecture and urbanism by proposing to "bring the city into the building." For these reasons, the volumetric city is a problem that exists both at the architectural and urban scale simultaneously and will require scenarios at the urban scale developed through time to understand how volumetric architecture propagates and the broader impact that volumetric architecture can have on the city.

5 Keller Easterling, *Extrastatecraft*, 74.

10.15 *Parametric design will be used to rapidly test a variety of different ideas at scale to seek an optimal solution to the problematic of the volumetric city*

In order to test a variety of scenarios at scale, through time, a parametric strategy has been selected. A parametric design can take a set of rules that form an algorithm and repeat them many times over, enabling the design of more than just a single building, but a sequence of buildings all responding to the changing urban fabric.

This parametric strategy also enables a process of trial and error, rapidly testing a variety of parameter assignments in order to refine the set of rules that can define a city designed for vitality. This digitally replicates the process proposed by the avant-gardists and modernists of proposing and building a design, learning from how the design affects the city. However, it shortcuts the long approval and construction process that stalled or ended many of these schemes, and doesn't subject the city and its inhabitants to the effects of the architecture before some initial analysis has speculated and substantiated what that effect will be. This creates an iterative design process that refines the design and regulation of the volumetric city with each repetition and allows for radical ideas to be tested without consequence before they are implemented in the real world.

Since the number of public buildings the city can employ is limited, and the test site that will be selected in downtown Toronto already has several prominent municipal spaces and cultural institutions (including Old City Hall, Yonge-Dundas Square, Massey Hall, Ed Mirvish Theatre, and Allen Gardens), the scenarios will focus primarily on altering the urban regulations rather than adding new municipal buildings. For a larger test site, such as the whole city, the placement of new municipal buildings and cultural centres would be a significant addition to the algorithm.

Recalling Jacobs' proposition that the city is a "chessboard," Jacobs has already provided an idea which abstracts the city into a rule-based operation. This concept will be expanded upon to define how parametric design can simulate urban growth through an algorithmic process. This system has two agents with different motivations and different controls, taking turns playing on the chessboard to achieve their goals: the municipality has only a few pieces—public buildings—to play with, and so can primarily control the composition of the chessboard by altering the rules of the game—urban regulations; whereas the development industry holds the majority of pieces but must follow the regulations put in place by the municipality.[6]

6 Jacobs, *The Death and Life*, 167.

10.16 *The algorithm used in the parametric design will focus on the generation and depletion of urban resources that create vitality*

It has been identified that urban resources are quantifiable physical qualities of the urban fabric that enable the public to use space freely, equitably, and for a variety of formal and informal uses; and that this vibrant and diverse use of public space creates the city's vitality. Since this vitality of the public realm is the goal of the volumetric city, the focus of the algorithm used to generate the simulation of the built environment will be the generation and depletion of urban resources.

10.17 *The three questions will be answered by comparing a vitality-driven scenario of the volumetric city to a profit-driven scenario, and comparing the volumetric city to the planar city*

In order to answer our first question, how the mechanisms of vibrant public streets can be integrated into building network pathways by designing for vitality, the first scenario produced will be a vitality-driven volumetric city. In order to answer our other questions about the volumetric city, two comparisons will be made. The first will evaluate how effective the vitality-driven volumetric city scenario is by comparing it to a profit-driven volumetric city. The second will evaluate if the benefits of the volumetric city justify the added difficulties, risks, and expenses it proposes by comparing a vitality-driven scenario of the volumetric city to a vitality-driven scenario of the planar city.

THREE SCENARIOS WILL BE COMPARED

10.18 *The Profit-Driven Volumetric City Scenario*

This scenario will apply Jacobs' logic about how urban resources are destroyed in the city by profit-driven developments which seek out the stability and investment potential of vibrant areas and develop them until the initial vitality that drew development to the area is replaced. The scenario speculates what would happen if current explorations into volumetric architecture were to continue, ultimately resulting in a city-wide implementation of volumetric architecture under the agency of development due to the City of Toronto's lack of ability to regulate development.

10.19 *The Vitality-Driven Volumetric City Scenario*

This scenario will apply Jacobs theories on generating vitality by identifying areas low in urban resources and creating developments to generate them throughout the three-dimensional field. It represents a model for the volumetric city directed by the municipality in order to work towards a vibrant city that follows Jacobs' values of community, inclusiveness, equitable economic opportunities, and increasing land value across the city.

10.20 *The Vitality-Driven Planar City Scenario*

This scenario takes the same principles explored in the vitality-driven volumetric city scenario, but applies them directly to the ground plane alone, removing all connections between buildings to create a solely planar public realm in the city. It represents the scenario in which the municipality recognizes the additional risks, costs, and difficulty of effectively creating an equitable and vibrant volumetric city, and instead decides to prohibit volumetric architecture and focus regulations and design on creating a vibrant and inclusive public space at the ground plane.

CHAPTER 11

THE UNDER-REGULATED VOLUMETRIC CITY CAN BE STUDIED THROUGH A PROFIT-DRIVEN SCENARIO

Now that three scenarios have been selected, how will they be defined? What will motivate them and how do they manifest? This first scenario represents a city whose volumetric quality is unregulated, and therefore motivated primarily by profit for the private sector. This includes the strategic targeting of vibrant areas of the city that are rich in urban resources, and the production of high-profit construction. This profit-driven volumetric city scenario will be compared to the next scenario, a vitality-driven volumetric city, to evaluate how effective the strategies for generating vitality are, and to suggest how severe the social and economic consequences of a profit-driven volumetric city may be.

11.01. The profit-driven development industry and the vitality-driven municipality create a diametrically opposed system

11.02. Urban resources can be used as a measure of the city's vitality potential

11.03. The value of urban resources is easily quantified by the private sector through land value

11.04. The full value produced by urban resources for the public realm is difficult to quantify

11.05. Since the value of urban resources is easy for the private sector to quantify, but difficult for the general public, this imbalance makes it hard to defend when the public loses urban resources due to over-development

11.06. The trade of urban resources is constrained by the city's regulations, but weaknesses in them can lead to over-development that consumes urban resources

11.07. The parametric design tool will translate the diametric opposition of development and the municipality as the profit-driven consumption of urban resources, and the vitality-driven production of urban resources

DEFINING THE PROFIT-DRIVEN SCENARIO:

11.08. Building networks are owned and regulated by the building owner

11.09. Building connections occur only within the same development until their ubiquity causes the demand for a unified network

11.10. Buildings are sited for low-risk and high reward by targeting areas with vitality

11.11. Building program is determined by the highest return on investment and marketability

11.12. Buildings are designed primarily for cost efficiency within regulations and precedence

"Both public and private participants have compelling reasons to understand the development process. The goal of private sector participants is to minimize risk while maximizing personal or institutional objectives—typically profit, but often non-monetary objectives as well. Fortunes have been made and lost in real estate development. Few business ventures are as heavily leveraged as traditional real estate development projects, magnifying the risk of ruin but also the potential for high returns to investors. The public sector's goals are to ensure public safety, to manage the impacts of real estate development on the community and the environment, and to promote smart development that is consistent with community's interests. These goals require balancing the market's need for constructed space against the public sector's responsibility to provide services, improve the quality of life, and limit environmental harm."

—*Real Estate Development - 5th Edition*[a]

11.01 The profit-driven development industry and the vitality-driven municipality create a diametrically opposed system

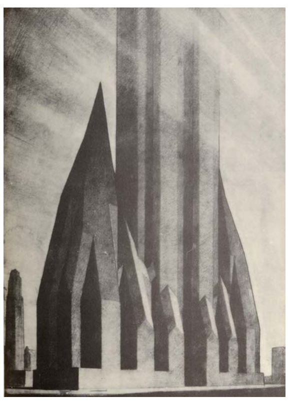


Figure 11.01: Study of maximum building envelopes in Metropolis of Tomorrow by Hugh Ferriss. The buidling form, derived from the minimum setback requirements, illustrates the tension between maximizing saleable floor area and design.

The quote above from Mike E. Miles, Laurence M. Netherton, and Adrienne Schmitz's *Real Estate Development - 5th Edition: Principles and Process* summarizes the tension between the private development industry and the municipality's regulatory authority: one driven to maximize profits, the other dedicated to the well-being of the city.[1] The municipality aims to direct development towards a city that benefits its inhabitants without restricting investment potential so much that development becomes either too risky or too unprofitable to be viable. Since Jacobs argues that development primarily pursues sites that already have vitality,[2] this places the public sector and private sector in opposition, in which the public sector's goal is to generate vitality, whereas the private sector's goal is to acquire vitality. One of the most substantial ways this affects buildings can be seen in the impact of setback rules. Setbacks were established by Louis Sullivan in 1891 and first implemented in New York City in 1916[3] in order to give the city the right to daylight. Simultaneously these maximum building envelopes defined the maximum amount of economic value that can be generated from a property. This concept has been explored by Hugh Ferriss' studies in the *Metropolis of Tomorrow*. This puts economics in direct tension with regulations, while simultaneously restricting architecture by predetermining form—any floor area that doesn't fill up this volume becomes lost revenue to the developer.

[a] Miles et al., Real Estate Development, 3.

1 Xu Feng, "Conversation 2" in *Masterplanning The Adaptive City*, ed. Tom Verebes (London and New York: Routledge, 2014), 50.
2 Jacobs, *The Death and Life*, 243.
3 Hugh Ferriss, *The Metropolis of Tomorrow* (New York: Dover Publications, 2005), 72.

11.02 *Urban resources can be used as a measure of the city's vitality potential*

Recalling the codified system established in Chapters 6 and 7 to explain the processes that produce vitality in the city, Jacobs argues that vitality is created by the many informal uses of public space (statement 06.04) and that physical qualities of the building fabric can either catalyze or inhibit the informal use of space, including: programmatic diversity, building age diversity, density, centrality, continuous urban street walls, short frontages, frequent openings, street activations, the flow of pedestrian traffic, suitable climate, daylight, privileged views, design, public infrastructure, eyes on the street, and connectivity (statement 07.01). This means that urban resources can generate the vitality of the city that both the municipality aims to create, and the development industry seeks to sell access to. Therefore, the quantity of urban resources provides a reasonable measure of the vitality potential of a neighbourhood. This makes sense intuitively, since urban resources have been defined as the characteristics that produce quality of life. For example, housing is more desirable when near popular streets with lots of people on them, access to a diverse array of amenities and retail, greater connectivity via nearby subway stops, or better daylight.

11.03 *The value of urban resources is easily quantified by the private sector through land value*

Since the developer will "seek to maximize return while minimizing risk,"[4] building locations with a high amount of vitality are pursued.[5] This is because the value of the development is dependent upon the, "quality and location of the subject property,"[6] and high-demand areas have a lower risk of unsold units. Therefore, the private sector effectively specifies a monetary value to the vitality of an area, and therefore the urban resources or informal uses it has access to. For instance, recall that increased connectivity by proximity to a subway station increased real estate values by 30%[7] and economist Dr. Irving Hoch's equation for increased real estate value by access to daylight.[8] This ultimately manifests in value calculations, an example of which is the net operating income which, "reflects a location's relative quality."[9] When a property

4 Mike Miles, Laurence Netherton, and Adrienne Schmitz, *Real Estate Development - 5th Edition : Principles and Process* (Washington: Urban Land Institute, 2015), 30.
5 Jacobs, *The Death and Life,* 243.
6 Miles, Netherton, and Schmitz, *Real Estate Development,* 189.
7 Marr, "Toronto Property Near Public Transit Worth 30% More," *Financial Post.*
8 Hoch, 90.
9 Miles, Netherton, and Schmitz, *Real Estate Development,* 190.

is sold to residents, the residents acquire access to the vitality of the city in their neighbourhood and the quality of their residence, gaining access to the informal uses and urban resources of the building fabric. In this manner the urban resources of the building fabric are commoditized by development and the value of urban resources to private development is easily quantified through land value.

11.04 *The full value produced by urban resources for the public realm is difficult to quantify*

Although the impact of urban resources is substantial in producing quality of life and street vitality, the full value of their impact on public space is difficult to quantify. For example, the report, *Capturing The Daylight Dividend In Buildings: Why And How?* by the Lighting Research Center of the Rensselaer Polytechnic Institute argues that accounting for the value produced from all the effects of daylight, described as *dividends*, can justify the added cost of day-lit building designs. These benefits could include: improved productivity, increased job satisfaction, reduced absenteeism, increased sales, increased student performance, reduced energy demand, and improved human well-being, through "day-lighting's impact on aesthetics, vision, and photobiology."[10] The article explains that developers are typically not willing to accept the higher cost of smaller floor plate depths and buildings designed for daylighting, yet, "current research results are leading to a realization of broader economic benefits from daylighting, a dividend that may strongly justify initial construction expenses."[11] In the case of the city's public spaces, all the value provided by daylight throughout all of the city's public spaces would be difficult to determine, yet Jacobs notes that daylight in public space encourages street traffic,[12] which increases opportunities for small businesses, social encounters, and therefore community growth and street safety. These dividends impact the everyday decisions of the city's inhabitants and when applied across the millions of inhabitants of a city and for all urban resources on a daily basis, their impact is substantial.

10 Russell Leslie, "Capturing the Daylight Dividend in Buildings: Why And How?," *Building and Environment* 38, no.2 (2003): 382.
11 Ibid., 381.
12 Jacobs, *The Death and Life*, 103.

11.05 *Since the value of urban resources is easy for the private sector to quantify, but difficult for the general public, this imbalance makes it hard to defend when the public loses urban resources due to over-development*

Although land value can be quantified, because the vitality created by urban resources in public space are more subjective qualities, operating at the scale of the city and to a large number of people, the vitality created by urban resources in the public realm is difficult to quantify, and therefore, hard to defend. For example, Lynch argues that this is why many cities have been designed for cars rather than people—its much easier to measure vehicular traffic data than pedestrian, and its effects are more visible.[13] Jacobs explains that because of the complexity of urban issues and the bureaucracy of local politics, it can be difficult for citizens to initiate simple changes, and impossible for difficult tasks to be accomplished.[14] In contrast, the weaknesses of city regulations are continually being probed by the profit-driven private sector which seeks new ways to test codes, guidelines and the resistance of appeal boards for new ways to increase revenue and decrease risk. When the weaknesses in the system are found, an area becomes over-developed, or a project is simply poorly designed, this can have a negative impact on the surrounding inhabitants who lose access to urban resources, and therefore quality of life. If a new development does detract from the building fabric by depleting the areas urban resources, this becomes problematic as:

1) The loss of valuable urban fabric has already occurred and citizens and the city can only be compensated.
2) Citizens must organize themselves, and pursue legal action at their own expense against well-funded organizations.[15]
3) Since it is difficult to quantify and prove the full extent of the dividends lost, it is difficult for them to receive the full value of their losses back.[16]
Typically, losses can only be identified when they reach effects drastic enough that they are plainly visible.

13 Lynch, *Good City Form,* 152.
14 Jacobs, *The Death and Life,* 413.
15 Ibid.
16 Hoch, 96-97.

11.06 *The trade of urban resources is constrained by the city's regulations, but weaknesses in them can lead to over-development that consumes urban resources*

Since the municipality's role is to direct the development of the city in a way that improves quality of life, the regulations it uses constrain the actions of development to ensure the best interests of the public aren't compromised. Development can contribute urban resources by providing density, diversity, and design for street activation. However, since the pursuit of properties with vitality leads to clustering developments that decrease diversity, and designing for street activation may either be not a priority or not economical, if the city's regulations aren't capable of countering these effects, this means that development can destroy urban resources by demolishing the existing diverse building fabric through over-development (Figure 11.06). Beyond the reduction of diversity, other losses of urban resources could include the removal of well designed spaces that created active street frontage, added users straining existing amenities or infrastructure, or the building reducing the atmospheric quality of the neighbourhood (for example, common complaints by neighbours include the loss of daylight[17] and load on schools).[18]

While creating a marketable development requires creating livable conditions and competing with other similar developments, it is indifferent to contributions to the city as a whole that don't contribute to the development itself. In substitution of this loss in vitality, the development can create marketable living conditions for its buyers through other means (shared luxury amenity spaces, privately accessed privileged views and daylight, security guards and cameras, etc). This means that through the agency of development, when city regulations are insufficient to preserve or generate urban resources, urban resources may be created or expended depending on whether a given development adds or removes diversity.

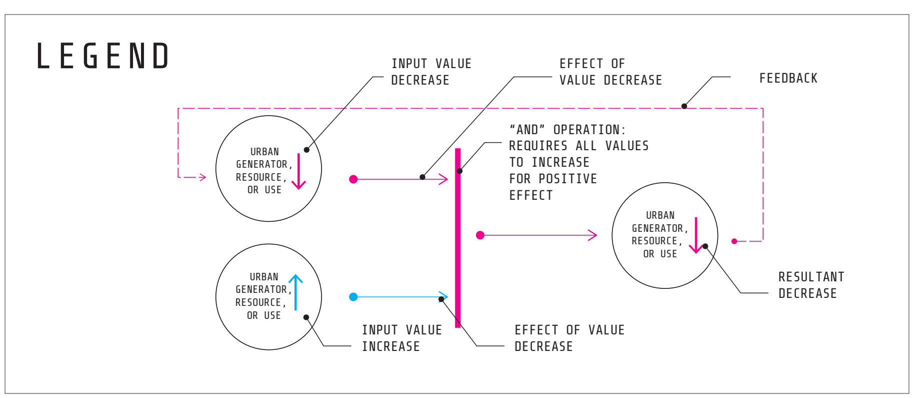
In Toronto, it would be reasonable to question whether the regulations in place are enough to counter the effects of over-development. The already rapid pace of construction has built up Toronto's empty spaces and threatens to develop diverse building fabric.[19] Toronto's zoning plan not only allows too many mixed uses in the downtown to be effective but also has allowable

17 Bink, "Condos Throwing Shade," *City News*.
18 Andrea Gordon, "Toronto Schools Bracing For Wave Of Highrise Neighbours," *The Toronto Star* (Toronto, ON), last modified April 9, 2017, https://www.thestar.com/yourtoronto/education/2017/04/09/toronto-schools-bracing-for-wave-of-highrise-neighbours.html.
19 Benjamin Boles, "Condos Are Destroying Art Galleries on Queen West," *Vice*, last modified February 7, 2017, https://www.vice.com/en_ca/article/8gevpb/condos-are-destroying-art-galleries-on-queen-west.

heights so unrealistic that they aren't considered implementable. The *Tall Building Guidelines* do little to support Jacobs' criteria for street vitality, at times even contradicting her suggestions. The guidelines aren't legally enforceable, and the continual overruling by the OMB against the municipality's advisement give the municipality arguably no control over the siting, height, program, or design of the buildings constructed. Combined, this would mean Toronto's regulations are too weak to constrain development to produce urban resources, and the parametric design will extend this under-regulated situation for the volumetric city into a profit-driven scenario.

11.07 *The parametric design tool will translate the diametric opposition of development and the municipality as the profit-driven consumption of urban resources, and the vitality-driven production of urban resources*

Since the fundamental proposition of volumetric cities is the production of the city's vitality throughout the three-dimensional field and because urban resources have been established as the measure of the building fabric's potential for vitality, therefore, the focus of the parametric design tool developed will be on the production and consumption of urban resources. The vitality-driven scenario will constrain development through effective regulations that target the production of urban resources throughout the building fabric. In contrast, the profit-driven scenario will target the most economical construction including the pursuit of properties in areas rich in urban resources, even past the point in which the urban resources are being destroyed by the new developments. Without constraints limiting factors such as siting, building height, connectivity, program, and price tiers of the new buildings, the economic motive that drives all of these decisions is allowed to create the over-development that would consume urban resources.



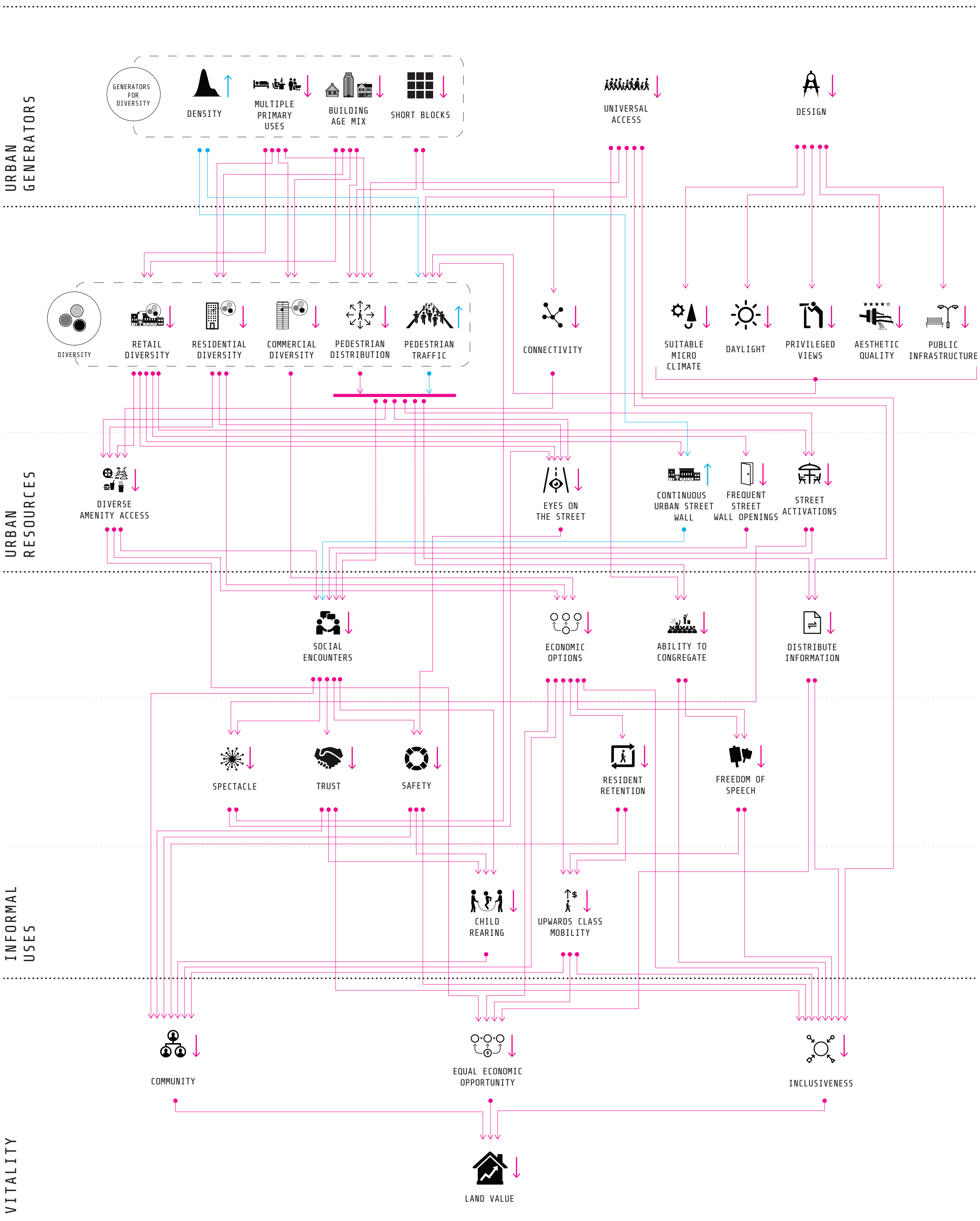


Figure 11.06: Diagram showing how the conditions created by over-development can deplete the urban resources that produce vitality in the public realm. In the parametric design tool, these relationships will be utilized under the argument that the quantifiable physical characteristics generated have the potential to produce the subjective quality of vitality.

DEFINING THE PROFIT-DRIVEN SCENARIO

11.08 *Building networks are owned and regulated by the building owner*

The building owner retains control of the building network, and therefore can determine if inter-building connections or quasi-public amenity space will be created, as well as its location, design, and occupants. The building owner can restrict access to individuals or activities which they deem harmful to either their businesses, clients, or image.

11.09 *Building connections occur only within the same development until their ubiquity causes the demand for a unified network*

Buildings will at first connect only within the same development to create access to shared amenities to all of its occupants. Until a trend of inter-building connections is established in the city, these connections won't happen at the same floor levels or between developments; however, once the volumetric network has been substantially established, a tipping point is reached where the economic opportunity will encourage connections and buildings will form connections across developments.

11.10 *Buildings are sited for low-risk and high reward by targeting areas with vitality*

Buildings in highly desirable areas can be sold at higher rates, and are more stable and marketable investments. Therefore, buildings will be sited in areas with the highest amounts of urban resources, beginning with the lowest density parcels, followed by the oldest construction that isn't protected by historic or landmark status.

11.11 *Building program is determined by the highest return on investment and marketability*

The type of program, its diversity, and its floor area per unit will be determined by supply, demand, and marketability within effective regulations. Therefore, residential buildings will have mostly units of high price brackets in comparison to older construction, with the minimum amount of floor area and shared amenities necessary to remain marketable.

11.12 *Buildings are designed primarily for cost efficiency within regulations and precedence*

In Toronto, the podium-tower type provides the simplest design, is structurally efficient, cost-effective, encouraged by the *Tall Building Guidelines*, and responds to setback rules. Therefore, the building design will be primarily rectilinear podium-towers with a podium footprint variable by the site, podium height variable by setback regulations, building depth responsive to maximum floor depth criteria, and building height responsive to maximum height criteria.

CHAPTER 12

THE IDEAL VOLUMETRIC CITY CAN BE STUDIED THROUGH A VITALITY-DRIVEN SCENARIO

It has now been determined that the study will create a comparison of urban-scale scenarios of the future city in order to shed light on the strengths of a volumetric city designed for vitality. Next, the criteria for a vitality-driven model of urban growth will be determined. This includes the generation of urban resources by integrating a negative feedback loop that targets areas low in urban resources, identifying the qualities that are absent, and developing new construction that fulfills the local needs of the city. This process can then be adapted for both the volumetric and the planar city to determine whether the volumetric city provides significant advantages when designed for vitality.

12.01. The vitality-driven scenarios adopt Jacobs' values of creating inclusive communities, equitable economic opportunities, and increasing the city's land value holistically

12.02. Vitality will be created by the targeted generation of urban resources

12.03. Jacobs suggests generating urban resources through three methods of negative feedback: zoning for diversity, competitive diversion, and staunchness of public buildings

12.04. Jacobs strategies need adaptation to the contemporary context

12.05. Jacobs negative feedback can be assisted by additional criteria of minimum programmatic and price tier diversity requirements, minimum amounts of accessible amenities, performance responsive designs, and maximizing connectivity

DEFINING THE VITALITY-DRIVEN SCENARIO:

12.06. The building network is owned and regulated by the municipality

12.07. Buildings must connect when possible, and connections must be legible and coordinated

12.08. Buildings are sited primarily to create diversity

12.09. Buildings utilize location-specific responses to produce programmatic and price tier diversity

12.10. Buildings are designed using performance-based regulations

12.01 *The vitality-driven scenarios adopt Jacobs' values of creating inclusive communities, equitable economic opportunities, and increasing the city's land value holistically*

The vitality-driven volumetric city aims to re-create the conditions of vibrant streets throughout the volumetric building network by applying Jacobs' knowledge of street vitality, such as the need for producing diversity throughout the three-dimensional field of the city. However, in doing so, it is worth acknowledging that this also adopts the values that Jacobs perceives as good for the city, the most prominent of which include the formation of inclusive communities, equitable economic opportunities, and the targeted increase of the city's land values holistically. These values may not be as significant to the planners or the residents of the city as they are to Jacobs, but given her arguments that they are necessary to create social cohesion and economic growth, her values will be accepted as a reasonable preliminary goal for the vitality-driven scenarios.

12.02 *Vitality will be created by the targeted generation of urban resources*

By codifying the social and economic processes that Jacobs argues create vitality in the city, a useful system is produced which links specific and definable physical characteristics of the built environment directly to the vitality of the city. These characteristics of the built environment have been defined as urban resources, and now that they have been defined they may be quantified, regulated, and designed in order to generate the street vitality desired. Therefore, since the social, political, and economic functions of city streets cannot emerge on their own in the volumetric city (due to the large grain creating a spatial oligopoly and the private circulation network privatizing the commons), instead they can be programmed into the building fabric by the targeted generation of urban resources through regulation and design.

12.03 *Jacobs suggests generating urban resources through three methods of negative feedback: zoning for diversity, competitive diversion, and staunchness of public buildings*

Zoning for diversity is used to eliminate the sorting of uses caused by traditional zoning. Instead, zoning allows for a diversity of uses, building ages, and building types. Competitive diversion requires the use of taxation and regulations to suppress market forces that drive land-value up in prosperous neighbourhoods in order to allow for lower cost and lower density buildings to also be included in vibrant neighbourhoods.[1] This would initially reduce the city's tax base by artificially devaluing highly-desirable land;[2] however, it also encourages the development of higher cost and higher density buildings in areas that could benefit from their construction more.[3] By preventing over-development of successful areas and redirecting development to areas that would benefit most from the new construction, the quality and value of all areas of the city are progressively raised, such that the vitality of all neighbourhoods is increased, and land-value is raised throughout the city more uniformly.[4] Thus the ultimate effect is raising the city's taxation base by increasing land value across the city as a whole. The final criteria proposed by Jacobs is to recognize the social and economic value created by public buildings such as theatres and galleries, and to distribute their sites throughout the city to create vitality where it is needed; remaining staunchly in place, even as the high land-value created by the success of the neighbourhood encourages the sale of the lot to a high-density development proposal (Figure 12.03). [5]

Because this competitive diversion targets the long-term needs of the city rather than the short-term economic gains of a single development at a time, this would reduce the volatility of neighbourhoods swinging between high-end new developments and buildings neglected with age, and instead create an evenly developed city that has its vitality and land value raised holistically.[6] In the long run, this could ultimately minimize the risk in development by providing the entire city as an opportune area for development, rather than only a few vibrant areas; maintaining a consistent viable market for a variety of neighbourhoods, and preventing drastic changes in real estate costs. While this may reduce the revenue potential of individual lots, it would also maintain the practice of development as a viable investment by minimizing the risk potential for any given development and increasing the opportunity for development.

1 Jacobs, *The Death and Life,* 255.
2 Ibid.
3 Ibid.
4 Ibid.
5 Ibid., 254.
6 Ibid., 252.

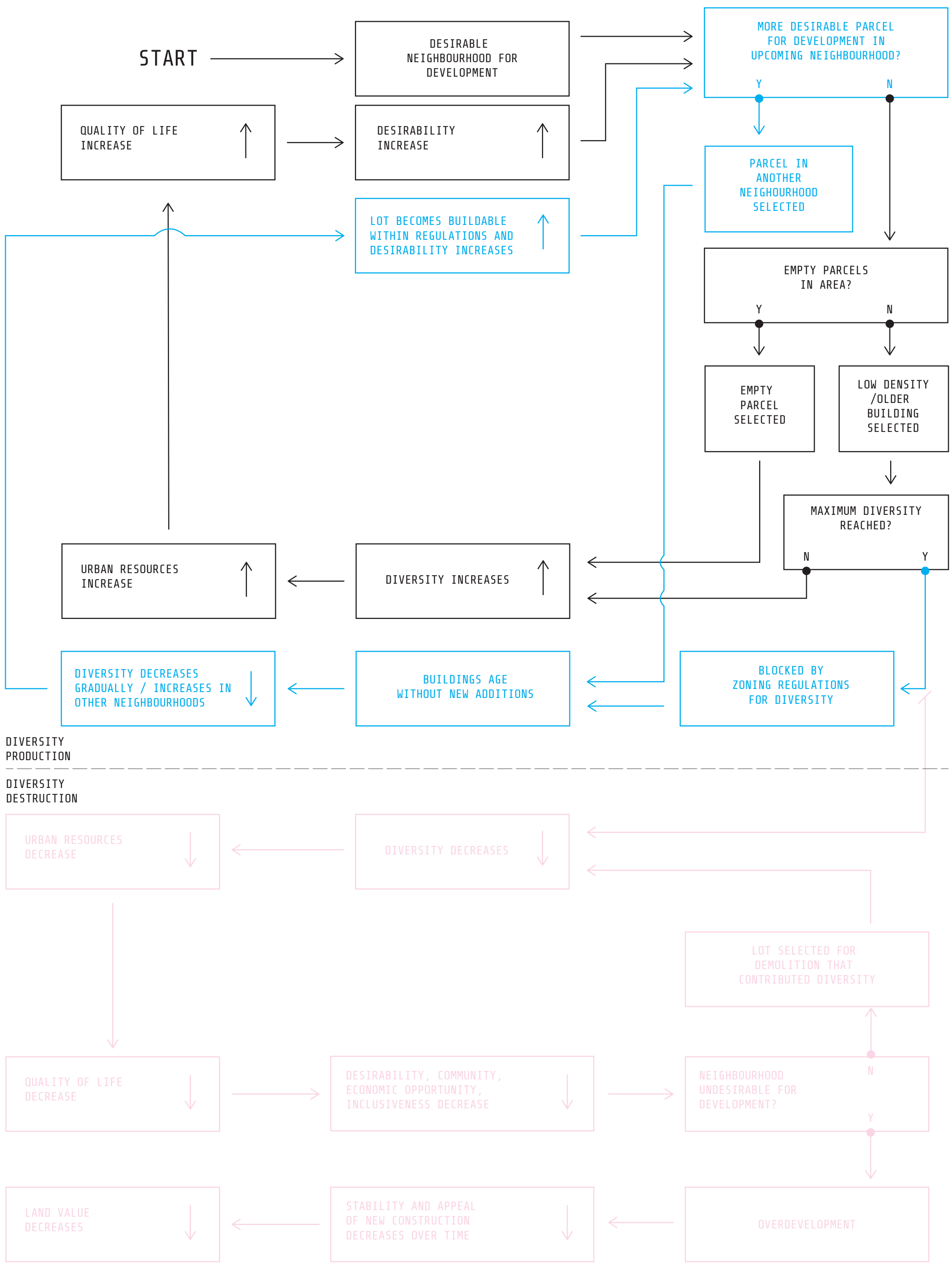


Figure 12.03: Representation of Jane Jacobs' concept for producing a negative feedback mechanism in the city that preserves diversity by suppressing excessive duplications of the same building type or use and creating competitive diversion.

12.04 *Jacobs' strategies need adaptation to the contemporary context*

It has already been established that in addition to economic forces that tend to group large-scale developments together, the limitations on the length of inter-building connections and the added economic potential of the volumetric city will also tend to group large-scale buildings together. The negative feedback mechanism suggested by Jacobs will help to reduce this tendency by siting buildings for diversity; however, since Jacobs published *The Death and Life of Great American Cities* in 1961, the downtown core of cities has changed. Accepted densities have increased, unit sizes have become smaller, economic forces driving development in Toronto stronger, and the cost of living substantially higher. The overly high densities that Jacobs' argues work against diversity by creating a standardization of building types have already emerged in many contemporary downtowns, creating standardization such as Toronto's influx of podium-tower construction. This means that Jacobs' negative feedback will need to be adapted with supplementary criteria that respond to contemporary conditions of the city and the volumetric city type.

12.05 *Jacobs' negative feedback can be assisted by additional criteria of minimum programmatic and price tier diversity requirements, minimum amounts of accessible amenities, performance responsive designs, and maximizing connectivity*

Although Jacobs' writings evoke images of low-density neighbourhoods of historic construction, her strategies don't exclude high-density buildings, rather they aim to create diversity from the composition of a variety of buildings. However, given the density and proximity of large-scale buildings already likely exceeds Jacobs' expectations for creating diversity through an assemblage of buildings, additional criteria will be necessary to bring diversity to the building scale, supplementing her existing concepts for competitive diversion.

For this reason, the vitality-driven scenario will introduce requirements for minimum amounts of programmatic and price-tier diversity within individual buildings. These minimum requirements will respond to the local conditions to create diversity in response to what already exists adjacent to the site by querying the makeup of the surrounding building fabric, comparing this to an ideal programmatic and price-tier distribution, NOTE: Here the intention is not to make development unprofitable, but to balance the risk and reward of development to respond to the city's needs in addition to profitable criteria. If a new development wants to take advantage of the low-risk of an over-developed area, it must provide a greater amount of affordable housing and public amenities that may decrease its revenue potential. If not, through competitive diversion, the development is directed to other areas that would benefit from more density and high-end housing that provide greater revenue potential, with an increased risk factor.

and specifying a minimum amount of each. In this manner, the new construction may contribute to diversity in relation to its surroundings at a grain size smaller than a city block.

Other criteria will directly specify urban resources. Inter-building connections will be encouraged up to a maximum distance and a maximum number of connections such that connectivity in three-dimensional space is maximized, extending Jacobs' criteria of short block lengths. Responsive building forms will optimize daylight to public and quasi-public spaces, as well as significant lines of sight between landmarks that can serve as wayfinding aids. The responsive building forms will also aid in aesthetic variation, allowing architects to respond more creatively to atmospheric conditions and improve designs, while also encouraging visual connections between various program types. Universal access will allow all members of the public to access all pathways in the building network, just as public access is allowed on all streets, ensuring diverse mixes of the population can be created, all amenities can be accessed, and no group is victimized by access controls.

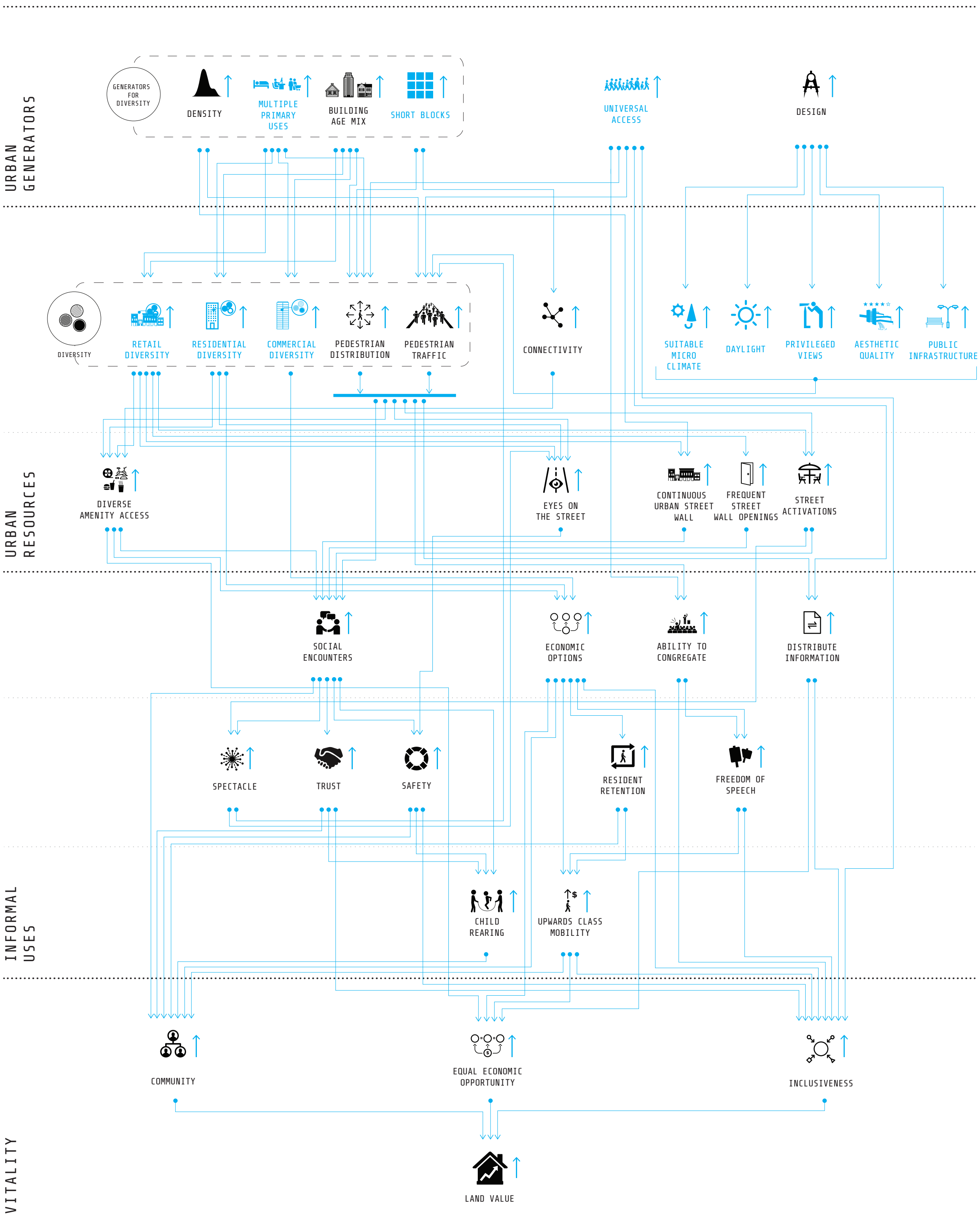
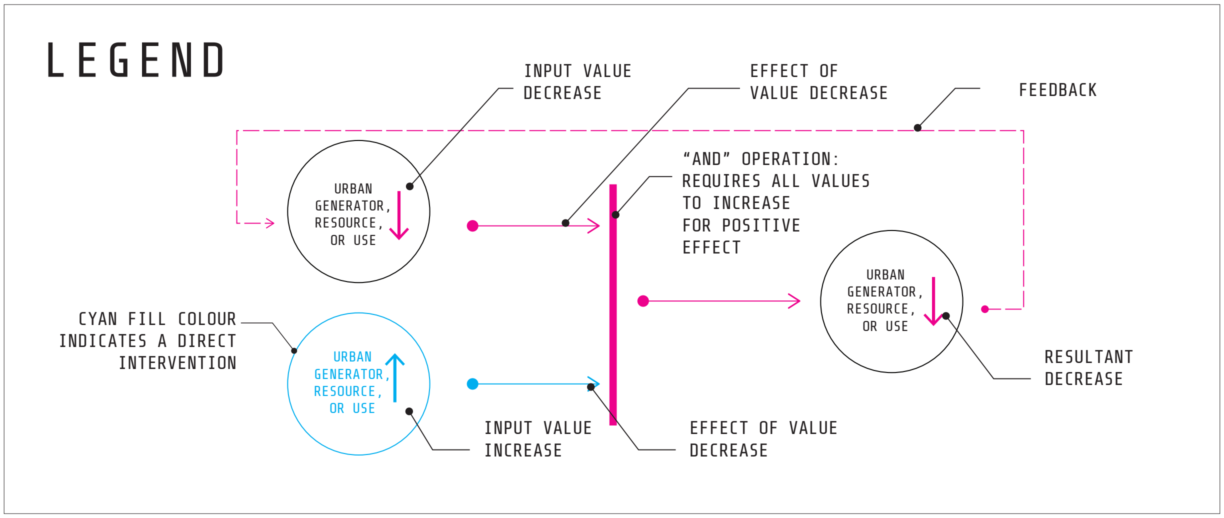


Figure 12.05: Reconstructing the urban processes that generate vitality by designing and regulating urban resources into the building fabric. The criteria highlighted in cyan will be directly produced through design and regulation in order to increase the production of the informal uses desired downstream.


LEGEND
INPUT VALUE
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URBAN
GENERATOR,
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TO INCREASE
FOR POSITIVE
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OR USE
CYAN FILL COLOUR
INDICATES A DIRECT
INTERVENTION
URBAN
GENERATOR,
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OR USE
RESULTANT
DECREASE
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EFFECT OF VALUE
DECREASE

DEFINING THE VITALITY-DRIVEN SCENARIO

12.06 *The building network is owned and regulated by the municipality*

Establishing public ownership early on enables the city to incorporate the building network into a master plan. The municipality can plan and design the building network just as effectively as any other public space, and influence the route and wayfinding of the network. Since the building network is civic infrastructure that provides access to services, amenities, institutions, offices, and retail, the loss of access to the building network by any member of the city would be a significant loss of freedom. Therefore, the building network must be publicly accessible and the right to occupy space cannot be taken away from the individual by a building owner.

12.07 *Buildings must connect when possible, and connections must be legible and coordinated*

An extension of Jacobs' "short blocks" generator, by encouraging connections, circulation through the network is more thoroughly mixed, dead-ends are minimized, and access is improved. Legible connections and specified levels of connection improve wayfinding which can be aided by maps and signage.

12.08 *Buildings are sited primarily to create diversity*

This is one of Jacobs' mechanisms for negative feedback and incorporates two generators of diversity: siting buildings to create both a mix of building ages and a mix of primary uses. Building sites will target areas of the city that have few urban resources, and compensate by constructing buildings complementary to the existing fabric in order to generate diversity and urban resources.

12.09 *Buildings utilize location-specific responses to produce programmatic and price tier diversity*

Diversity will be created within the composition of the building, responding to the adjacent building fabric by comparing it to an ideal distribution of programs and price tiers and specifying a minimum amount that the new construction must contribute to the diversity of programs and price tiers.

12.10 *Buildings are designed using performance-based regulations*

The restrictions of setback rules and other rigid regulations will be too inefficient for the high-density, multi-level public space scenario of the volumetric city. Therefore, designs must be more responsive to their context, accomplished through performance-based regulations which allow building form and design to be thoroughly determined by the architect and respond to daylight, significant lines of sight, and visual connections.

CHAPTER 13

A PARAMETRIC DESIGN TOOL IS PRODUCED TO SIMULATE THE GROWTH OF THE CITY BY ABSTRACTING THE BUILT ENVIRONMENT

Now that the criteria of the scenarios have been defined, the method of study can be determined. A custom parametric design tool will be developed that can rapidly produce iterations of these different scenarios. This will be done by abstracting the most relevant aspects of the built environment to the study of vitality in the volumetric city into digital representations that can be manipulated by parametric operations.

<u>SPECIFYING THE CAPABILITIES OF THE PARAMETRIC DESIGN TOOL:</u>

13.01. The intent of the parametric tool is to generate schematic designs of the future city

13.02. The parametric tool must be flexible to accommodate different scenarios

13.03. The parametric tool must provide an adequate amount of detail to understand the architectural scale

13.04. The parametric tool must recreate the development process with a suitable degree of realism

13.05. The scope of the parametric tool will be limited to the criteria relevant to the volumetric city and Jacobs' criteria for street vitality

13.06. The parametric tool will take a 3D model input and the user's parameters and run a recursive algorithm to generate a 3D model output

13.07. The parametric design is not intended to suggest specific physical solutions, but rather to form an impression of the result of performance-based codes and standards

SPECIFYING EXPECTATIONS FOR THE SCENARIO TESTS:

13.08. The scenarios can't prove vitality is created but can be assessed for their ability to foster vitality

13.09. Recording performance metrics of the scenarios will allow for a numeric evaluation of their ability to generate vitality

13.10. Spatializing the scenarios as a drawing set will allow for an architectural analysis of their ability to generate vitality

13.11. The result of the spatial and metric analysis of the scenarios should form an impression of how current design and regulations will impact the future of the city and its inhabitants

THE BUILT ENVIRONMENT IS ABSTRACTED INTO DIGITAL SPACE AS A SET OF DISCRETE OBJECTS WITH ASSIGNABLE PROPERTIES:

13.12. The parametric design tool will be written in the Processing programming language

13.13. The city is imported into Processing by abstracting the urban fabric as a field condition

13.14. Representing the building fabric as a grid of voxels creates greater spatial awareness and liberates the model from the dominance of the ground plane

13.15. The precision of the model will be determined by the digital objects that can be placed within it and the range of properties they can possess

CLASSES OF OBJECTS DESIGNED FOR THE DIGITAL MODELING ENVIRONMENT:

13.16. The Voxel

13.17. The Quadrant

13.18. The Core

13.19. The Building

SPECIFYING THE CAPABILITIES OF THE PARAMETRIC DESIGN TOOL

13.01 *The intent of the parametric tool is to generate schematic designs of the future city*

The intent of the parametric tool will be to generate schematic designs of the urban fabric which project the future growth of a selected site within the city. The software will be designed such that the process of development over time can be simulated with a reasonable amount of realism, the flexibility needed to generate the three scenarios proposed, and an appropriate level of detail. Therefore, the process is largely informed by determining which characteristics of the city are important to include in the parametric design tool, and which characteristics are not.

13.02 *The parametric tool must be flexible to accommodate different scenarios*

In terms of flexibility, the user should be able to specify a range of values for a wide variety of parameters controlling each stage of the growth algorithm that are relevant to either the planar or volumetric city, and either the profit-driven or vitality-driven scenarios. Wherever possible, rather than assigning values in the algorithm, an adjustable parameter should be used. This is because the settings for each of the three scenarios will be very different, and the exact values assigned to each parameter won't necessarily be known before running the program. They will need to be discovered through a process of trial and error, informed by the research completed and observation. This ability to rapidly edit parameters also allows for external participation, as well as the flexibility to use the program to create other scenarios and test radical new concepts of urban design.

13.03 *The parametric tool must provide an adequate amount of detail to understand the architectural scale*

The analysis will be interested in urban scale relationships with enough specificity to understand the human experience of inhabiting the space. This means that the built environment can be heavily abstracted, as the key relationships are the generation and depletion of urban resources, and therefore specific designs of buildings, or elements of buildings smaller than several meters in size aren't significant to the study. However, enough detail should be available, or the grain of the generated urban fabric small enough, such that the architectural visualization of the space will remain relatable to the human scale and buildings still retain their approximate form.

13.04 *The parametric tool must recreate the development process with a suitable degree of realism*

In regards to realism, because Jacobs' interventions, urban regulations, and the agency of development influence each stage of a building's development, the program must address the process from beginning to end. This includes the selection of a site, site analysis, the location of building cores, the building massing by program, and ultimately the possible depreciation of the site and vacancy. By including a process for each of these steps, a generative algorithm based on the constraints of building development can be approximated. The computational processes will be an abstraction of the actual processes; however, due to the modular nature of parametric design, these processes could also be refined further should a more precise model become necessary for future study.

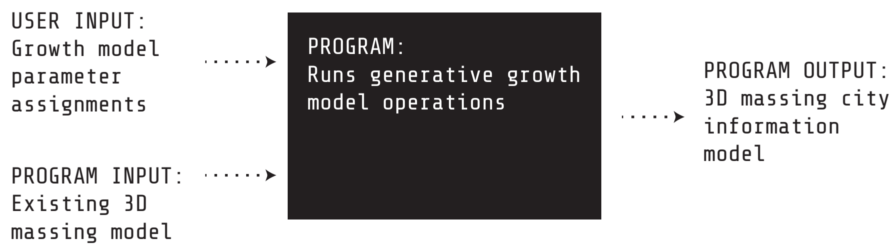
13.05 *The scope of the parametric tool will be limited to the criteria relevant to the volumetric city and Jacobs' criteria for street vitality*

Since the purpose of the tests is specifically to focus on the creation of a vibrant and inclusive street life as defined by Jacobs, the criteria investigated, and therefore necessary to simulate, are only those relevant to the framework established in the codification of Jacobs work in Part Two, or the criteria of development and regulation in opposition to it. Simulating the full criteria of how building sites are chosen and developed would be both laborious and extraneous to the study, as these criteria will not be measured, tested or investigated. The program will be indifferent to these additional criteria—although they would provide a more accurate model of city growth, this accuracy won't be useful as it won't be studied. The outputted model will, therefore, generate one configuration of a possible iteration of the urban fabric within the criteria provided, and can later be analyzed for strengths and weaknesses within these criteria.

13.06 *The parametric tool will take a 3D model input and the user's parameters and run a recursive algorithm to generate a 3D model output*

The scenario models will be generated by importing a model of the test site's existing fabric, accepting parameter assignments from the user that specify values relating to real-world criteria, and running a recursive algorithm on the model that incrementally generates new building developments. When the user opens the program, the massing data will import automatically, and the simulation can begin once the on-screen parameters are set to the desired values. The on-screen view of the digital environment will show the progress of the growth model, which can ultimately be exported to a set of points and imported into the 3D-modeling program, Rhinoceros, for further visualization and analysis by using a Grasshopper script.

Figure 13.06: High-level diagram of how the program will be used to generate models of urban fabric by accepting a 3D model of the site, and running an algorithm with user defined parameters to generate a new model.



13.07 *The parametric design is not intended to suggest specific physical solutions, but rather to form an impression of the result of performance-based codes and standards*

In *A Theory of Good City Form*, Kevin Lynch makes a call to shift away from restrictive low-level goals and solutions towards performance standards applied at the urban scale.[1] His aim is to produce goals that are general, and thus, "do not dictate particular physical solutions, and yet whose achievement can be detected and explicitly linked to physical solutions."[2] Given the shortcomings of overly prescriptive physical strategies in Toronto, such as the setback rules that led to the standardization of the podium-tower building type, the model output from the parametric design tool is intended not to suggest specific physical solutions. Instead, the output can be used to visualize an impression of the building fabric that results from performance standards that suggest minimum requirements of daylight, diversity, and other urban resources, while allowing architects and planners the flexibility to specify an exact strategy of their own within these constraints.

1 Lynch, *Good City Form,* 108.
2 Ibid.

SPECIFYING EXPECTATIONS FOR THE SCENARIO TESTS

13.08 *The scenarios can't prove vitality is created but can be assessed for their ability to foster vitality*

The investigation of the three scenarios is to determine the ability for different models of urban growth to generate urban resources that create informal street functions for the city's inhabitants. Jacobs' work states that merely creating urban resources doesn't guarantee the vibrancy of street life and equality that the work aspires to—other social, political, and economic conditions outside of urban planning are also necessary. However, Jacobs asserts that her criteria can enable the processes in the city that are necessary for vitality to occur.[1] Therefore, it won't be possible to test directly if this computational approach will create all the informal uses of space that contribute to an inclusive and vibrant street life; however, it will be possible to assess the urban fabric for the conditions necessary for inclusive and vibrant street life to emerge.

13.09 *Recording performance metrics of the scenarios will allow for a numeric evaluation of their ability to generate vitality*

To help determine if the spatial and programmatic conditions for vitality of street life to occur are present in the scenario models, several performance metrics will be calculated and recorded over time and by location in three-dimensional space in order to observe how the urban fabric changes throughout the simulation. These metrics include: performance scores of Jane Jacobs' four generators of diversity; a record of the floor area of each type, subtype, and price tier of program over time; a measure of the risk of vacancy due to low levels of diversity; floor area ratio; the number, type and public level of building connections; the number of distinct building networks; and building site locations; among others. These metrics will show a general picture of the city's ability to create the conditions necessary for vibrant street life in three-dimensions throughout time. The measurement of performance in the third (vertical) dimension of space is significant in assessing the ability of volumetric city growth to provide vitality of street life throughout the three-dimensional field, as the conditions at different levels of the city, from grade level, skyway

1 Jacobs, *The Death and Life*, 249.

strata levels, up to penthouse levels can vary drastically in the volumetric city, and is a significant distinction between the volumetric and the planar city. Recording these metrics at regular intervals through time is also significant given the impact of a building network will change dramatically over time as the network grows. As contemporary urban analyses generally operate in two-dimensional space (for instance the planar representation of the city as a flat projection of the qualities of three-dimensional space in GIS software), this four-dimensional record can provide new insights into the qualities of both the volumetric city and the planar city.

13.10 *Spatializing the scenarios as a drawing set will allow for an architectural analysis of their ability to generate vitality*

The spatialization of each of the three scenarios will also be helpful in understanding the architectural potential of these possible built environment futures. Since the goal of the parametric tool is not an explicit parametric urban design, or the authoritarian assignment of architectural form, but rather a means to project the influence of three distinct scenarios, the architectural representation of these scenarios will not be an absolute design, but rather an indication of the spatial qualities and relationships established by the urban fabric. By representing the scenarios through sections and abstract renderings, the first insights into the occupation and habitation of these possible cities can be explored, initiating the process of architectural design, and crystallizing the relationship of the inhabitant with the street and the building network.

13.11 *The result of the spatial and metric analysis of the scenarios should form an impression of how current design and regulations will impact the future of the city and its inhabitants*

The metric and architectural comparison of these three scenarios of urban growth will shed light on the latent potential of the city under three different conditions of regulation, development, and design. The goal will be to use the numerical and architectural analysis to speculate how each scenario will affect the lives of its inhabitants in order to anticipate future problems or opportunities that lie within the current regulatory system and design of volumetric architecture, and to evaluate the necessity of volumetric architecture. To return to Keller Easterling's understanding of disposition, the repetition of infrastructure and the impact of regulations have a latent potential—an agency that impacts the world and the people in it. Not only does the contemporary regulatory framework combined with the agency of the architect, planner, and developer create a disposition for a range of potentials for the growth of the city; but additionally the city, as social, political, and economic infrastructure, imposes a disposition onto its inhabitants through the various possibilities available or restricted to its inhabitants' by spatial and regulatory relationships. By simulating scenarios of different design and regulation pathways that would impact the city's growth, an image of the possible quality of life in the city can be glimpsed that can inform intelligent decisions, shaping the growth of the city for the benefit of all of its inhabitants.

VITALITY-DRIVEN VOLUMETRIC SCENARIO CRITERIA INCORPORATED INTO THE PARAMETRIC DESIGN TOOL

SITING

1. Distribute public building sites evenly throughout the city rather than clustered together in "cultural centres." Keep them in place regardless of the value of an acquisition offer. Public buildings attract people and similar businesses that create vitality that should be spread throughout the city, that vitality is destroyed when the public buildings are relocated.

2. Direct private building siting towards areas that could benefit from their added density and that their program would bring diversity to an area. Over-development reduces diversity, and therefore street activity, whereas under-developed areas could benefit from what the building brings to the area by increasing diversity and density.

3. Start with areas that are low in one of Jane Jacobs generators for diversity but high in the other three. These areas will gain vitality the fastest.

4. Parcels can be combined if they meet a minimum age and density criteria, but don't need to be contiguous to be combined into a single building development. Volumetric cities can connect in three-dimensions, buildings don't need to be continuous at grade.

5. Parcels can only be combined up to a maximum area that puts an upper limit on the grain size of parcels. Singular ownership of a large area destroys diversity the most, an upper limit ensures singular ownership can't create a spatial oligopoly.

6. Buildings may cantilever over adjacent lots and streets, subject to negotiation, as long as the cantilever doesn't obstruct views or daylight. This increases the volumetric quality of the city and increases density unintrusively without taller buildings.

SITE RESPONSES

7. Buildings are only allowed small height gains on adjacent buildings, but are allowed to use a large comparison radius to determine the height gain. Height gains should be incremental, but towers shouldn't be sited too close together, therefore they are allowed to reference more distant towers.

8. Performance-based guidelines are used to reduce shading, especially shading of public spaces, and encourage buildings that respond appropriately to optimize daylight. Shade discourages the use of public space, buildings with more interesting shapes provide more visual connections to adjacent program and can produce better designs that give the building an identity.

9. A skyline shape is specified in response to significant landmarks such as the CN Tower and enforces a maximum height that is location specific. The CN Tower helps for wayfinding and the iconic skyline of Toronto should be considered in building heights.

10. Buildings are encouraged to create extra floor area at significant connective strata. More programmed spaces keep the building network more populated. Also increases density.

11. Significant sightlines are identified in the city and preserved. Assists with wayfinding and spatial quality, as well as encouraging more interesting formal responses.

12. Facade articulation such as terracing, "pixelation," or other forms, are encouraged. Facade articulations provide more view aspects from the interior space, increasing daylight and visual connections inside. Also provides accessible exterior spaces larger than a balcony, visual connections to adjacent programs (especially public strata), and produces more interesting forms.

13. Cantilevering can be reduced over public spaces as necessary. Prevents public spaces from feeling overly enclosed or shaded.

14. Enforce a minimum distance from adjacent buildings. Volumetric buildings can grow throughout three-dimensional space due to the cantilever allowance, but they shouldn't encroach on existing construction.

BUILDING CORES & CONNECTIONS

15. Building cores of the same development must have a minimum height variation. Reduces urban wall effect and standardization.

16. Inter-building connections are encouraged to adjacent buildings whenever possible, up to a maximum feasible length and a maximum number of connections. Improves connectivity that increases diversity, access, and pedestrian traffic.

17. Heights for all inter-building connections are pre-determined at specified strata and public or quasi-public program should tie directly into these strata. Keeps wayfinding as simple as possible.

18. The first strata is at approximately podium height. Buildings are already close together at this height, unused roof spaces can be incorporated into the network, and amenities in podiums can be linked together.

19. Connection strata occur regularly, suggested around every 10-15 floors, such that no one will ever be too far from the public network. Decreases alienation in towers by providing a visually close public datum and increases walkability by keeping amenities within walking distance in the building network, decreasing reliance on elevators.

20. Strata heights can vary slightly by building but by no more than one floor in either direction. Any more and access decreases.

21. All building connections and cores that serve them are publicly accessible. The building network is owned, controlled, regulated, designed, and governed by the publicly accountable municipality. This ensures no demographics are formally or informally discouraged from using the public infrastructure network and no valid uses of the space are discouraged. Both increase vitality by increasing diversity and the use of space.

22. All building connections are considered a part of the same network, if a building connection is created, assume others will connect to it in the future. This ensures access and connectivity are not inhibited.

BUILDING COMPOSITION

23. Large-scale buildings must make a minimum contribution to the programmatic diversity of the immediate area. This can be determined by comparing the local programmatic composition to an ideal distribution appropriate for the area and specifying a minimum amount necessary to contribute to the programmatic use types in the greatest deficit.

24. Large-scale buildings must make a minimum contribution to the price-tier diversity of the immediate area. The process can be similar to the above. Both work to increase diversity such that the building network is regularly populated and no groups isolated from a portion of the city.

25. Various strategies can be used to provide programmatic and price-tier mixes. They can vary by development, by building, by structural element, by strata, by floor, or within a floor. Strata provide an opportunity create transitions to new programs and create a new datum that can be priced as "ground floor" or "penthouse."

26. A mix of rectilinear and free-form construction can be encouraged. This mix may also occur within the same development, with different structural elements providing a different formal strategy. Form won't be prescribed, but a balance of free-form formal experimentations to improve fit and aesthetic interest, combined with rectilinear construction to maintain coherence and economy, is likely preferable.

26. All roof surfaces should be used when possible, and can be integrated into the building network. Appropriate uses include recreational spaces, landscaped spaces, small-scale agricultural uses, and sustainable energy harversting.

FACTORS NOT SIMULATED

27. Public and quasi-public programs should have short frontages onto the building network or street, with glass facades for visual connections, frequent entrances, and should spill out onto the street with programmed street activations where possible.

28. Public infrastructure such as lights, benches, garbage cans, and restrooms should be adequately provided to allow for public use of the space.

PROFIT-DRIVEN VOLUMETRIC SCENARIO CRITERIA INCORPORATED INTO THE PARAMETRIC DESIGN TOOL

SITING

1. Significant public buildings will largely stay in place because of their history and public resistance; however, an option to buy-out the building site when its development potential reaches a high threshold can be added at a later date.

2. Private building development targets areas that are performing well with high amounts of vitality, indicated by high performance scores. The new construction may contribute urban resources if the building happens to add diversity or fulfill local needs, but it is not designed to, it is designed to be the most economically viable construction for the site.

3. Start development in areas with the highest combination of performance and development potential scores, these areas have the lowest risk and highest potential return on investment,

4. Parcels are combined with a more liberal minimum age and density criteria than the vitality-driven scenario, allowing more lots to be combined and increasing revenue potential for the site. Lots must be contiguous; however, as it is assumed regulations haven't advanced to allow for unconventional building sites made possible by volumetric architecture.

5. A gracious maximum lot area is assigned, allowing for the greatest revenue potential achieved through combined sites. Lots can be as large as city blocks.

6. Sky-bridges may cross streets or adjacent lots, but buildings may not put programmable space within this volume. This assumes performance-based regulations haven't been developed to allow for unconventional forms, and forces buildings higher to achieve greater densities rather than making greater use of horizontal connections.

SITE RESPONSES

7. Buildings are allowed a liberal height gain on immediately adjacent buildings, creating greater saleable floor area. This is derived from OMB approvals of building heights based on adjacent precedents creating continually increasing height paradigms.

8. Daylighting is a factor considered in the placement of the building core, but without performance-based regulations, the building form is unresponsive to daylighting criteria, governed instead by the more economical standardization of floor plates.

9. A skyline shape is specified in response to significant landmarks such as the CN Tower, but the height allowances are more liberal than the vitality-driven scenario since the existing skyline profile guidelines in Toronto are largely dismissed by OMB rulings.

10. Floor area at sky-bridge levels is determined by the floor plate, since unique protrusions are less economical.

11. Sightlines may influence the locating of building cores, but the building form won't be responsive to significant sightlines.

12. Facade articulations beyond balconies for residential units are not encouraged since standardized floor plates are more economical.

13. Buildings are not permitted to cantilever over adjacent sites, however sky-bridges may cross other properties.

14. Any distance between towers greater than 7m is permitted. The minimimum distance between building is already generous in Toronto, with precedence of some towers permitted as close as 7.2m apart (ex: 561 Sherbroune).[1]

1 Edward Skira, "561 Sherbourne," *Urban Toronto*, accessed on November 10, 2017, http://urbantoronto.ca/forum/threads/toronto-561-sherbourne-128m-43s-medallion-p-s-ibi.8416/page-4.

BUILDING CORES & CONNECTIONS

15. Building cores of the same development may be the same height.

16. Inter-building connections to adjacent buildings aren't actively encouraged, but can be implemented when economically viable for the development. However, the maximum length of inter-building connections is reduced from the vitality-driven scenario since longer connections can be less economical, even though they can improve connectivity.

17. Height levels for inter-building connections are not governed by the city, and each development may choose its own connection levels. Once the number of building networks passes a threshold, the economic benefits of creating an integrated system will encourage developments to select connection levels at the same heights.

18. Podium heights are used for private terraces, and connection to adjacent buildings at this strata isn't actively encouraged.

19. Distance between levels where inter-building connections occur aren't specified, and can be determined by the individual development until a unified network is established.

20. Strata heights are allowed greater variation between buildings, even after the threshold to create an integrated building network system is surpassed.

21. All building connections and cores that serve them are quasi-public. The building network is owned, controlled, regulated, designed, and governed by the building's owners and their hired partners. This ensures the building owners can control access to the building to defend the building's safety, but also gives control of the building network to the private sector.

22. Even though adjacent developments may connect to each other, it is dependent upon the agreement of the two building owners and existing buildings are not required to permit new connections.

BUILDING COMPOSITION

23. The program selected is by the most economical for the site, rather than the most diverse. Given the high housing demand and the condominium boom, the most popular is residential, with allowance for some office space as well. Amenities, and institutional uses are mostly only required to maintain marketability, and must meet the standards of the residents of the development. Retail is encouraged by the municipality.

24. The pricing of units is determined by the market alone, including the continued impact of foreign investment artificially inflating demand. Without affordable housing provisions, the higher price tiers are favoured for the new construction, with rates only dropping after decades of aging.

25. Program and price mixes are not required. Programs will tend to group together as identifiable residential neighbourhoods or business districts are more marketable and mixing uses within buildings can require greater variation in the building, and therefore greater costs. Price tiers tend to group together with new construction of similar cost grouped together, separate from groups of older buildings with decreased cost. Price tiers vary within buildings exclusively by level and floor area, with the highest price tiers at the top of the building.

26. Rectilinear construction is almost always used as it is the most cost effective to build.

26. Roof surfaces are used only to provide private terraces for residents and meet the minimum green roof requirements from the city.

FACTORS NOT SIMULATED

27. Public and quasi-public programs tend to have longer frontages with less frequent entrances and less programmed street spaces as a result of the selection of more corporate retail tenants.

28. Public infrastructure such as lights, signage, benches, garbage cans, and restrooms are targeted towards the residents of the building, and features are used to discourage loitering or limit access and navigation.

THE BUILT ENVIRONMENT IS ABSTRACTED INTO DIGITAL SPACE AS A SET OF DISCRETE OBJECTS WITH ASSIGNABLE PROPERTIES

13.12 *The parametric design tool will be written in the Processing programming language*

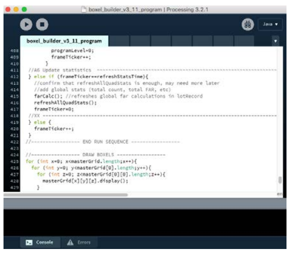


Figure 13.12: Screen capture of the Processing Integrated Development Environment

Processing is an open source programming language derived from Java. Targeted at designers, its simplified syntax makes it conducive to greater participation from others. Possible alternatives may be Grasshopper or Rhino Script, which both integrate with the Rhinoceros 3D-modeling program directly; however, the standalone and free Processing environment allows for more outside participation, as the program can be exported and run on anyone's computer. This means that with the parametric design tool's on-screen user interface for controlling the generative algorithm's parameters, anyone can generate a unique urban growth scenario without any additional knowledge, or custom scenarios can be crafted with additional modules of code.

13.13 *The city is imported into Processing by abstracting the urban fabric as a field condition*

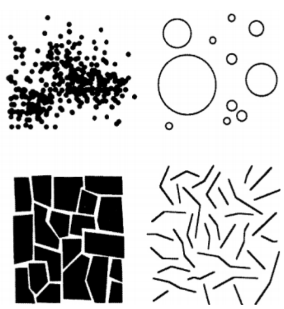


Figure 13.13: Modern and Classical Organisational Strategies: Field Conditions, from Stan Allen's essay Object to Field

In order to code within any environment, a process of abstraction must occur in which the physical environment is digitized and physical objects are represented by geometry and values. In order to create a flexible modeling environment that can generate both simple and radical forms, as well as to create a localized awareness of building geometry smaller than the scale of a building, the entire urban fabric is dissolved into a three-dimensional field condition—a grid. In *Points and Lines*, Stan Allen establishes architectural field conditions as, "any formal or spatial matrix capable of unifying diverse elements while respecting the identity of each," specifying that, "overall shape and extent are highly fluid and less important than the internal relationship of parts, which determine the behaviour of the field."[1] Thus, the dissolution of urban form into the three-dimensional field reinterprets the city as the macro-scale manifestation of small-scale relationships.

1 Stan Allen, *Points+ Lines: Diagrams And Projects For The City* (New York: Princeton Architectural Press, 1999), 92.

13.14 *Representing the building fabric as a grid of voxels creates greater spatial awareness and liberates the model from the dominance of the ground plane*

Instead of representing discrete buildings with precise 3D geometry, this process of abstraction represents the city through small cells called voxels which can be manipulated, store data, and read data from their surroundings. The dissolution of built form liberates the program from preserving arbitrary structures and enables the program to generate unconventional forms that are responsive to their environments. This is also consistent with the thesis' exploration of equality in three-dimensional space. By equalizing the three-dimensional urban fabric with a homogeneous grid, the model is freed from existing conceptual biases of the role of the ground plane.

13.15 *The precision of the model will be determined by the digital objects that can be placed within it and the range of properties they can possess*

As a geographic database cannot contain a complete description of the physical environment, "its contents must be carefully selected to fit within the limited capacity of computer storage devices."[2] Therefore, a set of standards for what fits within this description must be established in order to create a complete and accurate, however, limited, representation of the built environment. This set of standards is referred to by the Institut géographique national (IGN) as the *terrain nominal* ("nominal ground") and is the specification of the precision of the map. This specification determines both the degree to which the symbolic model represents reality, as well as the size of the dataset, affecting the file sizes, processing speed, and the ability for users to interpret the visualizations.[3] Therefore, in order to create a consistent, accurate, and workable model of the test site, the *terrain nominal* of the model must be established first.

The following descriptions outline the extents of the dataset that will be imported and generated in the digital environment by describing the types of objects that can be placed within this environment and their properties. These objects include the representation of building massing and property lots as a congregation of voxels, the subdivision of the building environment into quadrants, the structural cores of tall buildings, and

2 Paul Longley et al., *Geographic Information Systems And Science* (Hoboken: John Wiley & Sons, 2005), 80.
3 Ibid.

the recognition of buildings as a collection of the voxels and building cores. Since processing is an objected-oriented programming language, objects can be placed in the digital modeling environment and types of these objects can be defined that determine: what data the objects can store, and what functions the objects can perform. Once these object types, known as *classes* (Figure 13.15), are defined, specific instances of the type, known as *objects,* can be created in the digital environment with specific properties assigned.

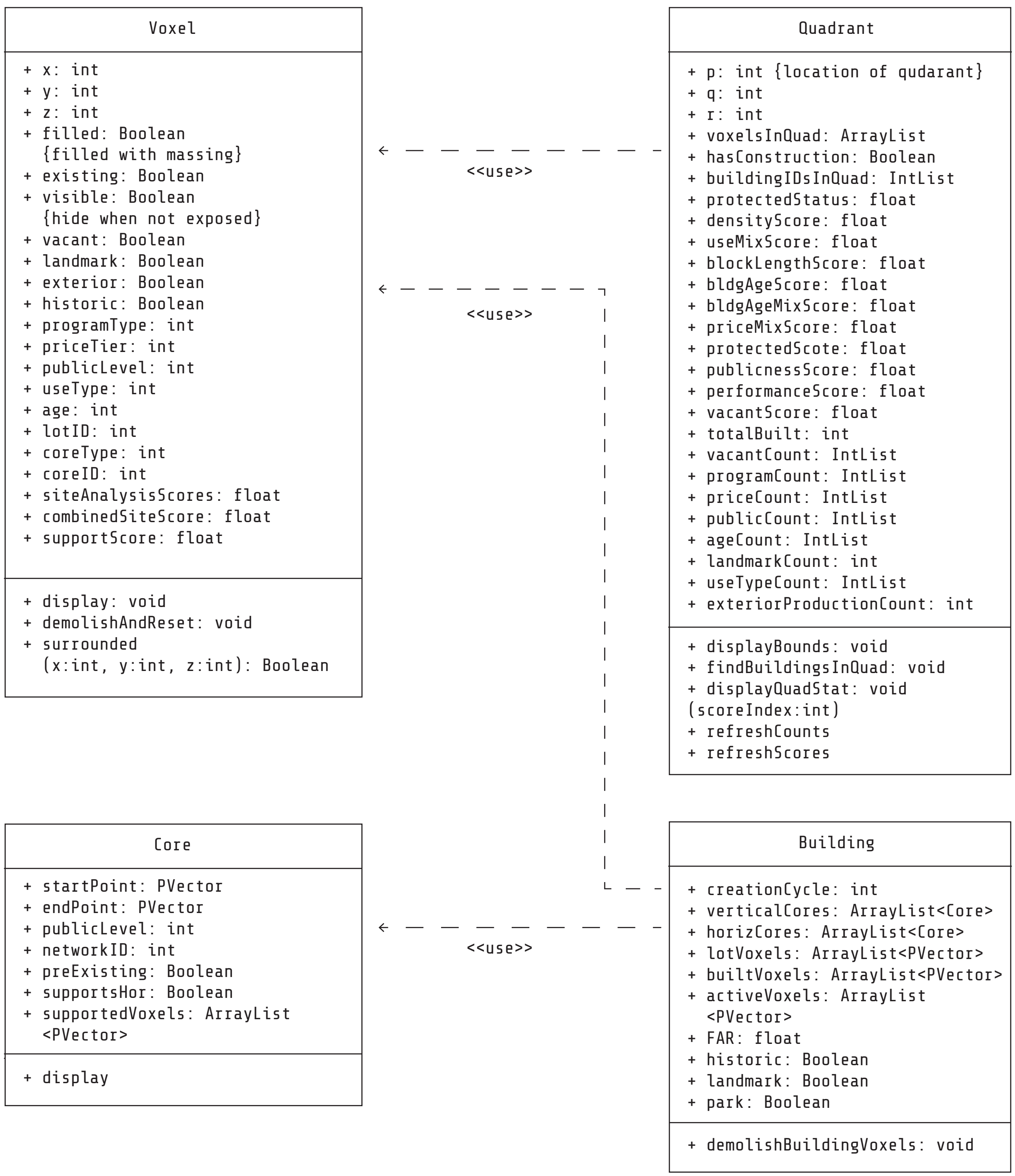


Figure 13.15: Unified Modeling Language (UML) Class Diagram of the four most prominent types of objects that can be placed within the digital modeling environment.

CLASSES OF OBJECTS DESIGNED FOR THE DIGITAL MODELING ENVIRONMENT

13.16 *The Voxel*

The voxel is the basic unit used within the modeling environment (Figure 13.16.b). It will be the building block which represents all massing within the city. By combining voxels together, a building can be represented. By assigning program types and price tiers, different types of buildings and exterior spaces can be represented. Voxels will be 7m x 7m x 7m—this dimension has been chosen as it is a round number which can approximate two stories of a building with a floor to floor height of 3.5m, and relates roughly to various residential unit sizes. One voxel can represent roughly two typical low-range, one bedroom condominium apartments (ex: 507 sq ft or 47m2) or a single typical three bedroom apartment (ex: 1088 sq ft or 101 m2)[1]. Smaller units could give greater definition to building form, but this has been deemed an unnecessary amount of detail which would only increase the amount of processing required in the simulation. The voxels used are assigned one of eleven program types, and one of four price tiers (Figure 13.16.a). Although it would be possible to indicate more specific types of programmatic use, such as the difference between a restaurant and a grocery store, the goal of the exercise is not to prescribe which specific program should go where, as that would be impractical to businesses relocating within the city, but rather to represent how different types of program can mix together.

1 Condos.ca, "Condos in CityPlace, Downtown," *Condos.ca,* accessed on October 20, 2017, https://condos.ca/toronto/cityplace.

TAXONOMY OF VOXEL TYPES

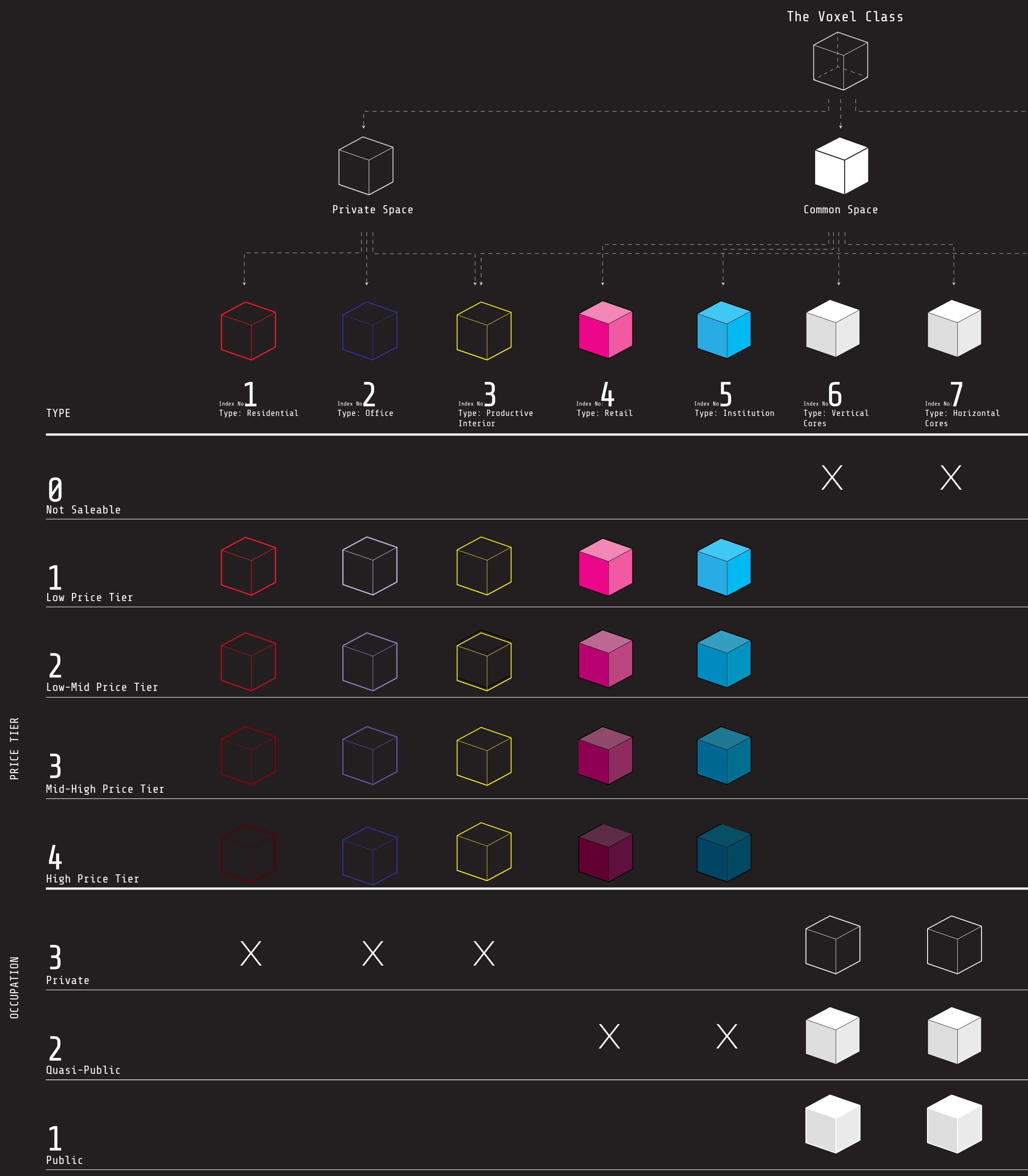
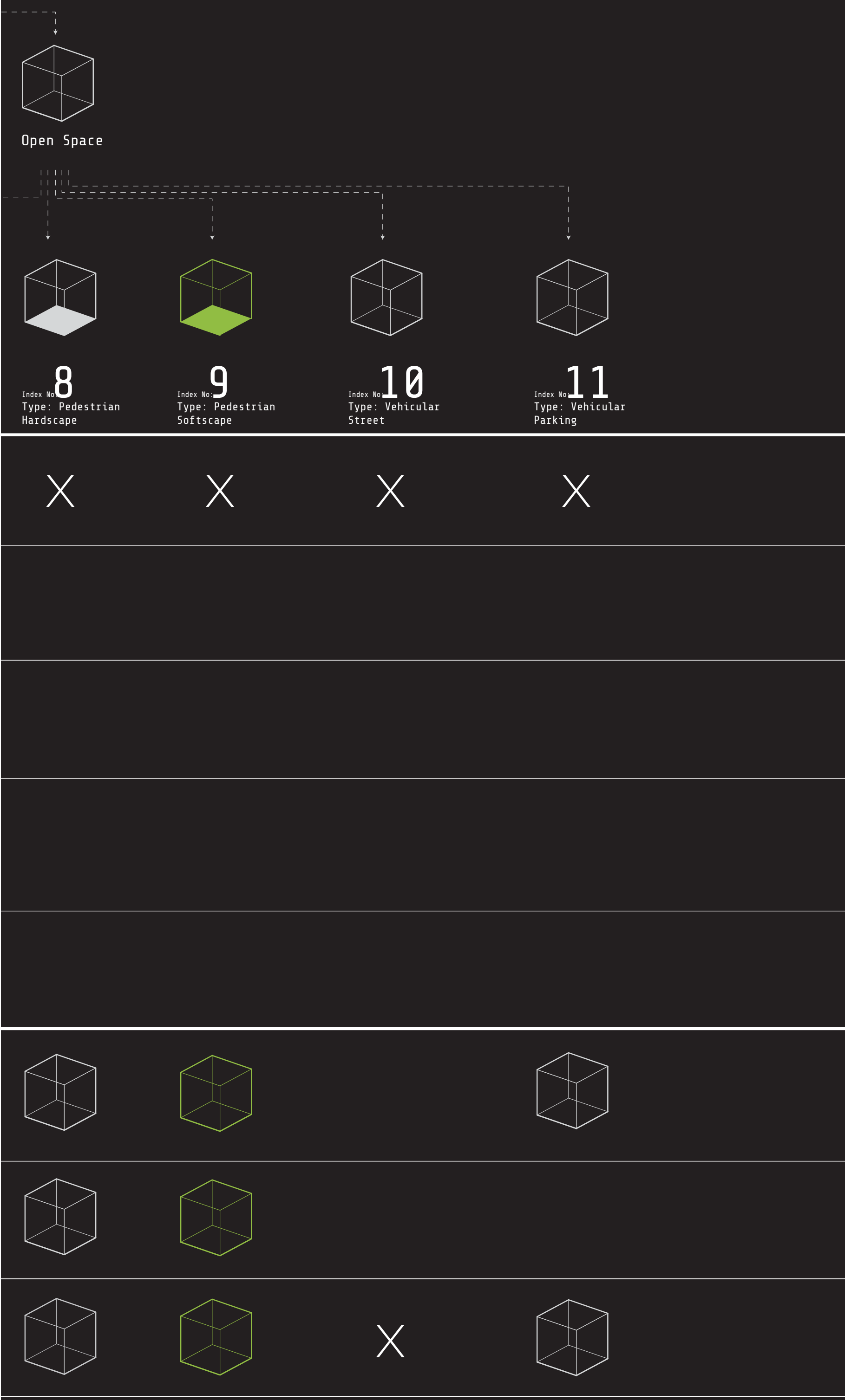


Figure 13.16.a: Hierarchical diagram of voxel program types and subtypes. These different programmatic uses, price tiers, and interiority states will be specified within the model, and are one of the key factors differentiating unique voxels in the model and their behaviour.



13.17 *The Quadrant*

In order to create a localized awareness of the composition of the urban fabric, the model is subdivided into quadrants. Quadrants will store information about their composition including the number of voxels they contain for each voxel property, and performance scores of the quadrant. This will enable information about a specific area within the model to quickly be analyzed or accessed, and will be crucial to creating spatial awareness of each voxel's surroundings. Quadrants will be 1,000 voxels large at 10 voxels x 10 voxels x 10 voxels in dimension (70m x 70m x 70m). This was chosen as a number that is easy to work with, that is small enough to denote a specific part of the urban fabric, but large enough of a sample size to provide meaningful information.

13.18 *The Core*

Building cores provide structure and circulation for large buildings, and therefore are significant to the determination of building massing and circulation within the city. Since the generative algorithm will create inter-building connections that also perform the functions of support and circulation, these will be referred to as "horizontal cores," and will be simulated using the same class. Core objects will be represented as a simple straight line denoting the path and end points of the core massing to be built, with awareness of their location in the model, the degree to which they are public, and the building network they belong to.

13.19 *The Building*

The building object is a record of the voxels of a single development, the core objects supporting them, and the voxels of the lot that they occupy. Therefore, buildings objects aren't drawn objects on screen—the field condition of the digital environment is conserved by making building objects a collection of voxel objects on the grid. Building objects can also store information including: the age of the building, the building network they belong to, and statistics about the programmatic composition of the building.

DEFINING THE VOXEL CLASS

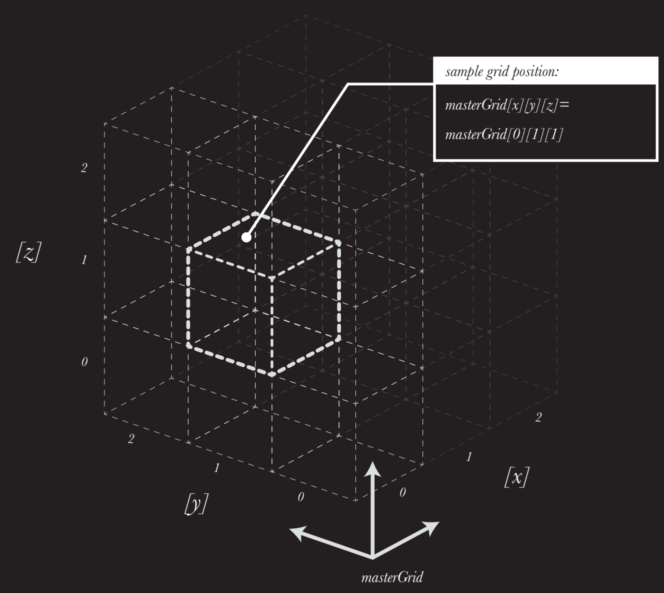


Figure 13.16.b: Diagram of an object instance of the voxel class.

PROPERTIES
Dimensions: 7m x 7m x 7m
Volume: 343m^3
Surface Area: 294m^2
Footprint: 49m^2
Floors: 2
GFA: 98m^2

FUNCTIONS
display(): Displays the voxel in the viewport
surrounded(): Determines whether or not the voxel is surrounded by other voxels
demolishAndReset(): sets the filled state to false and all voxel properties to their default value

---

VARIABLES

Name	Type	Range	Description
x, y, z	integer	0-xMax, yMax, zMax	Define the object's position in the masterGrid
filled	Boolean	true, false	Determines if the voxel position is occupied with building massing or empty. When true the voxel can be represented in the model, and can have properties assigned to it
existing	Boolean	true, false	Records whether the massing was existing in the previous program cycle
visible	Boolean	true, false	Determines whether or not the voxel is visible; used mostly to save processing power, as voxels that are hidden from view are not rendered
vacant	Boolean	true, false	Records whether the voxel has been flagged for vacancy risk potential

VARIABLES (CONTINUED)

landmark	Boolean	true, false	Records whether the massing represented by the voxel has been assigned the special distinction of a landmark
exterior	Boolean	true, false	Massing property that defines if the voxel's programmatic use is exterior program or interior building program
historic	Boolean	true, false	Records whether the massing represented by the voxel has been assigned the special distinction of a historic building
age	integer	-100 - ∞	Records the building cycle the voxel was constructed in. Existing massing is given an age up to -100, representing 100 years before present
programType	integer	1-11	An index value from 1-11 that defines the building program
priceTier	integer	0-4	Defines the economic accessibility of occupying the building at the voxel location
publicLevel	integer	0-3	Defines the amount of public access permitted, from private, to quasi-public, and public
useType	integer	0-2	Defines if the massing is primary use or secondary use as defined by Jacobs
lotID	integer	0-∞	Records which lot the voxel occupies
coreType	integer	0-2	Determines which core type supports the voxel where 0=grade supported, 1=vertical core, 2=horizontal core
coreID	integer		Records the index number of the specific core that supports the voxel
supportScore	float		A measure that scores the likelihood of the voxel to become constructed in relationship to its distance away from structural elements that could support it
siteAnalysisScore	FloatList	0-1	Describes how beneficial (1.00) or detrimental (0.00) the current position would be if constructed based on the site analysis for a range of criteria
combinedSiteScore	float	0-1	Combines the site analysis scores for all criteria by weighted influence in order to produce one combined site score that describes the likelihood of construction at the voxel location

DEFINING THE QUADRANT CLASS

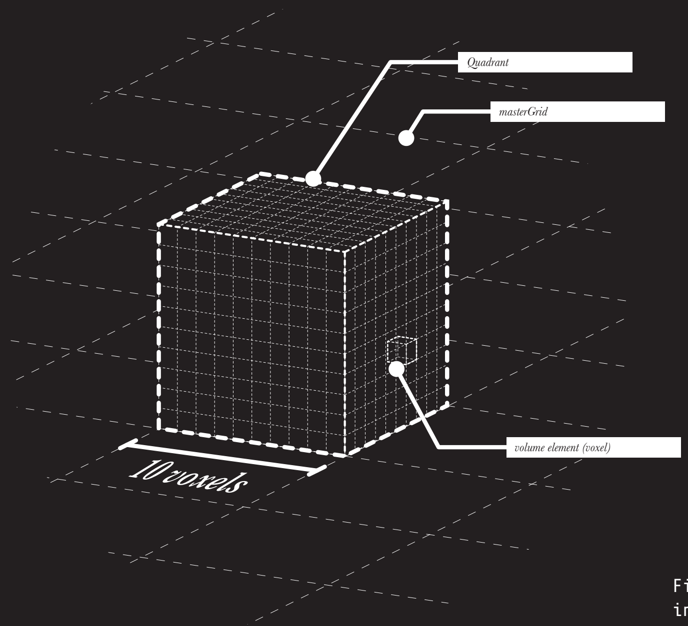


Figure 13.17: Diagram of an instance of the quadrant class.

PROPERTIES
Size: 10 voxels x 10 voxels x 10 voxels
Dimensions: 70m x 70m x 70m
Volume: 343,000m^3
Floors: 20
Footprint: 4,900m^2
Potential Floor area: 98,000m^2

FUNCTIONS
displayBounds(): Displays the quadrant boundary in the program viewport
refreshCounts(): Refreshes the recorded numbers of all objects in the quadrant object
refreshScores(): Refreshes the quadrant performance and development scores based on the quadrant object counts
findBuildingsInQuad(): Records the index number of all buildings the quadrant contains

VARIABLES

Variable Name	Variable Type	Range	Description
p, q, r	int	0 - ∞	Identifies the quadrant location
voxelsinQuad	ArrayList <PVector>	0 - 1,000	List of all the voxel positions in the quadrant that are set to occupied
hasConstruction	Boolean	true,false	Identifies if any voxels in the quadrant are set to occupied
buildingIDsInQuad	IntList	0-∞	Records a list of all building indexes that are within the bounds of the quadrant
protectedStatus	Boolean	true,false	Records if the number of protected voxels has surpassed a threshold that gives the whole quadrant a protected status
densityScore	float	0-1	Diversity score describing the building density within the quadrant

VARIABLES (CONTINUED)

useMixScore	float	0-1	Diversity score measuring the amount of programmatic use diversity
blockLengthScore	float	0-1	Diversity score measuring the amount of three-dimensional connectivity in the quadrant
bldgAgeScore	float	0-1	Development score measuring the overall age of the quadrant
bldgAgeMixScore	float	0-1	Diversity score measuring the mix of building ages within the quadrant
priceMixScore	float	0-1	Diversity score measuring the amount of price tier mix within the quadrant
protectedScore	float	0-1	Development score measuring the degree to which the quadrant has protected distinctions such as landmarks, parks, and historic buildings
publicnessScore	float	0-1	Diversity score measuring the amount of true public access the quadrant has
performanceScore	float	0-1	Combination of all weighted diversity scores
vacantScore	float	0-1	Development score measuring the likelihood for vacant buildings to be developed
totalBuilt	int	0-1000	Number of voxel positions in the quadrant assigned as filled
vacantCount	IntList	0-1000	Number of voxels in the quadrant flagged for vacancy potential
programCount	IntList	0-1000	Number of voxels in the quadrant by each program type
ageCount	IntList	0-1000	Number of voxels in the quadrant by every 10 building cycles in age
landmarkCount	int	0-1000	Number of landmark voxels in the quadrant
useTypeCount	IntList	0-1000	Number of voxels in the quadrant of primary and secondary uses as defined by Jacobs
exteriorProductionCount	int	0-1000	Number of voxels in the quadrant that are both production use type and exterior program

DEFINING THE CORE CLASS

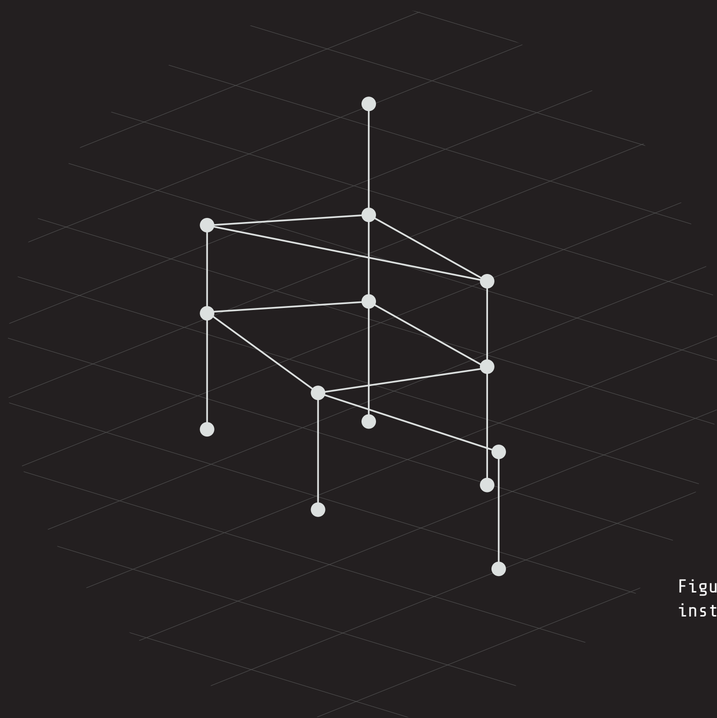


Figure 13.18: Diagram of an instance of the core class.

VARIABLES

Variable Name	Variable Type	Range	Description
startPoint	PVector	0,0,0-xMax, yMax, zMax	Start location of the core
endPoint	PVector	0,0,0-xMax, yMax, zMax	End location of the core
publicLevel	int	0-2	Degree of public access of the core object where 0=private, 1=quasi-public, 2=public
networkID	int	0-∞	Index number of the building network the core belongs to
preExisting	Boolean	true,false	Records if the core was generated or existing
supportsHor	Boolean	true,false	Records if a horizontal core may support voxels
supportedVoxels	ArrayList	<PVector>	List of all voxels supported

DEFINING THE BUILDING CLASS

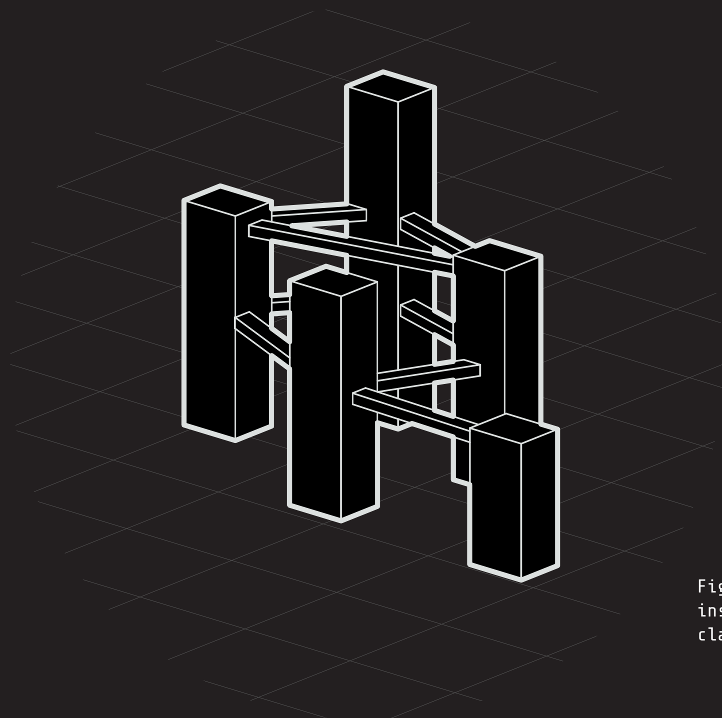


Figure 13.19: Diagram of an instance of the building class.

VARIABLES

Variable Name	Variable Type	Range	Description
creationCycle	int	0 - ∞	Specifies which program cycle the building was created on
vertCoreIDs	ArrayList	<Core>	List of vertical core objects contained in the building
horiCoreIDs	ArrayList	<Core>	List of horizontal core objects contained in the building
activeVoxels	ArrayList	<PVector>	Specifies all voxels within the site boundary
builtVoxels	ArrayList	<PVector>	Specifies all built voxels which make up the building
FAR	float	0.00-∞	Records the floor area ratio of the building
historic	Boolean	true,false	Specifies whether the building has historic status
landmark	Boolean	true,false	Specifies whether the building has landmark status
park	Boolean	true,false	Specifies whether the building has park status

CHAPTER 14

THE PARAMETRIC DESIGN TOOL IS DESIGNED TO SIMULATE DIFFERENT URBAN SCENARIOS BY USING ADJUSTABLE PARAMETERS

The criteria the parametric design tool must fulfill have now been prescribed. The tool can be edited to represent the various scenarios by adjusting user-assignable parameters different values. The following descriptions explain what each parameter of the design tool does and how it can be set to different values to achieve a variety of results.

THE PARAMETRIC DESIGN TOOL CAN BE CONTROLLED WITH A GRAPHICAL USER INTERFACE OF FOUR CONTROL PANELS:

14.01. Run controls window

14.02. Building environment view window

14.03. Parameters window

14.04. Statistics view window

THE DESIGN TOOL'S ALGORITHM CAN BE ADJUSTED BY SETTING USER-DEFINABLE PARAMETERS:

14.05. Global analysis parameters

14.06. Site selection parameters

14.07. Site analysis parameters

14.08. Building core location parameters

14.09. Massing construction parameters

THE PARAMETRIC DESIGN TOOL CAN BE CONTROLLED WITH A GRAPHICAL USER INTERFACE OF FOUR CONTROL PANELS

The control panels form the user interface of the parametric design tool and allow the user to edit the generative algorithm by altering parameter settings, view the model from a variety of angles and display modes, start and stop the simulation, and receive feedback about the contents of the model environment and the progress of the current building development. These activities are organized into four panels: the run controls window, building environment view window, parameters window, and statistics view window.

14.01 *Run controls window*

The run controls window gives the user the ability to start, pause, stop, and quit the generative algorithm. The window provides the option to specify the number of building cycles after which to export 3D and statistic data, and at which building cycle to quit the program. It also allows the user to change view modes, choose between oblique and perspective drawing modes, switch between pre-determined views, orbit the model, and follow the development process.

14.02 *Building environment view window*

The building environment view window displays the current state of the 3D model of the test site in the digital environment. This view will be updated with each step of the growth model in order to show the progress of the site selection, demolition, site analysis, and construction of new buildings. The view primarily shows the abstraction of building massing as voxels, with different view modes to show program type, price tier, building age, density, vacancy risk, parcel number, network number, type of structural support, and historic or landmark status. The view can also be changed to show other objects and values including: quadrants, quadrant scores, building cores, building cores by network, and building cores by public level. While the algorithm is running the view also shows temporary objects such as site analysis scores and character envelopes. In order to view specific areas of the model, the model can be rotated by dragging the view, and zoomed in and out with the scroll-wheel.

A heads-up-display on the view window shows significant information about the status of the model including: the current activity and subactivity of the algorithm, the current building cycle, the selected scenario preset, the view mode and angle, the most recent 10 quadrants selected, a legend explaining the current view mode, statistics about the number and properties of the voxels built in the model, a graph of the current performance scores, and statistics about the composition of the building network.

14.03 *Parameters window*

The Parameters control panel is used to alter values used by the generative algorithm. It is made up of sliders and control knobs which set specific values, lower and upper bounds, and weightings for various parts of each process in the algorithm. Further documentation of each parameter is provided later in the chapter. Developed through a guess-and-check process, three different preprogrammed settings have been provided which represent the three scenarios under investigation: the vitality-driven volumetric city, the profit-driven volumetric city, and the vitality-driven planar city. These settings can be accessed from the "presets" drop-down button. Users can also form unique scenarios by editing parameters directly, creating a participatory tool that doesn't require prior experience.

14.04 *Statistics view window*

The Statistics View window shows the current numerical state of the model, showing graphs that describe the model's current properties including: quadrant performance scores, quadrant development scores, voxel count by program, voxel count by price tier, voxel count by public level, core counts by public level, floor area ratio, quadrant selections, number of distinct building networks, and building connection heights.

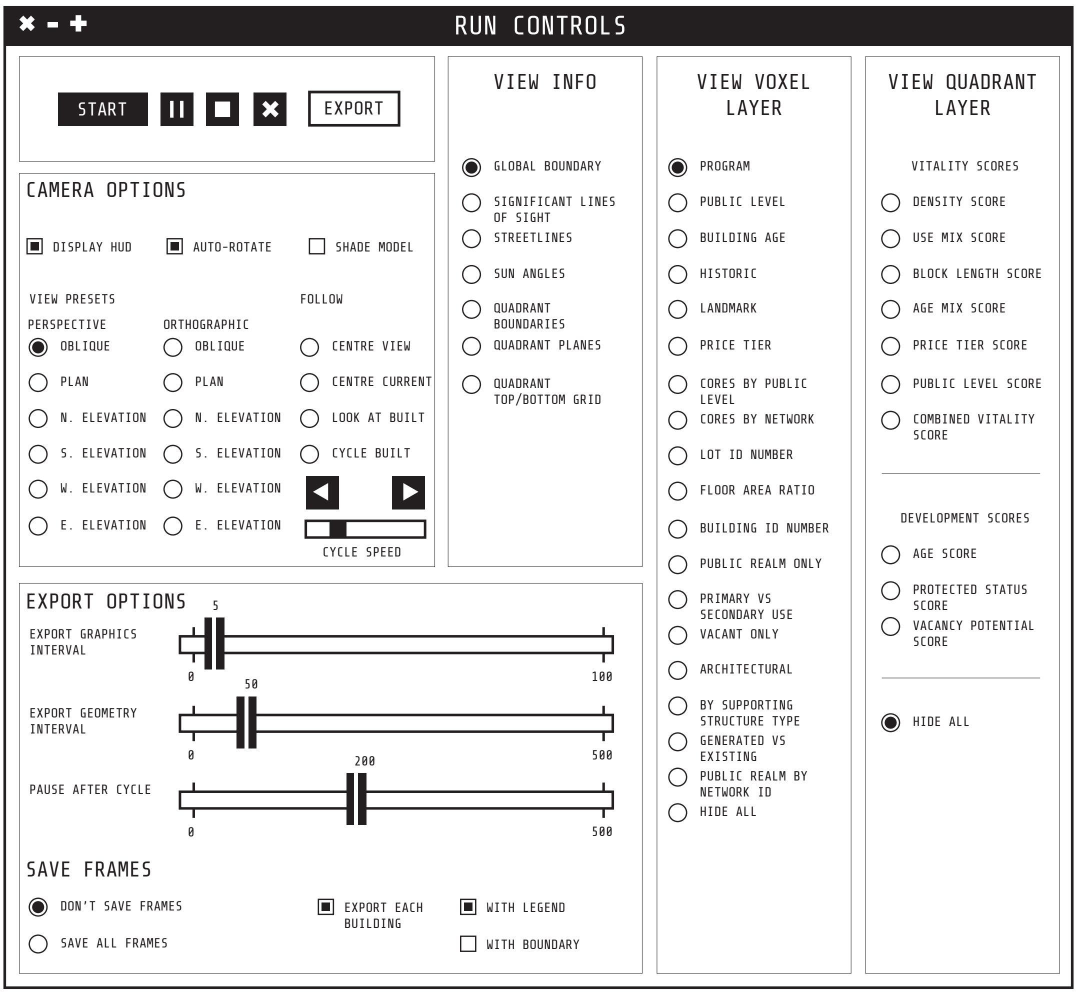


Figure 14.01: Diagram of the parametric design tool's run control panel which allows the user to start and stop the building cycle, change views, and export the generated geometry.

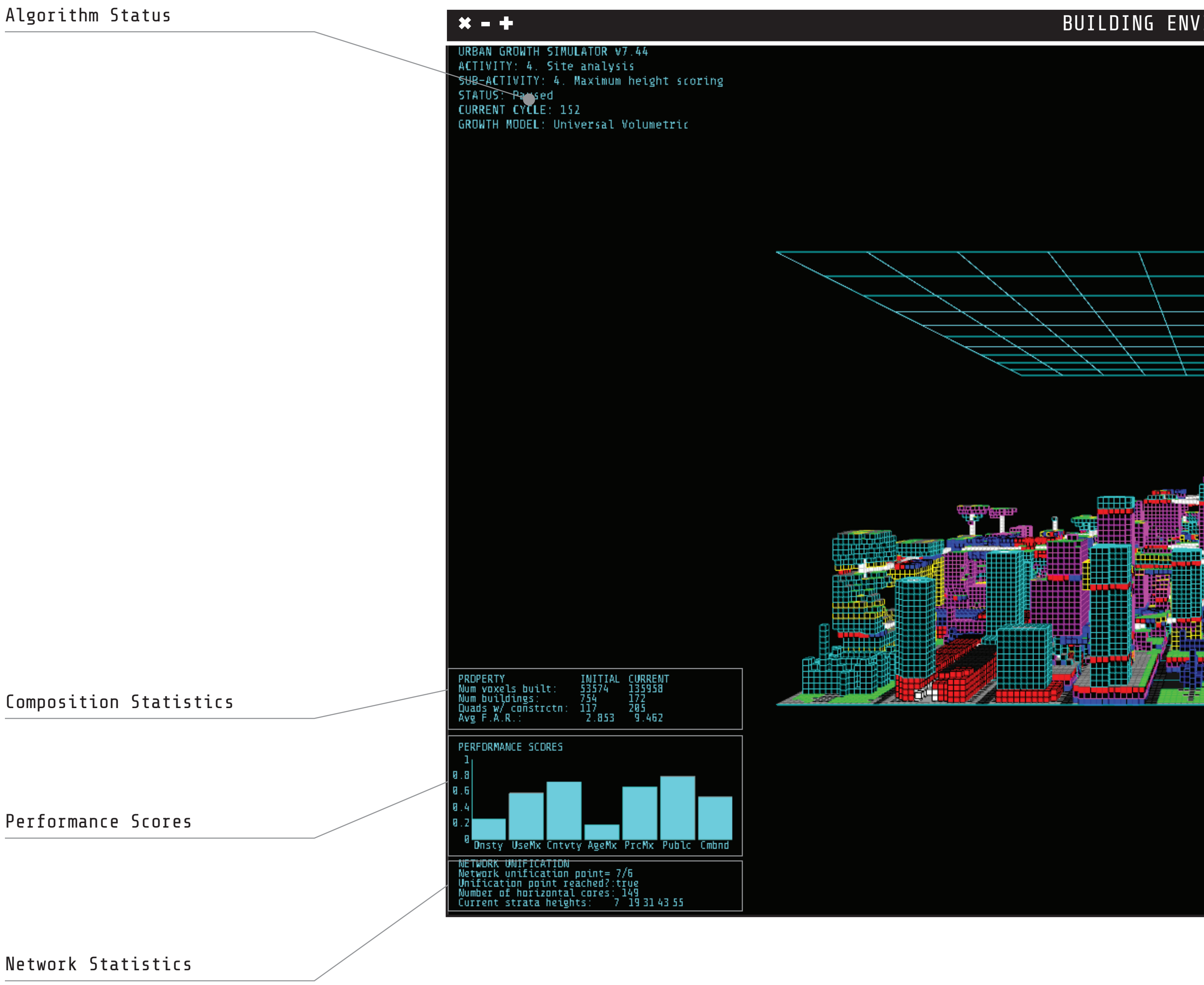
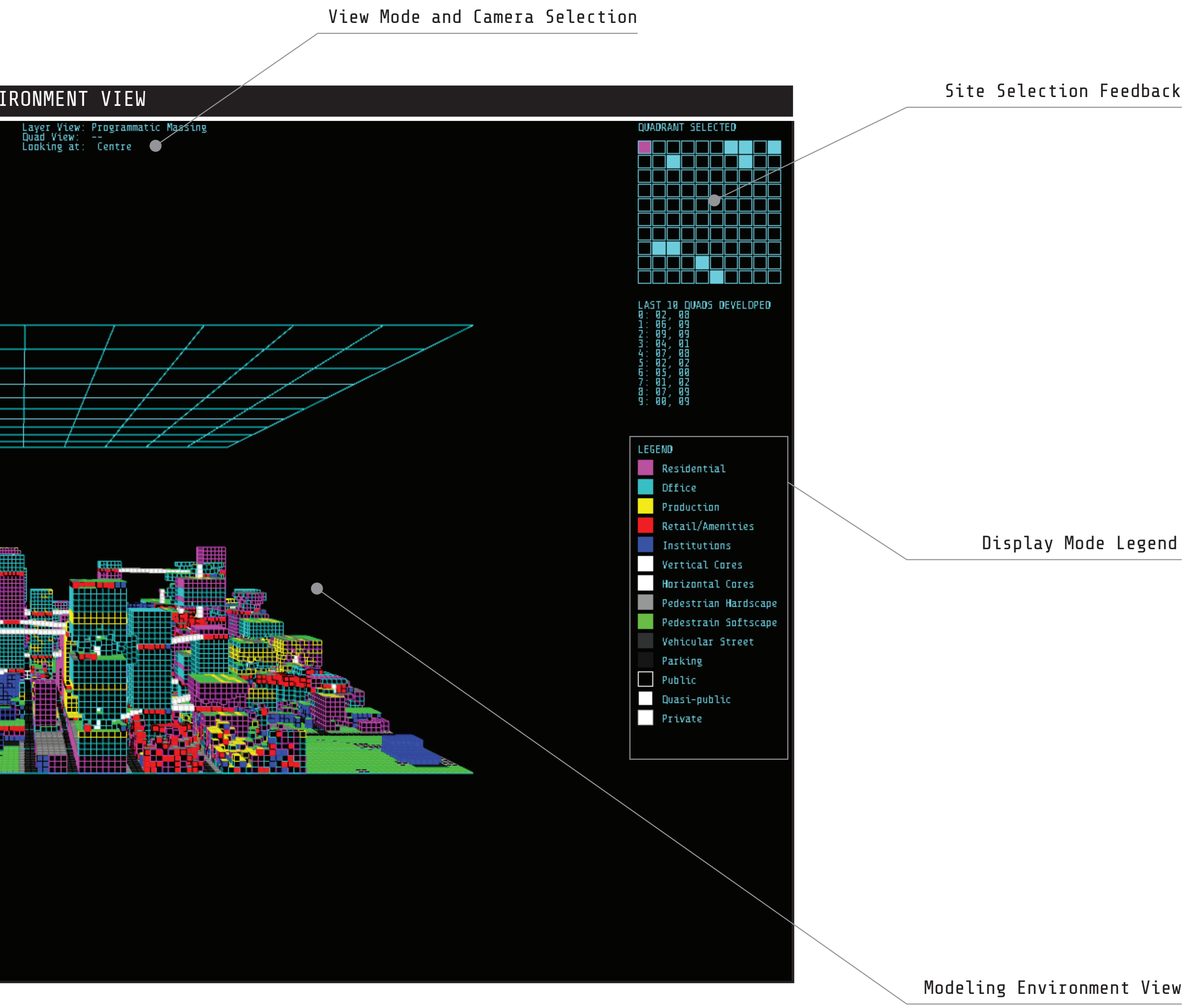


Figure 14.02: Diagram of the Building Environment View window which displays the 3D modeling environment used by the program, allowing the user to receive visual feedback on the progress of the simulation.


View Mode and Camera Selection
Site Selection Feedback
IRONMENT VIEW
Layer View: Programmatic Massing
Quad View: --
Looking at: Centre
QUADRANT SELECTED
LAST 10 QUADS DEVELOPED
0: 02, 08
1: 06, 09
2: 09, 09
3: 04, 01
4: 07, 08
5: 02, 02
6: 05, 00
7: 01, 02
8: 07, 09
9: 00, 09
LEGEND
Residential
Office
Production
Retail/Amenities
Institutions
Vertical Cores
Horizontal Cores
Pedestrian Hardscape
Pedestrain Softscape
Vehicular Street
Parking
Public
Quasi-public
Private
Display Mode Legend
Modeling Environment View

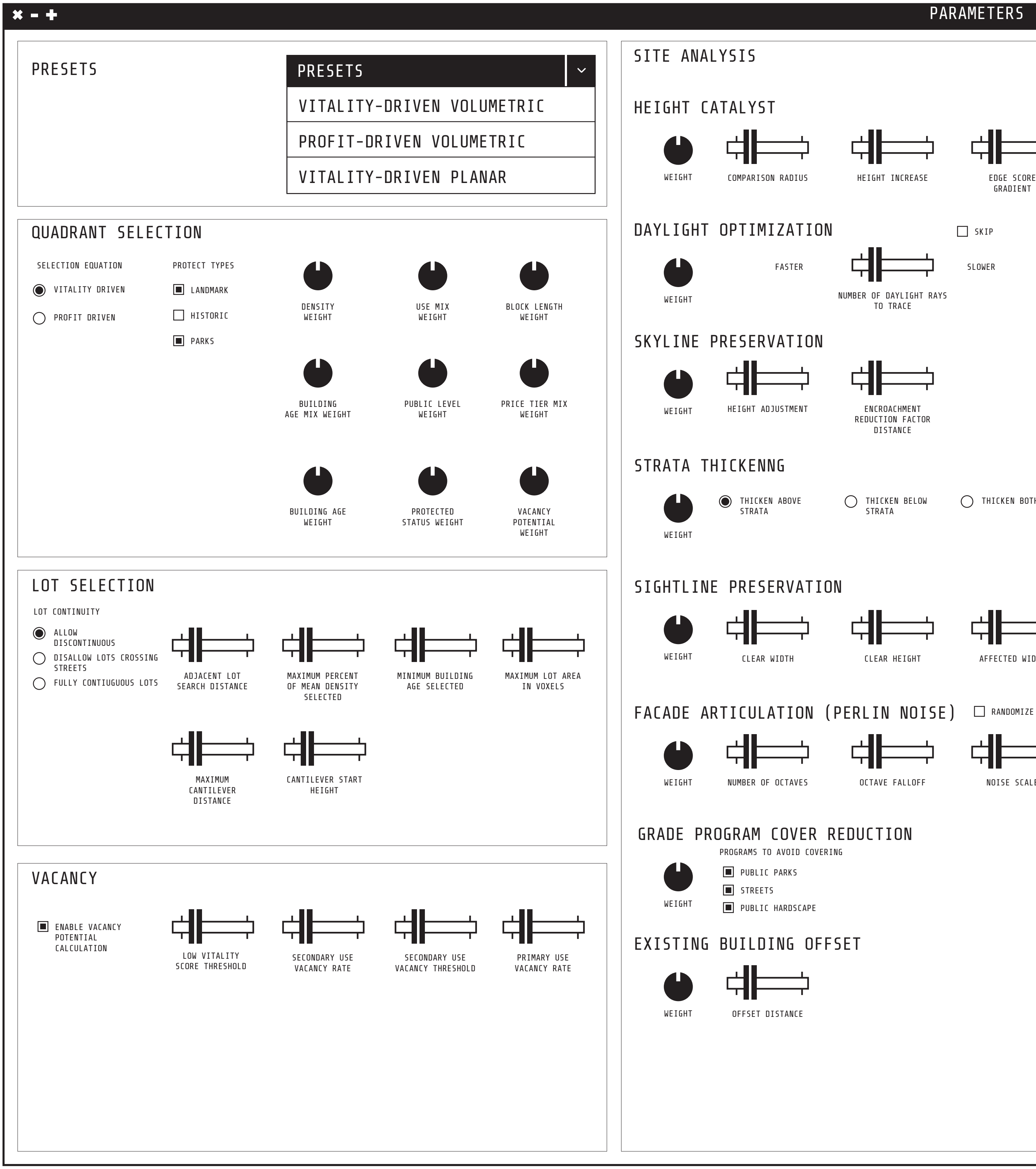


Figure 14.03: Diagram of the parameter input interface of the generative algorithm. This panel allows the user to modify settings within the generative algorithm to create a specific scenario that responds to different conditions in the model environment.

CORE LOCATING

VERTICAL CORE OPTIONS

CORE DENSITY

MINIMUM DISTANCE FROM STREET

MINIMUM DISTANCE FROM OTHER CORES

MINIMUM CORE HEIGHT VARIATION

HORIZONTAL CORE OPTIONS

■ CONSTRUCT HORIZONTAL CORES

MAXIMUM LENGTH WITHIN DEVELOPMENT

MAXIMUM LENGTH TO ADJACENT DEVELOPMENTS

FIRST STRATUM LEVEL

FREQUENCY OF STRATA BY FLOOR

NETWORK OPTIONS

NETWORK INTEGRATION POINT

MAXIMUM SAME DEVELOPMENT CONNECTIONS

MAXIMUM ADJACENT DEVELOPMENT CONNECTIONS

PERMITTED STRATA LEVEL VARIATION

STRATA VARIATION

- ◉ STATIC STRATA
- ○ STATIC AFTER NETWORK INTEGRATION
- ○ ALWAYS RANDOMIZE

PUBLIC LEVEL

- ◉ PUBLIC
- ○ QUASI-PUBLIC
- ○ PRIVATE

MINIMUM VERTICAL CORE DISTANCE FROM ADJACENT LOT

BUILDING TARGETS

PRICE TIER TARGETS

LOW-TIER

LOW-MID TIER

MID-HIGH TIER

HIGH TIER

GENERAL TARGET OPTIONS

TARGET FILL % OF MAXIMUM ENVELOPE

PROGRAMMATIC USE SURVEY DISTANCE IN QUADRANTS

MINIMUM PERCENTAGE OF PUBLIC AMENITIES AND INSTITUTIONS

MINIMUM DIVERSITY COMPENSATION PAST TARGET

PROGRAM TYPE TARGETS

RESIDENTIAL

OFFICE

PRODUCTION

RETAIL/AMENITIES

INSTITUTIONAL

PEDESTRIAN HARDSCAPE

PEDESTRIAN SOFTSCAPE

EXTERIOR PRODUCTION

■ FORCE AMENITY PROGRAM AT STRATA

BUILDING MASSING

GRADE SUPPORTED	VERTICAL CORES	HORIZONTAL CORES
MAXIMUM SUPPORT DISTANCE FROM STRUCTURE	MAXIMUM SUPPORT DISTANCE FROM STRUCTURE	MAXIMUM SUPPORT DISTANCE FROM STRUCTURE
	MASSING TYPE TO CONSTRUCT	
◉ FREEFORM	◉ FREEFORM	◉ FREEFORM
○ RECTILINEAR	○ RECTILINEAR	○ RECTILINEAR
○ EITHER	○ EITHER	○ EITHER
○ NONE	○ NONE	○ NONE
	USE MIX	
◉ PRIMARY USE	◉ PRIMARY USE	◉ PRIMARY USE
○ SECONDARY USE	○ SECONDARY USE	○ SECONDARY USE
○ BOTH	○ BOTH	○ BOTH
○ EITHER	○ EITHER	○ EITHER
MAXIMUM NUMBER OF USES	MAXIMUM NUMBER OF USES	MAXIMUM NUMBER OF USES
□ RANDOMIZE	□ RANDOMIZE	□ RANDOMIZE
◉ DEVELOPMENT	◉ DEVELOPMENT	◉ DEVELOPMENT
○ CORE	○ CORE	○ CORE
○ STRATA	○ STRATA	○ STRATA
○ FLOOR	○ FLOOR	○ FLOOR
○ SUB-FLOOR	○ SUB-FLOOR	○ SUB-FLOOR
○ CORE TO SUB-FLOOR	○ CORE TO SUB-FLOOR	○ CORE TO SUB-FLOOR
SUB-FLOOR LEVEL GRAIN	SUB-FLOOR LEVEL GRAIN	SUB-FLOOR LEVEL GRAIN
	PRICE TIER MIX	
◉ BY HEIGHT	◉ BY HEIGHT	◉ BY HEIGHT
○ BY STRATA	○ BY STRATA	○ BY STRATA
○ SUB-FLOOR	○ SUB-SFLOOR	○ SUB-SFLOOR
○ HEIGHT OR SUB-FLOOR	○ STRATA OR SUB-FLOOR	
SUB-FLOOR LEVEL GRAIN	SUB-FLOOR LEVEL GRAIN	SUB-FLOOR LEVEL GRAIN
	ROOF PROGRAM MIX	
■ HARDSCAPE	□ HARDSCAPE	■ HARDSCAPE
□ SOFTSCAPE	■ SOFTSCAPE	□ SOFTSCAPE
□ PRODUCTION	□ PRODUCTION	■ PRODUCTION
SUB-FLOOR LEVEL GRAIN	SUB-FLOOR LEVEL GRAIN	SUB-FLOOR LEVEL GRAIN

Figure 14.04: The statistics window of the parametric design tool's user interface provides visualizations of the model's numerical data including composition and performance scores.

THE DESIGN TOOL'S ALGORITHM CAN BE ADJUSTED BY SETTING USER-DEFINABLE PARAMETERS

The user parameters are how the generative algorithm is controlled to simulate the different conditions of each scenario. Assigning the generative algorithm with a set of parameters creates a set of instructions defined by numbered values which represents a specific set of regulations and design standards. The documentation provided for each parameter includes a description of what the parameter controls, an example of how the parameter can be set, a diagram which illustrates the effect of the parameter in the model, and information about the parameter's properties in the program's code. The user parameters are divided into five sections by the phase of the building cycle:

Global analysis parameters: control how the algorithm will analyze the model and produce scores that measure either vitality or development potential

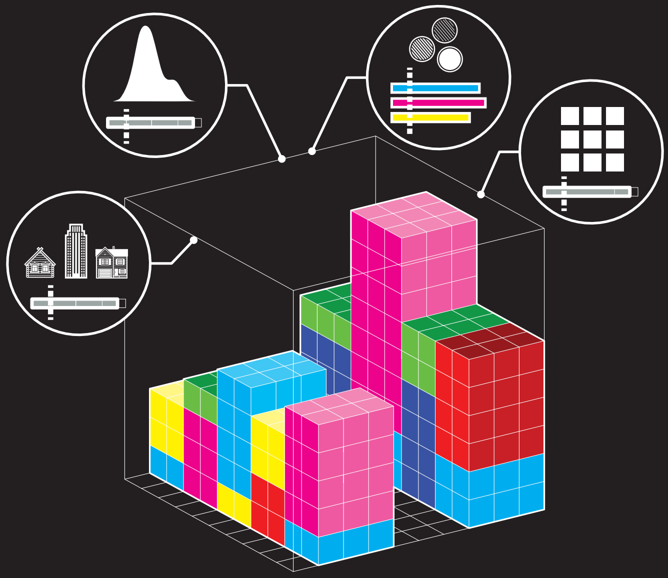
Site selection parameters: control what criteria are used to select the next building site by interpreting how each quadrant of the model scores for a variety of vitality and development potential scores

Site analysis parameters: control how site-specific factors influence the building form, including which site-specific factors to consider, how strongly to consider them, and how the site-specific factors are defined

Core location parameters: control the decision process guiding the location of building cores including how many, how close they can be to other objects, and how tall they can be

Building massing construction parameters: control the decision process in assigning building massing, including the type of form to generate, formal and structural constraints, and program and price tier distributions

14.05 GLOBAL ANALYSIS PARAMETERS



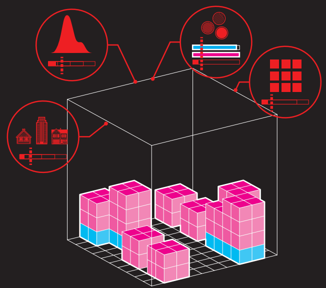
DESCRIPTION: Control how the algorithm will analyze the model and produce scores that measure either vitality or development potential. This is summarized by a single metric called “vacancy potential” which measures the amount of the building fabric at risk of becoming vacant, having its land value drop, or attaining a poor quality of life, due to its low amount of vitality as measured by the vitality performance scores. The vacancy potential creates a localized indication of at-risk areas throughout the three-dimensional field.

VACANCY POTENTIAL

FIGURE 14.05.01

LOW VITALITY SCORE THRESHOLD

DESCRIPTION: The combined quadrant diversity score below which secondary use program becomes flagged for vacancy potential. This part of the process simulates the condition in which low diversity doesn’t produce enough street traffic to provide local businesses and amenities with enough businesses to sustain itself.



SETTING: A low setting of 0.01 would mean that only severely low quadrant diversity scores of 0.00 would cause secondary uses to become vacant, whereas a high score of 0.99 would cause all diversity scores except a perfect 1.00 to cause secondary use vacancy, making vacancy much quicker.

TYPE: float RANGE: 0.00-1.00 UNIT: score

ASSIGNMENTS:
Vitality-Driven Volumetric Value: 0.24
Profit-Driven Volumetric Value: 0.24
Vitality Driven Planar Value: 0.24

FIGURE 14.05.02

SECONDARY USE VACANCY RATE

DESCRIPTION: The number of voxels that will become vacated per building cycle when the combined diversity score of a quadrant falls below the "low vitality score threshold" parameter.

SETTING: A low value of 1 will cause only 1 secondary use voxel to become vacant per building cycle when the quadrant diversity score is below the threshold, whereas a high value of 500 will cause half of all secondary use voxels in the quadrant to become vacant when the quadrant falls below the combined quadrant diversity score threshold.

TYPE: integer   RANGE: 0 - 500   UNIT: voxels

ASSIGNMENTS:
Vitality-Driven Volumetric Value: 10
Profit-Driven Volumetric Value: 10
Vitality Driven Planar Value: 10

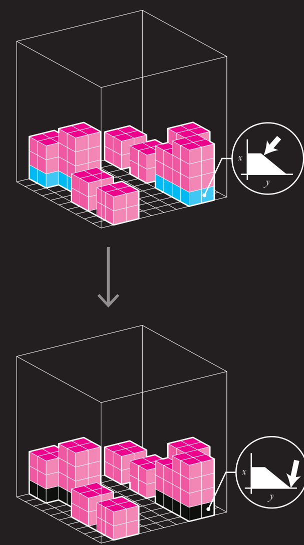


FIGURE 14.05.03

SECONDARY USE VACANCY LIMIT

DESCRIPTION: The number of vacant secondary use voxels per quadrant above which primary use voxels will begin to be flagged for vacancy. Simulates the condition in which the lack of secondary uses and amenities causes the value of primary use to decline, and ultimately become vacant.

SETTING: A low value of 1 will cause even a small amount of secondary use vacancy to trigger primary use vacancy, whereas a high value of 500 will causes primary use vacancy to occur only once all secondary use has been vacated in the quadrant.

TYPE: integer   RANGE: 0-500   UNIT: voxels

ASSIGNMENTS:
Vitality-Driven Volumetric Value: 100
Profit-Driven Volumetric Value: 100
Vitality Driven Planar Value: 100

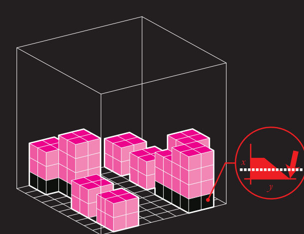


FIGURE 14.05.04

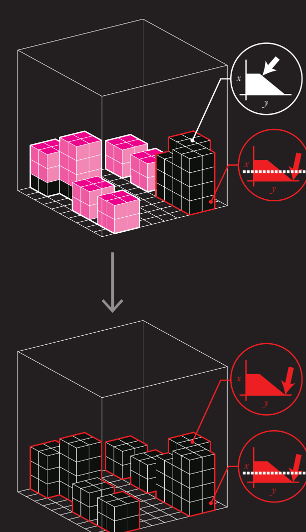
PRIMARY USE VACANCY RATE

DESCRIPTION: The number of primary use voxels that will become vacated per building cycle when the secondary use vacancy limit is exceeded.

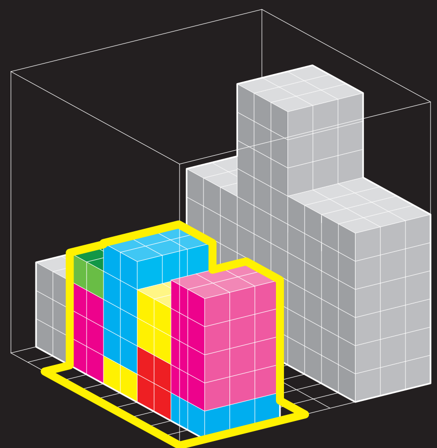
SETTING: Setting a low value of 1 will cause only 1 primary use voxel to become vacated per building cycle when the percentage of secondary use vacancy rises above the secondary use vacancy limit, whereas a high value of 500 will cause half of all primary use voxels in the quadrant to become vacant when the secondary use vacancy limit is exceeded.

TYPE: integer   RANGE: 0 - 500   UNIT: voxels

ASSIGNMENTS:
Vitality-Driven Volumetric Value: 10
Profit-Driven Volumetric Value: 10
Vitality Driven Planar Value: 10



14.06 SITE SELECTION PARAMETERS



DESCRIPTION: Control what criteria are used to select the next building site by interpreting how each quadrant of the model scores for a variety of vitality and development potential. The parameters control what quadrant will be chosen, followed by which lot within the quadrant, and which lots in the vicinity to merge into a single parcel.

QUADRANT SELECTION

FIGURE 14.06.01

QUADRANT SELECTION EQUATION

DESCRIPTION: Determines what factors contribute to the quadrant selected for a building site and in which way. There are two different equations available: vitality driven quadrant selection, and profit driven quadrant selection.

SETTING: Selecting the vitality driven equation will select quadrants first that have low vitality scores in order to improve problematic areas with new developments. Selecting the profit-driven equation will select quadrants with high vitality scores in order to capitalize on the value of the area with new developments. Both favour high development potential scores

TYPE: selection

UNIT: equation

RANGE:
vitality-driven
profit-driven

ASSIGNMENTS:

Vitality-Driven Volumetric Value:	vitality-driven
Profit-Driven Volumetric Value:	profit-driven
Vitality Driven Planar Value:	vitality-driven

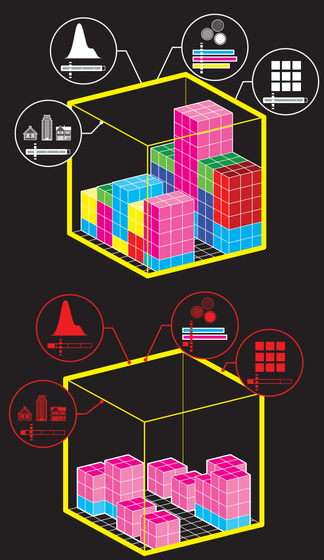


FIGURE 14.06.02

PROTECTED TYPES

DESCRIPTION: Determines which types of program are preserved from demolition and areas discouraged from quadrant selection based on program types.

SETTING: Selecting a program type will prevent all instances of it from being demolished.

TYPE: selection UNIT: program RANGE: landmarks, historic, parks

ASSIGNMENTS:
Vitality-Driven Volumetric Value: landmark, parks
Profit-Driven Volumetric Value: landmark, parks
Vitality Driven Planar Value: landmark, parks

FIGURE 14.06.03

DENSITY SCORE WEIGHT

DESCRIPTION: The density vitality score is used to evaluate how densely built the quadrant is. The weight control knob determines the strength of the effect of density in relation to the other factors. A high score indicates a high density.

SETTING: A low setting of 0.00 gives the density score no affect in the site selection process, whereas a high setting of 1.00 gives the density score the highest possible affect in the site selection process.

TYPE: float UNIT: weighting RANGE: 0.00-1.00

ASSIGNMENTS:
Vitality-Driven Volumetric Value: 1.0
Profit-Driven Volumetric Value: 1.0
Vitality Driven Planar Value: 1.0

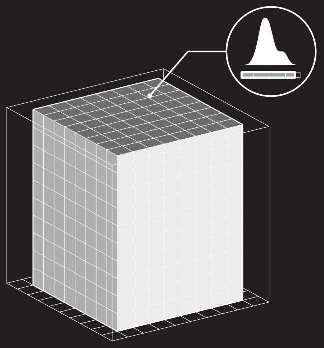


FIGURE 14.06.04

PROGRAMMATIC USE MIX SCORE WEIGHT

DESCRIPTION: This vitality score measures the amount of mix of programmatic use types. The weight control knob determines the strength of the affect of density in relation to the other factors. A high score indicates a high primary use mix.

SETTING: A low setting of 0.00 gives the programmatic use mix score no affect in the site selection process, whereas a high setting of 1.00 gives the score the highest possible affect in the site selection process.

TYPE: float UNIT: weighting RANGE: 0.00-1.00

ASSIGNMENTS:
Vitality-Driven Volumetric Value: 0.35
Profit-Driven Volumetric Value: 0.9
Vitality Driven Planar Value: 0.35

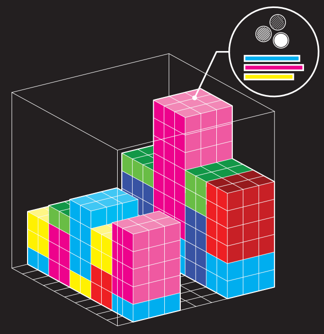


FIGURE 14.06.05

BLOCK LENGTH SCORE WEIGHT

DESCRIPTION: The block length vitality score is used to evaluate how well the quadrant is performing for connectivity. Adapted to three dimensions, vertical connectivity is also considered a factor. A high score indicates a high amount of connectivity. The weight control knob determines the strength of the affect of block length in relation to the other factors.

SETTING: A low setting of 0.00 gives the block length score no affect in the site selection process, whereas a high setting of 1.00 gives the score the highest possible affect in the site selection process.

TYPE: float UNIT: weighting RANGE: 0.00-1.00

ASSIGNMENTS:
Vitality-Driven Volumetric Value: 0.3
Profit-Driven Volumetric Value: 0.7
Vitality Driven Planar Value: 0.3

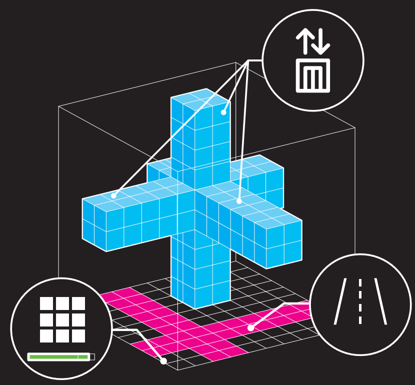


FIGURE 14.06.06

BUILDING AGE MIX SCORE WEIGHT

DESCRIPTION: The building age mix vitality score is used to evaluate how well the quadrant is performing in terms of building age mixes. A high score indicates a large amount of building age mix. The weight control knob determines the strength of the affect of building age mix in relation to the other factors.

SETTING: A low setting of 0.00 gives the building age mix score no affect in the site selection process, whereas a high setting of 1.00 gives the score the highest possible affect in the site selection process.

TYPE: float UNIT: weighting RANGE: 0.00-1.00

ASSIGNMENTS:
Vitality-Driven Volumetric Value: 0.35
Profit-Driven Volumetric Value: 0.90
Vitality Driven Planar Value: 0.35

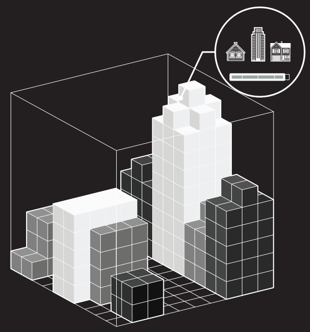


FIGURE 14.06.07

PUBLIC LEVEL SCORE WEIGHT

DESCRIPTION: The public level vitality score evaluates how much of the program and infrastructure is publicly accessible. A high score indicates a large amount of public accessibility. The weight control knob determines the strength of the public level score in relation to the other factors.

SETTING: A low setting of 0.00 gives the public level score no affect in the site selection process, whereas a high setting of 1.00 gives the score the highest possible affect in the site selection process.

TYPE: float UNIT: weighting RANGE: 0.00-1.00

ASSIGNMENTS:
Vitality-Driven Volumetric Value: 0.25
Profit-Driven Volumetric Value: 0.50
Vitality Driven Planar Value: 0.25

FIGURE 14.06.08

PRICE TIER MIX SCORE WEIGHT

DESCRIPTION: The price tier mix vitality score measures how thoroughly the price tiers are mixed within the quadrant. A high score indicates a high mix of price tiers. The weighting parameter assigns how influential the price tier mix score will be in relation to the other factors.

SETTING: A low setting of 0.00 gives the price tier mix score no affect in the site selection process, whereas a high setting of 1.00 gives the score the highest possible affect in the site selection process.

TYPE: float UNIT: weighting RANGE: 0.00-1.00

ASSIGNMENTS:
Vitality-Driven Volumetric Value: 0.35
Profit-Driven Volumetric Value: 0.90
Vitality Driven Planar Value: 0.35

FIGURE 14.06.09

BUILDING AGE SCORE WEIGHT

DESCRIPTION: The building age development potential score indicates how likely a site is to be developed based on the average age of its buildings. This parameter represents the tendency for sites that have recently been developed to not be developed again for a while, and conversely how aging buildings tend to be demolished. A high score indicates an area of older buildings.

SETTING: A low setting of 0.00 gives the building age score no affect in the site selection process, whereas a high setting of 1.00 gives the score the highest possible affect in the site selection process.

TYPE: float UNIT: weighting RANGE: 0.00-1.00

ASSIGNMENTS:
Vitality-Driven Volumetric Value: 1.0
Profit-Driven Volumetric Value: 0.7
Vitality Driven Planar Value: 1.0

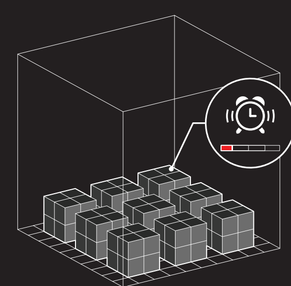


FIGURE 14.06.10

PROTECTED STATUS SCORE WEIGHT

DESCRIPTION: The protected status development potential score indicates how likely a site is to be developed based on the likelihood of the buildings being preserved. This parameter represents the tendency for parks, landmarks or heritage buildings to persevere longer than less noteworthy sites. A high score indicates few protected sites in the quadrant.

SETTING: A low setting of 0.00 gives the protected status score no affect in the site selection process, whereas a high setting of 1.00 gives the score the highest possible affect in the site selection process.

TYPE: float UNIT: wighting RANGE: 0.00-1.00

ASSIGNMENTS:
Vitality-Driven Volumetric Value: 1.0
Profit-Driven Volumetric Value: 0.4
Vitality Driven Planar Value: 1.0

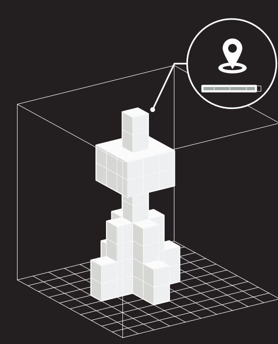


FIGURE 14.06.11

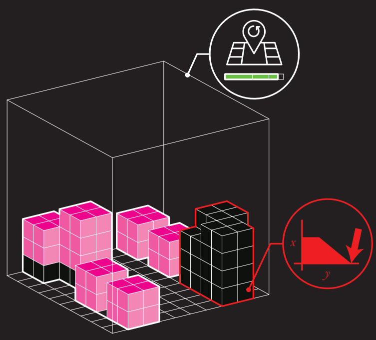
VACANCY POTENTIAL SCORE WEIGHT

DESCRIPTION: Vacancy potential score measures the amount of the building fabric in the quadrant that has been flagged for risk of vacancy. A high score indicates no vacancy potential in the quadrant, where as a low score indicates a large portion of the fabric is at risk of vacancy.

SETTING: A low setting of 0.00 gives the vacancy potential score no affect in the site selection process, whereas a high setting of 1.00 gives the score the highest possible affect in the site selection process.

TYPE: float UNIT: wighting RANGE: 0.00-1.00

ASSIGNMENTS:
Vitality-Driven Volumetric Value: 1.0
Profit-Driven Volumetric Value: 1.0
Vitality Driven Planar Value: 1.0



LOT SELECTION

FIGURE 14.06.12

LOT DISCONTINUITY

DESCRIPTION: Determines whether or not merged lots for the current building type must by continuous.

SETTING: “Allow discontinuous” allows for any parcel within the adjacent lot search distance to be merged, “disallow lots crossing streets” prohibits only lots on the other side of a street, and “force completely continuous” doesn’t allow any amount of lot discontinuity.

TYPE: selection UNIT: --
RANGE: allow discontinuous, disallow lots crossing streets, force completely continuous

ASSIGNMENTS:
Vitality-Driven Volumetric Value: allow discontinuous
Profit-Driven Volumetric Value: force completely continuous
Vitality Driven Planar Value: allow discontinuous

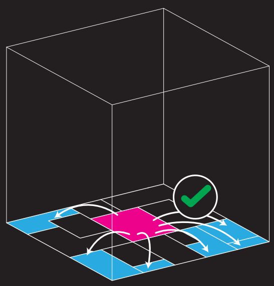


FIGURE 14.06.13

ADJACENT LOT SEARCH DISTANCE

DESCRIPTION: The adjacent lot search distance is the distance away from the selected lot that will be queried for amalgamation with the current building site, simulating the process in which developers combine several smaller lots into one larger building site.

SETTING: A small value of 0 reduces the search distance away from the selected lot to 0, meaning no other lots will be considered, whereas a distance of 20 will consider lots 20 voxels away from the current lot.

TYPE: integer UNIT: voxels RANGE: 0-20

ASSIGNMENTS:
Vitality-Driven Volumetric Value: 8
Profit-Driven Volumetric Value: 2
Vitality Driven Planar Value: 6

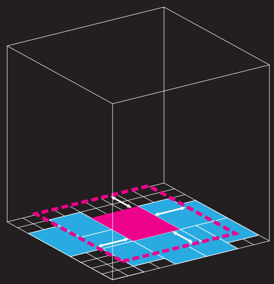


FIGURE 14.06.14

MAXIMUM PERCENT OF MEAN DENSITY

DESCRIPTION: The percentage of the average FAR in the model below which demolition of the building is allowed. Simulates the tendency for low density areas to become developed first.

SETTING: A low setting of 1% means that any building 1% or greater of the average FAR in the model environment cannot be demolished. Whereas a high setting of 200% means that only buildings twice the average FAR are protected from development.

TYPE: integer UNIT: percentage RANGE: 0-300

ASSIGNMENTS:
Vitality-Driven Volumetric Value: 250%
Profit-Driven Volumetric Value: 110%
Vitality Driven Planar Value: 125%

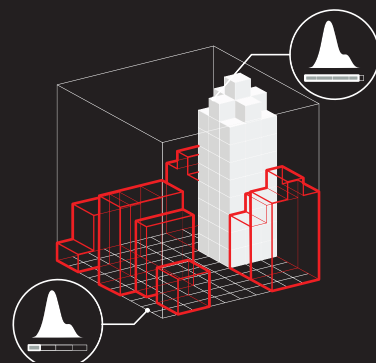


FIGURE 14.06.15

MINIMUM BUILDING AGE SELECTED

DESCRIPTION: The age above which building demolition is permitted. Describes the tendency for recently built buildings not to be demolished for development.

SETTING: Selecting a low value such as 1 means that any building 1 building cycle or older can be demolished for development, whereas a high setting such as 50 means that any building younger than 50 building cycles cannot be demolished for development.

TYPE: integer UNIT: building cycles RANGE: 0-50

ASSIGNMENTS:
Vitality-Driven Volumetric Value: 25
Profit-Driven Volumetric Value: 25
Vitality Driven Planar Value: 30

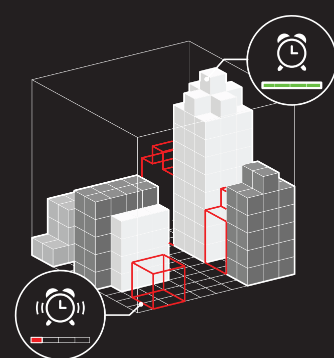


FIGURE 14.06.16

MAXIMUM LOT AREA

DESCRIPTION: Determines the largest possible area for a single lot in order to prevent the grain of parcels from becoming increasingly larger and inhibiting diversity.

SETTING: A low value of 5 restricts lots to 5 voxels in area, whereas a high value of 3,600 allows lots as large as 3,600 voxels.

TYPE: integer UNIT: voxels RANGE: 5-3,600
ASSIGNMENTS:
Vitality-Driven Volumetric Value: 400
Profit-Driven Volumetric Value: 900
Vitality Driven Planar Value: 350

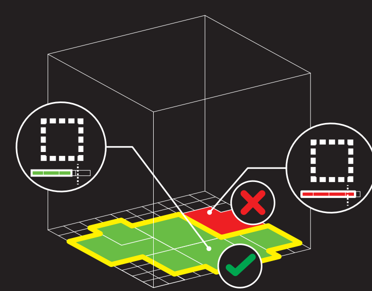


FIGURE 14.06.17

MAXIMUM CANTILEVER DISTANCE

DESCRIPTION: The allowable cantilever is the distance away from the site boundary within which the building may cantilever. This allows for increased density and radical forms by taking advantage of unused space and dissolving the influence of the ground plane on the building form.

SETTING: A low setting of 0 restricts the cantilever distance to 0, whereas a high setting of 15 allows the building to cantilever up to 15 voxels away from the site line.

TYPE: integer   UNIT: voxels   RANGE: 0-15

ASSIGNMENTS:
Vitality-Driven Volumetric Value: 7
Profit-Driven Volumetric Value: 0
Vitality Driven Planar Value: 2

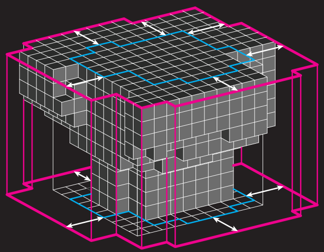


FIGURE 14.06.18

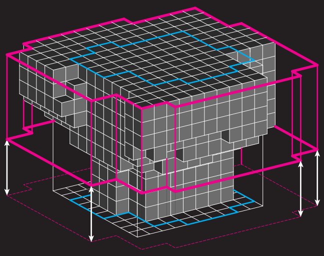
CANTILEVER START HEIGHT

DESCRIPTION: Determines the height at which the allowed site cantilever begins. This reduces the extent to which an adjacent building can encroach on the ground plane of the surrounding lots, fixing the base of the building within the lot boundary.

SETTING: A low value of 0 allows the building to cantilever just above grade level, whereas a high value of 75 doesn't permit any cantilevering into adjacent sites until after 75 voxels of height.

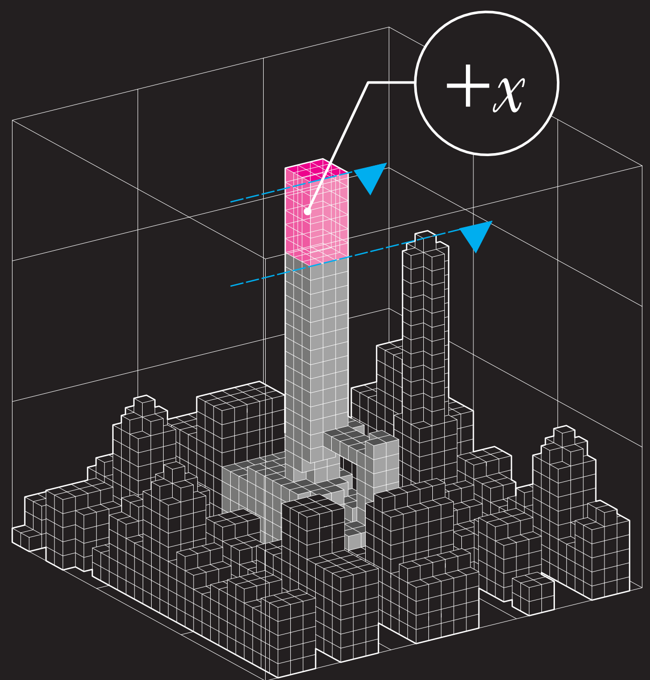
TYPE: integer   UNIT: voxels   RANGE: 0-75

ASSIGNMENTS:
Vitality-Driven Volumetric Value: 8
Profit-Driven Volumetric Value: 7
Vitality Driven Planar Value: 9



14.07 SITE ANALYSIS PARAMETERS

HEIGHT CATALYST



DESCRIPTION: Allows the current building development's height to be influenced by the height of adjacent buildings, exceeding the precedent building height and modeling the standard of height precedent used in allowable building heights in Toronto. This creates the ability to increase density while creating variation in the skyline.

FIGURE 14.07.01

HEIGHT CATALYST WEIGHT

DESCRIPTION: Controls the amount of influence this site analysis parameter exerts in comparison to the other site analysis parameters.

SETTING: Setting a low value of 0.00 gives this characteristic no effect, whereas a value of 1.00 gives the highest possible weight to this parameter.

TYPE: float   UNIT: weighting   RANGE: 0.00-1.00

ASSIGNMENTS:
Vitality-Driven Volumetric Value: 0.7
Profit-Driven Volumetric Value: 0.7
Vitality Driven Planar Value: 0.7

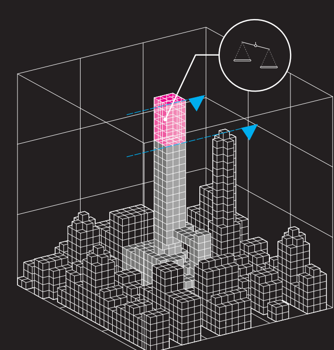


FIGURE 14.07.02

COMPARISON RADIUS

DESCRIPTION: Determines the distance away from the current site within which existing buildings will impact the height of the current development.

SETTING: A low setting of 1 voxel will search only 1 voxel away from the site boundary for adjacent building heights, whereas a high setting of 100 will search for adjacent building heights up to 100 voxels away from the site boundary.

TYPE: integer UNIT: voxels RANGE: 0-100

ASSIGNMENTS:
Vitality-Driven Volumetric Value: 25
Profit-Driven Volumetric Value: 26
Vitality Driven Planar Value: 25

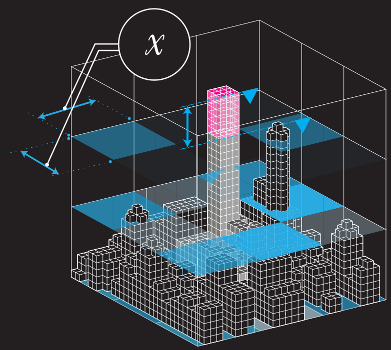


FIGURE 14.07.03

HEIGHT INCREASE

DESCRIPTION: Determines the amount of height the current building development can have in addition to the height of the tallest adjacent building found.

SETTING: A low value of 0 matches the height of the adjacent building, whereas a high value of 100 adds a possible 100 voxels in height to the current building development in comparison to the highest adjacent building found.

TYPE: integer UNIT: voxels RANGE: 0-100

ASSIGNMENTS:
Vitality-Driven Volumetric Value: 6
Profit-Driven Volumetric Value: 7
Vitality Driven Planar Value: 7

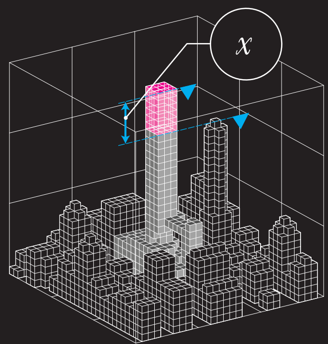


FIGURE 14.07.04

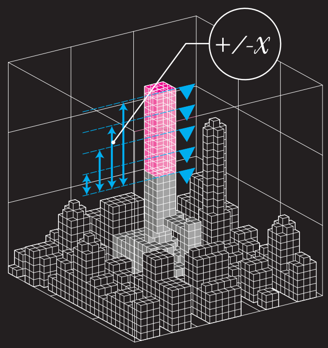
TOP HEIGHT REDUCTION GRADIENT

DESCRIPTION: Creates a reduction factor in building height as the height approaches the maximum allowed building height, gradually discouraging large amounts of massing close to the maximum building height.

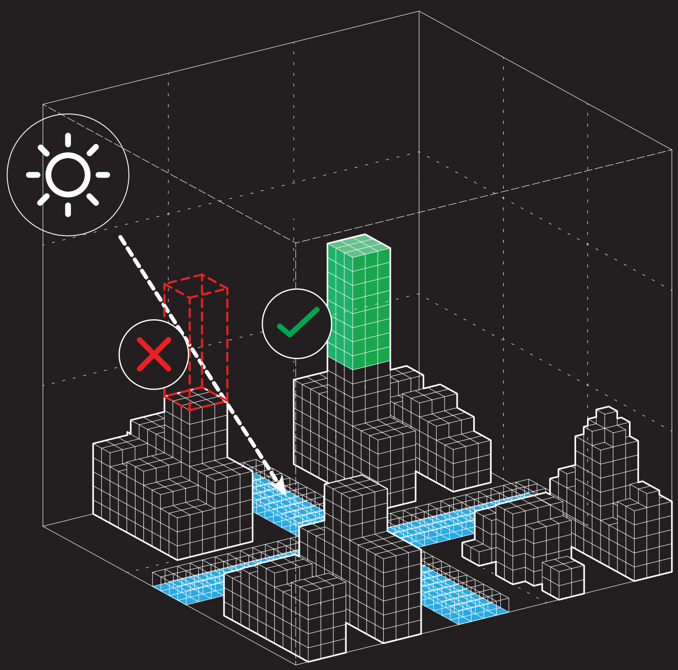
SETTING: A low setting of 0 creates no reduction gradient, whereas a setting of 50 creates a reduction gradient zone of 50 voxels in height.

TYPE: integer UNIT: voxels RANGE: 0-50

ASSIGNMENTS:
Vitality-Driven Volumetric Value: 0
Profit-Driven Volumetric Value: 0
Vitality Driven Planar Value: 0



DAYLIGHTING PUBLIC SPACE



DESCRIPTION: This site response improves the atmospheric quality of public spaces by creating performance-based daylighting rules that respond to the specific sun angles and local geometry of existing shadows and public space. This protects the public right to daylight and increases street activity by minimizing the street desolating effects of shadows. This process works by ray-tracing the sunlight trajectories of 9 sun angles throughout the day and year, reducing massing in areas that shade public space significantly, reducing massing in areas that shade private program, and encouraging massing in areas that are already shaded.

FIGURE 14.07.05

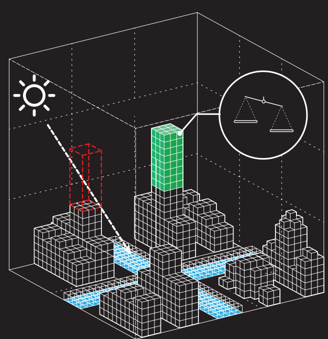
DAYLIGHTING WEIGHT

DESCRIPTION: Controls the amount of influence this site analysis parameter exerts in comparison to the other site analysis parameters.

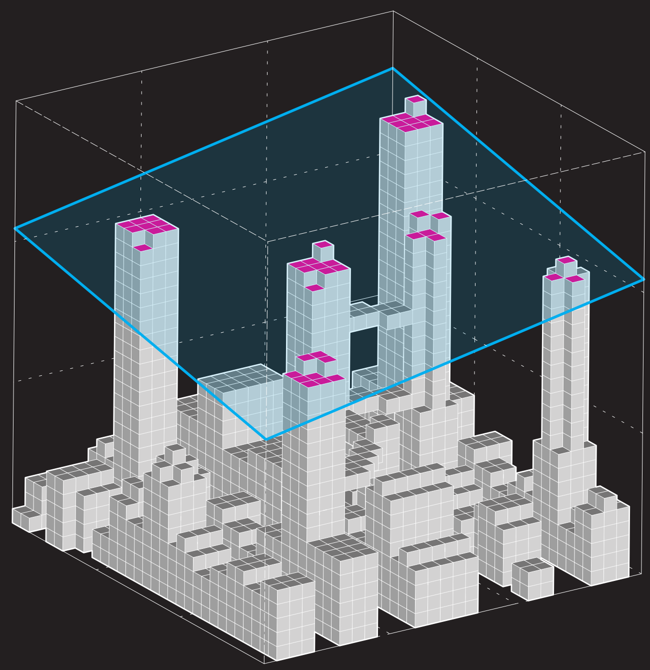
SETTING: Setting a low value of 0.00 gives this criterion no effect, whereas a value of 1.00 gives the highest possible weight to this criterion.

TYPE: float UNIT: weighting RANGE: 0.00-1.00

ASSIGNMENTS:
Vitality-Driven Volumetric Value: 1.0
Profit-Driven Volumetric Value: 0.0
Vitality Driven Planar Value: 0.6



SKYLINE PROFILE



DESCRIPTION: Preserves the character of the skyline by introducing a locally defined absolute maximum height limit. For example, the shape of the skyline can preserve the prominence of the CN tower by prohibiting growth beyond observation deck level of the CN tower, protecting wayfinding in the city and the prominence of the landmark.

FIGURE 14.07.06

SKYLINE PROFILE WEIGHT

DESCRIPTION: Controls the amount of influence the skyline parameter exerts in comparison to the other site analysis parameters.

SETTING: Setting a low value of 0.00 gives this criterion no effect, whereas a value of 1.00 gives the highest possible weight to this criterion.

TYPE: float UNIT: weighting RANGE: 0.00-1.00

ASSIGNMENTS:
Vitality-Driven Volumetric Value: 1.0
Profit-Driven Volumetric Value: 1.0
Vitality Driven Planar Value: 1.0

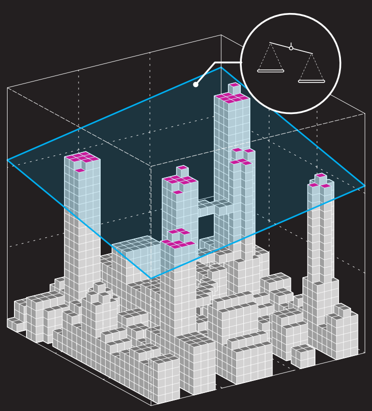


FIGURE 14.07.07

TOP HEIGHT REDUCTION GRADIENT

DESCRIPTION: Creates a zone below the maximum height with a gradually reduced skyline site analysis score.

SETTING: Setting a low value of 0 creates no gradient zone, making the skyline score go from 1.00 below the maximum height and 0.00 at and above the maximum height. Setting a high value of 20 creates a gradually decreasing skyline site analysis score as the maximum height is approached.

TYPE: integer   UNIT: voxels   RANGE: 0 - 20

ASSIGNMENTS:
Vitality-Driven Volumetric Value: 0
Profit-Driven Volumetric Value: 0
Vitality Driven Planar Value: 0

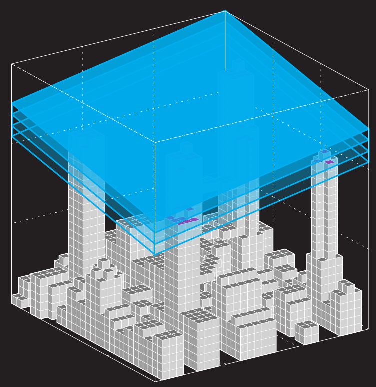


FIGURE 14.07.08

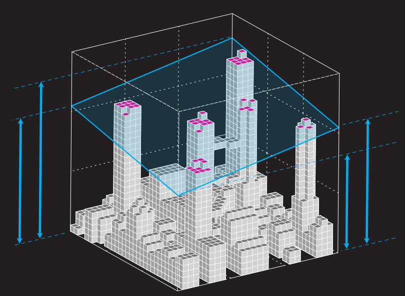
HEIGHT ADJUSTMENT

DESCRIPTION: Determines the maximum allowable building height - voxels above this height will receive a score of 0. A predetermined skyline shape can be loaded into the parametric design tool with an adjustable height.

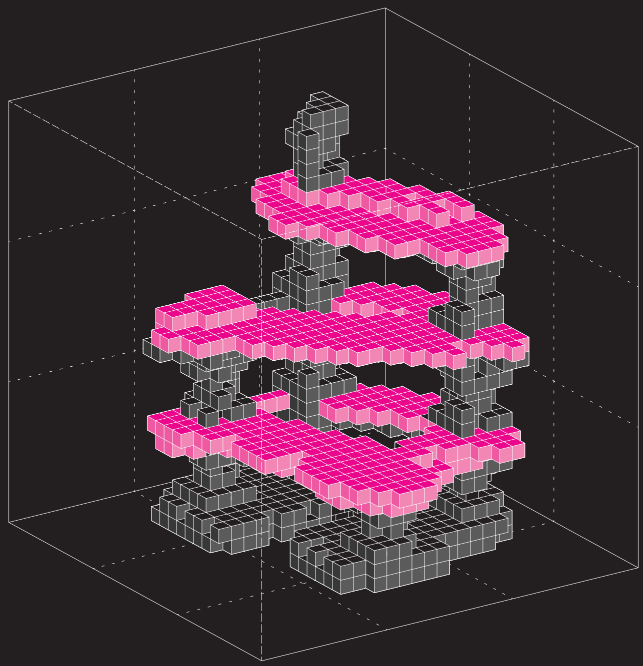
SETTING: Setting a low value of 10 will reduce the maximum height of new construction to 10 voxels in height, whereas a high value of 100 will make a very tall maximum height of 100 voxels.

TYPE: integer   UNIT: voxels   RANGE: -25 to +25

ASSIGNMENTS:
Vitality-Driven Volumetric Value: -5
Profit-Driven Volumetric Value: -5
Vitality Driven Planar Value: -5



STRATA THICKENING



DESCRIPTION: Allow for increased density, additional amenities, and additional accessible exterior roof space by thickening the building depth near strata levels. Thickening strata levels will help ensure there are enough businesses and services at strata to keep them active and provide reasons to visit.

FIGURE 14.07.09

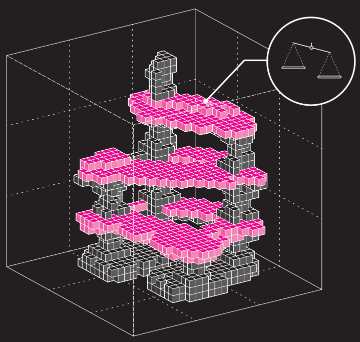
STRATA THICKENING WEIGHT

DESCRIPTION: Controls the amount of influence this parameter exerts in comparison to the other site analysis parameters.

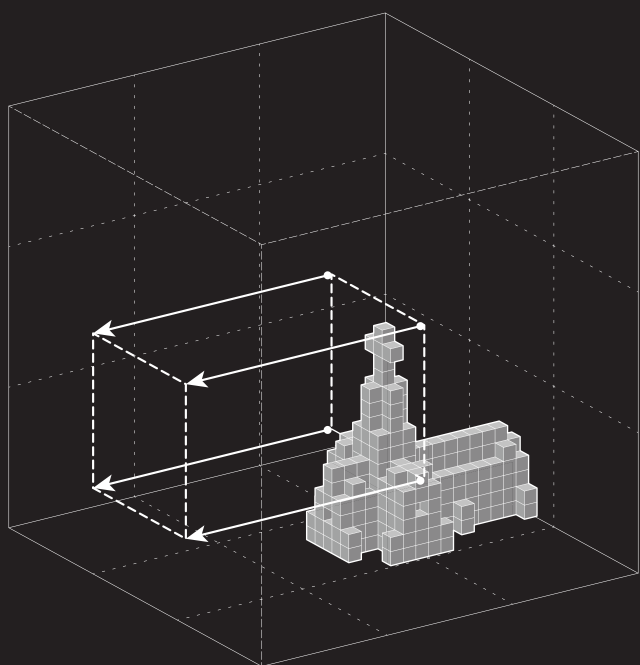
SETTING: Setting a low value of 0.00 gives this criterion no effect, whereas a value of 1.00 gives the highest possible weight to this criterion.

TYPE: float UNIT: weighting RANGE: 0.00-1.00

ASSIGNMENTS:
Vitality-Driven Volumetric Value: 0.2
Profit-Driven Volumetric Value: 0.0
Vitality Driven Planar Value: 0.0



SIGHTLINE PRESERVATION



DESCRIPTION: Identify and preserve significant lines of sight in the city by creating a clear corridor. Improves wayfinding in the city, increases the number of privileged views, and provides morphological variation, thereby reducing the monotony of the street grid.

FIGURE 14.07.10

SIGHTLINE PRESERVATION WEIGHT

DESCRIPTION: Controls the amount of influence this parameter exerts in comparison to the other site analysis parameters.

SETTING: Setting a low value of 0.00 gives this criterion no effect, whereas a value of 1.00 gives the highest possible weight to this criterion.

TYPE: float UNIT: weighting RANGE: 0.00-1.00

ASSIGNMENTS:
Vitality-Driven Volumetric Value: 0.6
Profit-Driven Volumetric Value: 0.0
Vitality Driven Planar Value: 0.4

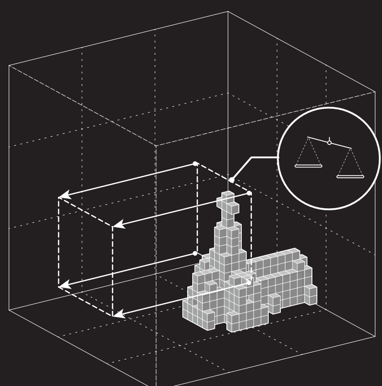


FIGURE 14.07.11

CLEAR WIDTH

DESCRIPTION: Determines the width of the clear view corridor on either side of the sightline. Spaces within this width will receive a sightline preservation site analysis score of 0.

SETTING: Setting a low value of 0 eliminates the view corridor by assigning a width of 0, whereas a high value of 20 assigns a very large clear view corridor 20 voxels wide.

TYPE: integer UNIT: voxels RANGE: 0 - 20

ASSIGNMENTS:
Vitality-Driven Volumetric Value: 4
Profit-Driven Volumetric Value: 4
Vitality Driven Planar Value: 4

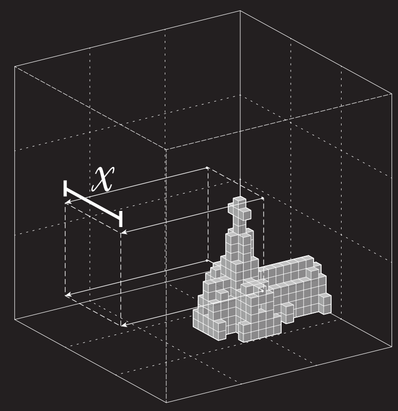


FIGURE 14.07.12

CLEAR HEIGHT

DESCRIPTION: Determines the height of the clear view corridor in number of voxels away from the sightline. Grid spaces within this height will receive a sightline preservation site analysis score of 0.

SETTING: Setting a low value of 0 eliminates the view corridor by assigning a height of 0, whereas a high value of 20 assigns a very large clear view corridor 20 voxels in height.

TYPE: integer UNIT: voxels RANGE: 0 - 20

ASSIGNMENTS:
Vitality-Driven Volumetric Value: 3
Profit-Driven Volumetric Value: 3
Vitality Driven Planar Value: 3

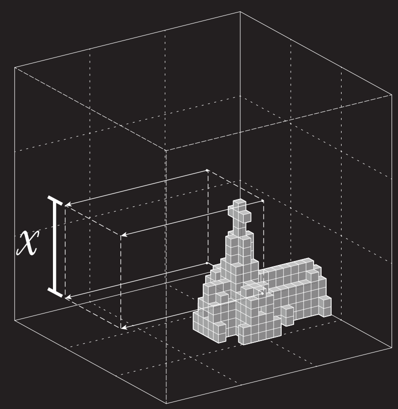


FIGURE 14.07.13

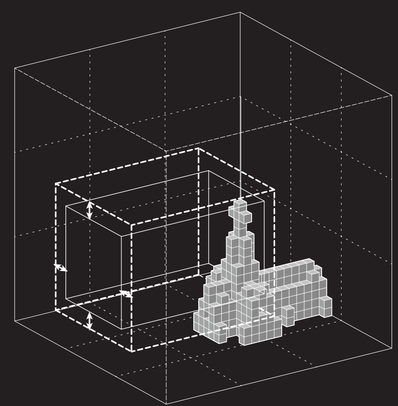
REDUCTION GRADIENT WIDTH

DESCRIPTION: Determines the distance outside the view corridor that has a reduced scoring to create a gradient of reduced scores at the sightline corridor's edge.

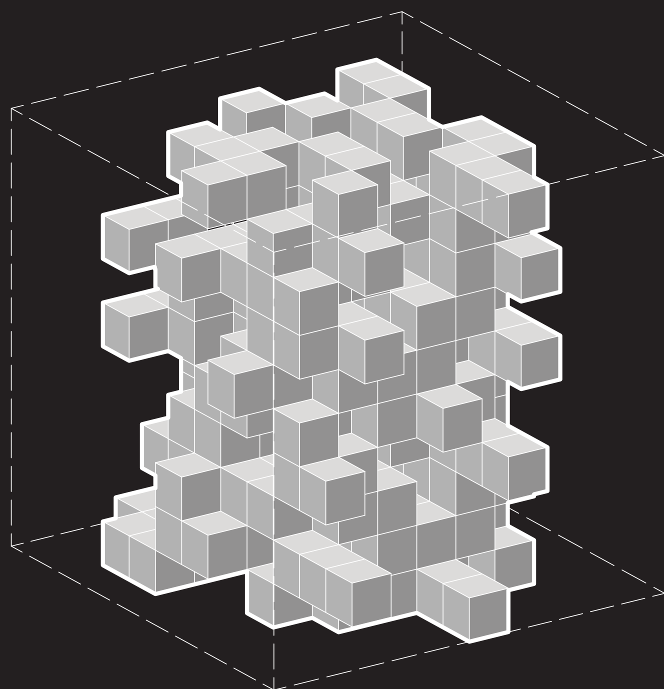
SETTING: Setting a low value of 0 creates no score gradient at the outer edge of the view corridor, whereas a high value of 10 creates a gradually increasing score from the clear view corridor, to a distance 10 voxels away.

TYPE: integer UNIT: voxels RANGE: 0 - 10

ASSIGNMENTS:
Vitality-Driven Volumetric Value: 5
Profit-Driven Volumetric Value: 5
Vitality Driven Planar Value: 5



FACADE ARTICULATION (PERLIN NOISE)



DESCRIPTION: The facade articulation site analysis criteria uses a 3-D Perlin noise generator to create a small amount of variation between adjacent voxels that can be used to encourage non-rectilinear shapes and pixelated building edges. Controlling the scale, octaves, and falloff of the noise generator can create different shapes from gentle waves to random noise.

FIGURE 14.07.14

FACADE ARTICULATION WEIGHT

DESCRIPTION: Controls the amount of influence this parameter exerts in comparison to the other site analysis parameters.

SETTING: Setting a low value of 0.00 gives this criterion no effect, whereas a value of 1.00 gives the highest possible weight to this criterion.

TYPE: float   UNIT: weighting   RANGE: 0.00-1.00

ASSIGNMENTS:
Vitality-Driven Volumetric Value: 0.1
Profit-Driven Volumetric Value: 0.0
Vitality Driven Planar Value: 0.2

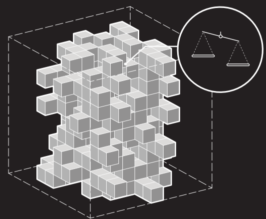
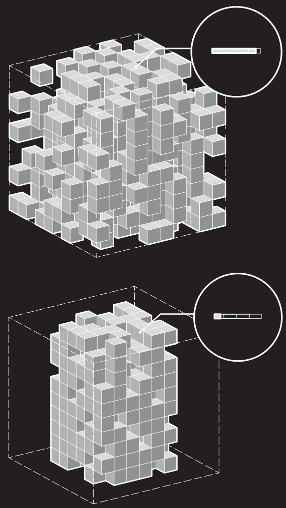


FIGURE 14.07.15

NOISE SCALE



DESCRIPTION: Noise scale controls the scale of the Perlin noise generator.

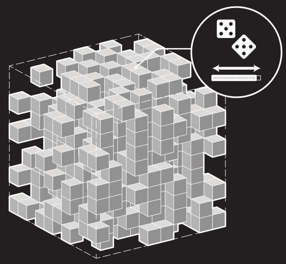
SETTING: A small value close to 0.00 creates a larger scale with small incremental changes in the randomized values between voxels. A large value close to 1.00 creates a finer scale with larger increments in the randomized values between voxels.

TYPE: float UNIT: score RANGE: 0.00-1.00

ASSIGNMENTS:
Vitality-Driven Volumetric Value: 0.06
Profit-Driven Volumetric Value: 0.06
Vitality Driven Planar Value: 0.06

FIGURE 14.07.16

RANDOMIZE NOISE SCALE



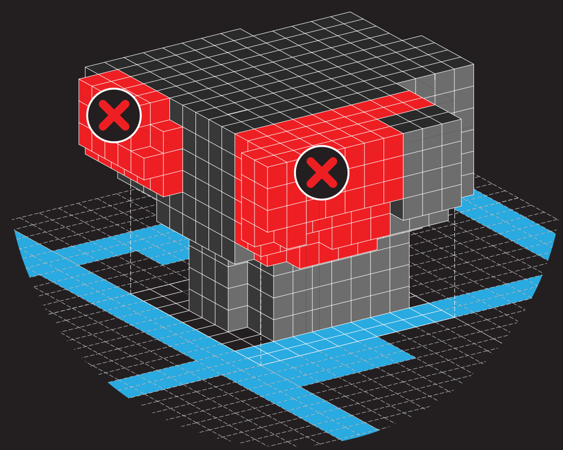
DESCRIPTION: Creates variation between developments by assigning different values to the noise scale parameter with each new development.

SETTING: Turning the randomization on selects a new noise scale value each building cycle, turning the randomization off keeps the same initial setting for all building cycles.

TYPE: boolean UNIT: -- RANGE: true/false

ASSIGNMENTS:
Vitality-Driven Volumetric Value: true
Profit-Driven Volumetric Value: true
Vitality Driven Planar Value: true

GRADE PROGRAM COVER REDUCTION



DESCRIPTION: This site analysis criteria allows for buildings to avoid cantilevering directly over specific public program at grade.

FIGURE 14.07.17

GRADE PROGRAM COVER REDUCTION WEIGHT

DESCRIPTION: Controls the amount of influence this parameter exerts in comparison to the other site analysis parameters.

SETTING: Setting a low value of 0.00 gives this criterion no effect, whereas a value of 1.00 gives the highest possible weight to this criterion.

TYPE: float UNIT: weighting RANGE: 0.00-1.00

ASSIGNMENTS:
Vitality-Driven Volumetric Value: 0.4
Profit-Driven Volumetric Value: 1.0
Vitality Driven Planar Value: 0.5

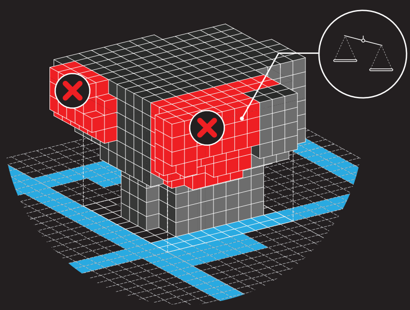


FIGURE 14.07.18

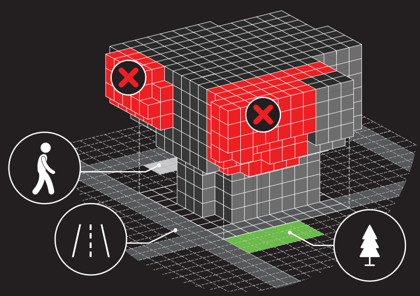
PROGRAMS TO AVOID COVERING

DESCRIPTION: Selects which program types at grade to avoid cantilevering directly over.

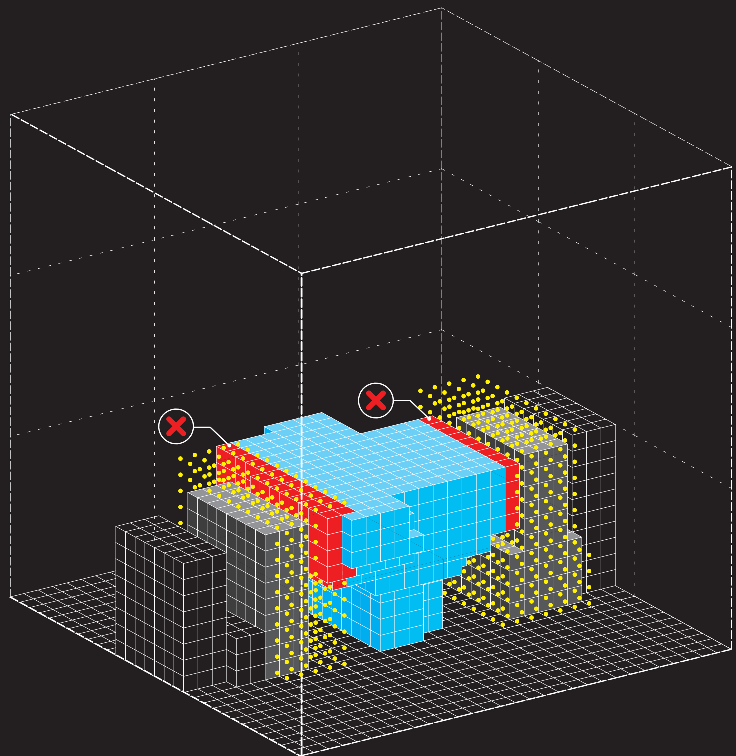
SETTING: Pedestrian hardscape, pedestrian softscape, and vehicular streets can each be selected as programs at grade that will be discouraged from cantilevering over.

TYPE: multiple booleans UNIT: -- RANGE: true/false

ASSIGNMENTS:
Vitality-Driven Volumetric Value:
hardscape: true | softscape: true | streets: true
Profit-Driven Volumetric Value:
hardscape: true | softscape: true | streets: true
Vitality Driven Planar Value:
hardscape: true | softscape: true | streets: true



EXISTING BUILDING OFFSET



DESCRIPTION: Since buildings are able to cantilever over adjacent lots, the building offset criterion prevents buildings from encroaching too much on an adjacent building by specifying a minimum allowable distance away.

FIGURE 14.07.19

EXISTING BUILDING OFFSET WEIGHT

DESCRIPTION: Controls the amount of influence this parameter exerts in comparison to the other site analysis parameters.

SETTING: Setting a low value of 0.00 gives this criterion no effect, whereas a value of 1.00 gives the highest possible weight to this criterion.

TYPE: float　　　UNIT: weighting　　　RANGE: 0.00-1.00

ASSIGNMENTS:
Vitality-Driven Volumetric Value: 0.7
Profit-Driven Volumetric Value: 0.9
Vitality Driven Planar Value: 0.5

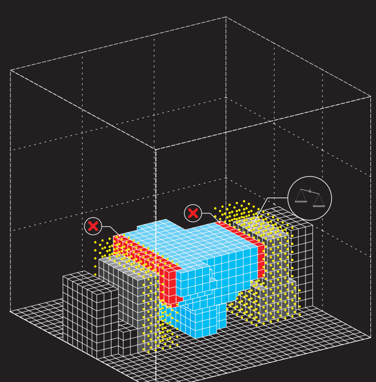
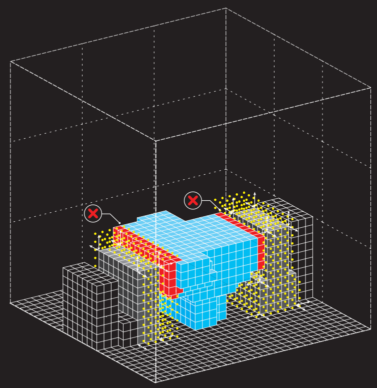


FIGURE 14.07.20

OFFSET DISTANCE



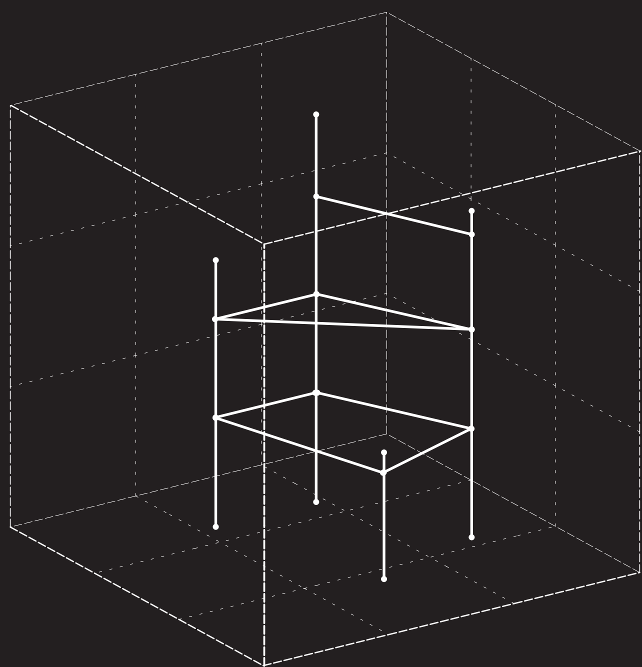
DESCRIPTION: Defines the minimum distance allowed between the current building development and existing construction.

SETTING: A small value of 0 requires no offset from existing buildings, whereas a large value of 10 requires at least 10 voxels between the existing building and the new massing.

TYPE: integer UNIT: voxel RANGE: 0 - 10

ASSIGNMENTS:
Vitality-Driven Volumetric Value: 3
Profit-Driven Volumetric Value: 2
Vitality Driven Planar Value: 3

14.08 BUILDING CORE LOCATION PARAMETERS



DESCRIPTION: These parameters control the decision process guiding the location of building cores and horizontal inter-building connections that ultimately make up the building network; including how many, how close they can be to other objects, and how tall they can be.

VERTICAL CORE OPTIONS

FIGURE 14.08.01

CORE DENSITY

DESCRIPTION: Determines the number of cores to be constructed in relation to the area of the site.

SETTING: A low setting of 10 will request one core for every 10 voxels of site area, whereas a high setting of 1,000 will request a core for every 1,000 voxels of site area.

TYPE: integer   UNIT: voxels   RANGE: 10-1000

ASSIGNMENTS:
Vitality-Driven Volumetric Value: 80
Profit-Driven Volumetric Value: 100
Vitality Driven Planar Value: 80

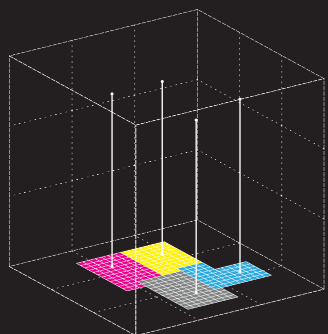


FIGURE 14.08.02

MINIMUM DISTANCE FROM STREET

DESCRIPTION: Determines the minimum distance cores must be placed away from the street edge.

SETTING: A low setting of 0 will allow cores to be built adjacent to the street edge, whereas a high setting of 10 will enforce a minimum distance of 10 voxels away from the street; superseded by the requirement for a minimum of at least 1 core regardless of the street distance parameter in the event the distance specified exceeds the size of the site.

TYPE: integer UNIT: voxels RANGE: 0-10

ASSIGNMENTS:
Vitality-Driven Volumetric Value: 3
Profit-Driven Volumetric Value: 3
Vitality Driven Planar Value: 3

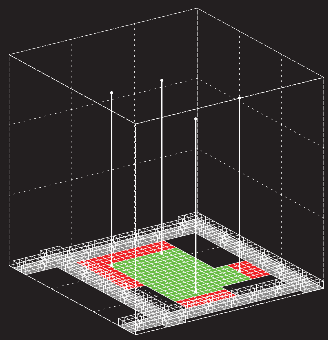


FIGURE 14.08.03

MINIMUM CORE TO CORE DISTANCE

DESCRIPTION: Determines the minimum distance required between cores in either the x or y axis.

SETTING: Within this distance from an existing core, all possible core locations are eliminated. A low value of 0 means cores may be immediately adjacent to each other, whereas a high-value of 50 means cores must be at least 50 voxels apart.

TYPE: integer UNIT: voxels RANGE: 0-50

ASSIGNMENTS:
Vitality-Driven Volumetric Value: 10
Profit-Driven Volumetric Value: 10
Vitality Driven Planar Value: 10

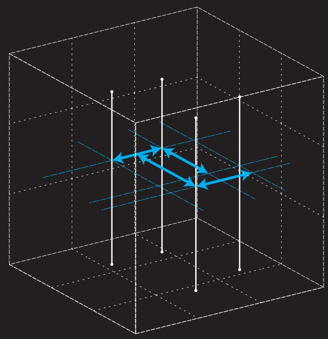


FIGURE 14.08.04

MINIMUM CORE HEIGHT VARIATION

DESCRIPTION: Determines the minimum amount of variation between core heights within a single development.

SETTING: A low value of 0 mandates no difference between core heights, whereas a high value of 50 requires at least 50 voxels of height difference between cores of the same development.

TYPE: integer UNIT: voxels RANGE: 0-50

ASSIGNMENTS:
Vitality-Driven Volumetric Value: 8
Profit-Driven Volumetric Value: 2
Vitality Driven Planar Value: 10

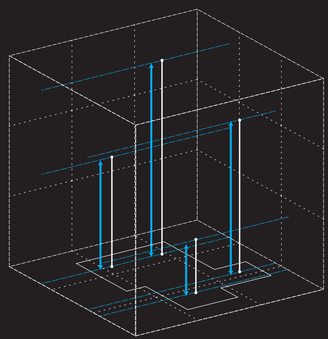


FIGURE 14.08.05

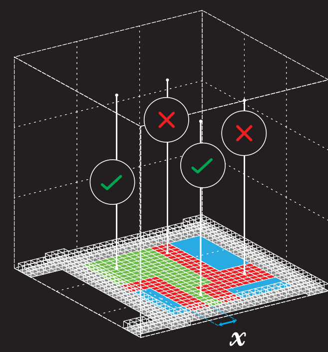
MINIMUM DISTANCE FROM ADJACENT LOT

DESCRIPTION: Determines the minimum distance cores must be placed away from an adjacent property. This is done in order to prevent inefficient placement being ensuring building cores are not being built against the property line.

SETTING: A low setting of 0 will allow cores to be built adjacent to other parcels, whereas a high setting of 10 will enforce a minimum distance of 10 voxels away from another parcel.

TYPE: integer UNIT: voxel RANGE: 0-10

ASSIGNMENTS:
Vitality-Driven Volumetric Value: 1
Profit-Driven Volumetric Value: 2
Vitality Driven Planar Value: 1



HORIZONTAL CORE OPTIONS

FIGURE 14.08.06

ENABLE HORIZONTAL CORES

DESCRIPTION: Determines if horizontal connections between vertical cores are enabled.

SETTING: When this parameter is enabled, the program will initiate the process to build horizontal cores. When disabled, only vertical cores will be permitted in the simulation and inter-building connections will not be made.

TYPE: boolean UNIT: -- RANGE: true/false

ASSIGNMENTS:
Vitality-Driven Volumetric Value: true
Profit-Driven Volumetric Value: true
Vitality Driven Planar Value: false

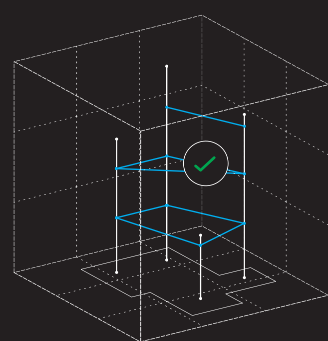


FIGURE 14.08.07

MAXIMUM LENGTH WITHIN DEVELOPMENT

DESCRIPTION: Specifies the maximum distance horizontal cores can span from vertical core to vertical core within the same development.

SETTING: Setting a low value of 1 will only allow horizontal core connections when vertical cores are 1 voxel apart, whereas a high value of 100 will allow vertical cores up to 100 voxels away from each other to become connected by a horizontal core.

TYPE: integer UNIT: voxels RANGE: 1-100

ASSIGNMENTS:
Vitality-Driven Volumetric Value: 20
Profit-Driven Volumetric Value: 20
Vitality Driven Planar Value: --

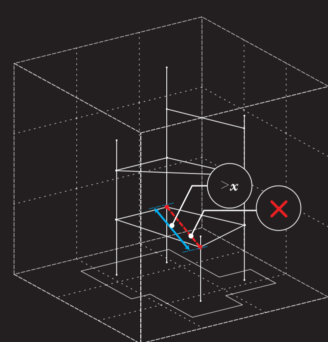


FIGURE 14.08.08

MAXIMUM LENGTH TO ADJACENT DEVELOPMENT

DESCRIPTION: Specifies the maximum distance horizontal cores can span from a vertical core of the current development to a vertical core of an adjacent development.

SETTING: Setting a low value of 1 will only allow horizontal core connections when vertical cores of different developments are 1 voxel apart, whereas a high value of 100 will allow vertical cores of different developments up to 100 voxels away from each other to become connected by a horizontal core.

TYPE: integer   UNIT: voxels   RANGE: 1-100

ASSIGNMENTS:
Vitality-Driven Volumetric Value: 28
Profit-Driven Volumetric Value: 24
Vitality Driven Planar Value: --

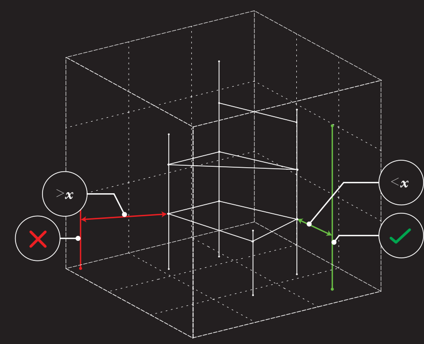


FIGURE 14.08.09

FIRST STRATUM LEVEL

DESCRIPTION: Determines the height from grade at which the first horizontal connection may occur.

SETTING: Setting a low value of 1 will allow the first horizontal core from grade to occur 1 voxel space above ground level, whereas a high value of 50 will make the first stratum of horizontal cores 50 voxels above ground level.

TYPE: integer   UNIT: voxels   RANGE: 1-50

ASSIGNMENTS:
Vitality-Driven Volumetric Value: 7
Profit-Driven Volumetric Value: 12
Vitality Driven Planar Value: --

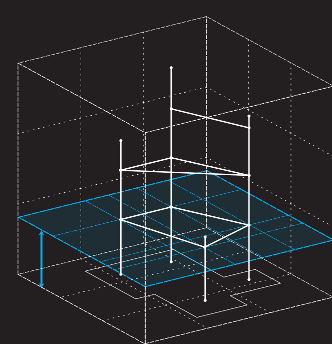


FIGURE 14.08.10

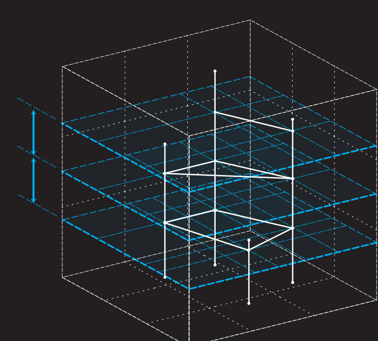
FREQUENCY OF STRATA LEVELS

DESCRIPTION: Determines the vertical spacing between strata of horizontal cores after the first stratum.

SETTING: Setting a low value of 1 will create strata of horizontal cores every 1 voxel above the first stratum, whereas a high value of 50 will create strata of horizontal cores every 50 voxels apart.

TYPE: integer   UNIT: voxels   RANGE: 12-74

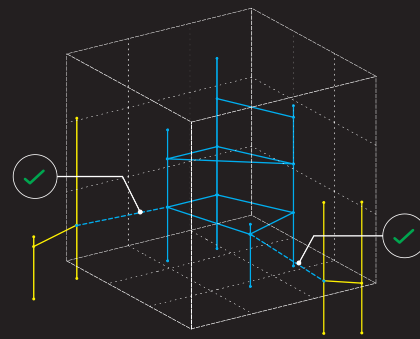
ASSIGNMENTS:
Vitality-Driven Volumetric Value: 12
Profit-Driven Volumetric Value: 22
Vitality Driven Planar Value: --



NETWORK OPTIONS

FIGURE 14.08.11

NETWORK INTEGRATION POINT



DESCRIPTION: The number of distinct building networks from different developments after which the networks become integrated into a single system. This is done by fixing strata levels at a specific height, allowing connections between different developments, and harmonizing the network identification numbers of all connected cores.

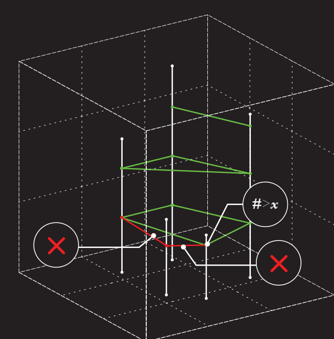
SETTING: A low setting of 0 starts a volumetric building network as a single harmonized network, whereas a high setting of 50 requires 50 separate volumetric building networks before being unified.

TYPE: integer UNIT: building networks RANGE: 0-50

ASSIGNMENTS:
Vitality-Driven Volumetric Value: 6
Profit-Driven Volumetric Value: 12
Vitality Driven Planar Value: --

FIGURE 14.08.12

MAXIMUM NUMBER OF SAME DEVELOPMENT CONNECTIONS



DESCRIPTION: Determines the maximum number of horizontal cores a vertical core can have per strata within the same development.

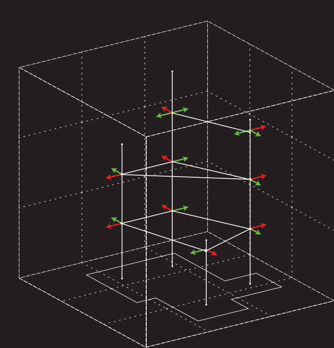
SETTING: Setting a low value of 1 will only allow each vertical core to have 1 horizontal core connection. A high value of 8 will allow up to 8 horizontal cores to be connected to each vertical core at every strata.

TYPE: integer UNIT: horizontal cores RANGE: 1-10

ASSIGNMENTS:
Vitality-Driven Volumetric Value: 2
Profit-Driven Volumetric Value: 2
Vitality Driven Planar Value: --

FIGURE 14.08.13

MAXIMUM NUMBER OF ADJACENT DEVELOPMENT CONNECTIONS



DESCRIPTION: Determines the maximum number of horizontal cores a vertical core can have (per strata) to an adjacent development.

SETTING: Setting a low value of 1 will only allow each vertical core to have 1 horizontal core connection. A high value of 4 will allow up to 4 horizontal cores to be connected to each vertical core at every strata.

TYPE: integer UNIT: horizontal cores RANGE: 0-4

ASSIGNMENTS:
Vitality-Driven Volumetric Value: 1
Profit-Driven Volumetric Value: 1
Vitality Driven Planar Value: --

FIGURE 14.08.14

PERMITTED STRATA LEVEL VARIATION

DESCRIPTION: The distance in voxels away from the specified strata level that is considered within acceptable range to be considered a part of the given stratum.

SETTING: A low value of 0 requires all horizontal cores to be at the strata level's specified height, whereas a high level of 10 allows cores to be up to 10 voxels higher or lower than the strata.

TYPE: integer UNIT: voxel RANGE: 0-10

ASSIGNMENTS:
Vitality-Driven Volumetric Value: 1
Profit-Driven Volumetric Value: 3
Vitality Driven Planar Value: --

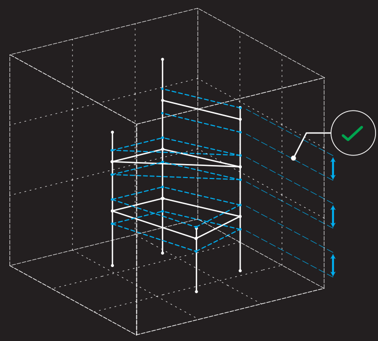


FIGURE 14.08.15

STRATA LEVEL RANDOMIZATION

DESCRIPTION: Simulates how different developments don't coordinate strata levels until after city-wide network unification.

SETTING: Selecting "static strata" fixes the strata at the specified heights, "static after network integration" fixes strata once the network integration point is reached, and "always randomize" will generate new strata heights every building cycle.

TYPE: selection RANGE:
static strata
static after network integration
always randomize

ASSIGNMENTS:
Vitality-Driven Volumetric Value: static strata
Profit-Driven Volumetric Value: static after network integration
Vitality Driven Planar Value: static strata

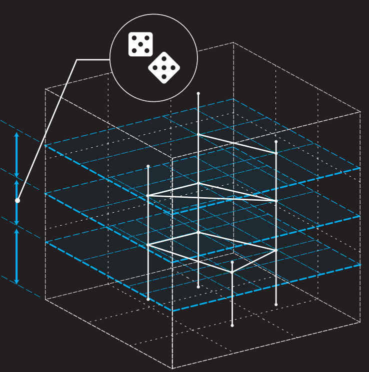


FIGURE 14.08.16

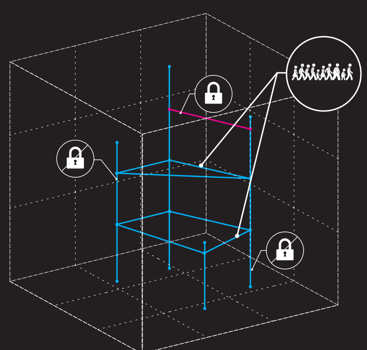
NETWORK PUBLIC LEVEL

DESCRIPTION: Determines the degree of publicness assigned to new inter-building connections, simulating how different cities may regulate building networks under their jurisdiction, and others remain under private control.

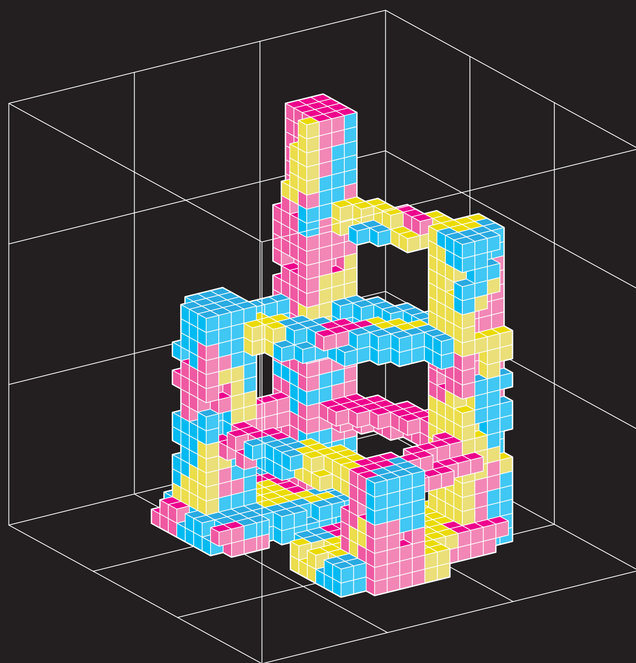
SETTING: Selecting "public" will assign a public designation to new horizontal and vertical building cores, "quasi-public" will assign them the quasi-public property, and "private" will assign them the "private" property.

TYPE: selection RANGE: public, quasi-public, private

ASSIGNMENTS:
Vitality-Driven Volumetric Value: public
Profit-Driven Volumetric Value: quasi-public
Vitality Driven Planar Value: private



14.09 MASSING CONSTRUCTION PARAMETERS



DESCRIPTION: The massing construction parameters control the decision process in assigning building massing; including the type of form to generate, formal and structural constraints, and program and price tier distributions.

BUILDING TARGET OPTIONS

FIGURE 14.09.01

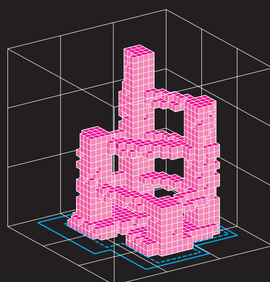
TARGET FILL OF MAXIMUM ENVELOPE

DESCRIPTION: Defines the target number of voxels to construct within the maximum boundary supported by the structural support character envelope.

SETTING: Setting a low percentage of 10% would only construct 10% of available voxels within the structural support character envelope, whereas a high setting of 100% would construct all voxels within the envelope.

TYPE: integer   UNIT: percentage   RANGE: 10-100

ASSIGNMENTS:
Vitality-Driven Volumetric Value: 55%
Profit-Driven Volumetric Value: 75%
Vitality Driven Planar Value: 55%



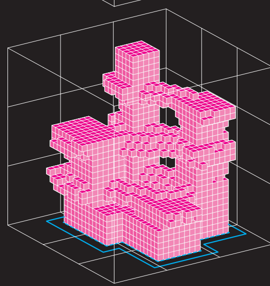


FIGURE 14.09.02

PROGRAMMATIC USE TARGETS

DESCRIPTION: Defines the target ratio of programmatic uses in the entire building environment. The user would set these use ratios based on the current or projected demands of the city and the generative algorithm will select voxel program types accordingly to try to match the desired ratio of programs distributed throughout the city.

SETTING: Each program type is given a slider which can receive a value from 0-100. Altering the sliders alters the amount of each program type in relation to the other program types. For instance, setting residential voxels to 50 and all other voxels types to 25 would create the same affect as setting residential voxels to 100 and all other voxel types to 50.

TYPE: integer UNIT: ratio RANGE: 0-100

ASSIGNMENTS:

Vitality-Driven Volumetric Value:

Residential:	28
Office:	22
Production:	5
Retail and amenities:	13
Institutional:	12
Pedestrian hardscape:	10
Pedestrian softscape:	5
Exterior production:	3

Profit-Driven Volumetric Value:

Residential:	30
Office:	25
Production:	1
Retail and amenities:	15
Institutional:	5
Pedestrian hardscape:	6
Pedestrian softscape:	3
Exterior production:	1

Vitality Driven Planar Value:

Residential:	28
Office:	22
Production:	5
Retail and amenities:	13
Institutional:	12
Pedestrian hardscape:	10
Pedestrian softscape:	5
Exterior production:	3

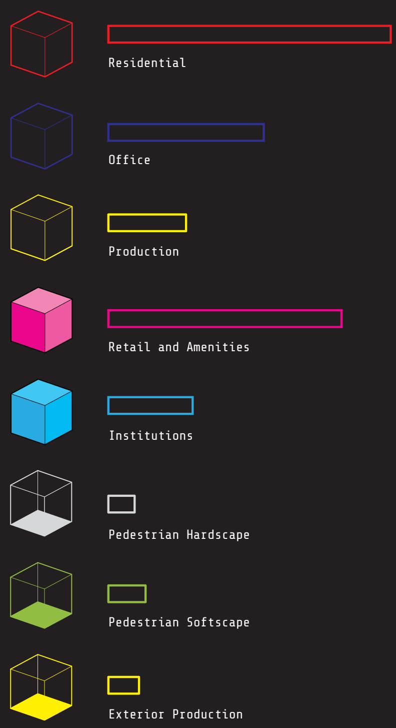


FIGURE 14.09.03

PRICE TIER TARGETS

DESCRIPTION: Defines the target ratio of price tiers in the entire building environment. The user would set these use ratios based on the current or projected demands of the city and the generative algorithm will select voxel price tier types accordingly to match the desired ratio of price tiers distributed throughout the city.

SETTING: Each price tier has a slider which accepts a value from 0-100. Altering the sliders alters the amount of each price tier in relation to the other price tiers.

TYPE: integer UNIT: ratio RANGE: 0-100

ASSIGNMENTS:
Vitality-Driven Volumetric Value:
- Low tier: 28
- Low-mid tier: 32
- Mid-high tier: 28
- High tier: 12

Profit-Driven Volumetric Value:
- Low tier: 5
- Low-mid tier: 12
- Mid-high tier: 58
- High tier: 25

Vitality Driven Planar Value:
- Low tier: 28
- Low-mid tier: 32
- Mid-high tier: 28
- High tier: 12

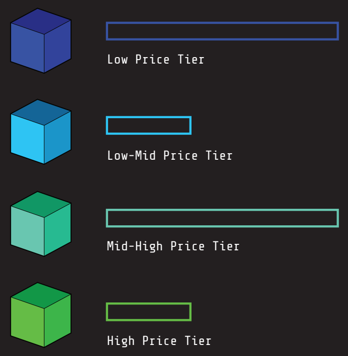


FIGURE 14.09.04

CATCHMENT SURVEY DISTANCE

DESCRIPTION: Specifies the range searched within in order to determine local programmatic use or price tier needs, that goes on to inform the current development's target program and price tier distributions.

SETTING: A low value of 0 forces the program to only consider the program within the current quadrant, whereas a high value of 15 considers all quadrants up to 15 quadrants away.

TYPE: integer UNIT: quadrants RANGE: 0-15

ASSIGNMENTS:
Vitality-Driven Volumetric Value: 3
Profit-Driven Volumetric Value: 6
Vitality Driven Planar Value: 3

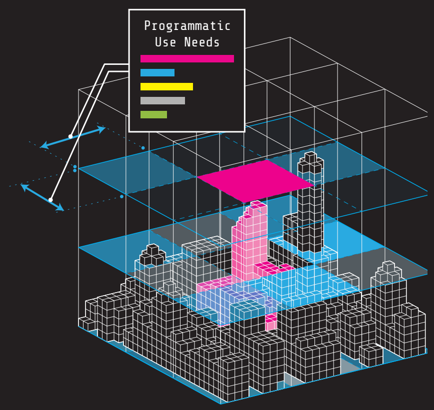


FIGURE 14.09.05

MINIMUM DIVERSITY COMPENSATION

DESCRIPTION: In some cases, the local programmatic use needs may be completely fulfilled by the introduction of only a few programs, the minimum diversity compensation introduces a small amount of additional programs to ensure the composition of the current development itself is diverse as well.

SETTING: Setting a small value of 0% specifies no additional programmatic uses, whereas a high value of 20% requires at least 20% of the building's program to be an additional diversity contribution.
TYPE: integer   UNIT: percent   RANGE:0-20

ASSIGNMENTS:
Vitality-Driven Volumetric Value: 15
Profit-Driven Volumetric Value: 0
Vitality Driven Planar Value: 20

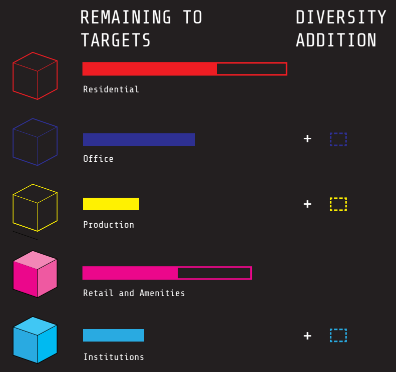


FIGURE 14.09.06

FORCE PUBLIC PROGRAMS AT STRATA

DESCRIPTION: This parameter determines whether or not quasi-public and public program will be mandated at strata levels.

SETTING: Selecting "quasi-public/public programs at strata" will require all program at strata levels to be program types that can potentially be publicly accessible.

TYPE: boolean   UNIT:--   RANGE: true/false

ASSIGNMENTS:
Vitality-Driven Volumetric Value: true
Profit-Driven Volumetric Value: true
Vitality Driven Planar Value: false

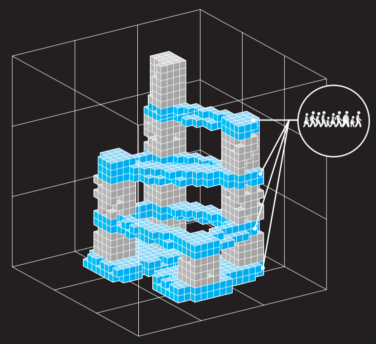


FIGURE 14.09.07

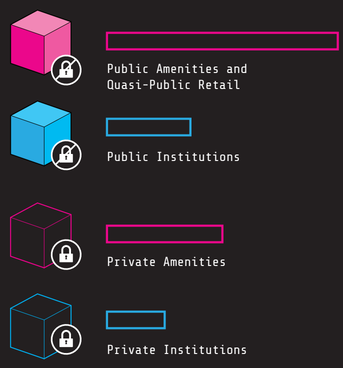
TARGET PUBLIC TO QUASI-PUBLIC RATIO

DESCRIPTION: Defines the target amount of program that is public out of all program types that can have a public distinction.

SETTING: A low value of 1% requires only 1% of program types that can be public to be public, making 99% of the program quasi-public. A high value of 100% requires all program types that can have a public distinction to be specified as public.

TYPE: integer   UNIT: percent   RANGE:0-100

ASSIGNMENTS:
Vitality-Driven Volumetric Value: 45
Profit-Driven Volumetric Value: 5
Vitality Driven Planar Value: 45



BUILDING MASSING

FIGURE 14.09.08

MAXIMUM STRUCTURE SUPPORT DISTANCE

DESCRIPTION: Defines the maximum dimensions supported by either the ground, vertical cores, or horizontal cores, as supporting structures.

SETTING: A low setting of 1 supports only voxels 1 position away from the supporting structure, whereas a high value of 25 supports voxels as far as 25 positions away from the structure.

TYPE: integer   UNIT: voxels   RANGE: 1-25

ASSIGNMENTS:

Vitality-Driven Volumetric Value:
    Grade: 7   Vertical core: 4   Horizontal core: 2

Profit-Driven Volumetric Value:
    Grade: 10   Vertical core: 4   Horizontal core: 1

Vitality Driven Planar Value:
    Grade: 7   Vertical core: 3   Horizontal core: --

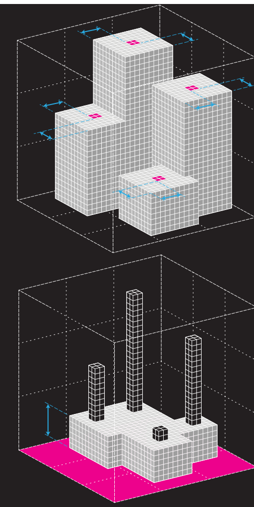


FIGURE 14.09.09

GROWTH METHOD

DESCRIPTION: Determines whether the building massing is generated as a rectilinear form, or free-form.

SETTING: Setting the value as false allows the building to be generated using the free-form algorithm, whereas setting the value to true constrains the massing generation to rectilinear forms.

TYPE: boolean   UNIT: statement   RANGE: true/false

ASSIGNMENTS:

Vitality-Driven Volumetric Value:
    Grade: 7   Vertical core: 4   Horizontal core: 2

Profit-Driven Volumetric Value:
    Grade: 10   Vertical core: 4   Horizontal core: 1

Vitality Driven Planar Value:
    Grade: 7   Vertical core: 3   Horizontal core: --

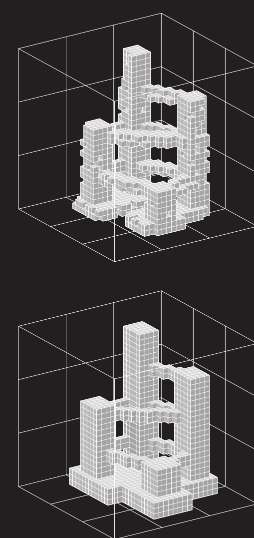


FIGURE 14.09.10

USE TYPES

DESCRIPTION: Determines which types of program can be assigned to a support structure. As a simplification, residential, office, and productive programs have been considered primary programs and retail, amenities, and institutions secondary programs.

SETTING: Either just primary uses, just secondary uses, both primary and secondary uses, or a randomized selection of either can be selected for inclusion on the support structure's programmed mass.

TYPE: selection   RANGE: primary uses, secondary uses, both uses, either uses

ASSIGNMENTS:

Vitality-Driven Volumetric Value:
  Grade: both   Vertical core: primary   Horizontal core: both

Profit-Driven Volumetric Value:
  Grade: secondary   Vertical core: primary   Horizontal core: secondary

Vitality Driven Planar Value:
  Grade: secondary   Vertical core: primary   Horizontal core: both

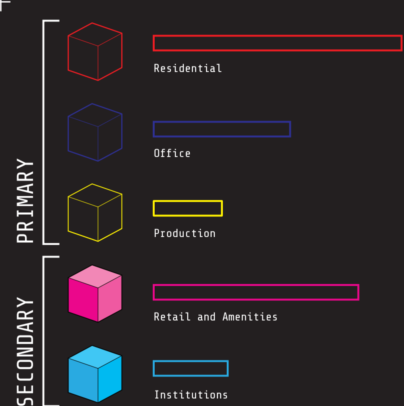


FIGURE 14.09.11

MAXIMUM NUMBER OF PROGRAMMATIC USES

DESCRIPTION: The maximum number of programs the selected support structure can accommodate.

SETTING: A low value of 1 allows only 1 program of voxels supported by the structural element whereas a high value of 5 allows all building programs.

TYPE: integer   UNIT: program   RANGE: 1-5

ASSIGNMENTS:
Vitality-Driven Volumetric Value:
    Grade: 5   Vertical core: 2   Horizontal core: 4
Profit-Driven Volumetric Value:
    Grade: 5   Vertical core: 2   Horizontal core: 2
Vitality Driven Planar Value:
    Grade: 5   Vertical core: 2   Horizontal core: 4

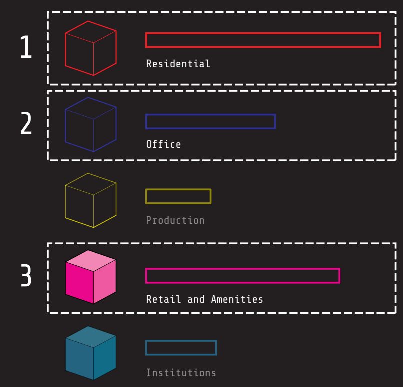


FIGURE 14.09.12

RANDOMIZE NUMBER OF PROGRAMMATIC USES

DESCRIPTION: Allows for various levels of programmatic mix for some structural elements by randomizing the number of programs the structure can accommodate.

SETTING: Enabling randomization selects a new maximum number of programmatic uses for the given structure.

TYPE: boolean   UNIT:--   RANGE: true/false

ASSIGNMENTS:
Vitality-Driven Volumetric Value:
 Grade: true   Vertical core: false   Horizontal core: false
Profit-Driven Volumetric Value:
 Grade: true   Vertical core: false   Horizontal core: false
Vitality Driven Planar Value:
 Grade: false   Vertical core: false   Horizontal core: false

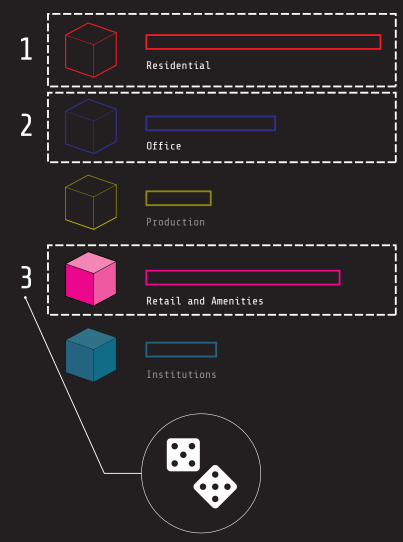


FIGURE 14.09.13

USE MIX PLACEMENT ALGORITHM

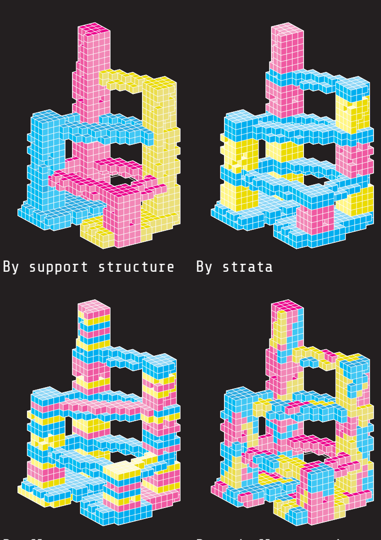
DESCRIPTION: Determines at which hierarchy within the building development mixing of uses takes place. A variety of placement algorithms have been provided to represent simplified versions of different strategies.

SETTING: Selecting “development” assigns the same program to the whole development, “core” assigns different program for each core, “strata” assigns a new program after each strata level, “floor” assigns a new program at each level, “sub-floor” assigns a new program every specified number of voxels within a floor.

VITALITY-DRIVEN VOLUMETRIC: Grade: floor or sub-floor;
Vertical core: core to sub-floor; Horizontal core: core to sub-floor

PROFIT-DRIVEN VOLUMETRIC: Grade: floor; Vertical core: core;
Horizontal core: core

VITALITY DRIVEN PLANAR: Grade: floor or sub-floor;
Vertical core: core to sub-floor; Horizontal core: core to sub-floor



By support structure   By strata

By floor   By sub-floor grain

FIGURE 14.09.14

PROGRAMMATIC USE SUB-FLOOR GRAIN

DESCRIPTION: When a sub-floor use mix is selected, this parameter determines the number of voxels after which a new program is selected, creating a grain finer than a mix of uses by floor level.

SETTING: Setting a low value of 1 selects a new program type every voxel, whereas setting a high value of 100 selects a new program type every 100 voxels.

TYPE: integer   UNIT: voxels   RANGE: 1-100

ASSIGNMENTS:
Vitality-Driven Volumetric Value:
Grade: 30   Vertical core: 60   Horizontal core: 40
Profit-Driven Volumetric Value:
Grade: 30   Vertical core: 60   Horizontal core: 40
Vitality Driven Planar Value:
Grade: 30   Vertical core: 60   Horizontal core: 40

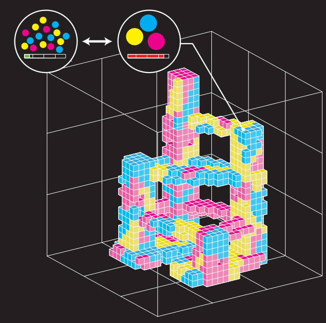


FIGURE 14.09.15

PRICE TIER MIX PLACEMENT ALGORITHM

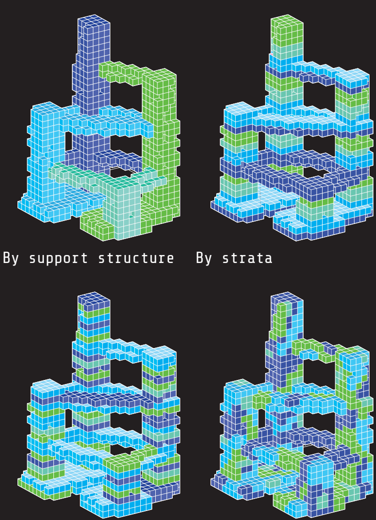
DESCRIPTION: Determines at which hierarchy within the building development mixing of price tiers takes place. A variety of placement algorithms have been provided to represent simplified versions of different strategies that could potentially be used to mix price tiers.

SETTING: Selecting “height” assigns price tiers in relation to their vertical distance from grade, by “strata” assigns price tiers in relation to their vertical distance from each strata, and “sub-floor” selects a new price tier every set number of voxels within a floor.

VITALITY-DRIVEN VOLUMETRIC: Grade: height or sub-floor;
Vertical core: strata or sub-floor; Horizontal core: sub-floor

PROFIT-DRIVEN VOLUMETRIC: Grade: height;
Vertical core: height; Horizontal core: height

VITALITY DRIVEN PLANAR: Grade: height or sub-floor
Vertical core: height or sub-floor; Horizontal core: --



By support structure   By strata

By floor   By sub-floor grain

FIGURE 14.09.16

PRICE TIER MIX SUB-STRATA GRAIN

DESCRIPTION: When a sub-floor price tier mix is selected, this parameter determines the number of voxels after which a new price tier is selected. This produces a grain finer than a mix of price tiers assigned by floor level.

SETTING: Setting a low value of 1 selects a new price tier every voxel, whereas setting a high value of 100 selects a new price tier every 100 voxels.

TYPE: integer   UNIT: voxels   RANGE: 1-100

ASSIGNMENTS:
Vitality-Driven Volumetric Value:
Grade: 100   Vertical core: 80   Horizontal core: 60
Profit-Driven Volumetric Value:
Grade: 80   Vertical core: 50   Horizontal core: 35
Vitality Driven Planar Value:
Grade: 100   Vertical core: 80   Horizontal core: 60

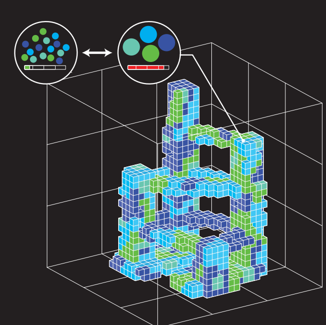


FIGURE 14.09.17

ROOF PROGRAM TYPES ENABLED

DESCRIPTION: Determines which programs can be assigned to the roofs of the building.

SETTING: Enabling pedestrian hardscape, pedestrian softscape, or exterior productive uses allows these programs to be assigned to empty voxels on top of constructed voxels.

TYPE: selection UNIT:-- RANGE: hardscape, softscape, production

VITALITY-DRIVEN VOLUMETRIC VALUE: Grade: hardscape, softscape, production; Vertical core: hardscape, softscape, production; Horizontal core: hardscape, softscape

PROFIT-DRIVEN VOLUMETRIC VALUE: Grade: hardscape, softscape, Vertical core: none, Horizontal core: hardscape, softscape

VITALITY DRIVEN PLANAR VALUE: Grade: hardscape, softscape, production; Vertical core: hardscape, softscape, production; Horizontal core: --

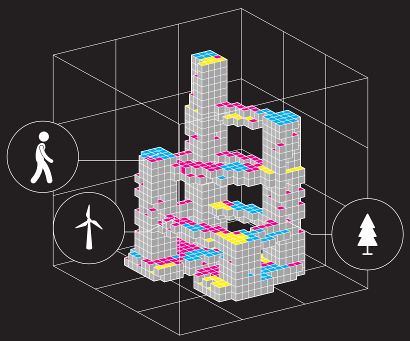


FIGURE 14.09.18

EXTERIOR PROGRAM USE MIX GRAIN

DESCRIPTION: Determines the number of voxels after which a new exterior program is selected.

SETTING: Setting a low value of 1 selects a new exterior program type every voxel, whereas setting a high value of 100 selects a new program every 100 voxels.

TYPE: integer UNIT: voxels RANGE: 1-100

ASSIGNMENTS:

Vitality-Driven Volumetric Value:

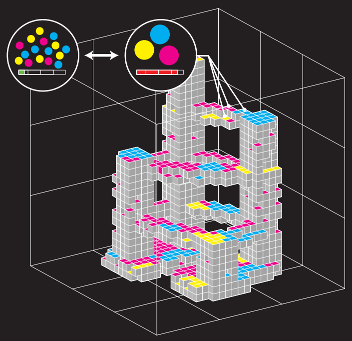
Grade: 120 Vertical core: 15 Horizontal core: 80

Profit-Driven Volumetric Value:

Grade: 120 Vertical core: 15 Horizontal core: 80

Vitality Driven Planar Value:

Grade: 120 Vertical core: 15 Horizontal core: 80



CHAPTER 15

THE PARAMETRIC DESIGN TOOL SIMULATES THE GROWTH OF THE CITY BY ALGORITHMICALLY REPLICATING THE STAGES OF DEVELOPMENT

With the operation of the parametric design tool detailed, the following descriptions illustrate how the parametric design tool works. This is principally accomplished with the simulation of the various stages of development repeated in continuous loop one building site at a time, progressively developing the city site-by-site.

15.01. Algorithm overview

15.02. Construction of the digital modeling environment

15.03. Global analysis

15.04. Site selection activity

15.05. Site analysis activity

15.06. Core location activity

15.07. Building massing activity

15.08. Repetition of the building cycle

15.01 ALGORITHM OVERVIEW

The specifications for the parametric tool require the program to be flexible, create a suitable level of realism, and to provide a sufficient amount of detail for analysis. So far, the establishment of the *terrain nominal* has defined the level of detail the program recognizes, and the user-operated parameters have given the program its flexibility by allowing control over the generative algorithm. Next, the level of realism will be established by outlining how the generative algorithm operates. Once the user sets the on-screen parameters to the desired settings for the given scenario, the program performs a series of recursive operations on the building fabric which replicate the process of building development in the city.

A high-level overview of the major processes of the generative algorithm is drawn as an activity diagram in Unified Modeling Language (Figure 15.01.a) using the notation defined in Martin Fowler's *UML Distilled*.[1] Once the user has initiated the simulation (step 1), the following activities are initialized sequentially: (2) the entire modeling environment is analyzed; (3) a site is chosen based on this analysis and existing construction demolished; (4) the site is analyzed for its local qualities and needs; (5) the building cores are located; (6) the massing of the building constructed; and (7) the process is repeated until the algorithm is stopped. Each of these major steps will be explored in greater detail later in the chapter.

The replication of these physical processes in building development as steps of the algorithm is necessary to provide a reasonable depiction of the sequential progress of construction in the city and also provides a useful hierarchy in the parametric design. In the city, development occurs at many building sites simultaneously, working at different paces and stages, but here this process is reduced to a linear process in order to simplify the operations of the program and to give the development in progress a static urban fabric to reference and respond to.

1 Martin Fowler, *UML Distilled: A Brief Guide To The Standard Object Modeling Language* (Boston: Addison-Wesley Professional, 2004) 118-129.

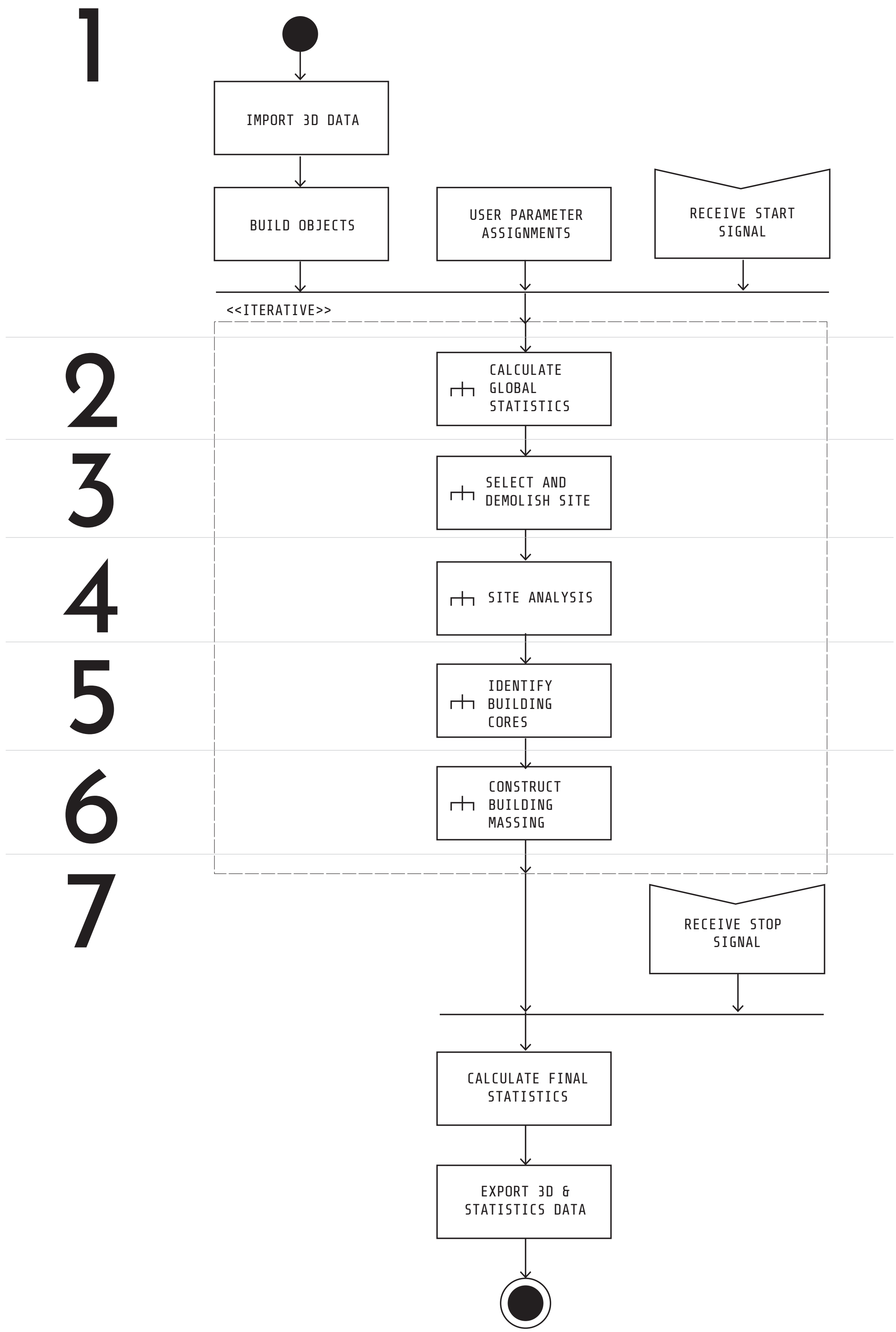
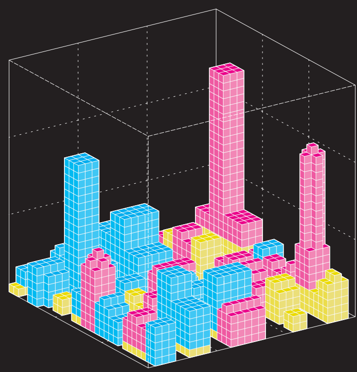
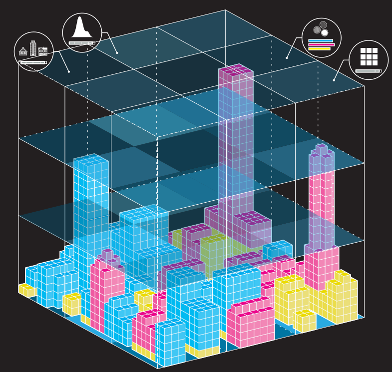


Figure 15.01.a: Top-level Unified Modelling Language Activity Diagram of high-level program operations.

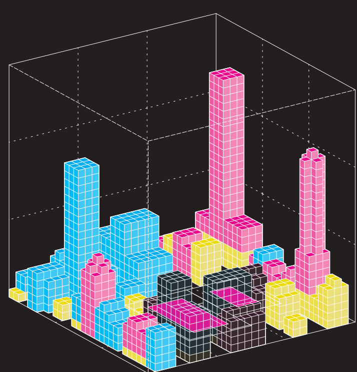
FIGURE 15.01.b: Algorithm overview steps



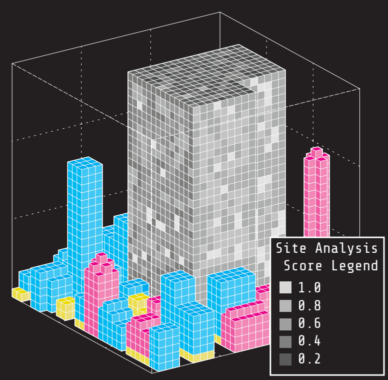
1. CONSTRUCT DIGITAL BUILDING ENVIRONMENT
Before the generative process begins the parametric environment and existing city fabric must be established. This step constructs the building blocks that will represent the buildings, lots, and circulation that make up the city.



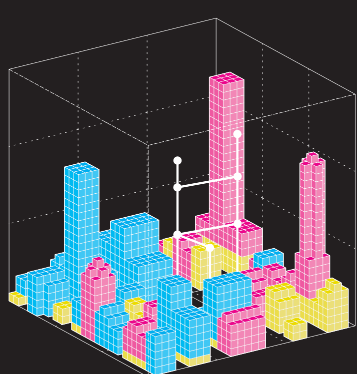
2. GLOBAL STATISTICS CALCULATION
The system calculates a set of a statistics for the entire modeling environment, including counting the number of objects in the model, and calculating performance scores for each quadrant.



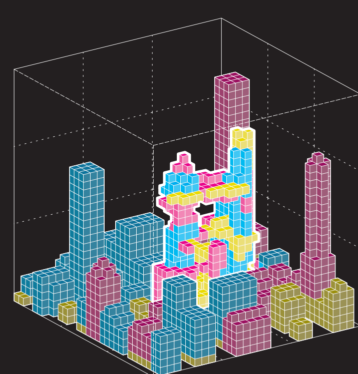
3. SELECT AND DEMOLISH BUILDING SITE
A building site is selected based on the quadrant scores, surrounding lots are amalgamated based on the density and age of buildings they contain, and the buildings on the combined building site are demolished.



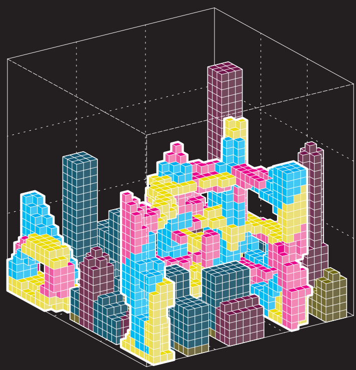
4. SITE ANALYSIS
The site analysis subactivity scores each voxel within the bounds of the site based on six criteria pertaining to external influences of the surrounding building fabric on the current development.



5. LOCATE BUILDING CORES
This step uses the site analysis scores and the user-inputted core parameters to identify the main structure and circulation routes for the building.



6. CONSTRUCT BUILDING MASSING
The massing of the building is determined based on the relation of the site analysis scores, the location of the building cores, the behaviour of each type of program, and the relation to surrounding program.



7. REPEAT 2-6 UNTIL STOP SIGNAL
The building process begins again from the global analysis, beginning the next development. After the desired number of cycles has passed, the generative process can be stopped and the statistics and massing of the city at key intervals exported.

15.02 CONSTRUCTION OF THE DIGITAL MODELING ENVIRONMENT

The modeling environment is the virtual space in which all objects and operations of the growth simulation will take place. The bounds of this environment are determined by a "master grid," which is a three-dimensional array of empty voxel placeholders. In order to run the algorithm in an existing context, a 3D model of the existing site must be loaded into the empty grid. Before this model can be loaded into the parametric design tool, the data must be processed from an existing site model into a set of data points with assignable properties that can be read by the parametric design tool. This is accomplished through the following steps:

1. *Begin with a 3D model*: the geometry of the buildings on the site is acquired from the official City of Toronto data archives and loaded into Rhinoceros 5.0
2. *Convert geometry to closed polysurfaces:* buildings are processed or remodeled accordingly to create closed objects for all buildings
3. *Classify by program type, age, and parcels:* the buildings will be categorized by program type, age, and historic or landmark status and loaded into the environment separately so that these properties can inform the design
4. *Create a 3D grid of point objects:* a grid of points is created covering the entire bounds of the site at 7m intervals
5. *Isolate enclosed points:* the Grasshopper plugin is used to preserve only the points that are contained within the building polysurfaces
6. *Export points as a coordinate list:* a second grasshopper script is used to translate the coordinates of the points to a text file that can be read by Processing

Now that the existing building fabric geometry has been processed, it can be imported into the parametric design tool and mapped to the grid of the modeling environment.

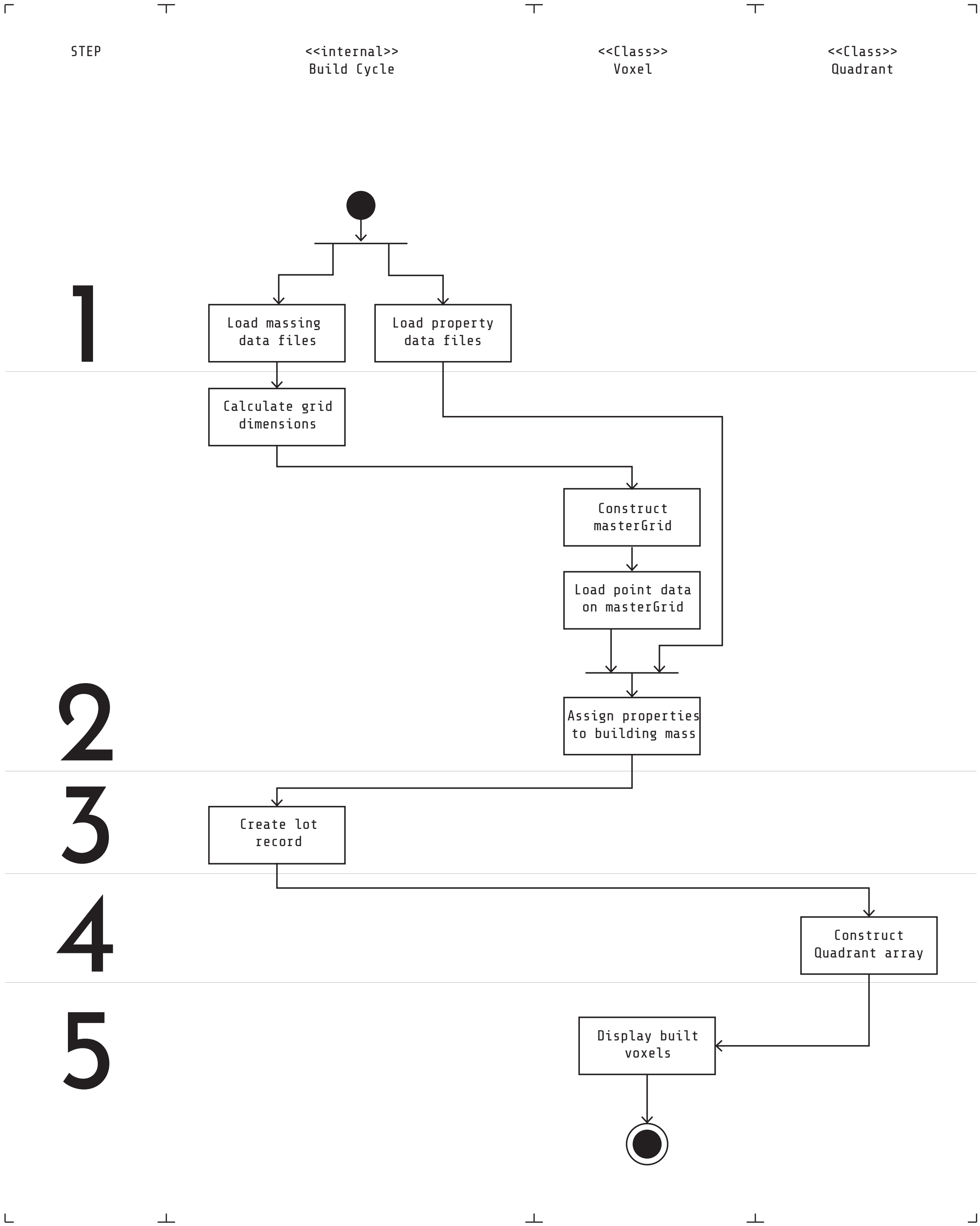


Figure 15.02.a: UML subactivity diagram illustrating the logic process of importing coordinate point data into Processing's 3D environment as voxel objects.

The test site selected to run the scenarios is a 1km x 1km stretch of downtown Toronto between College Street and Queen Street West, and Sherbourne Street and Bay Street. This location was chosen for several reasons that make it an ideal location to test volumetric architecture. First, the site's current vitality from its central location, famous tourist attractions, and high-density buildings provides the highest amount of intensity at the ground plane, meaning that introducing a building network here should have the least likelihood of desolating the street. Second, the site already has examples of volumetric architecture with the multi-level interior street-scape of the Eaton Centre, the sky-bridges at Ryerson University's campus and St. Michael's Hospital, and the adjacent PATH network which connects to the Eaton Centre's lower levels. The mix of high and low density provides both context for high-rise buildings with opportunity for development, as well as existing diversity of older neighbourhoods that should be preserved. The site already has many proposals for high-density towers, including a new sky-bridge development complex proposed by Quadrangle Architects at Yonge and Gerrard. Finally, the significant landmarks including the Old City Hall, Massey Hall, Ed Mirvish Theatre, St. Michael's Basilica, Metropolitan United Church, and Allan Gardens, provide a variety of obstacles to development that make developing the entirety of the site impossible and a continuous building network more difficult. (Figure 15.02.b)

The model of the site imported into the parametric design tool has several different data layers in addition to the massing that can be referenced by the generative algorithm including: programmatic use, building age, building parcel, building core by network and degree of publicness, building density, historic buildings, landmark buildings, degree of publicness, and price tier (Figure 15.02.c).

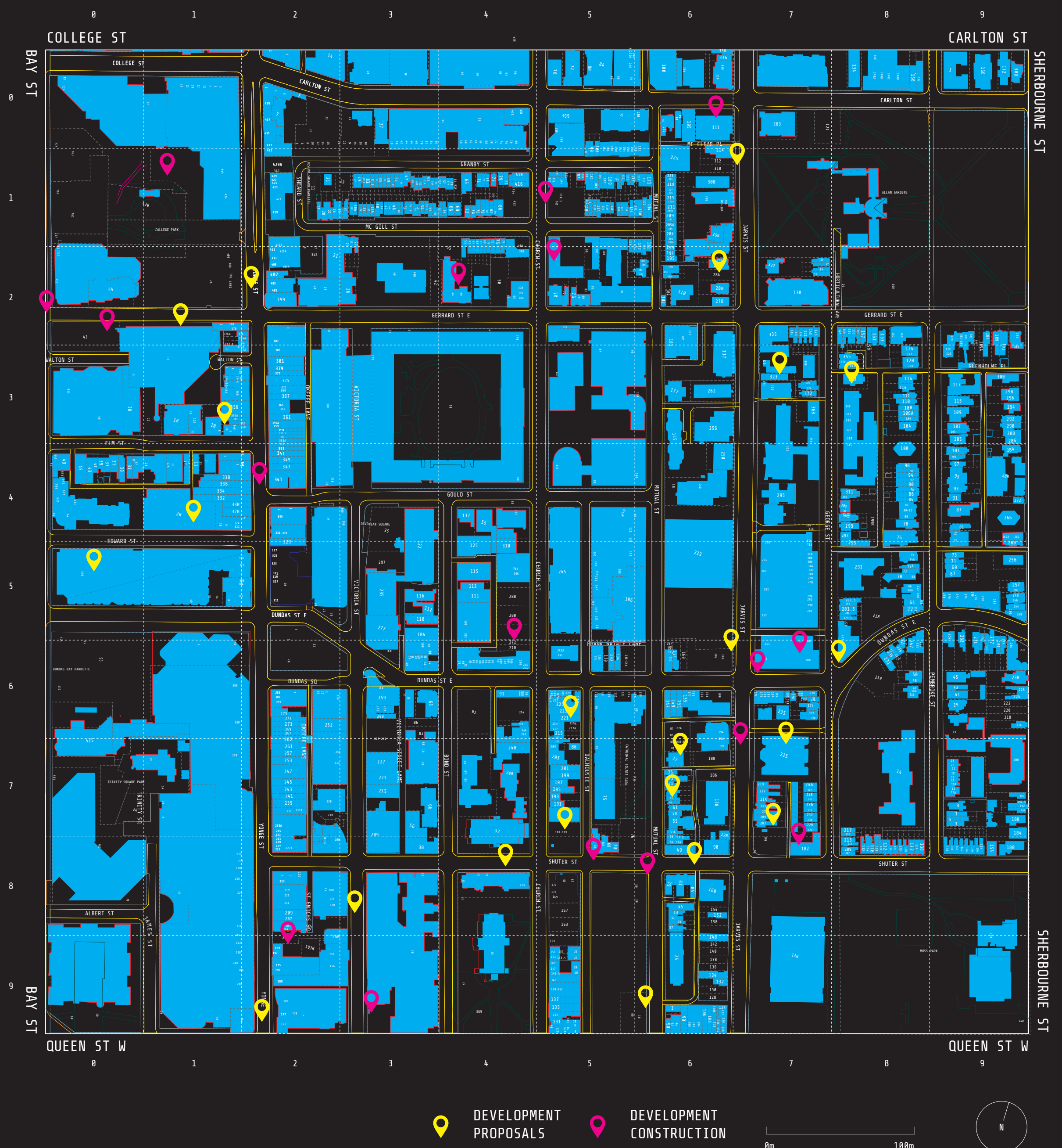
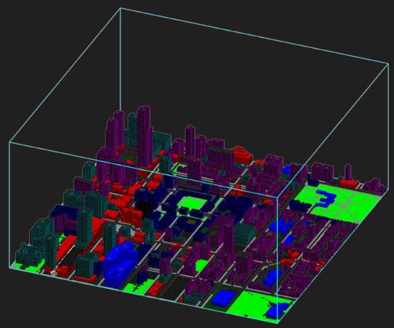
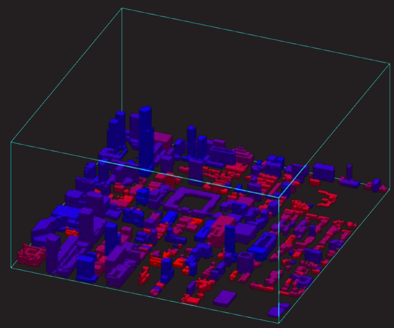


Figure 15.02.b: Site plan of 1 km² test location in Toronto highlighting upcoming developments.

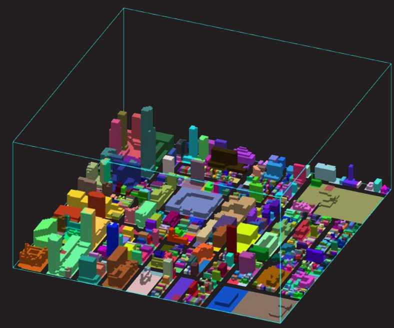
Figure 15.02.c:Data layers of the site model imported into the parametric design tool



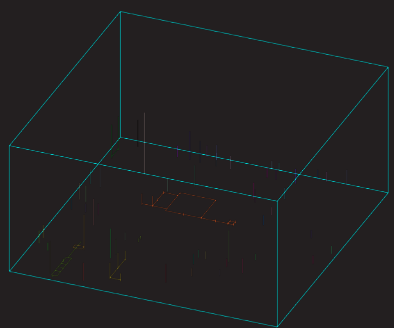
Programmatic use



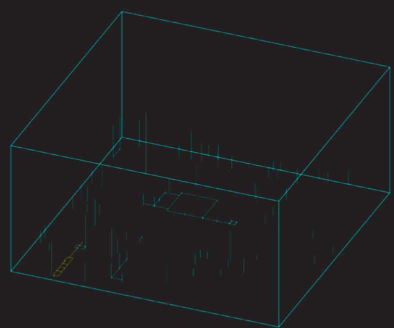
Building age



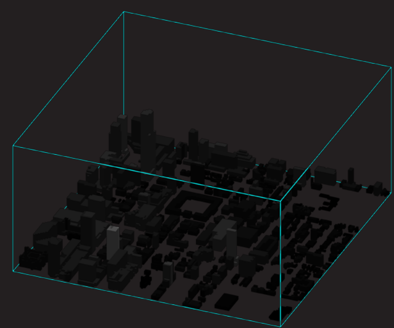
Building parcel



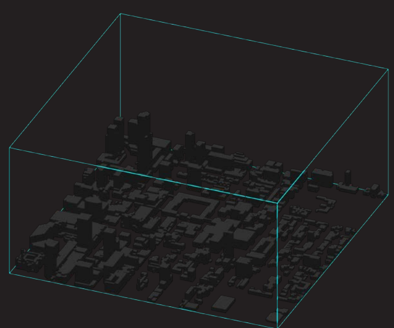
Building core by network



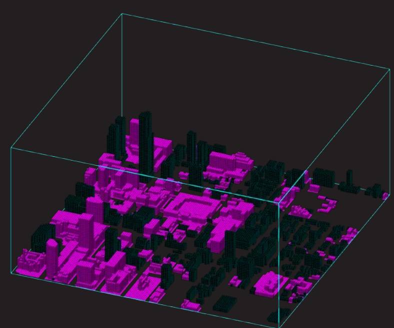
Building core by amount of public access



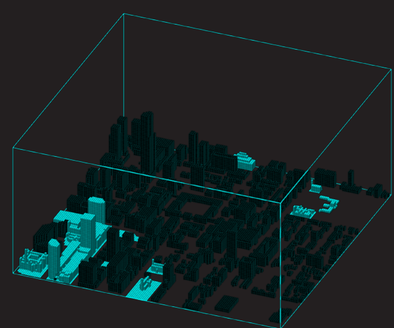
Building density



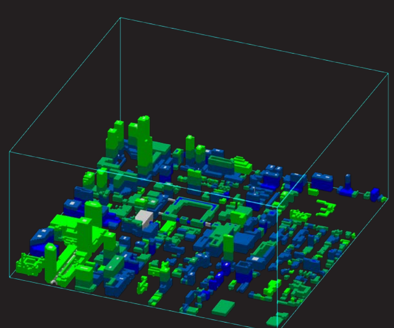
Buildings generated by the simulation



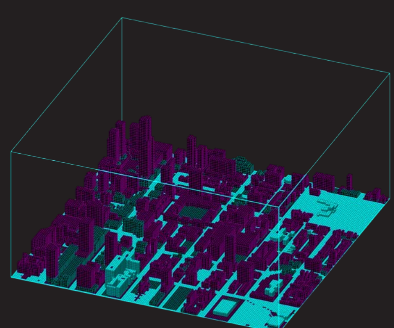
Historic buildings



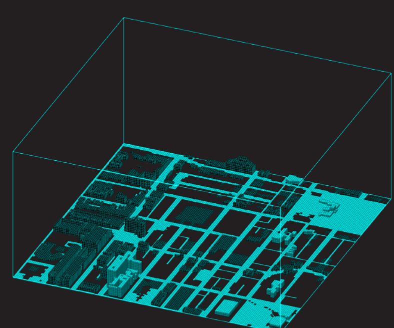
Landmark buildings



Price tier of saleable floor area

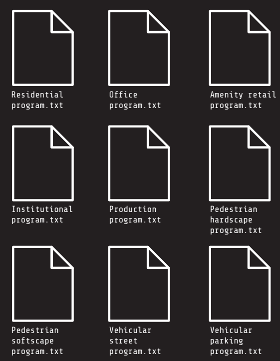


Private vs public

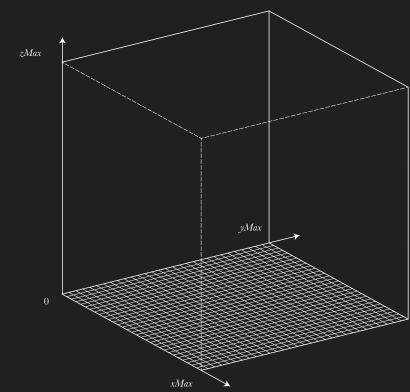


Public realm

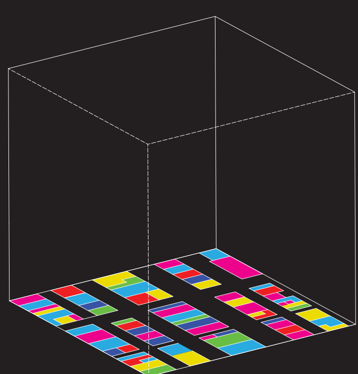
FIGURE 15.02.d: Construction of the digital modeling environment steps



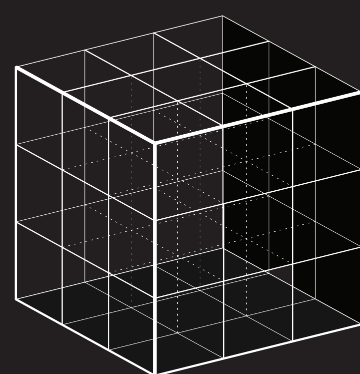
1. LOAD COORDINATE DATA FILES
Coordinate text files are loaded into a new String array for each program type, building age, landmark or historic status, and lot. The text strings are then converted into a list of integers that will later be used to construct the building massing.



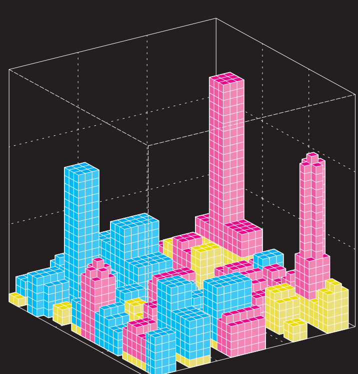
2. DIVIDE THE ENVIRONMENT INTO A 3D GRID OF VOXELS
The test site is divided into a three-dimensional grid of voxels at 7m increments that can be set as either “occupied” if there is building massing at the location, or “unoccupied” if not. Even voxels that are unoccupied can store data.



3. CREATE A RECORD OF ALL THE PARCELS IN THE ENVIRONMENT
Parcel data is loaded by grid location and used to create a new list of the lots in the test site, each with a list of all the voxels it contains.



4. SUBDIVIDE THE ENVIRONMENT INTO QUADRANTS
The test site is subdivided into quadrants that detect localized information about the urban fabric without needing to query all of the surrounding voxels each time information is requested.



5. CONSTRUCT EXISTING BUILDING MASSING
The building massing data loaded as coordinates is constructed in the environment by changing the properties of the selected voxels to “occupied,” and assigning the program type, building age, and historic or landmark status to the voxels.

15.03 GLOBAL ANALYSIS

Although the existing building massing is loaded into the modeling environment, not much is yet known about the composition of the urban fabric or its characteristics of vitality and development potential. In order to begin interacting with the building fabric, it is, therefore, necessary to analyze the geometry and make judgments about its composition.

The first calculations are simple records of the number of objects in the environment: the number of voxels built in the entire site, number of each voxel in each quadrant by program type and price tier, FAR calculations by lot, and the number of building cores of each type. These statistics are referenced by various operations later in the program and help determine target geometry and provide feedback about the composition and performance of the model.

The second set of calculations is a scoring of each quadrant such that the algorithm can respond to specific needs arising due to the local conditions at a specific building site. Each quadrant is scored for Jacobs' four generators of diversity, price mix, and public level distribution, and these scores are combined into an overall vitality score. Quadrants are also scored for development potential based on the age of the buildings, historic or landmark status, and the amount of vacant space. Using these summary statistics, specific areas within the test site can be selected based on their composition, or referenced by other processes, in order to respond without continually querying all voxels in the model. These scores will also be a significant method of tracking the performance of the scenarios.

The third set of calculations responds to the vitality scores by evaluating the model for areas at risk of vacancy, or what Jacobs calls *forces of decline and regeneration*.[1] These calculations account for the fact that the city is not only built up, but also wears down as areas are neglected, devalue, or are vacated. This process is simulated based on Jacobs' analysis which describes how: initially secondary uses become vacated when generators for diversity in an area are low and create little frequent pedestrian

1 Jacobs, *The Death and Life*, 242.

Note: Since Jacobs' attributes primary use vacancy as the result of a loss of secondary uses over time, primary use vacancy is calculated first such that the secondary use vacancy that occurs within a given building cycle affects the next building cycle instead of the current one, therefore, not causing further primary use vacancy within the same cycle.

street traffic to support secondary uses;[2] and next, primary uses become vacated as secondary uses leave an area, making the area less favourable to inhabit.[3] Using these criteria, voxels are assigned a vacancy-risk property when the diversity scores fall below a user-specified threshold. This vacancy-risk can either be interpreted literally, as tenants closing or moving to a new location; or metaphorically, as an indication that the performance of the neighbourhood has decreased enough to cause an inferior quality of life for its inhabitants. The calculation of vacancy prone areas indicates which areas of the model are performing the poorest for Jacobs criteria throughout three-dimensional space, and also allows the generative algorithm to respond to this condition.

Once all of these calculations have been performed, the parametric tool is now aware of the different properties, performance, and composition of the building fabric, and the process of building construction can begin.

2 Ibid., 245.
3 Ibid.

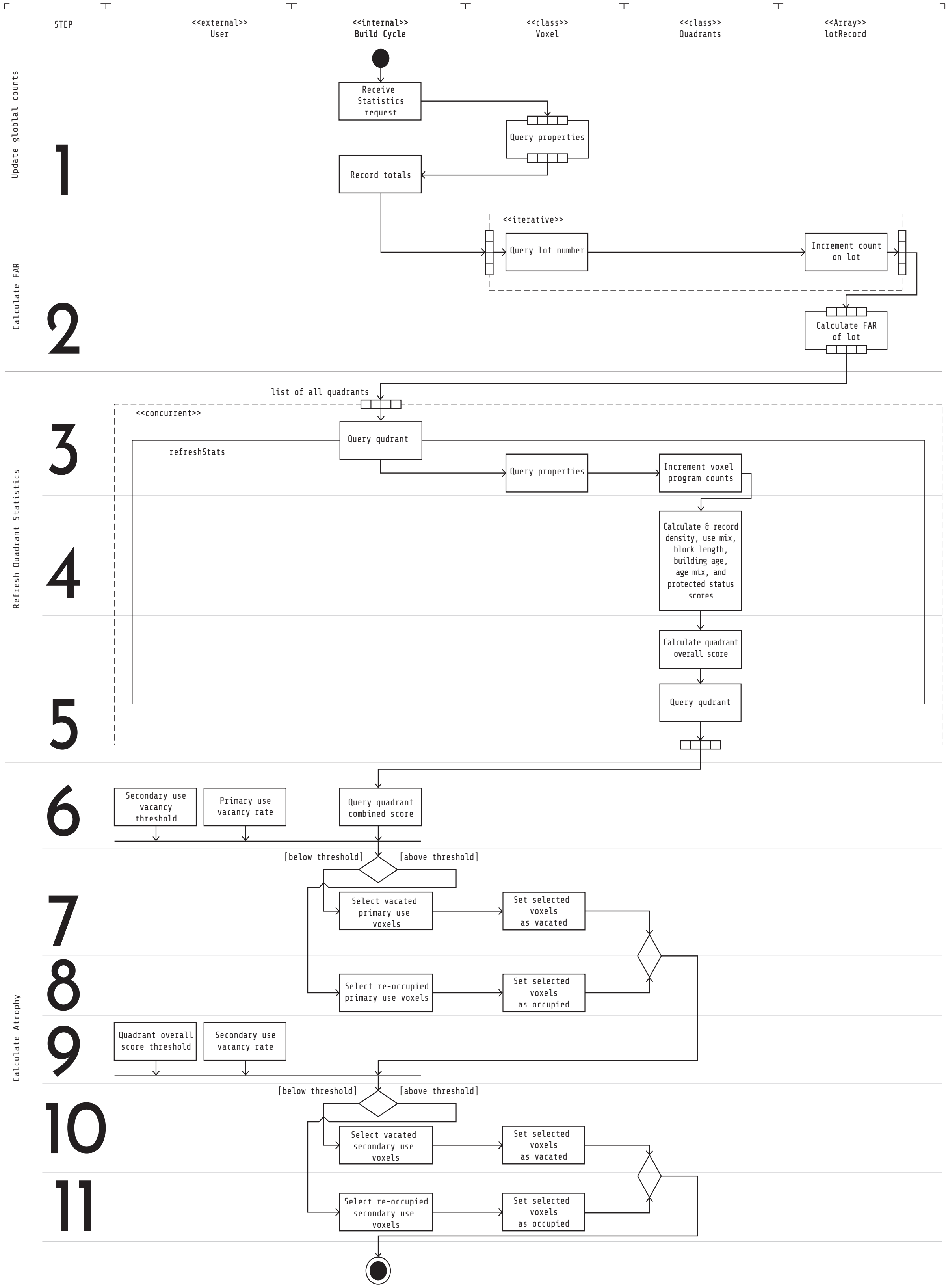
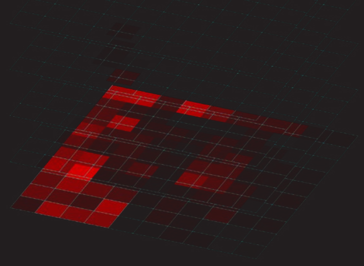
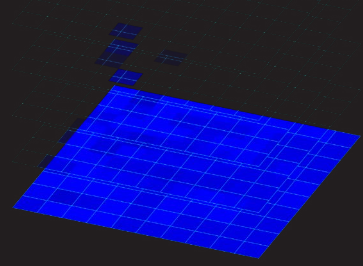


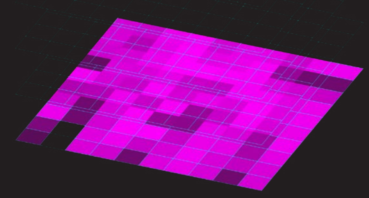
Figure 15.03.a: UML subactivity diagram indicating the global analysis process through which the objects in the environment are counted, quadrants are scored, and building vacancy determined.



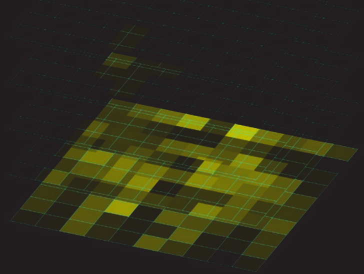
Density Score



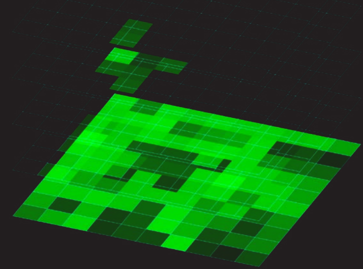
Connectivity Score



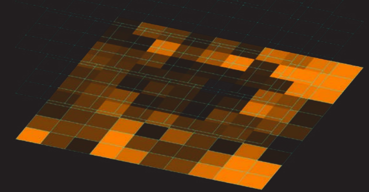
Mix of Price Tiers Score



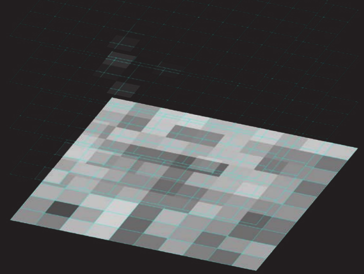
Age Mix Score



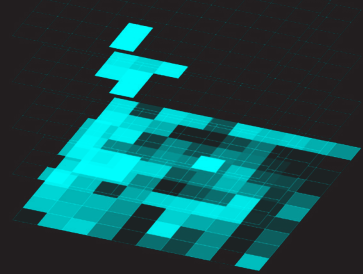
Programmatic Use Mix Score



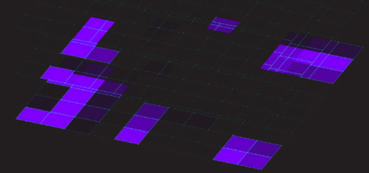
Public Accessibility Score



Overall Performance Score



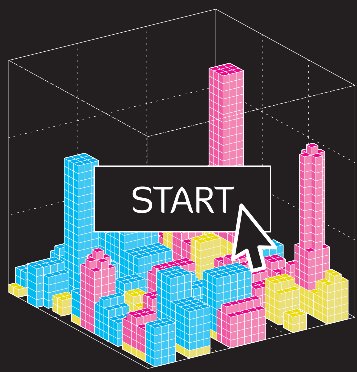
Building Age Score



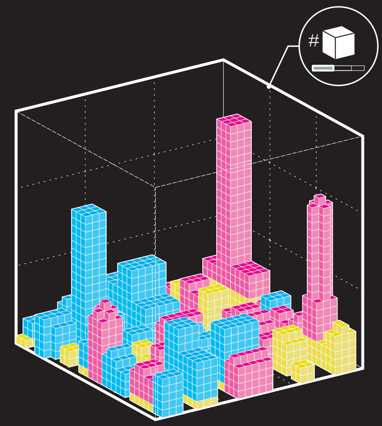
Protected Status Score

Figure 15.02.b: Initial vitality scores show how the building fabric is performing for Jane Jacobs' criteria for vitality throughout three-dimensional space before the model has been modified

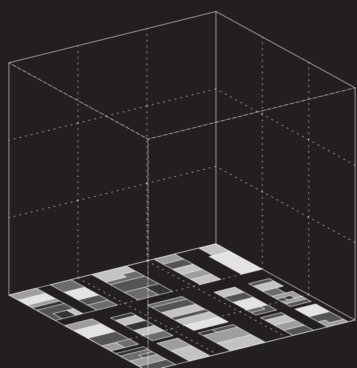
FIGURE 15.03.c: Global analysis steps



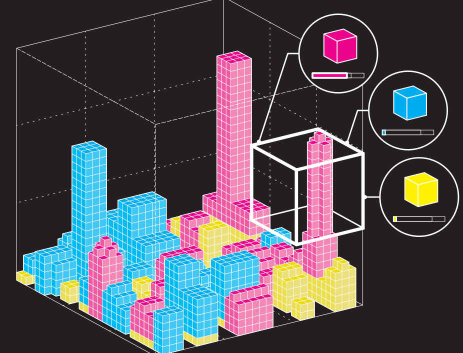
1. RECEIVE START COMMAND
The “START” button on the Run Controls window initiates the building process by allowing the generative algorithm to run. The algorithm will run recursively until it is stopped by the user or at a set interval.



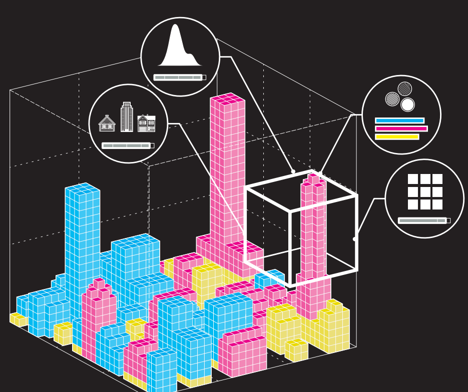
2. UPDATE GLOBAL VOXEL COUNTS
The total number of built voxels constructed in the environment is calculated by querying the entire extents of the grid.



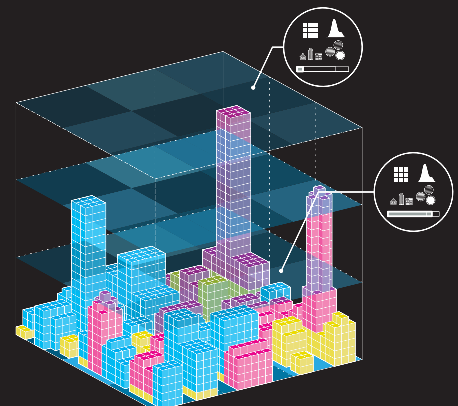
3. CALCULATE LOT FLOOR AREA RATIO
The floor area ratios (FAR) of all properties are calculated. Each lot is queried for the number of voxels on the site, and the FAR recorded as the ratio of the building’s total built floor area to the area of the property.



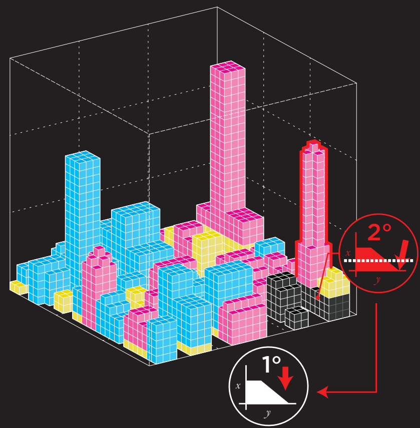
4. COUNT VOXELS BY PROPERTIES IN QUADRANTS
Each quadrant is queried for the built voxels that it contains of each program type and sub-type, creating a localized record of the quadrant’s composition by amount and use of building program, price tier, and other criteria.



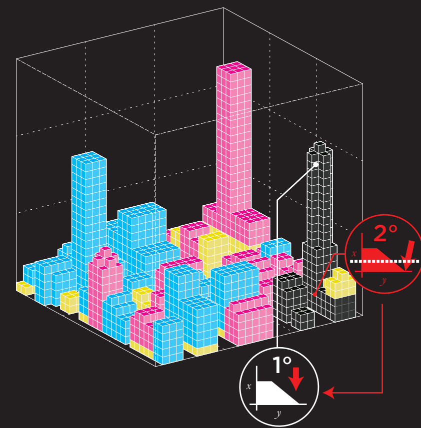
5. CALCULATE QUADRANT SCORES
Scores based on Jacobs’ four generators for diversity (density, primary use mix, building age mix, and short blocks) are calculated for each quadrant based on its composition of program, price tiers, and ages; and historic or landmark status.



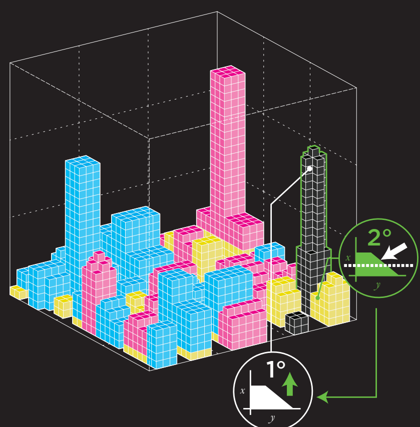
6. CALCULATE COMBINED QUADRANT SCORES
The performance scores are combined to provide an average score of the performance of the quadrant’s built fabric in terms of diversity.



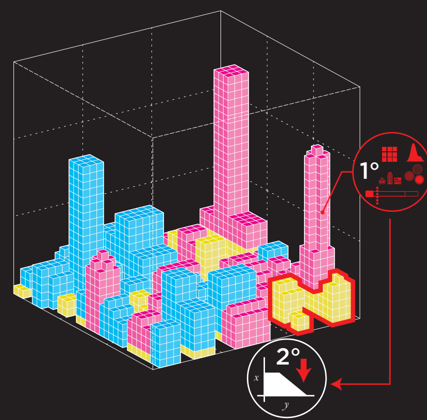
7. CALCULATE PRIMARY USE VACANCY
If the surrounding secondary uses become increasingly assessed as vacant, it will eventually pass below the user-defined threshold, triggering the vacancy of primary use at the rate specified in the parameters window.



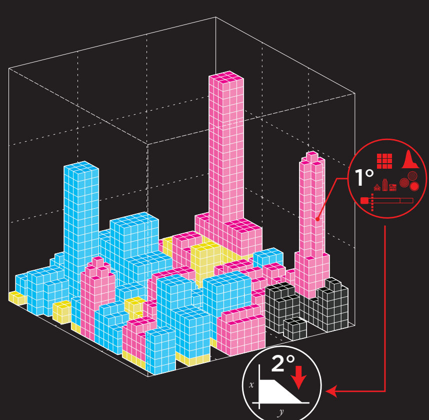
8. SET PRIMARY USE VOXELS AS VACANT
The number of voxels determined by the primary use vacancy rate are changed to the state of "vacant."



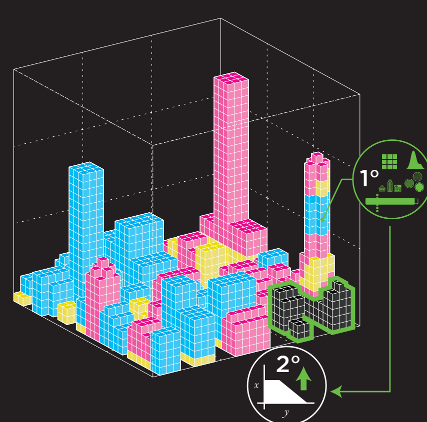
9. PRIMARY USE RECOVERY
If the number of vacant secondary use voxels passes above the specified threshold (due to secondary use recovery from added diversity), primary use recovery begins, and the "vacant" assignment is removed from voxels.



10. CALCULATE SECONDARY USE VOXEL VACANCY
The vacancy of secondary use is determined by the quadrant performance scores. If the combined score of a quadrant falls below the user-defined threshold, vacancy of secondary use occurs at the rate specified by the secondary use vacancy rate.



11. SET SECONDARY USE VOXELS AS VACANT
The number of secondary use voxels specified by the secondary use vacancy rate are changed to the state of "vacant."



12. SECONDARY USE RECOVERY
If the combined quadrant performance scores pass above the threshold due to a new development creating diversity in the area, the secondary use becomes re-occupied and the "vacant" assignment is removed from the relevant voxels.

15.04 SITE SELECTION ACTIVITY

The site selection activity is the process in which the next building site is selected and cleared within the digital environment. In practice, this process is a complex combination of market conditions, desirability, and zoning involving many actors including: business owners, developers, architects, planners, the city, residents, investors, and the client. However, for the purposes of the simulation, this will be reduced to the selection of a quadrant, by either a vitality-driven or profit-driven site selection equation, followed by the selection of parcels to be combined into together within proximity to the quadrant.

The profit-driven site selection equation represents the most common real-world conditions, in which the developer has agency to select a specific site that provides suitable conditions for construction, within the constraints of the zoning plan. Since development predominantly seeks out high-demand areas with low-density or older construction,[1] this is replicated by targeting quadrants with high vitality scores and high development potential scores. The vitality-driven site selection equation models Jacobs' concept of *competitive diversion,* in which sites are selected beginning first with areas that have a low amount of generators for diversity.[2] This is represented by targeting quadrants with low vitality scores, in addition to high development potential scores.

Once a quadrant has been selected, parcels can be selected within proximity to the quadrant. Since the volumetric city makes it possible for buildings to connect even across streets, the potential for a development to span multiple discontinuous parcels will be accommodated for. This is accomplished by first selecting a parcel within the quadrant with a combination of the lowest density and highest age that isn't a protected building site, and then allowing the selection of additional parcels within a search radius. Parcels can be added based on a range of criteria, including whether or not they are continuous, whether or not they are across a street, a maximum density threshold, a minimum age threshold, and their protected status. Once all the lots have been selected, they are combined into one new parcel with a new lot number, and their contents are cleared to prepare for construction.

1 Ibid., 252.
2 Ibid., 176.

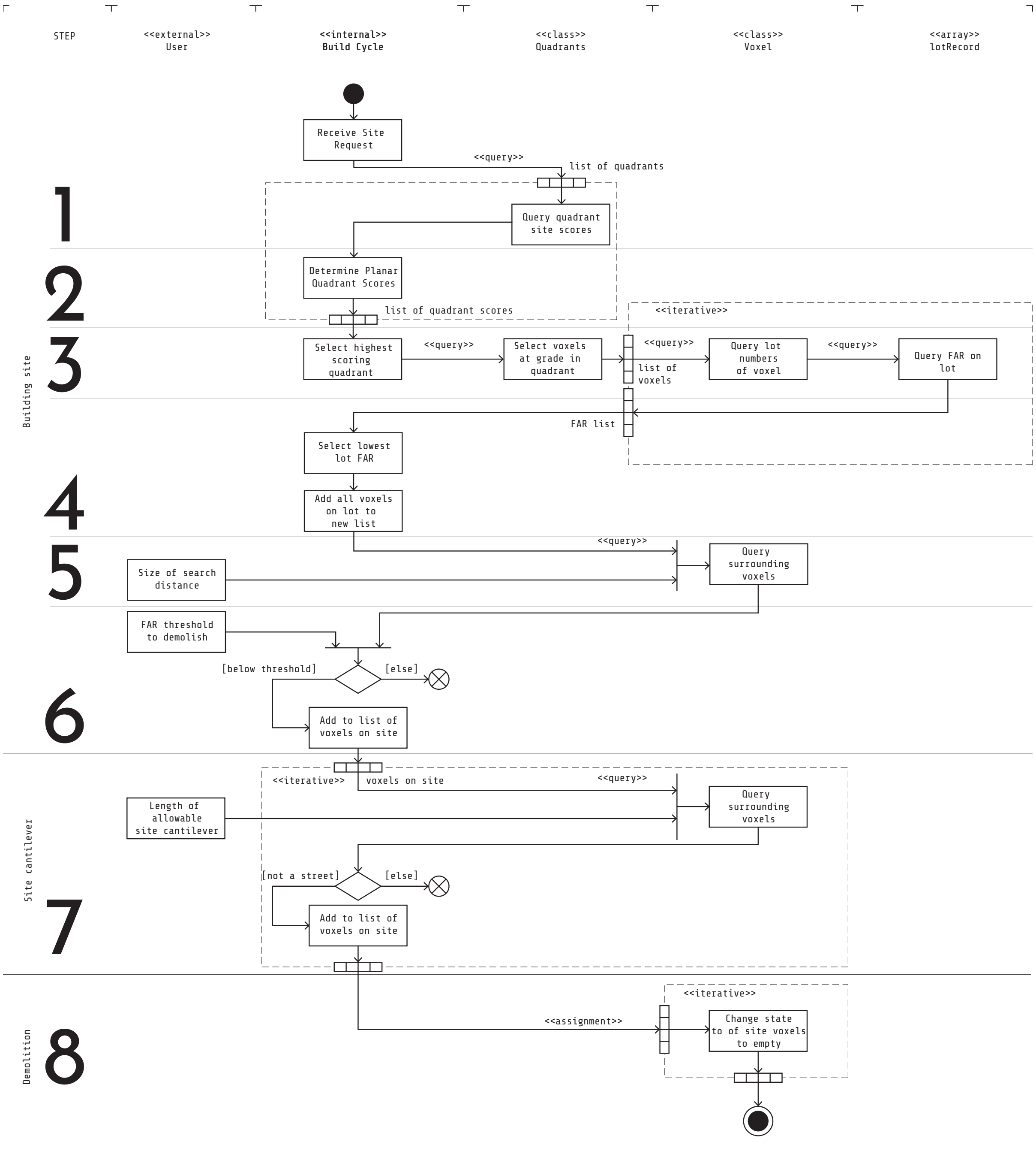
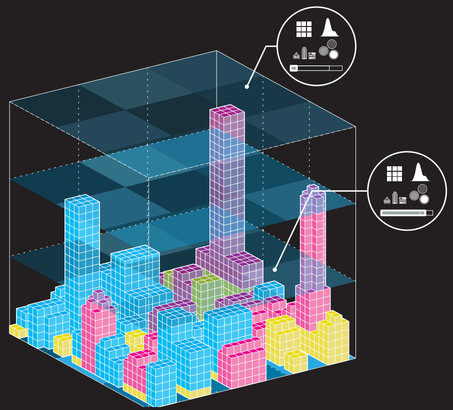
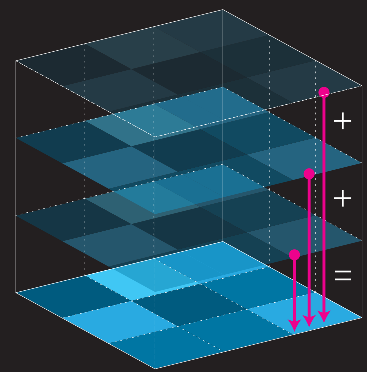


Figure 15.04.a: UML subactivity diagram illustrating the decision process of the site selection: selecting a qudrant, a parcel within the quadrant, amalgamating relevant surrounding parcels, and demolishing the built contents of the amalgamated lot.

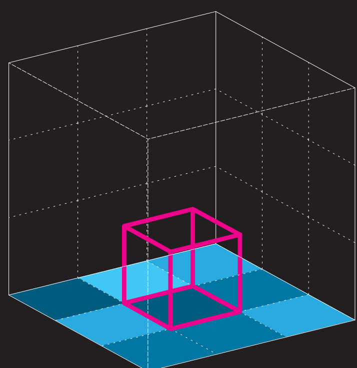
FIGURE 15.04.b: Site selection activity steps



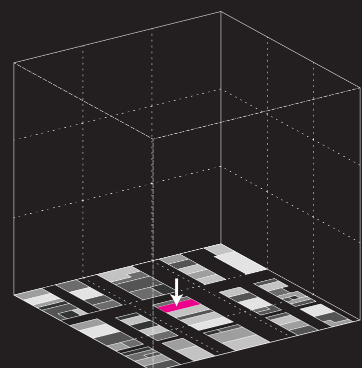
1. COMBINE WEIGHTED QUADRANT SCORES TO DETERMINE SITE SELECTION SCORE
A site selection score is made for each quadrant derived from the quadrant scores calculated in the previous stage using either a vitality-driven or a profit-driven equation.



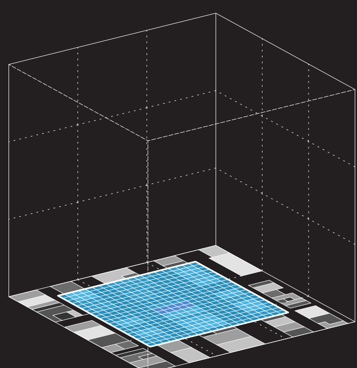
2. CALCULATE AVERAGE PLANAR SITE SELECTION SCORE
Since parcels are determined by the 2D ground plane, the scores of vertically stacked quadrants are averaged to create a 2D quadrant map of site selection scores representing the likelihood of site selection.



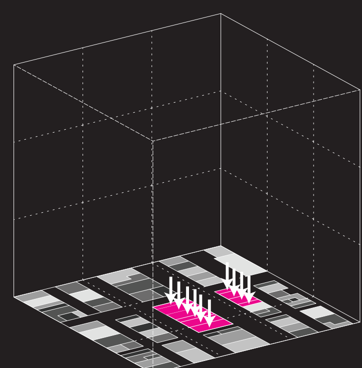
3. SELECT QUADRANT
The quadrant with the highest site selection score in the quadrant plane is selected as the most opportune site to develop based on the evaluated criteria of either the profit-driven or vitality-driven equations.



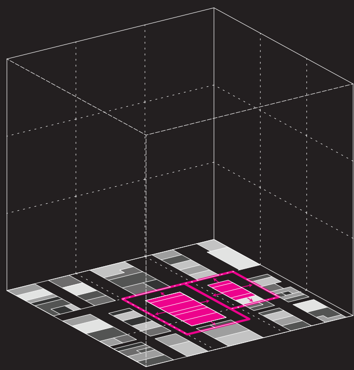
4. SELECT FIRST PARCEL
The first parcel of the site is located by selecting the property with the lowest FAR and the highest building age within the selected quadrant.



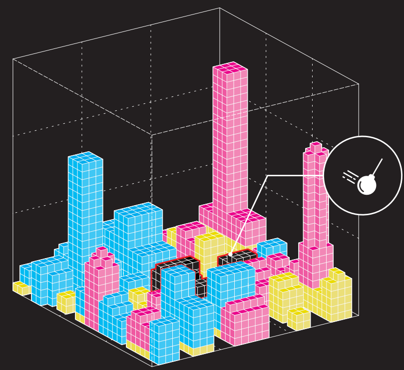
5. QUERY FOR POSSIBLE PARCELS TO COMBINE
A query radius is established the size of the “lot buffer” user-parameter. All parcels that fall within this search radius are queried for their FAR and building ages.



6. SELECT ADDITIONAL PARCELS
Parcels within the query radius that are below the FAR threshold and building age user-parameters are combined to create a larger parcel. Continuity of parcels and the ability for parcels to span streets are also considered.



7. ADD A CANTILEVER ZONE AROUND THE SITE
An “allowable cantilever” user-parameter allows the user to specify a distance around the site that can be cantilevered into to allow for increased density, alternative forms, and Jacobs’ suggestion of visual interruptions of the street grid.



8. DEMOLISH BUILDINGS ON SELECTED SITE
The voxels on the building site are set to the “unoccupied” state and their default properties restored, simulating the demolition of the existing buildings.

15.05 SITE ANALYSIS ACTIVITY

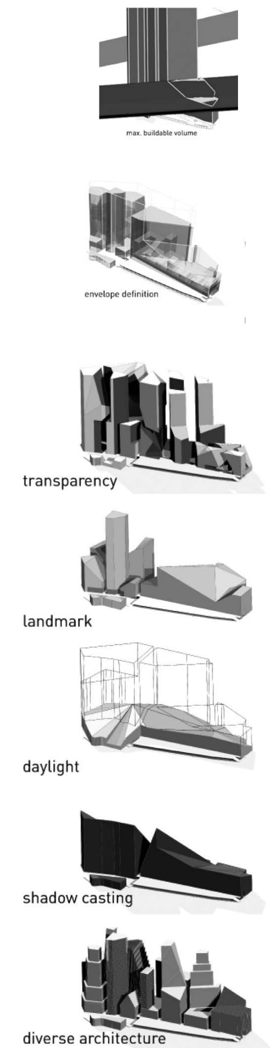


Figure 15.05.a: Layers of site criteria as character envelopes in the Kaisersrot proposal for Bishopsgate.

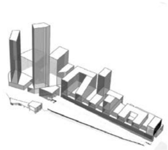


Figure 15.05.b: One permutation of the Bishopsgate proposal generated as the superimposition of site criteria character envelopes.

The site analysis process reflects the relationship between the surrounding urban fabric and each voxel within the bounds of the building site. By performing an analysis of all voxels within the site boundaries, the potentials of all available points in three-dimensional space are considered. Each point in space, because of its physical relationship with other pieces of the urban fabric and its relationship with existing regulations and proposed regulations, has its own properties, potentials, and characteristics—even when unbuilt. For example, the potential for each point to develop into the most opportune location for a specific type of program, or the ability to gain density in unexpected areas that don't shade other buildings or public spaces can be considered.

The strategy adopted to mediate the various factors which create this three-dimensional field of potentials is derived from the Kaisersrot Bishopsgate proposal, in which the external forces on the site are reflected as *character envelopes* (Figure 15.05.a). In the Bishopsgate proposal, these character envelopes are overlaid to create a building form proposal which is responsive to the surrounding urban fabric (Figure 15.05.b).[1] These superimposed character envelopes can be determined within the digital environment as performance regulations with greater precision than traditional rules such as set-backs and maximum buildings heights. A set of calculations for eight criteria is performed on each voxel in the entire boundary of the building site, including the allowable cantilever zone. These calculations are combined after applying a weighting factor to each character envelope score which controls the amount of influence the character envelope has. The final score of each voxel will be used to determine if the voxel will become occupied with programmed building massing or not.

1 Lehnerer, *Grand Urban Rules*, 255.

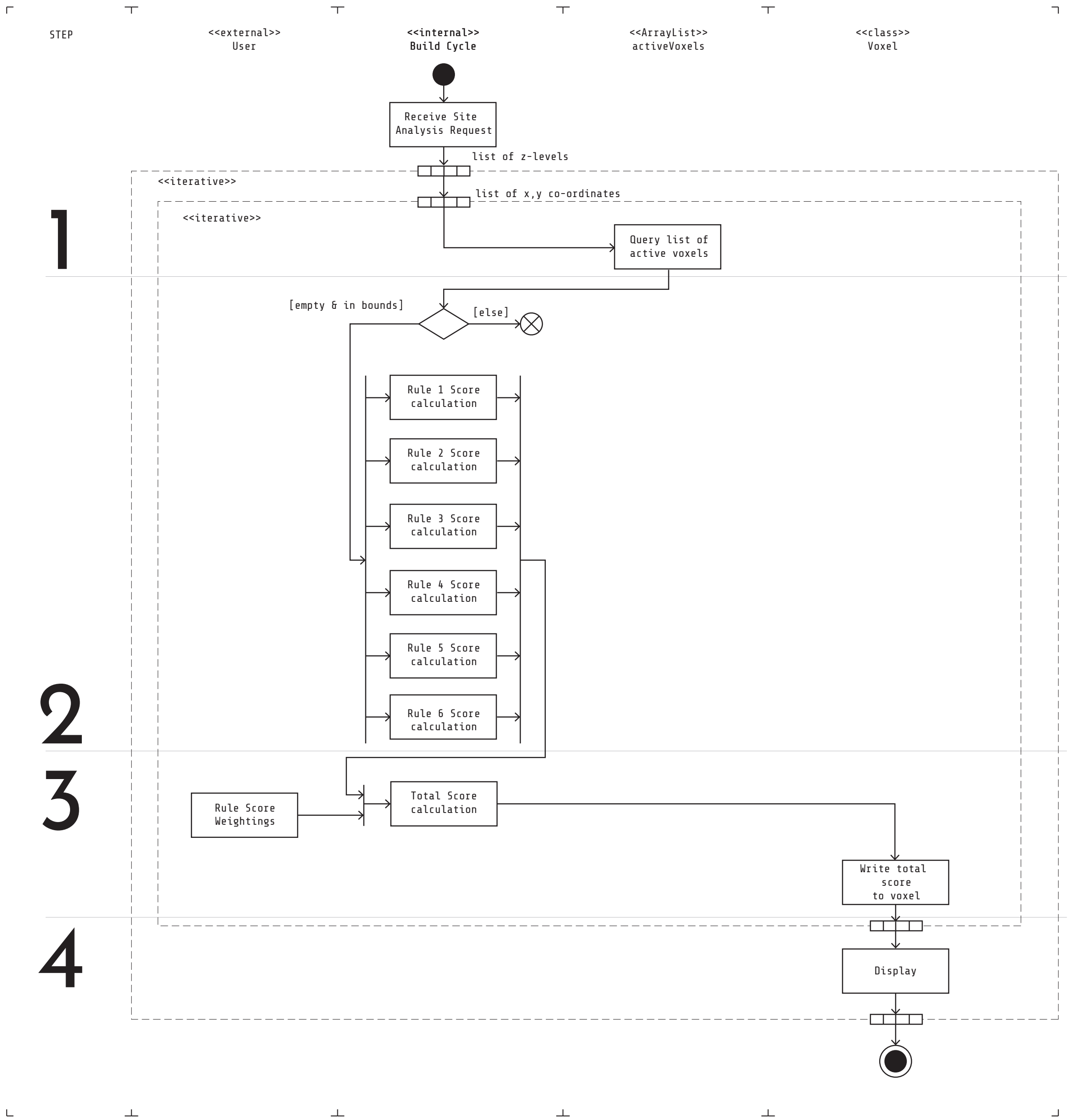
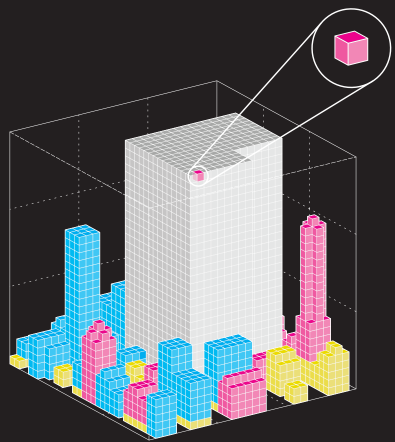


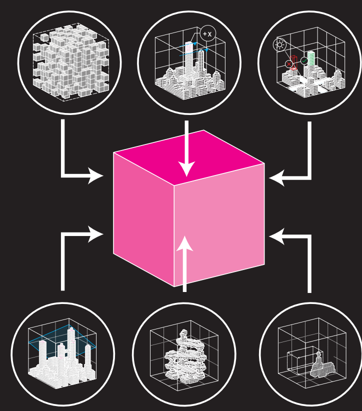
Figure 15.05.c: UML subactivity diagram illustrating the decision process of the site analysis activity: performing a scoring calculation for six criteria for each voxel within the site boundary.

FIGURE 15.05.d: Site analysis activity steps



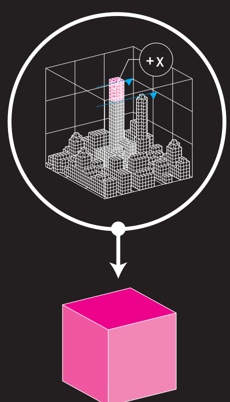
1. SELECT A VOXEL ON THE LIST OF BUILDING SITE VOXELS

The program first selects a voxel from the list of active voxels on the building site, which includes voxels at all z-locations within the site boundary, as well as within the allowable cantilever zone.



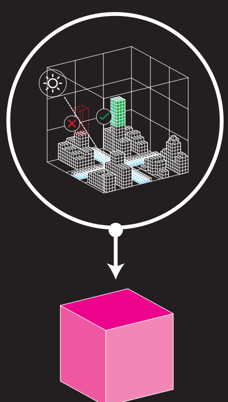
2. FOR EVERY VOXEL PERFORM EACH SCORING CALCULATION

Based on each voxel's specific location and relation to other voxels in the modeling environment, the voxel is scored for eight criteria that create six distinct character envelopes.



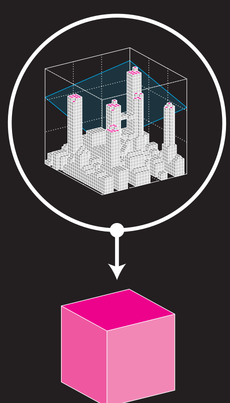
ENVELOPE 1: HEIGHT CATALYST

Scores the voxel high if there are other voxels built within the user-set search radius at the current height plus a user-set additional height. If there is no other construction at the height of the current voxel, the voxel is scored low.



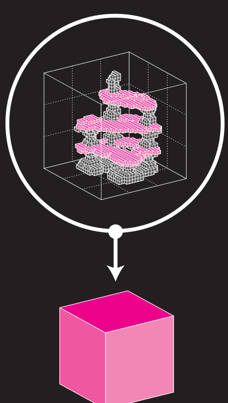
ENVELOPE 2: DAYLIGHT PUBLIC SPACE

Uses nine different sun trajectories. If the current voxel blocks sunlight to public space it is scored low, whereas if the current voxel has no interference with the sun because it is already shaded by other building massing, it is scored high.



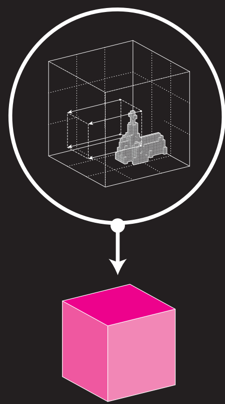
ENVELOPE 3: MAXIMUM HEIGHT

The maximum height score checks the current voxel against the maximum height allowed at the x-y location in the modeling environment and assigns a low score closer to the maximum z-height.

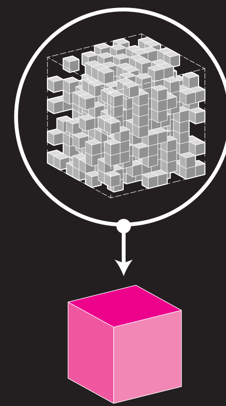


ENVELOPE 4: STRATA THICKENING

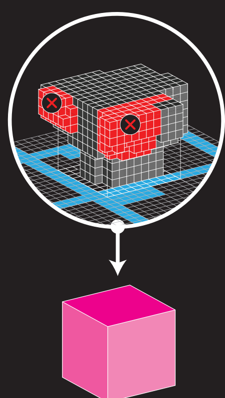
The strata thickening score gives the voxel a score based on its z-location in relation to the connection strata specified by the user. Voxels closer to the strata are scored higher, while voxels further from the strata are scored lower.



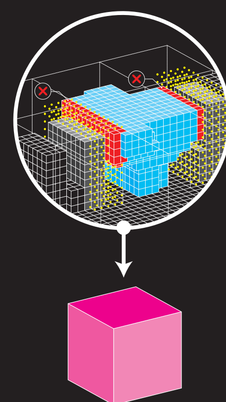
ENVELOPE 5: SIGHTLINES
The sightlines criterion checks the voxels against the geometry of key sightlines imported in the model. Voxels outside of the sightlines receive a full score, and voxels inside the sightlines receive a score of zero.



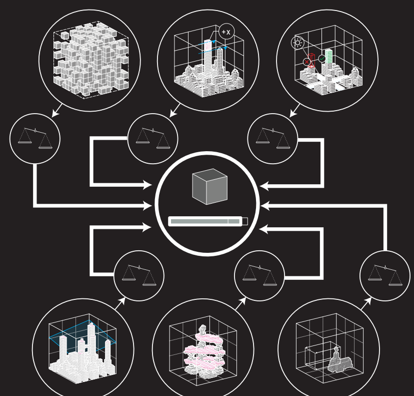
ENVELOPE 6: FACADE ARTICULATION
The facade articulation character envelope uses an adjustable Perlin noise generator to create subtle score differentiations between adjacent pixels, encouraging expressive facades.



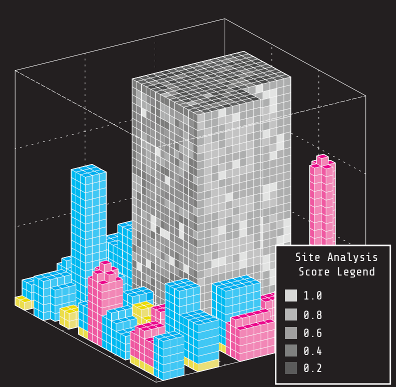
ENVELOPE 7: GRADE PROGRAM COVER REDUCTION
Used to reduce the likelihood that massing will be constructed directly over selectable public program types.



ENVELOPE 8: EXISTING BUILDING OFFSET
Used to reduce massing too close to existing buildings that can result from the cantilever zone.



3. APPLY SCORE WEIGHTING AND ASSIGN OVERALL SCORE
The scores of all 8 criteria are combined with their respective weightings assigned in the user-parameters and added together to create a combined site analysis score that reflects the likelihood of this particular voxel of being built.



4. REPEAT FOR ALL VOXELS TO DEFINE SITE ANALYSIS CHARACTER ENVELOPE
This process is repeated for every voxel in the list of active voxels on the building site, calculating a score for each scoring variable and recording the results.

15.06 CORE LOCATION ACTIVITY

Building cores work by efficiently combining the primary structure, circulation, and service-ways of tall buildings into a single element. The efficiency of this combination makes the core ubiquitous in tall buildings throughout the world. The amalgamation of these vital building functions makes building cores highly influential on the building design by restricting the form to floor plates which maximize the usable floor area within the allowable floor depth, repeated along a vertical axis. Therefore, defining the location and height of building cores and the allowable floor plate depth will determine which voxels are supported by this structure, adding another character envelope on the site.

Horizontal inter-building connections create pedestrian connections between buildings and require integration into the structural and circulation systems of the building. Inter-building connections would, therefore, be best planned simultaneously with the vertical core system in order to design the vertical cores to take the necessary loads and make the required circulation connections. This integration with vertical cores, combined with the major circulation and structural functions of inter-building connections, makes them essentially a horizontal version of the core system, and therefore the parametric tool will be designed to treat inter-building connections as horizontal core objects constructed between vertical cores. Due to their role in circulation, the design of this integrated vertical and horizontal core system influences not only the building massing, but also defines the three-dimensional building network throughout the city. A more complex version of the core location operations would allow for diagonal cores such as those indicated in OMA's Hyperbuilding; however, since vertical cores are still substantially more economical to build, the parametric design uses this opportunity to simplify the building network to either vertical or horizontal cores only.

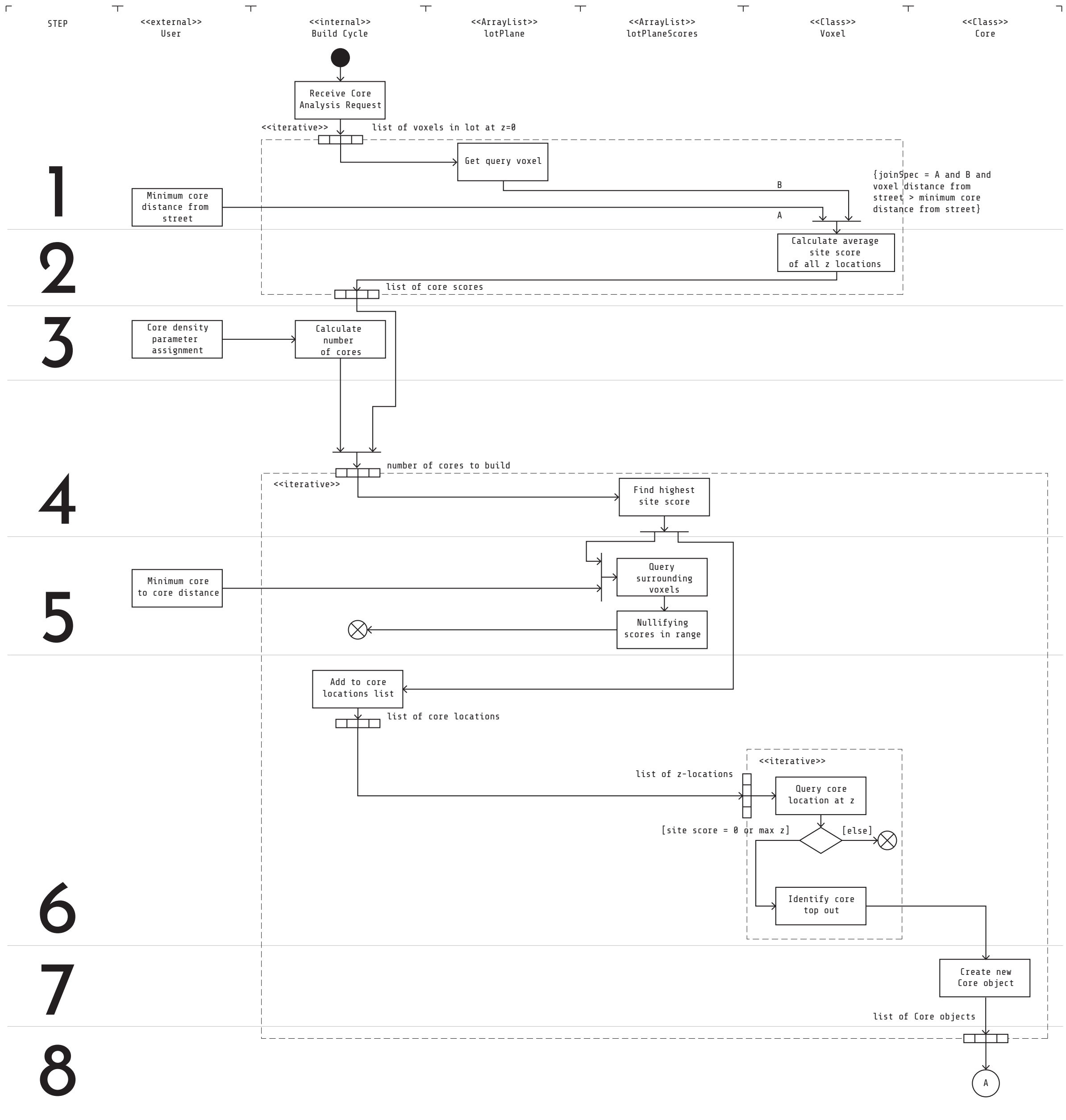


Figure 15.06.a: UML subactivity diagram illustrating the decision process of locating vertical building cores on the site and determining the core top-out height.

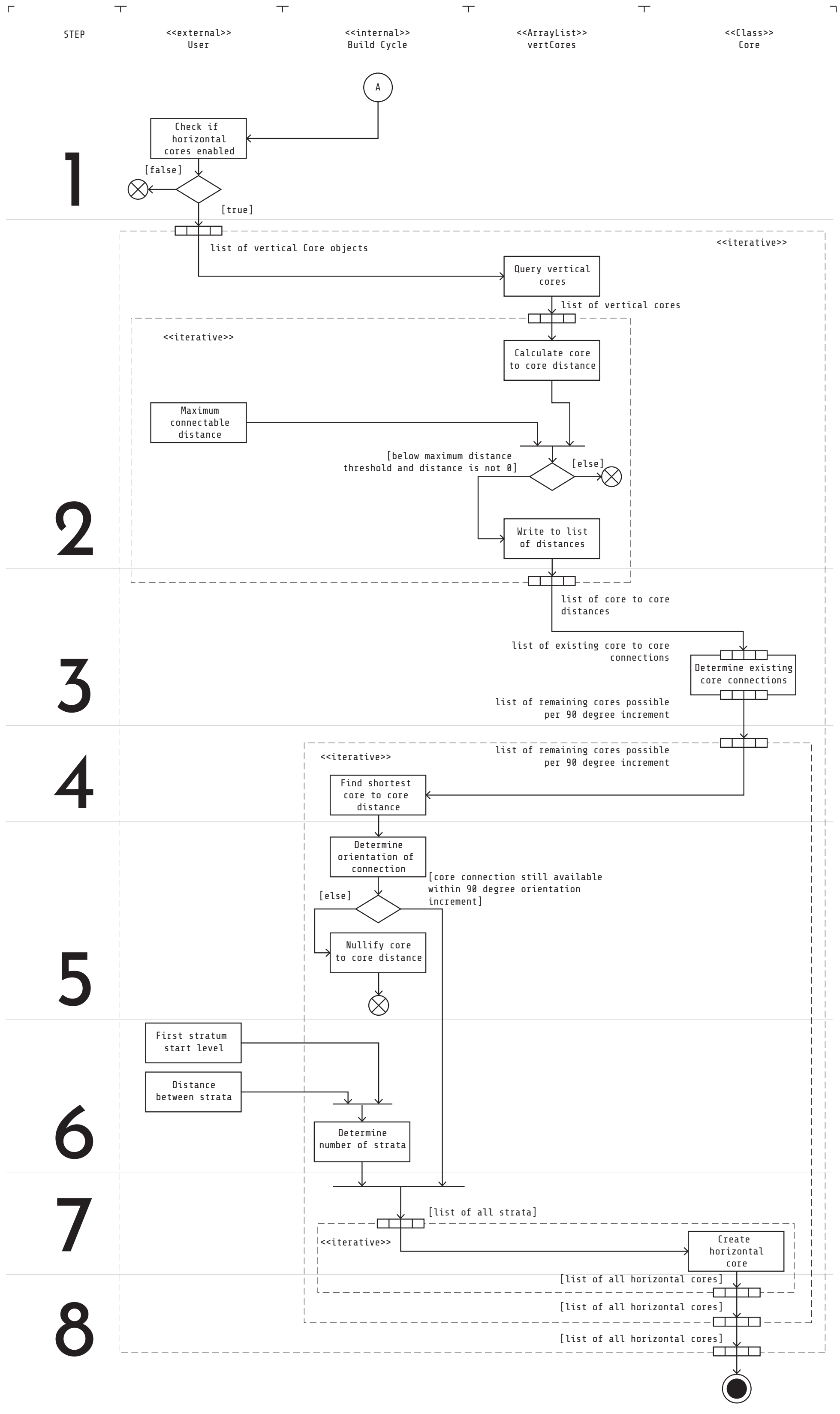
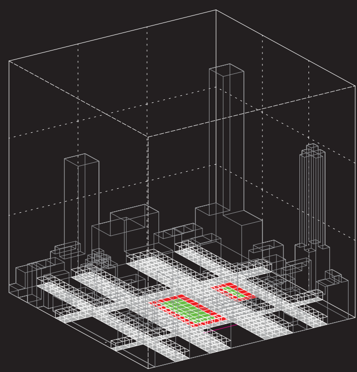
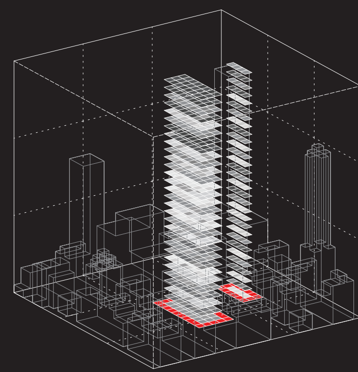


Figure 15.06.b: UML subactivity diagram detailing the horizontal core locating subactivities of the locate building cores activity.

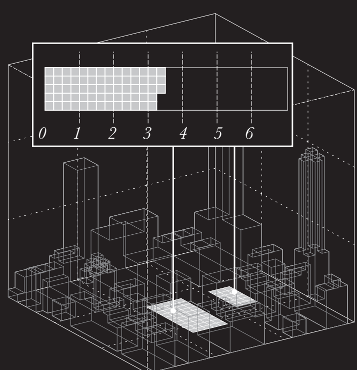
FIGURE 15.06.c: Core location activity steps



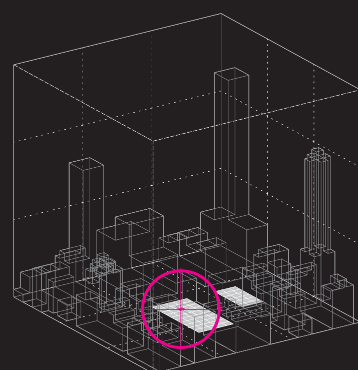
1. ELIMINATE POSSIBLE CORE LOCATIONS WITHIN MINIMUM STREET AND ADJACENT LOT DISTANCES
Cores adjacent to the street would be inefficient for floor layouts, therefore grade locations within a minimum distance from the street are eliminated from the list of possible core locations.



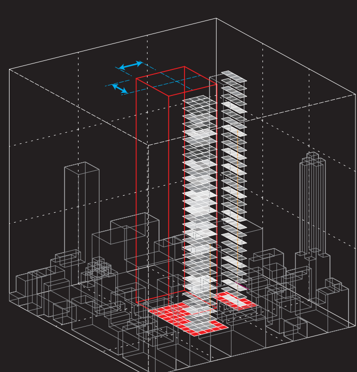
2. DETERMINE SITE SCORE OF POSSIBLE CORE LOCATIONS
For all remaining possible core locations in the x-y ground plane, the average site analysis score is calculated. This is done by finding the average of all site scores of every voxel in the z-dimension at this x-y location.



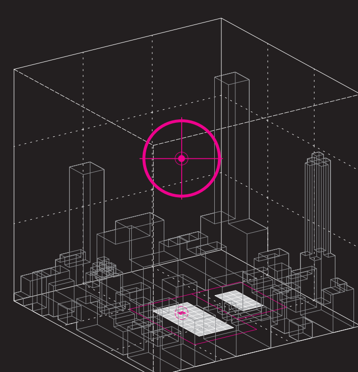
3. DETERMINE THE NUMBER OF CORES TO BUILD
The number of cores to build in the development is determined based on the area of the site and the core density parameter set by the user. It is calculated by dividing the site area in voxels by the core density parameter.



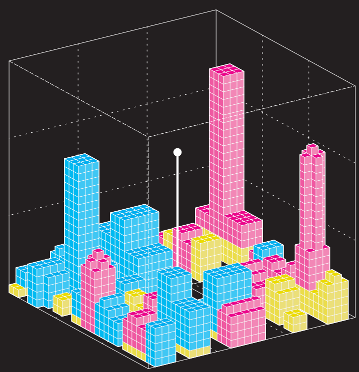
4. FIND THE CORE WITH THE HIGHEST SITE SCORE
The highest planar site analysis score is selected for the vertical core's location, representing the best location on the building site to focus the building massing.



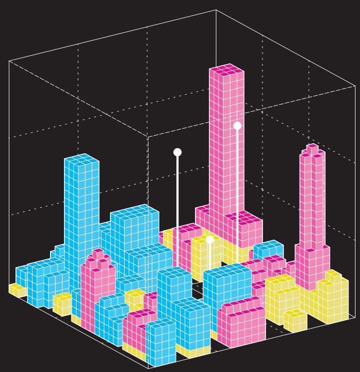
5. CORES MUST BE MINIMUM DISTANCE AWAY FROM EACH OTHER
Cores must be a minimum distance away from each other as specified by the core-to-core distance user-parameter. All possible core locations within this area are assigned a new score of zero.



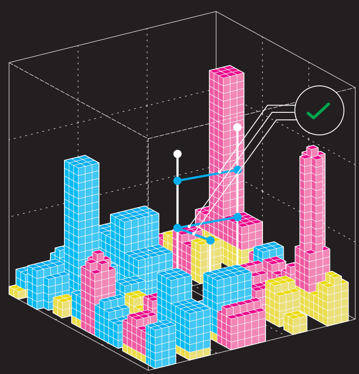
6. IDENTIFY TOP-OUT HEIGHT OF CORE
The maximum height of the core is determined based on the site scores of the voxels at the core location, the core height variety parameter, and the target FAR value.



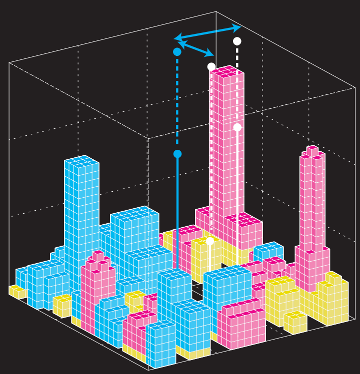
7. CREATE NEW CORE OBJECT
Now that the start and end locations of the core object are known, a new core object is created in the modeling environment.



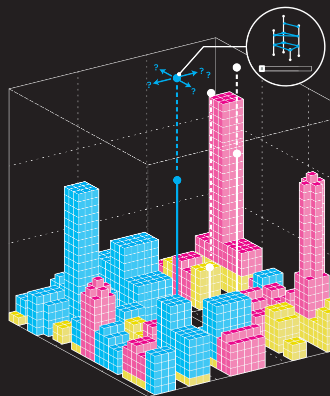
8. REPEAT FOR EACH REQUIRED CORE REMAINING
For every required core object remaining, steps 4-7 are repeated to select the best locations for the remaining vertical cores and build new core objects.



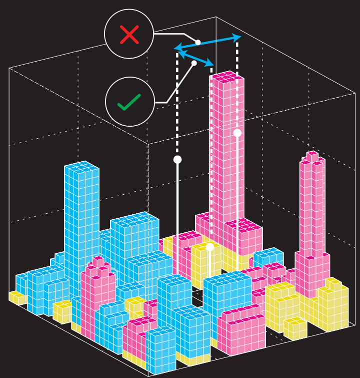
9. PROCEED IF HORIZONTAL CORES ARE ENABLED
Since the algorithm simulates both planar and volumetric cities, horizontal cores can be enabled or disabled in the user-parameters. The horizontal core creation subactivity only occurs if they are enabled.



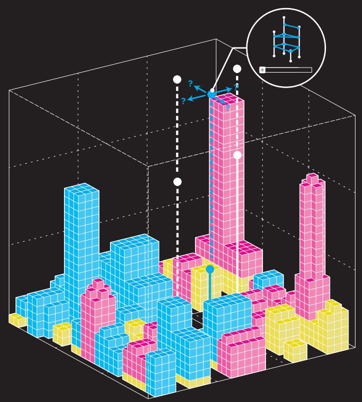
10. CREATE A LIST OF ALL CORE TO CORE DISTANCES WITHIN RANGE
In order to determine connections to both new cores and existing cores in the model, for each new vertical core, a list of distances to all other cores within reach is created.



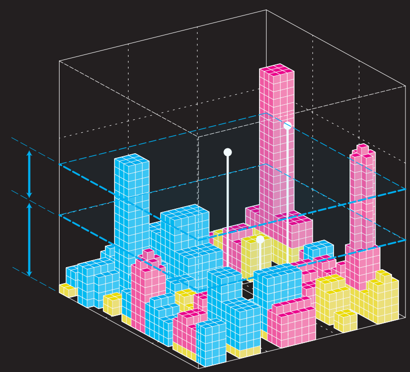
11. QUERY HOW MANY CORES ARE ALREADY CONNECTED
The current vertical core is queried to determine how many connections it already has with the surrounding cores. The vertical core can have a maximum number of total connections specified by the user-parameters.



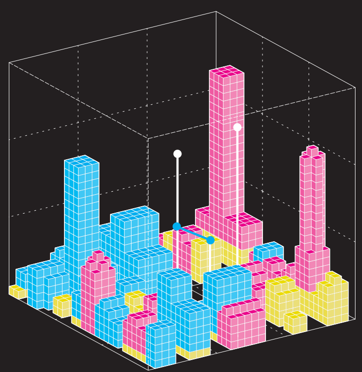
12. FIND THE SHORTEST CONNECTION
The shortest core to core distance is selected as the first candidate possible for forming a horizontal inter-building connection.



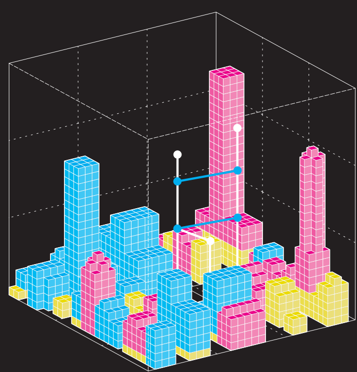
12. SELECT THE CLOSEST AVAILABLE CORE
If the closest vertical core hasn't reached its maximum number connections it is selected. If it has, the second closest core will be queried for available connections, and so on until a possible connection is found or no more cores remain.



13. DETERMINE STRATA LEVELS
The user parameters "first strata level" and "distance between strata" are used to determine the height and frequency of horizontal connections in the z-dimension. This creates the potential for multiple strata of connections between buildings.



14. CREATE NEW HORIZONTAL CORE OBJECT AT EACH STRATA AVAILABLE
A new horizontal core object is created between the two vertical cores at every strata level that both cores reach.



15. REPEAT FOR EACH POSSIBLE CORE REMAINING
Repeat steps 12-14 for each possible inter-building connection remaining for the current core. Repeat steps 10-14 for each of the other vertical cores created this building cycle such that each core can form all available connections to adjacent vertical cores.

15.07 MASSING CONSTRUCTION ACTIVITY

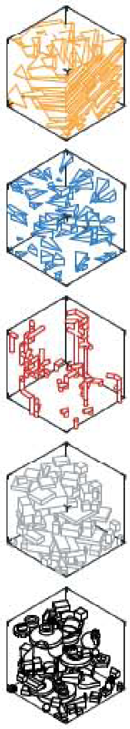


Figure 15.07.a: Placement of housing units by ideal criteria within MVRDV's Vertical Village.

The massing construction activity generates a schematic design for one possible permutation of a building on the selected site, within the regulations and design constraints of the scenario. This process is influenced by the *Village Maker* application by MVRDV and The Why Factory. In the Village Maker, the two-step application creates external criteria, called *core settings*, and individual criteria called *user settings*.[1] The program then takes the individual's specific house typology, desired views, daylight criteria, private space, and price range, and places the housing unit in the best location for the assigned criteria within the constraints of the pre-established core settings.[2] In this manner, the building model becomes optimized for the user's preferences within the constraints of the system.

Similarly, the massing construction activity of the parametric tool takes a selection of types (in this case voxels of different properties) and individually selects ideal locations for them within a predetermined framework that can be adjusted at each stage by the user parameters. The first two parts of this framework are the site analysis character envelopes generated at the site analysis stage, and a structural character envelope calculated during this stage based on the user-defined criteria of the maximum support provided by the constructed cores. Programmatic use and price tier distribution algorithms determine the properties the built voxels will have. First, the algorithms receive the amounts to assign of each programmatic use or price-tier property based on the criteria of the scenario and the composition of the surrounding building fabric. Next, these targets are assigned to all supported voxels on site by one of five different patterns. The final building massing is selected by one of two form processes: a free-form algorithm which successively builds the highest scoring voxels supported until a target density is achieved, or a rectilinear algorithm which builds only rectilinear shapes until the target density is achieved. The process is repeated separately with different values for each structural support object and each of these criteria can be altered by the user-parameters dependent on the demands of a specific scenario.

1 MVRDV and The Why Factory, *The Vertical Village: Individual, Informal, Intense* (Rotterdam: NAi Publishers, 2012), 423.
2 Ibid., 429.

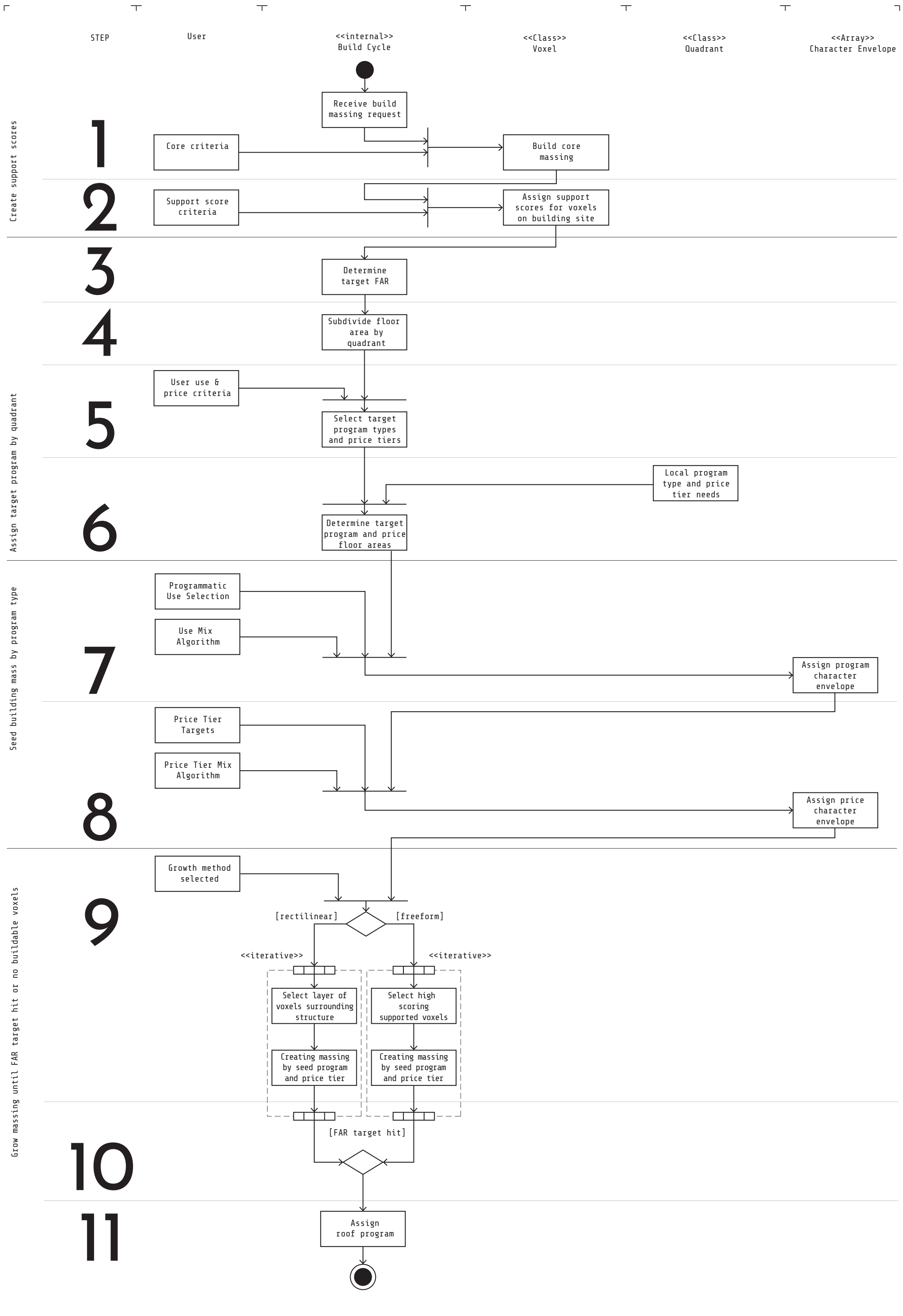
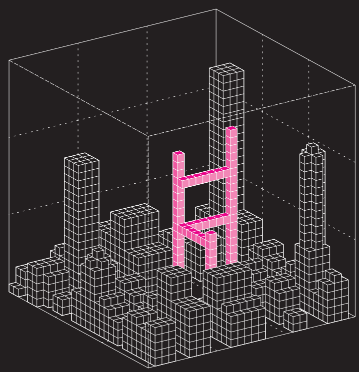
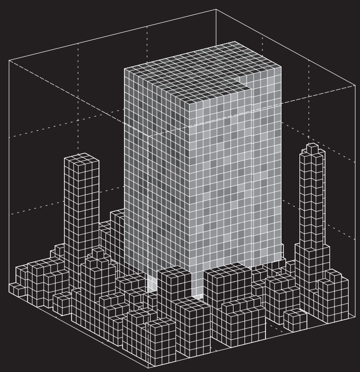


Figure 15.07.b: UML subactivity diagram of the subactivities involved in the generative algorithm's massing construction activity.

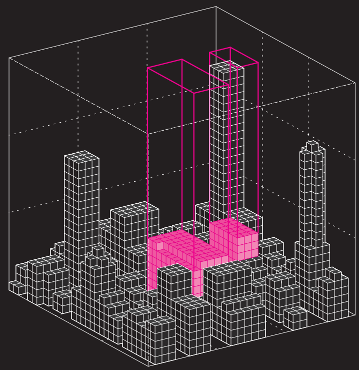
FIGURE 15.07.c: Massing construction activity steps



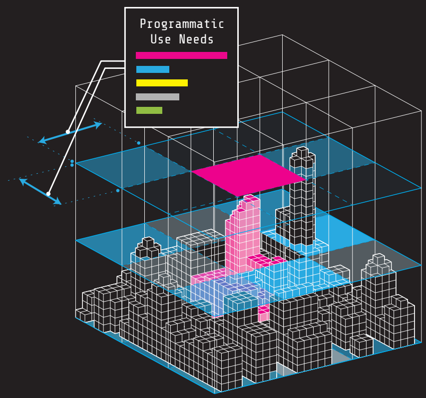
1. CONSTRUCT CORE MASSING
The first building massing to be constructed is the structural cores. The cores are made using the start and end point information from the core objects of the previous steps.



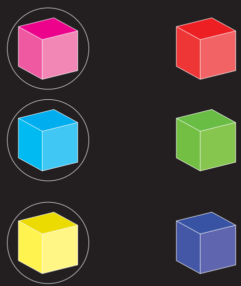
2. CALCULATE STRUCTURAL CHARACTER ENVELOPE
The user specified parameters for maximum building depth and maximum grade supported height are used to determine the massing that can be supported from the provided structure.



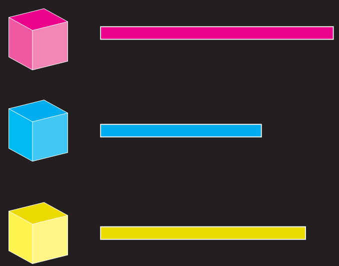
3. CALCULATE TARGET FLOOR AREA RATIO OF DEVELOPMENT
In order to provide determine when the massing construction process should stop, a target FAR is set based on the user’s criteria of the target fill of the structural character envelope.



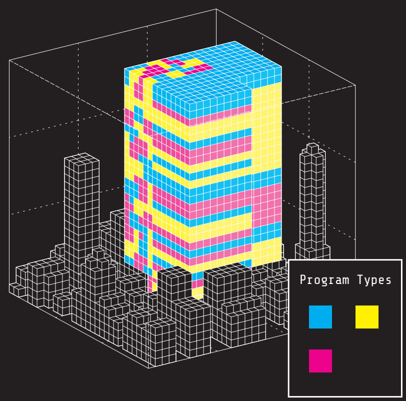
5. QUERY ADJACENT QUADRANTS FOR PROGRAMMATIC NEEDS
Within the catchment distance, adjacent quadrants are queried to determine which programs they are lacking, creating target program floor areas for the development in response to local programmatic needs.



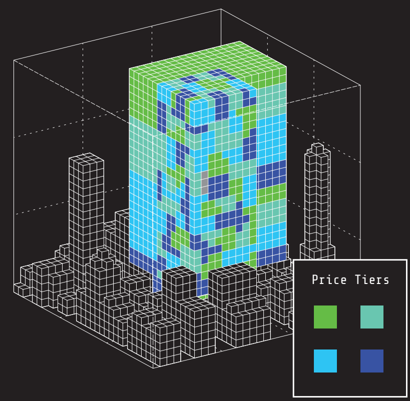
5. SELECT PROGRAM TYPES TO IMPLEMENT IN DEVELOPMENT
Selects which program types will be prioritized for the current support structure of the development based on the user assigned parameters, the requirements created by the surrounding context, and the most economical program to develop.



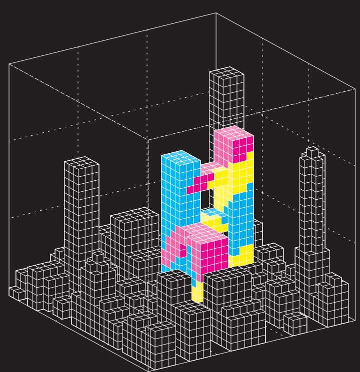
6. DETERMINE TARGET FLOOR AREAS BY PROGRAMMATIC USE
The short-list of requested building programs, combined with the total amount of floor area requested are combined to create target floor areas for each structural component.



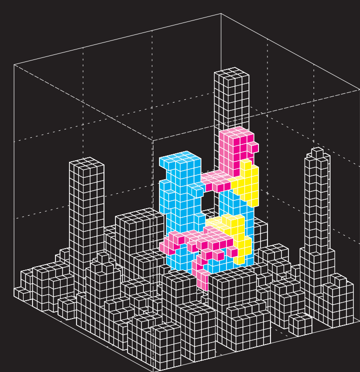
7. ASSIGN PROGRAMMATIC USE CHARACTER ENVELOPE
For each structural component, based on the target floor areas and the user selected programmatic use placement algorithm a programmatic use character envelope is used to generate the possible use assignments within the structural support envelope.



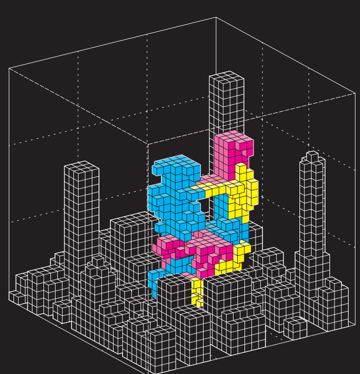
8. ASSIGN PRICE TIER CHARACTER ENVELOPE
For each structural component, based on the target price tiers and the user selected price tier placement algorithm, a price tier character envelope is used to generate the possible assignments within the structural support envelope.



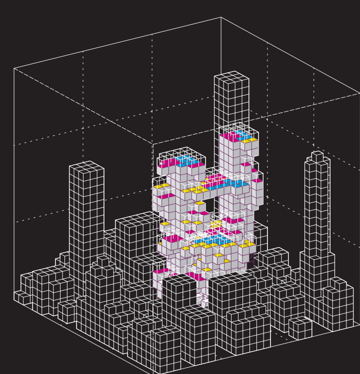
9a. CONSTRUCT VOXELS BY RECTILINEAR ALGORITHM
The building's voxels are now constructed by either the rectilinear or free-form algorithms. The rectilinear algorithm builds up the structural element equally in all directions until the target fill ratio is reached.



9b. OR CONSTRUCT VOXELS BY FREE-FORM ALGORITHM
If the free-form algorithm is selected for the structural component, supported voxels with the highest 10% of site analysis scores are constructed iteratively until the target fill ratio is reached.



10. FINISH BUILDING MASS GROWTH WHEN TARGET FAR REACHED
The building development's interior program is complete when the target fill ratio for each structural element is reached.



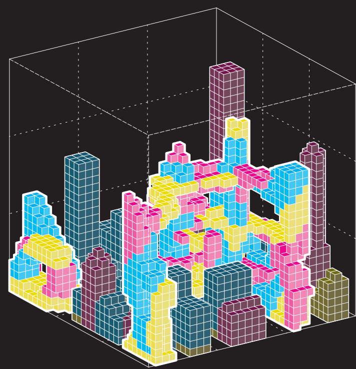
11. ASSIGN ROOFSCAPE PROGRAM
If the user-parameters specify roof program, roof program is assigned based on the selection of possible program types, the programmatic needs of adjacent quadrants, and the exterior program use mix grain.

15.08 REPEAT THE BUILDING CYCLE

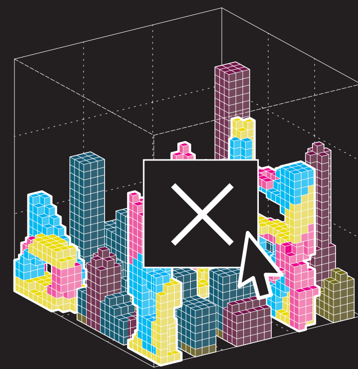
Once the massing construction activity is finished, one building cycle has been completed and the algorithm automatically begins again. The incremental process allows for the model to evolve based on the existing building fabric and to build iteratively from each successive building constructed in every building cycle. After the successive development of numerous sites, the building fabric gradually evolves to reflect the scenario defined by the parameters assigned to the algorithm. The algorithm starts the cycle over again at the global analysis activity such that the statistics and performance scores of the building fabric that make up the parametric design tool's understanding of the current building fabric can be updated with new geometry from the previous cycle.

The amount of development to simulate could be a fixed number of cycles, after all of the buildings have been replaced, or after all of the buildings have been replaced multiple times to see how the scenario could evolve further—constructing a new model based entirely on what the algorithm has generated itself, yet still derived from the previous existing fabric. After the desired number of building cycles have been completed, the model geometry can then be imported back into the Rhinoceros 3D-modeling program for further modeling and visualization by using a Grasshopper script which converts the voxel data points to geometry.

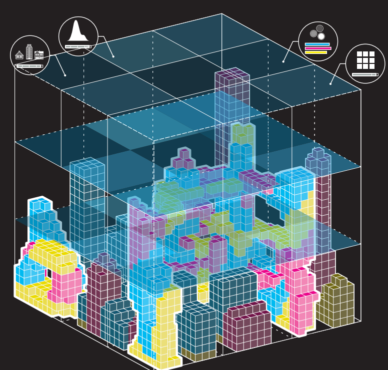
FIGURE 15.08: Repeat building cycle steps



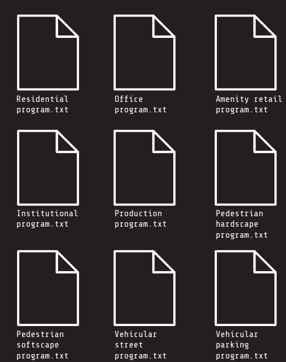
1. REPEAT THE BUILDING CYCLE UNTIL DESIRED TRANSFORMATION
The entire building cycle repeats, beginning with the global analysis activity, refreshing the global and quadrant statistics now that the state of the model has changed.



2. STOP BUILDING SIGNAL
The building cycle stops when a stop signal is sent, either by stopping the program manually or by setting a predetermined end cycle.

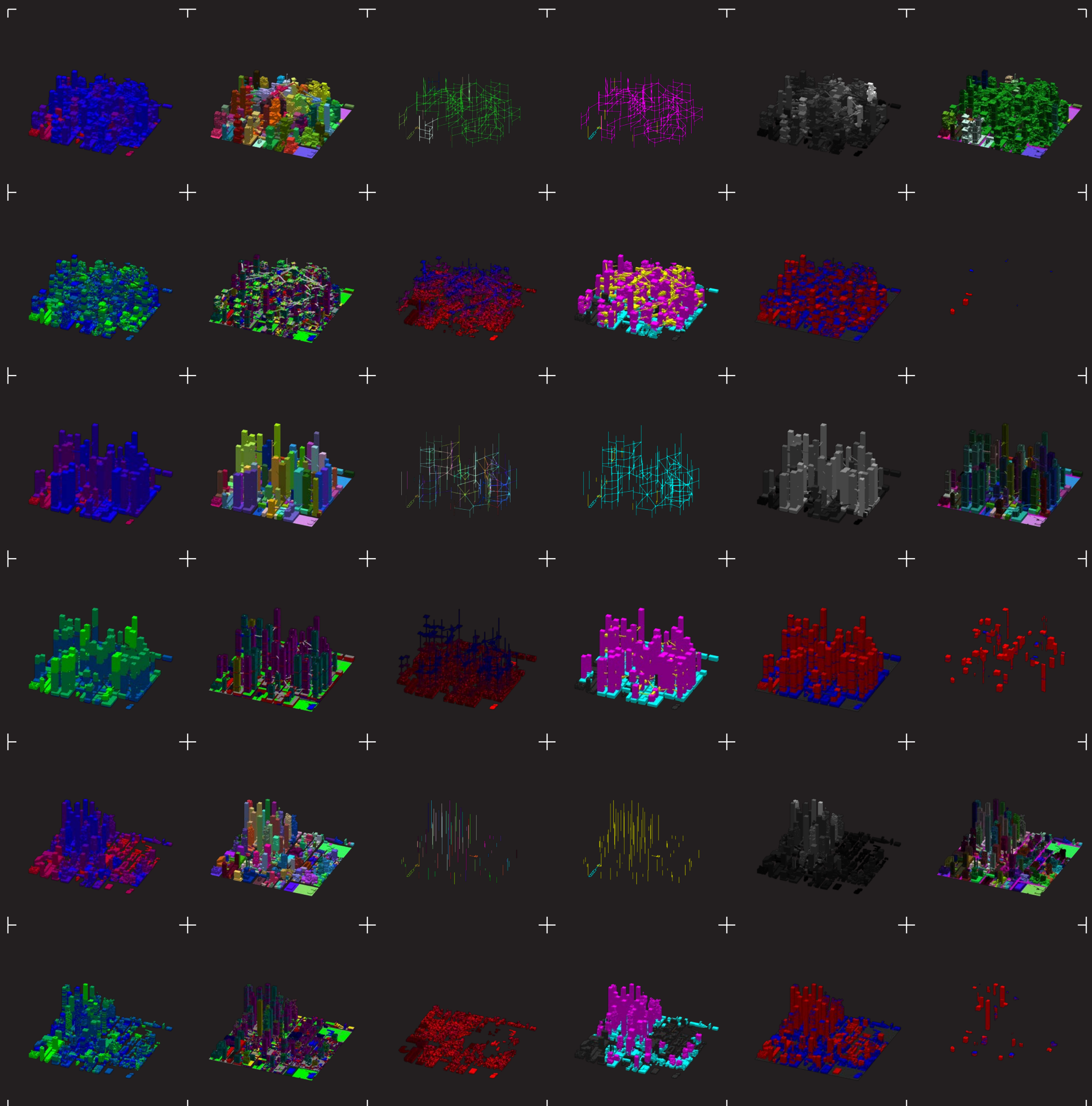


3. CALCULATE FINAL STATISTICS
Once the program has been stopped, the global statistics are updated once more to capture all changes to the state of the model.



4. EXPORT DATA
Once the final statistics have been calculated, the model geometry and the global and quadrant statistics at regular intervals throughout the building cycle are exported as text files and graphs for further processing and analysis.

IT HAS NOW BEEN ESTABLISHED THAT THE COMPARISON OF FUTURE URBAN SCENARIOS WILL BE USED TO EVALUATE THE EFFECTIVENESS OF THE VOLUMETRIC CITY. THESE WILL BE RAPIDLY GENERATED AT THE URBAN SCALE USING A CUSTOM PARAMETRIC DESIGN TOOL. THIS TOOL ESTABLISHES ITS PRECISION BY DEFINING A TERRAIN NOMINAL OF DISCRETE OBJECTS AND THEIR PROPERTIES THAT CAN BE PLACED AND MODIFIED IN A DIGITAL ENVIRONMENT. AN ALGORITHM IS USED TO GENERATE THE MODELS OF THE BUILDING FABRIC THAT CREATES A SUITABLE LEVEL OF REALISM BY REPLICATING THE PROCESSES OF DEVELOPMENT. THIS ALGORITHM CAN BE ADJUSTED TO GENERATE EACH OF THE SCENARIOS BY ASSIGNING VALUES TO A SET OF USER PARAMETERS THAT CONTROL THE OPERATIONS AT EACH STAGE OF THE ALGORITHM. NOW THAT THE PARAMETRIC TOOL HAS BEEN DESIGNED, IT CAN BE USED TO GENERATE THE THREE ESTABLISHED SCENARIOS OF STUDY.



PART FOUR

EVALUATING THE EFFECTIVENESS OF A VITALITY-DRIVEN VOLUMETRIC CITY THROUGH THE COMPARISON OF FUTURE URBAN SCENARIOS

NOW THAT THE PARAMETRIC DESIGN TOOL HAS BEEN DEVELOPED, PARAMETER ASSIGNMENTS CAN BE MADE THAT SPECIFY THE CONSTRAINTS OF EACH OF THE THREE SCENARIOS TO BE COMPARED: THE VITALITY-DRIVEN VOLUMETRIC CITY, THE PROFIT-DRIVEN VOLUMETRIC CITY, AND THE VITALITY-DRIVEN PLANAR CITY. ONCE THE SOFTWARE GENERATES THE MODELS OF THE BUILDING FABRIC, IT CAN BE VISUALIZED THROUGH A SET OF DRAWINGS THAT INHABIT THE DIGITAL FABRIC AND FORM AN IMPRESSION OF LIFE IN THE VOLUMETRIC CITY. THE SCENARIOS CAN BE COMPARED THROUGH THIS SPATIAL REPRESENTATION, AS WELL AS THROUGH AN ANALYSIS OF THE NUMERICAL DATA EXPORTED FROM THE SOFTWARE THAT RECORDS THE PROPERTIES OF THE MODEL. USING A COMBINATION OF THESE TWO METHODS OF ANALYSIS, THE EFFECTIVENESS OF THE VITALITY-DRIVEN SCENARIO AND THE SUITABILITY OF THE VOLUMETRIC CITY CAN BE EVALUATED.

CHAPTER 16 SCENARIOS ARE GENERATED USING THE PARAMETRIC DESIGN TOOL AND SPATIALIZED THROUGH A SET OF DRAWINGS

17 THE SCENARIOS ARE ASSESSED THROUGH A METRIC ANALYSIS OF THEIR COMPOSITION AND URBAN RESOURCES

18 THE SCENARIOS ARE COMPARED SPATIALLY AND NUMERICALLY TO EVALUATE THE EFFECTIVENESS OF VITALITY-DRIVEN VOLUMETRIC ARCHITECTURE

19 THE SCENARIO ANALYSIS IS USED TO MAKE CONCLUSIONS ON THE ROLE OF VOLUMETRIC ARCHITECTURE IN THE CITY

CHAPTER 16

SCENARIOS ARE GENERATED USING THE PARAMETRIC DESIGN TOOL AND SPATIALIZED THROUGH A SET OF DRAWINGS

With the custom parametric design tool designed and coded in Processing, this chapter will now show its implementation—beginning with importing the test site into the model, followed by running the simulation, producing models of the scenarios, and translating these models from point data to a spatialized representation as drawings.

16.01. Running the parametric design tool

16.02. Representing data points as architectural blocks

16.03. The proposed scenario: the vitality-driven volumetric city

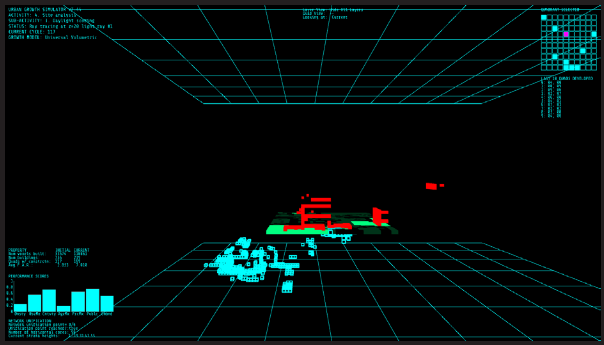
16.04. Comparative scenario 1: the profit-driven volumetric city

16.05. Comparative scenario 2: the vitality-driven planar city

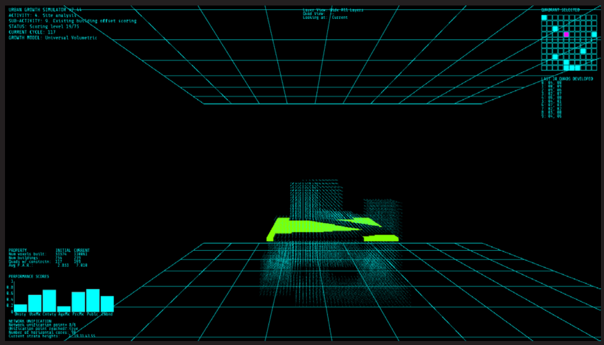
16.01 RUNNING THE PARAMETRIC DESIGN TOOL

In order to find specific value assignments for each parameter of the simulation, a process of trial-and-error was employed based on the motivations of each scenario. The simulation was run up to 100 building cycles for each scenario numerous times, and the generated model and statistics were observed for the desired effects. The main criteria for this process were ensuring the motivations of the scenarios were preserved (vitality-driven or profit-driven, volumetric or planar) and that the results represented realistic construction that could conceivably be built. In the case of the vitality-driven scenarios, this meant balancing the drive for vitality with the realism of the model by simultaneously directing the model towards the creative solutions and provocative forms suggested by the scenario, while attempting to preserve the coherence of the urban fabric. In the case of the profit-driven scenario, this meant balancing the profit-driven criteria with what regulatory restrictions would allow. Some of these criteria included accepting the scenario's implementation of the residential tower with a retail podium, the priority of high-end housing, amenities geared towards residents, economical forms and inter-building connections, maximized floor depth within legal restrictions, and building heights determined by the context of adjacent buildings. The final parameter assignments specified for each scenario are included with the parameter documentation in Chapter 14 (Figures 14.05-14.09). Future iterations could use the performance scores to provide feedback, automatically adjusting the user-presets based on the results in order to find an optimal solution through automation.

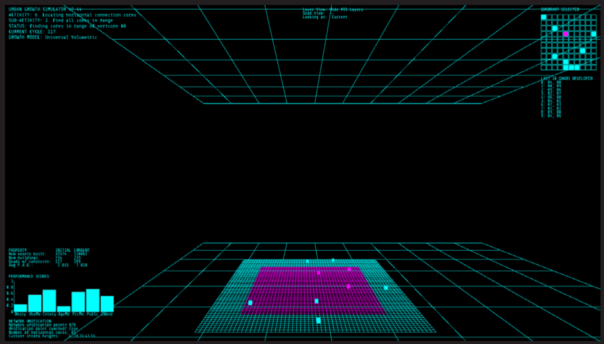
For all scenarios, the results the simulation produces are cumulative. The longer the simulation is run, the more buildings are generated and the more the forms, building heights, program selection, and price tier selections (among many other criteria) are responsive to the scenario criteria. This means that running the scenarios longer generated more intensive representations of the scenario, carrying out the intent of the scenario to a greater extreme and forming a more exaggerated portrayal of the scenarios' intents. For this study, all view modes and statistics have been exported at every building cycle, and the generated site model exported every 50 building cycles, up to a total of 200 repetitions (meaning 200 buildings have been generated in each scenario model). The drawings produced depict the scenario models after 150 repetitions of the buildings cycle.



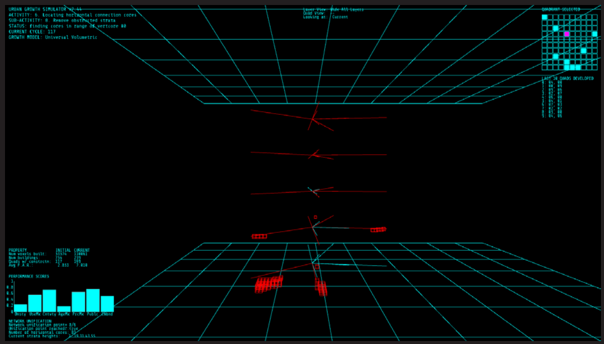
Site analysis: ray-tracing daylight optimization



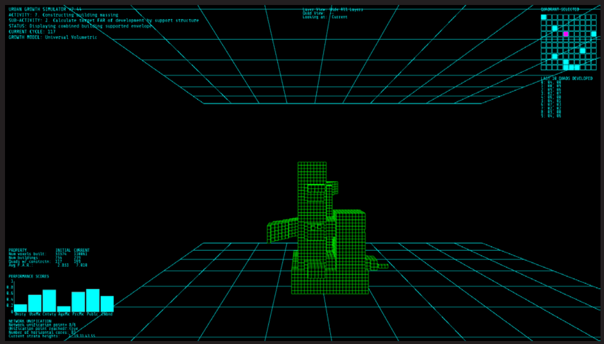
Site analysis: building offset



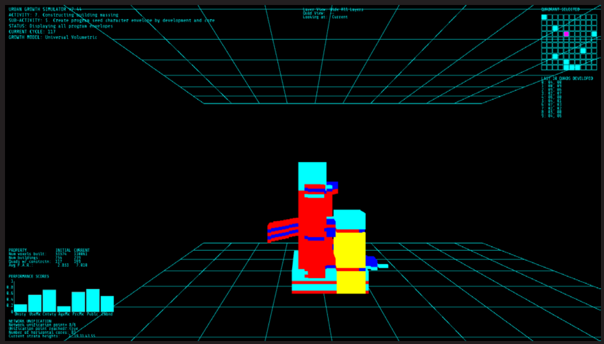
Core locating: finding the closest core connection



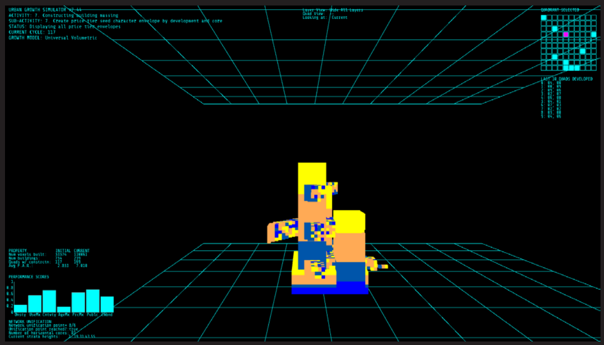
Core locating: finding available strata to connect



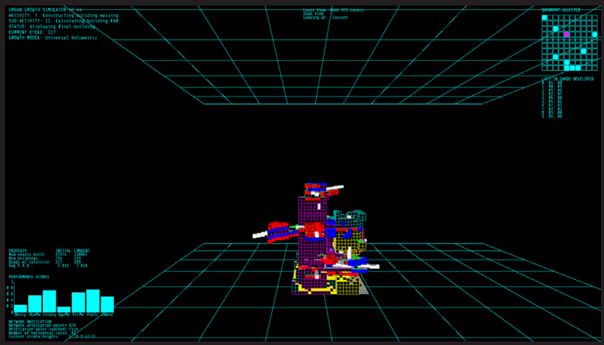
Massing construction: structural character envelope



Massing construction: program distribution envelope



Massing construction: price tier distribution envelope



Massing construction: final assembly

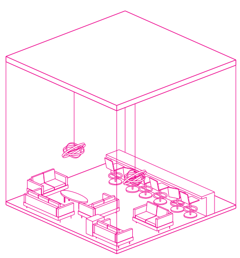
Figure 16.01: Screenshots of a few key processes in the generative algorithm running, as seen in the parametric design tool's building environment window. Full documentation of the parametric design tool in operation can be found in Appendix B.

16.02 REPRESENTING DATA POINTS AS ARCHITECTURAL BLOCKS

For each scenario, spatial representations will be generated by substituting each voxel's properties for a representative architectural block. The intent of these drawings isn't to suggest a specific algorithmically generated building design, but rather to form an abstract portrait of a possible future when an idea is carried to its logical extreme for decades, or even centuries. These drawings can help illuminate the future of the city by extending current design trends, regulations, and economic factors.

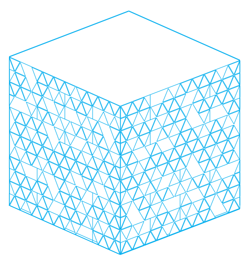
The parametric design tool generates building massing as voxels with assignable properties including: programmatic use, price tier, age, degree of publicness, supporting structure, vacancy, interiority versus exteriority, landmark or historic status, and building lot index. In order to represent these data points spatially, some of these properties are represented as standardized architectural blocks, specifically the voxel's programmatic use, price tier, and degree of publicness. The following blocks are icons for the type of spaces that they represent, and in actuality indicate a more diverse variety of programs and designs for whatever program would fit within their categories. However, the following key allows these significant properties to be deduced from the drawing, and representing the data points with these spatial abstractions can provide a meaningful snapshot of what the scenarios may look like. Even without deducing the specific program, price tier, and degree of publicness shown by each architectural block, the variety, mix, and spatial relationship between voxels can be discerned by viewing each drawing as a whole.

PUBLIC & QUASI-PUBLIC SPACE

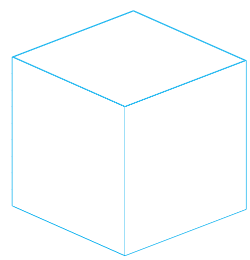


VIEW PROPERTIES
Colour: Magenta
View Layer: Program

PRIVATE SPACE

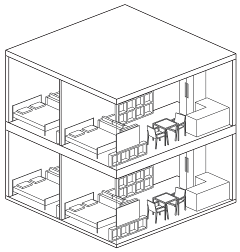


VIEW PROPERTIES
Colour: Cyan
View Layer: Facade

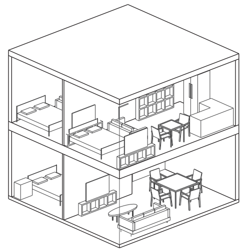


ALTERNATIVE VIEW PROPERTIES
Colour: Cyan
View Layer: Simplified Facade

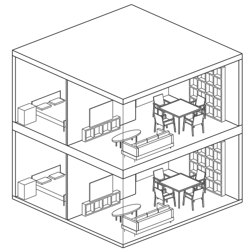
Figure 16.02.a: Spatial representation of voxel public level



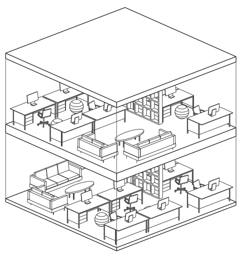
Program: Residential
Price Tier: Low
View: Program



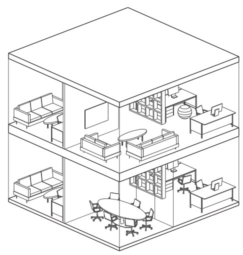
Program: Residential
Price Tier: Low-Mid
View: Program



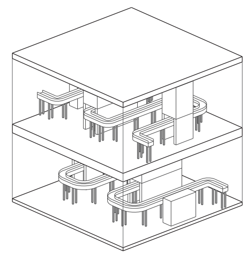
Program: Residential
Price Tier: Mid-High
View: Program



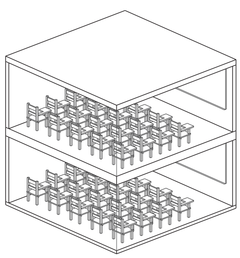
Program: Office
Price Tier: Mid-High
View: Program



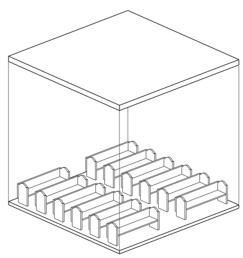
Program: Office
Price Tier: High
View: Program



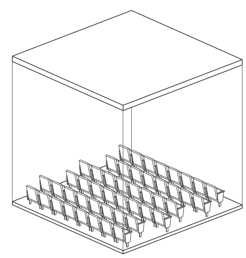
Program: Production
Price Tier: Low
View: Program



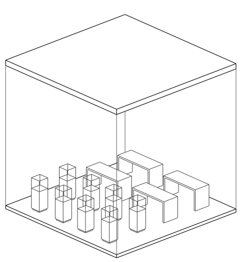
Program: Institution
Price Tier: Low
View: Program



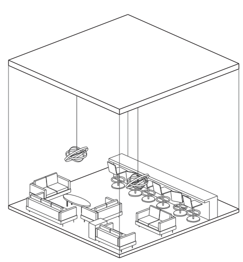
Program: Institution
Price Tier: Low-Mid
View: Program



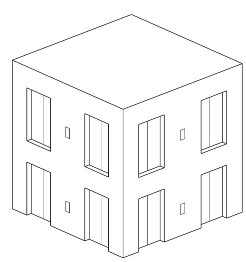
Program: Institution
Price Tier: Mid-High
View: Program



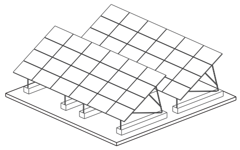
Program: Amenity/Retail
Price Tier: Mid-High
View: Program



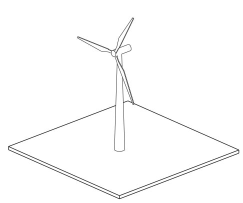
Program: Amenity/Retail
Price Tier: High
View: Program



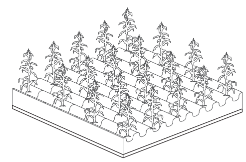
Program: Vertical Core
Type: Private
View: Program



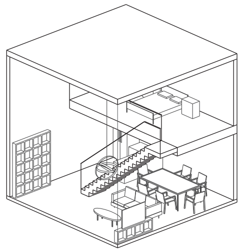
Program: Exterior Production
Price Tier: Low-Mid
View: Program



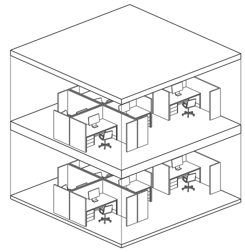
Program: Exterior Production
Price Tier: Mid-High
View: Program



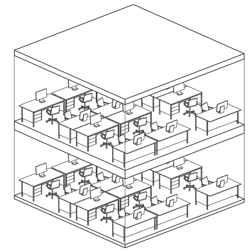
Program: Exterior Production
Price Tier: High
View: Program



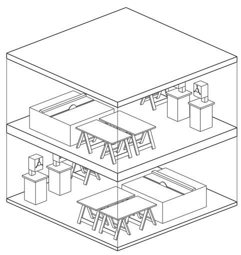
Program: Residential
Price Tier: High
View: Program



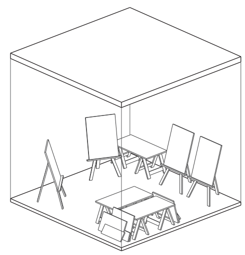
Program: Office
Price Tier: Low
View: Program



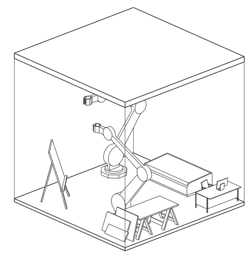
Program: Office
Price Tier: Low-Mid
View: Program



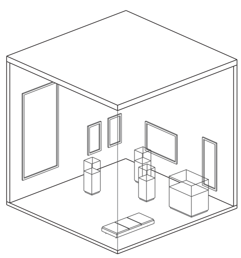
Program: Production
Price Tier: Low-Mid
View: Program



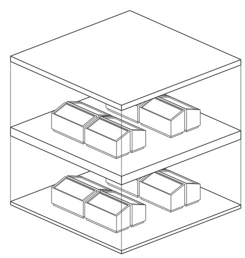
Program: Production
Price Tier: Mid-High
View: Program



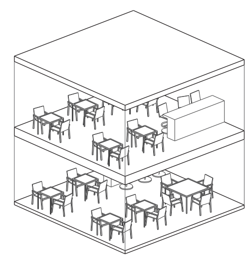
Program: Production
Price Tier: High
View: Program



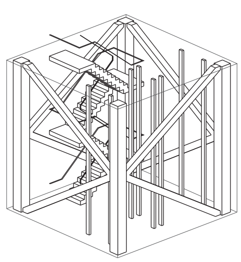
Program: Institution
Price Tier: High
View: Program



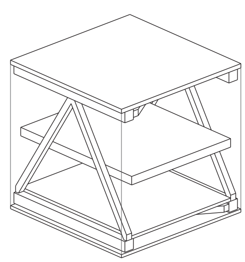
Program: Amenity/Retail
Price Tier: Low
View: Program



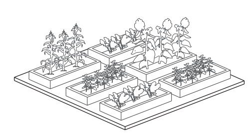
Program: Amenity/Retail
Price Tier: Low-Mid
View: Program



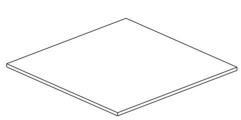
Program: Vertical Core
Type: Public
View: Program



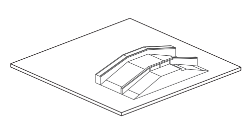
Program: Horizontal Core
Type: Public & Private
View: Program



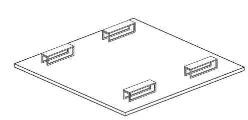
Program: Exterior Production
Price Tier: Low
View: Program



Program: Hardscape
Symbol: Plain
View: Program

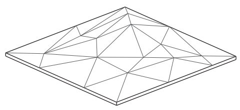


Program: Hardscape
Symbol: Skatepark
View: Program

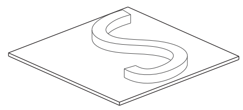


Program: Hardscape
Symbol: Benches
View: Program

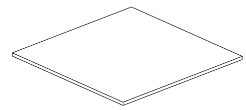
Figure 16.02.b: Spatial representations of voxel program and price tier assignments



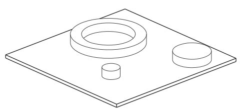
Program: Hardscape
Symbol:Sculpted
View: Program



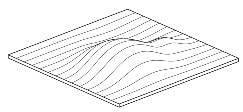
Program: Hardscape
Symbol: Freeform Bench
View: Program



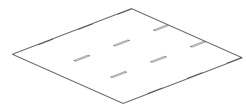
Program: Softscape
Symbol: Plain
View: Program



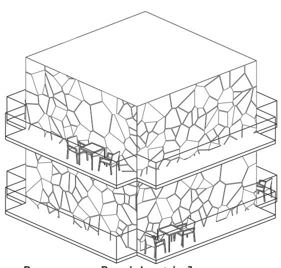
Program: Softscape
Symbol: Planter Benches
View: Program



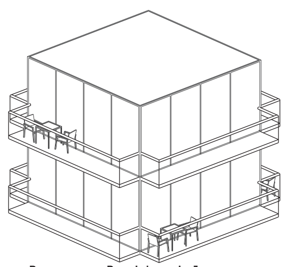
Program: Softscape
Symbol: Sculpted
View: Program



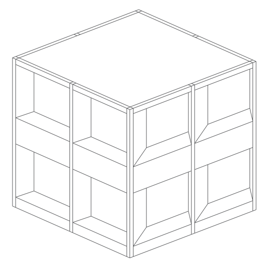
Program: Vehicular
Type: Street
View: Program



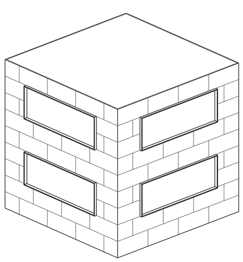
Program: Residential
Price Tier: Low-Mid
View: Facade



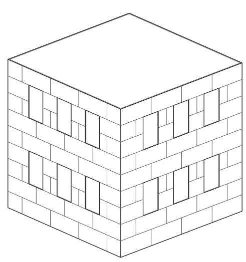
Program: Residential
Price Tier: Low
View: Facade



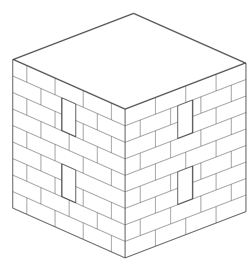
Program: Office
Price Tier: High
View: Facade



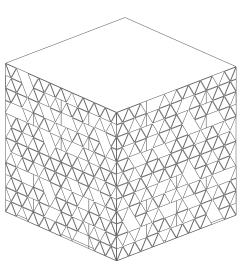
Program: Production
Price Tier: High
View: Facade



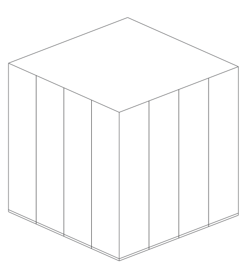
Program: Production
Price Tier: Mid-High
View: Facade



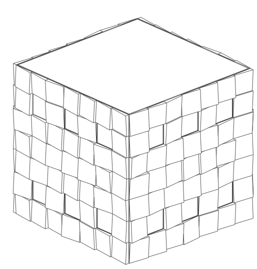
Program: Production
Price Tier: Low-Mid
View: Facade



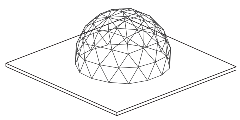
Program: Amenity/Retail
Price Tier: Low-Mid
View: Facade



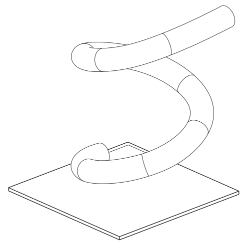
Program: Amenity/Retail
Price Tier: Low
View: Facade



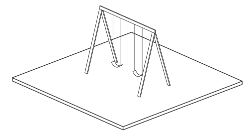
Program: Institution
Price Tier: High
View: Facade



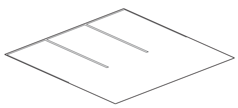
Program: Softscape
Symbol: Playground Bucky-ball
View: Program



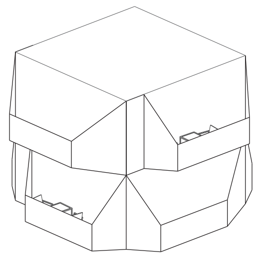
Program: Softscape
Symbol: Slide
View: Program



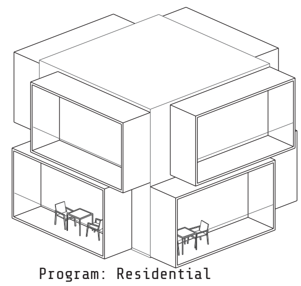
Program: Softscape
Symbol: Swings
View: Program



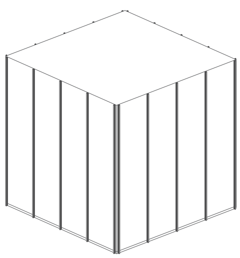
Program: Vehicular
Type: Parking
View: Program



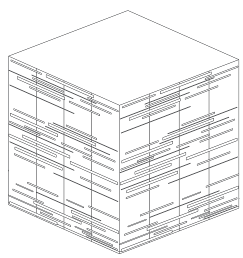
Program: Residential
Price Tier: High
View: Facade



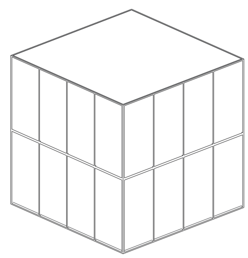
Program: Residential
Price Tier: Mid-High
View: Facade



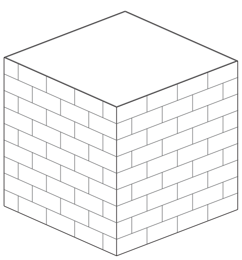
Program: Office
Price Tier: Mid-High
View: Facade



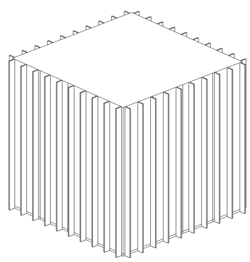
Program: Office
Price Tier: Low-Mid
View: Facade



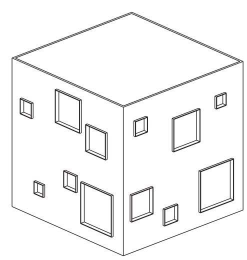
Program: Office
Price Tier: Low
View: Facade



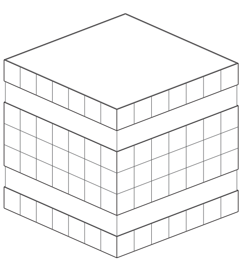
Program: Production
Price Tier: Low
View: Facade



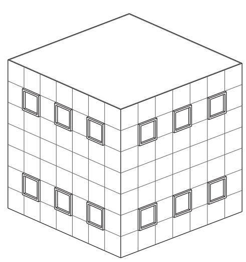
Program: Amenity/Retail
Price Tier: High
View: Facade



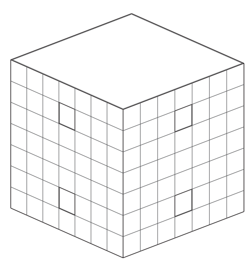
Program: Amenity/Retail
Price Tier: Mid-High
View: Facade



Program: Institution
Price Tier: Mid-High
View: Facade



Program: Institution
Price Tier: Low-Mid
View: Facade



Program: Institution
Price Tier: High
View: Facade

Figure 16.02.b (continued)

16.03 THE PROPOSED SCENARIO: THE VITALITY-DRIVEN VOLUMETRIC CITY

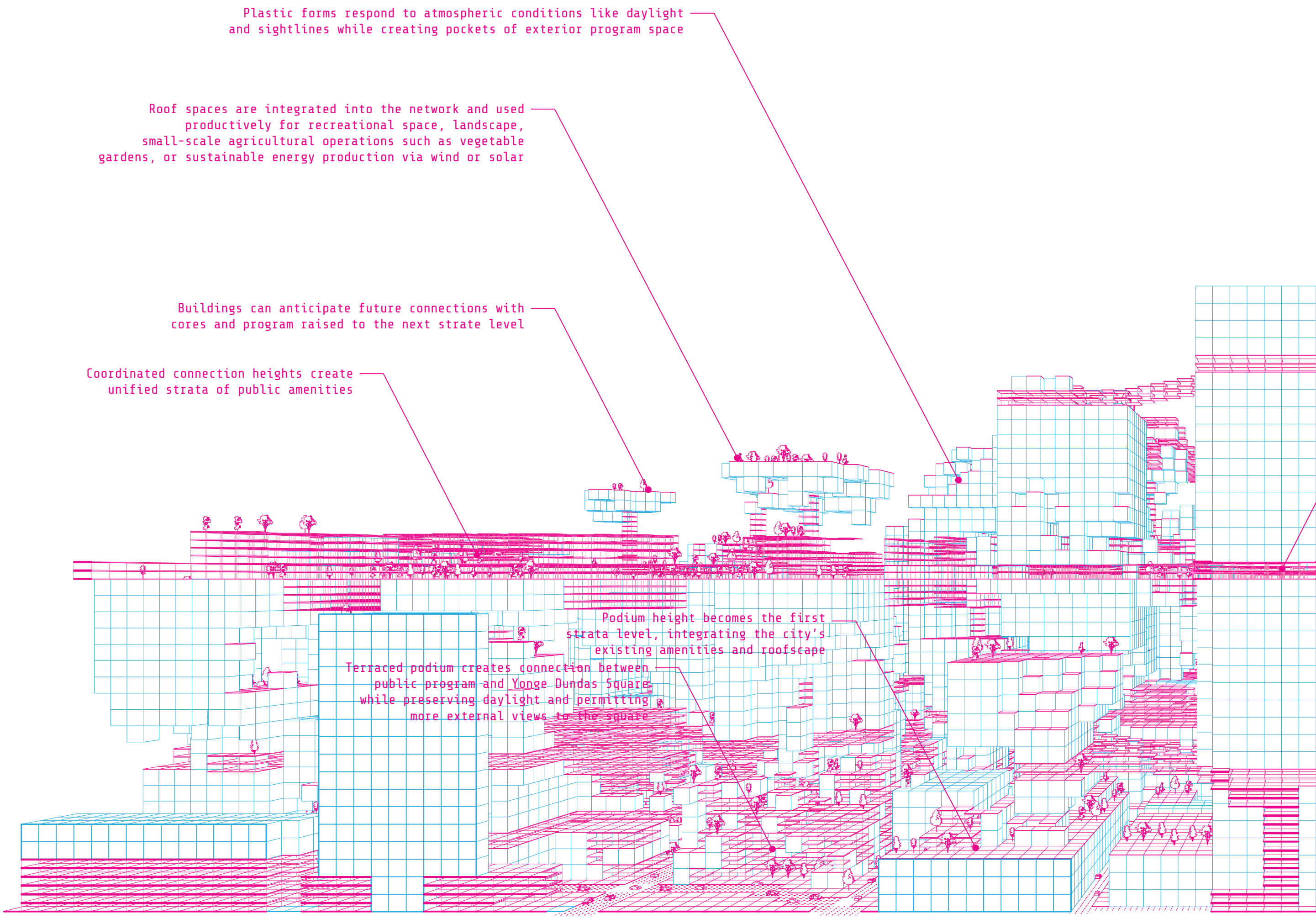
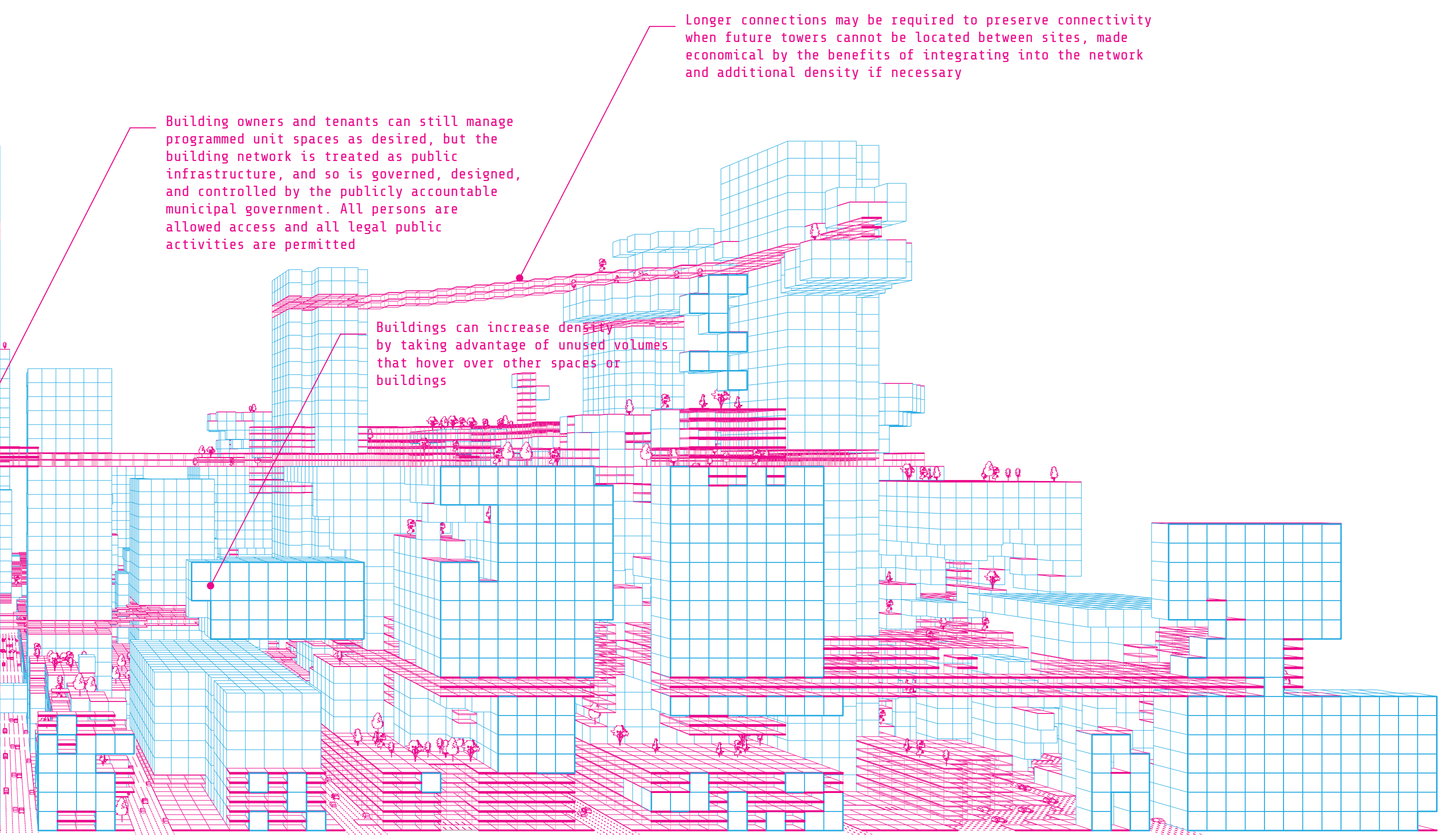
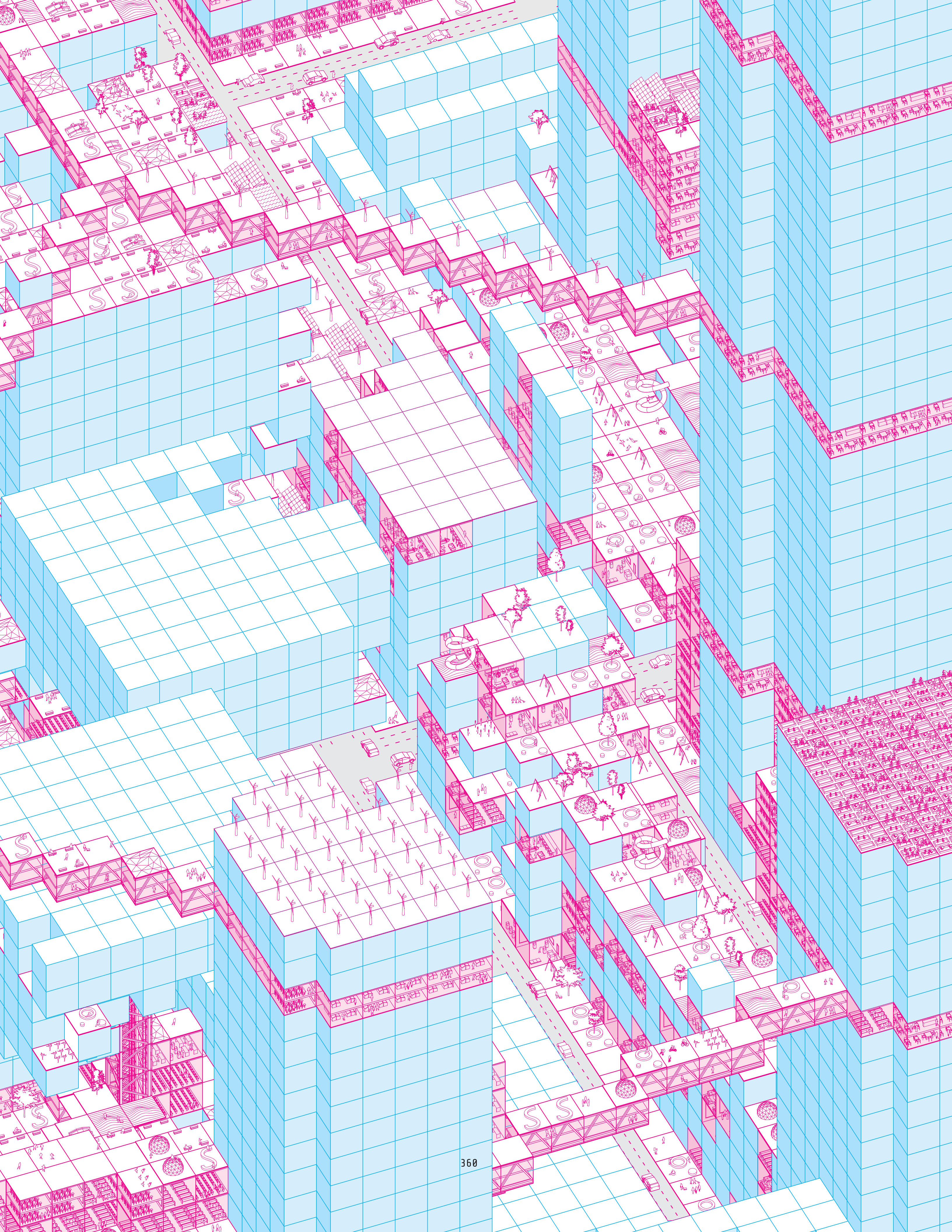


Figure 16.03.a: Section through the proposed scenario, a vitality-driven volumetric city, represented as generic voxels of either private program in cyan, or public and quasi-public program in magenta.





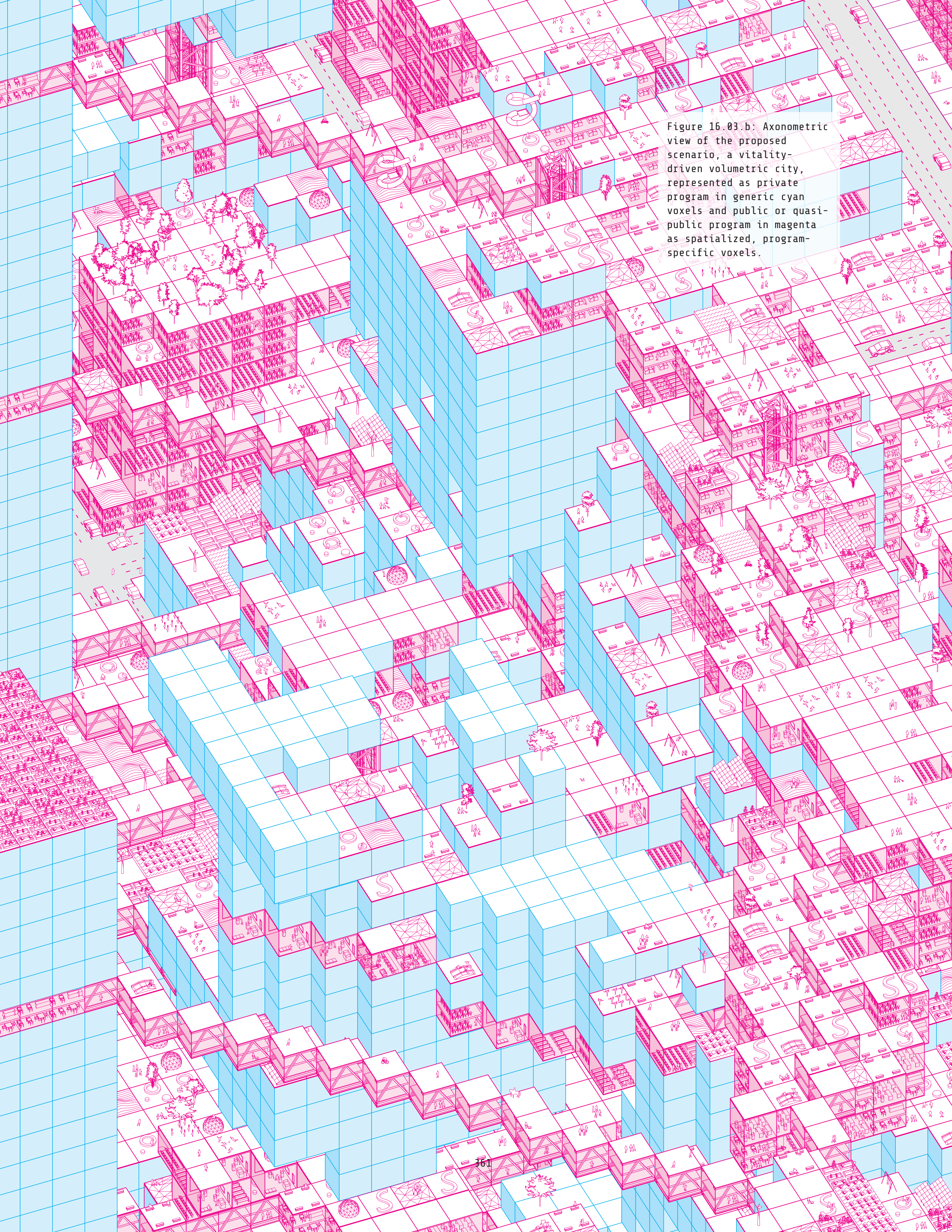
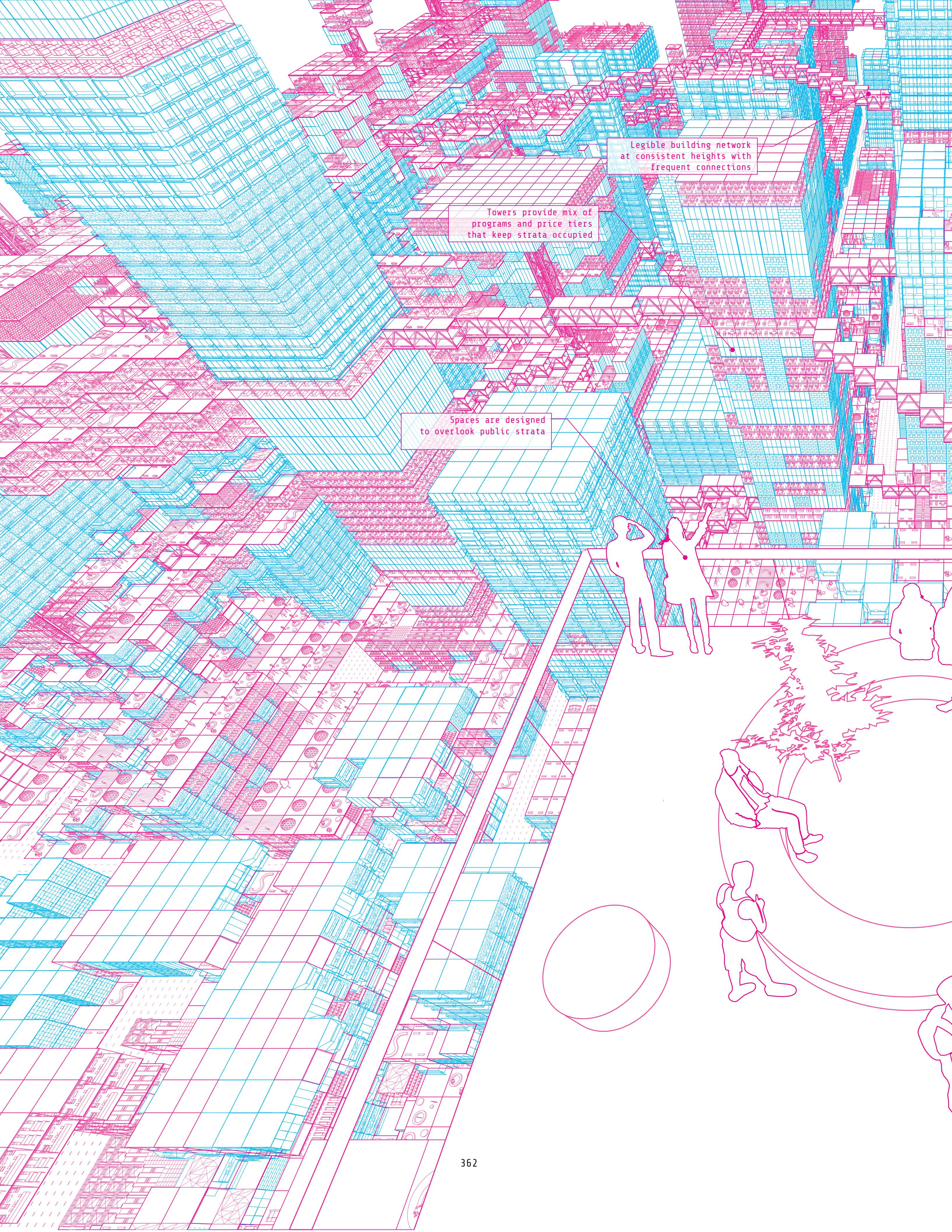


Figure 16.03.b: Axonometric view of the proposed scenario, a vitality-driven volumetric city, represented as private program in generic cyan voxels and public or quasi-public program in magenta as spatialized, program-specific voxels.


Legible building network at consistent heights with frequent connections
Towers provide mix of programs and price tiers that keep strata occupied
Spaces are designed to overlook public strata

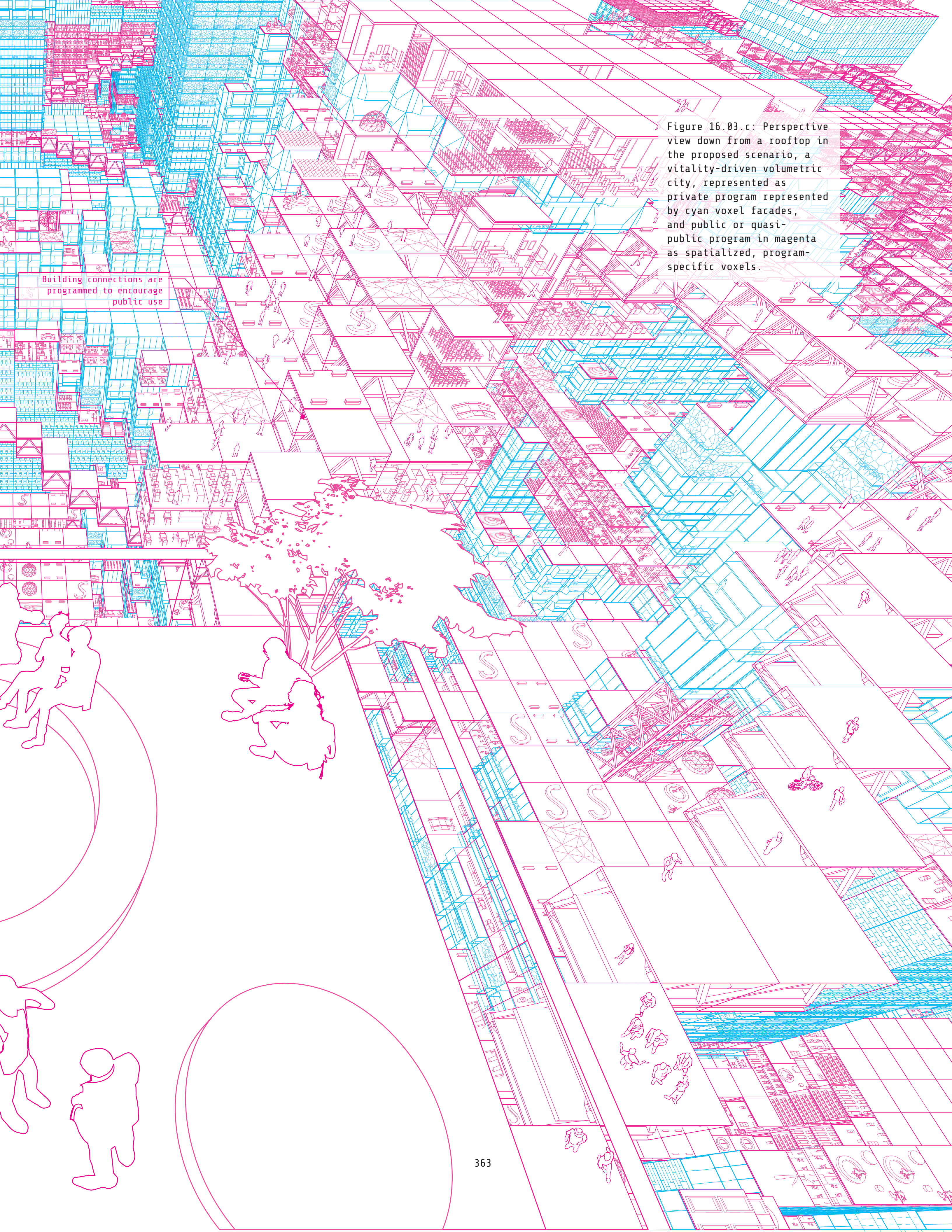


Figure 16.03.c: Perspective view down from a rooftop in the proposed scenario, a vitality-driven volumetric city, represented as private program represented by cyan voxel facades, and public or quasi-public program in magenta as spatialized, program-specific voxels.

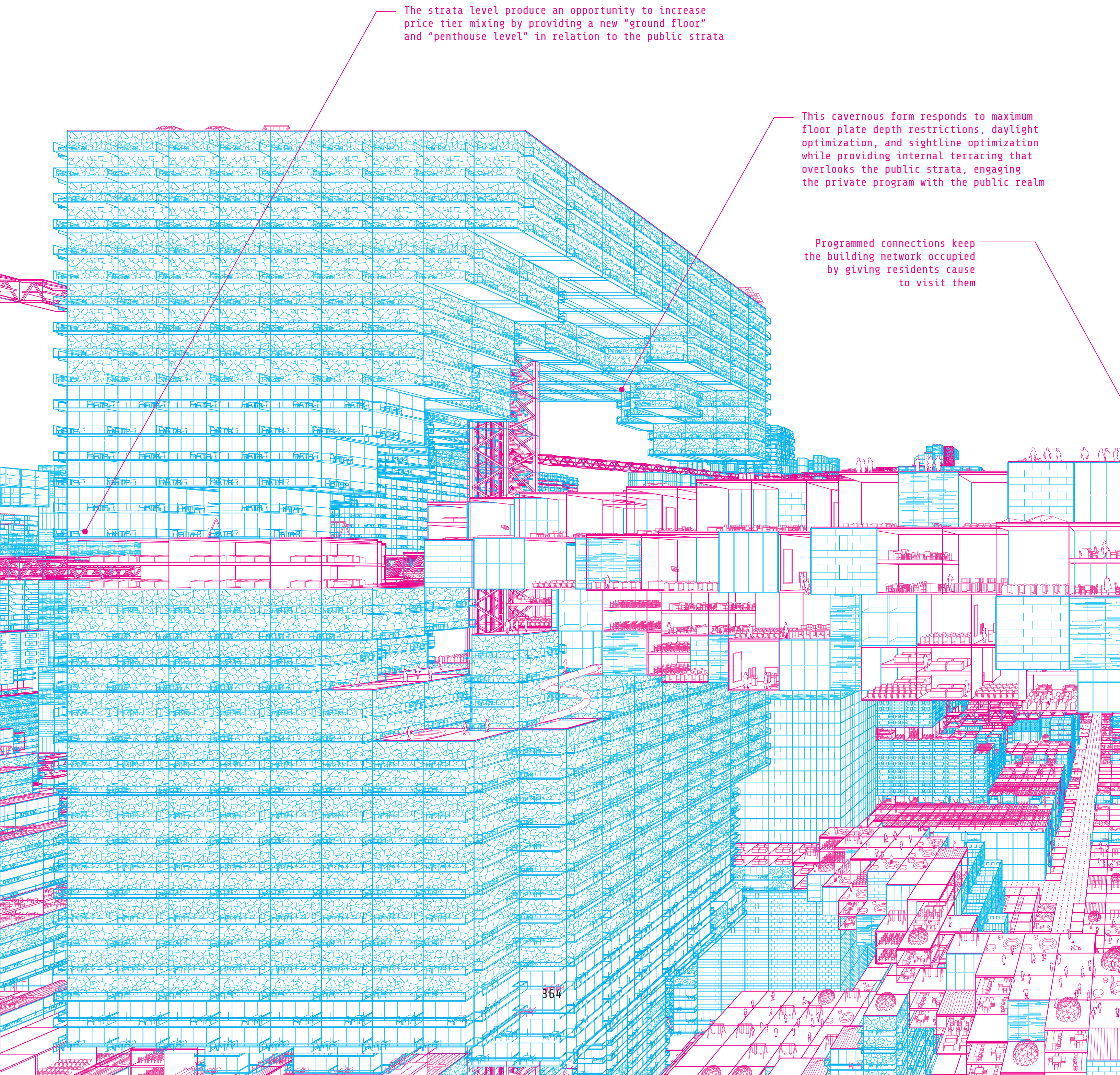
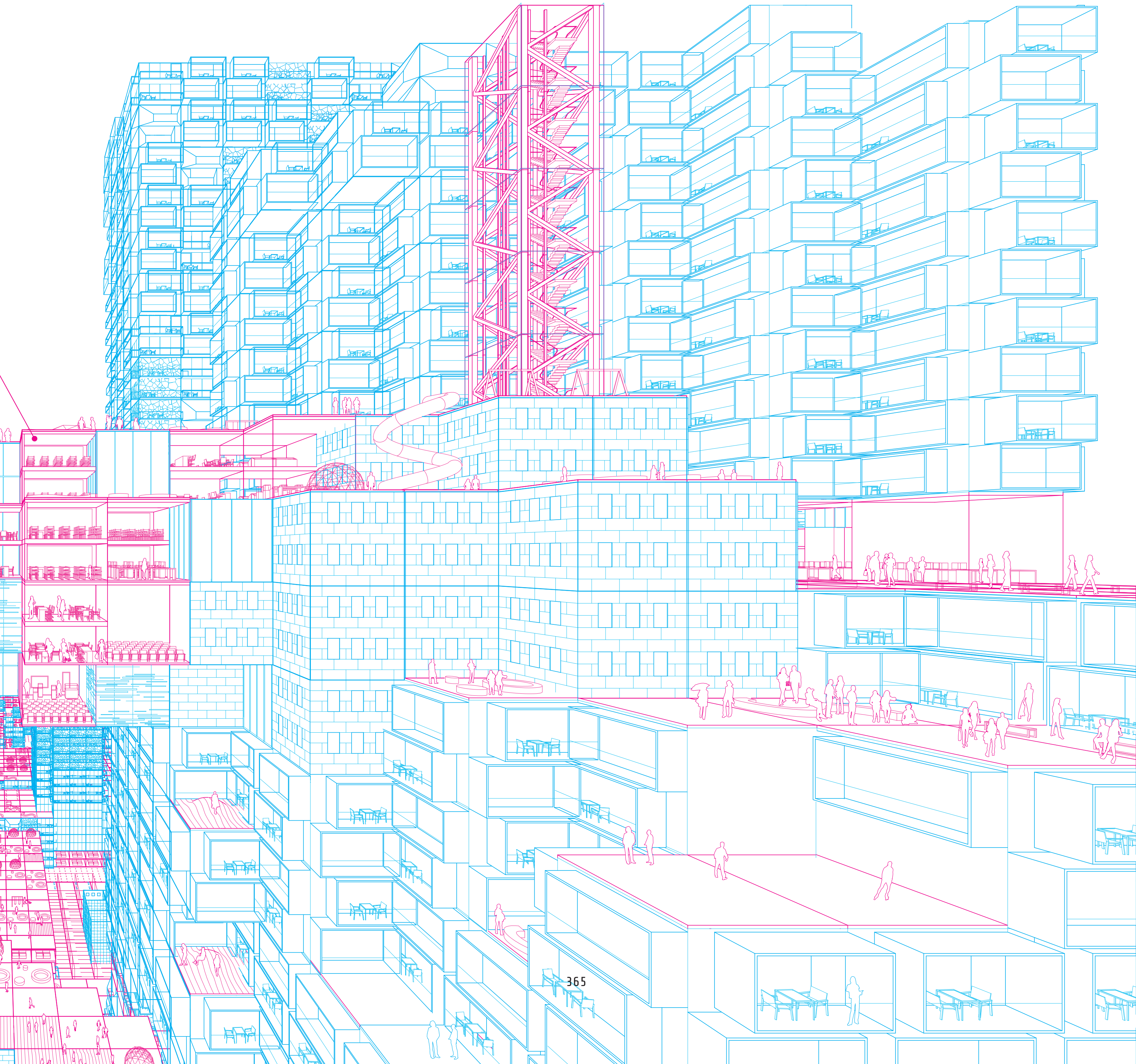
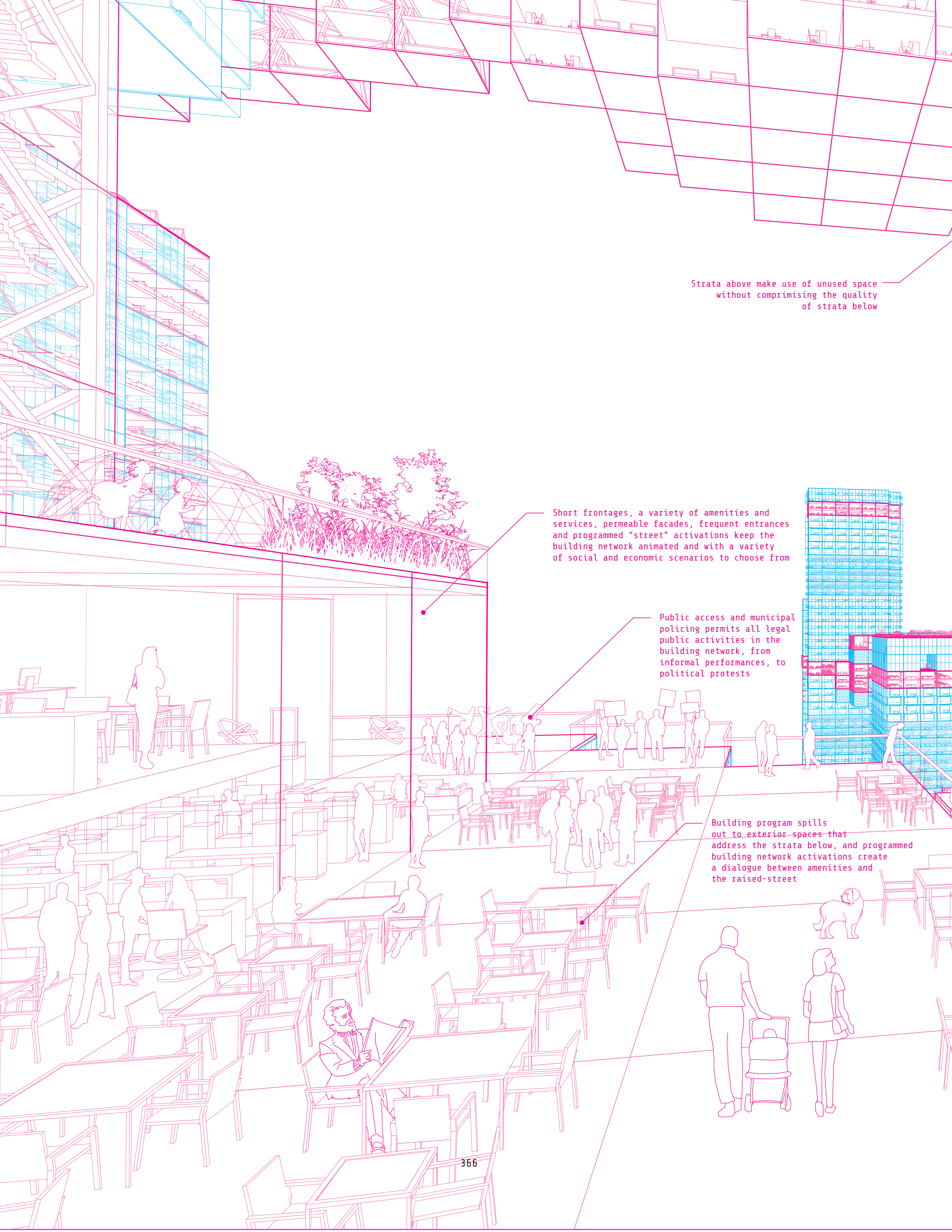

The strata level produce an opportunity to increase price tier mixing by providing a new “ground floor” and “penthouse level” in relation to the public strata
This cavernous form responds to maximum floor plate depth restrictions, daylight optimization, and sightline optimization while providing internal terracing that overlooks the public strata, engaging the private program with the public realm
Programmed connections keep the building network occupied by giving residents cause to visit them

Figure 16.03.d: Perspective view of a programmed sky-bridge in the proposed scenario, a vitality-driven volumetric city.




Strata above make use of unused space
without comprimising the quality
of strata below
Short frontages, a variety of amenities and
services, permeable facades, frequent entrances
and programmed “street” activations keep the
building network animated and with a variety
of social and economic scenarios to choose from
Public access and municipal
policing permits all legal
public activities in the
building network, from
informal performances, to
political protests
Building program spills
out to exterior spaces that
address the strata below, and programmed
building network activations create
a dialogue between amenities and
the raised-street

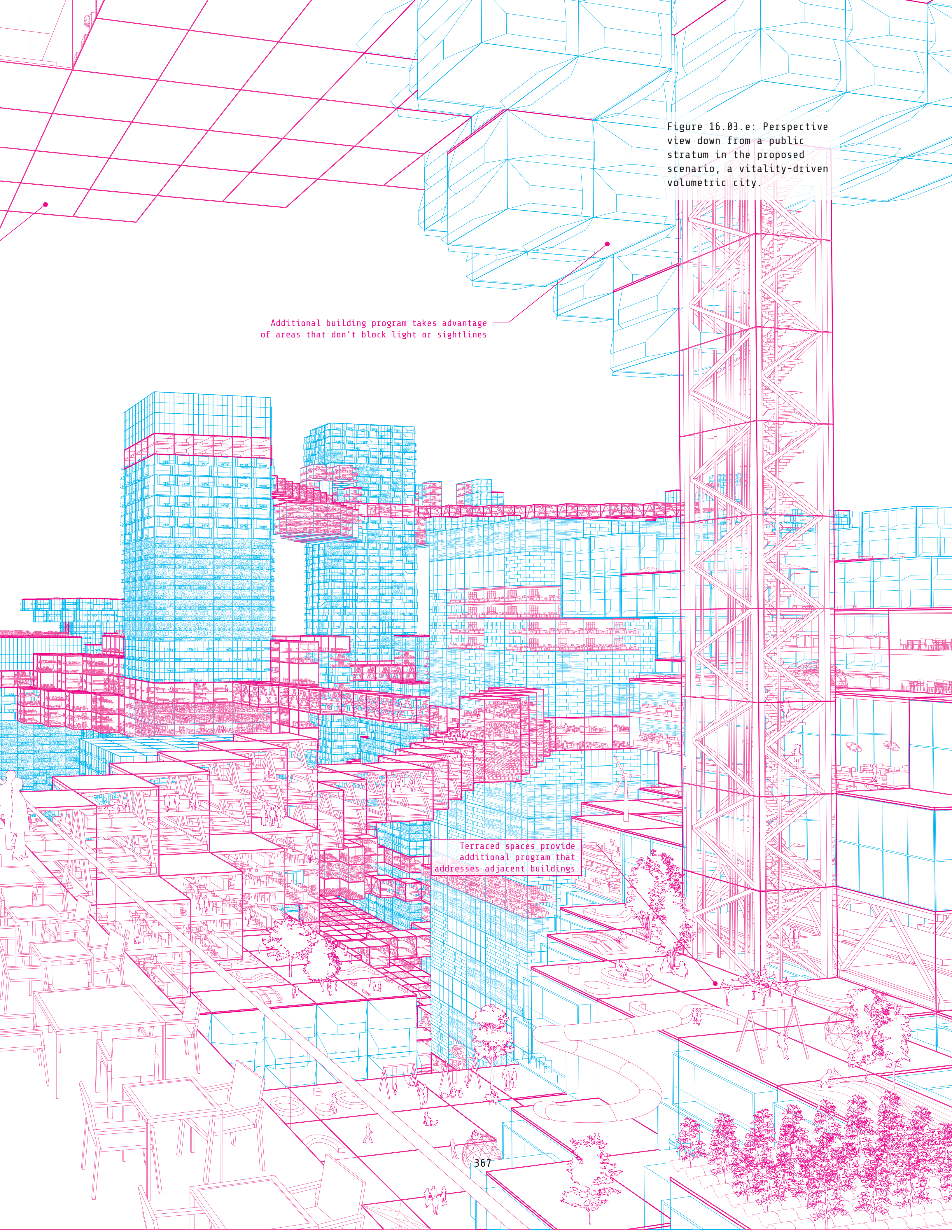


Figure 16.03.e: Perspective view down from a public stratum in the proposed scenario, a vitality-driven volumetric city.

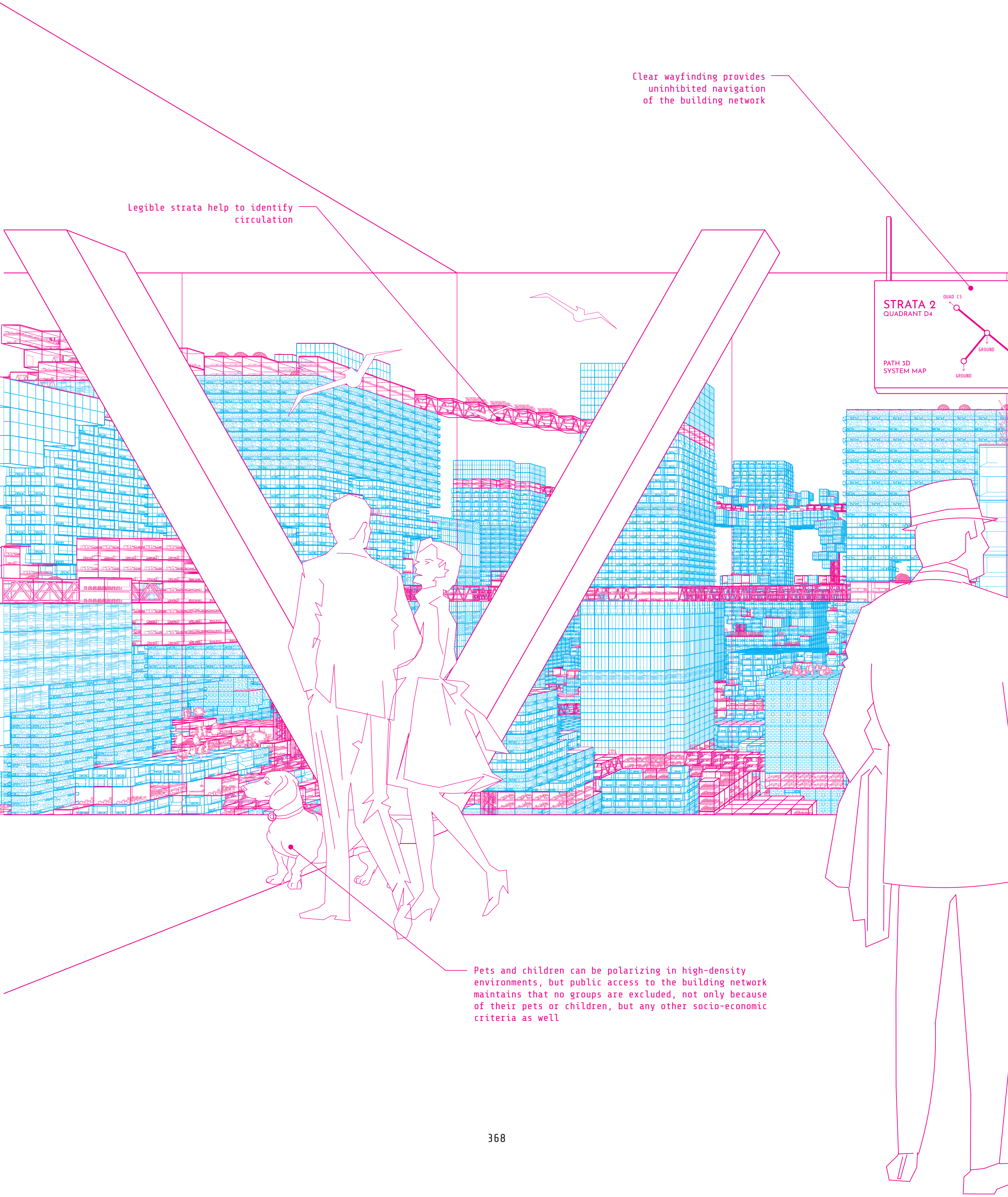
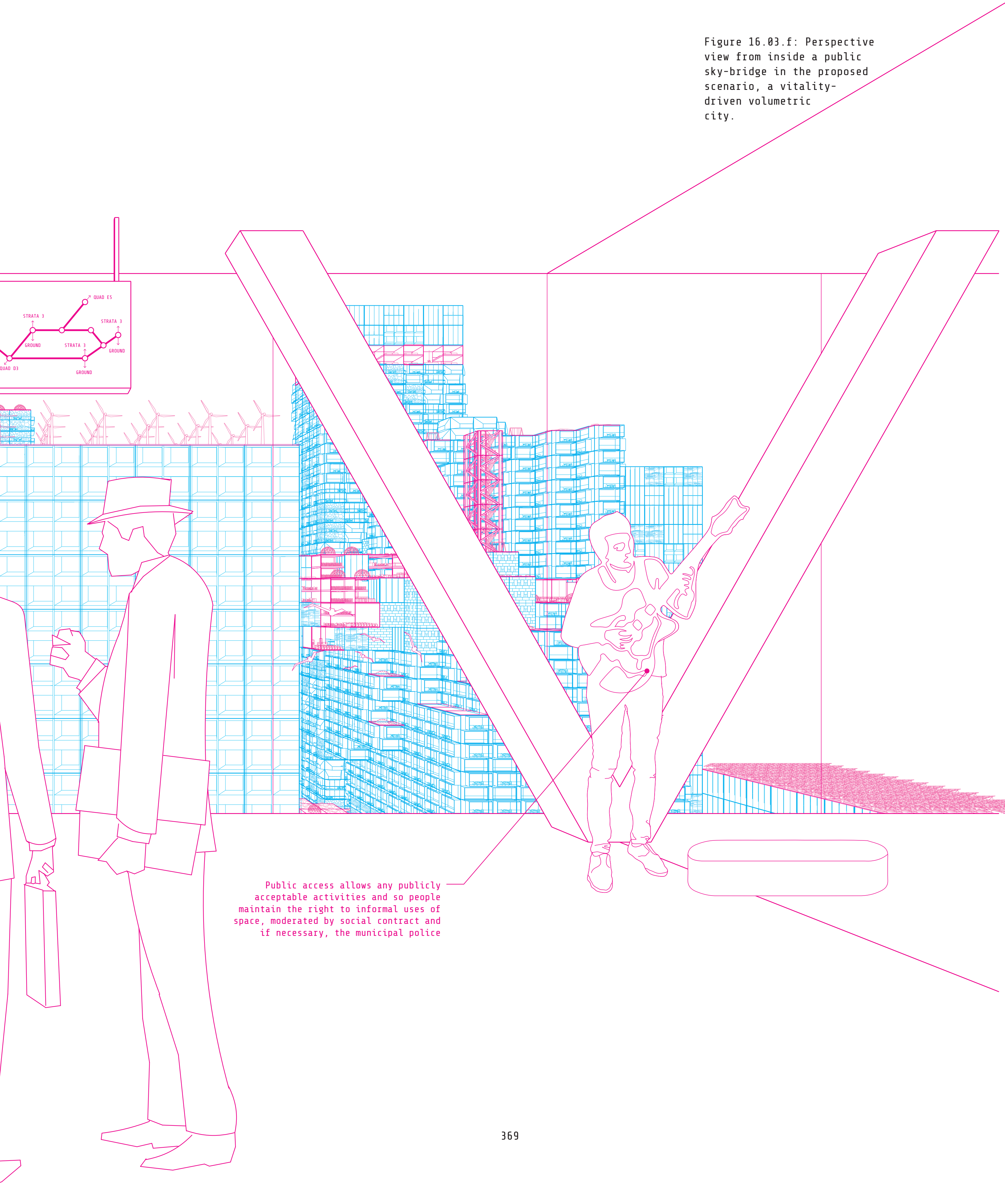
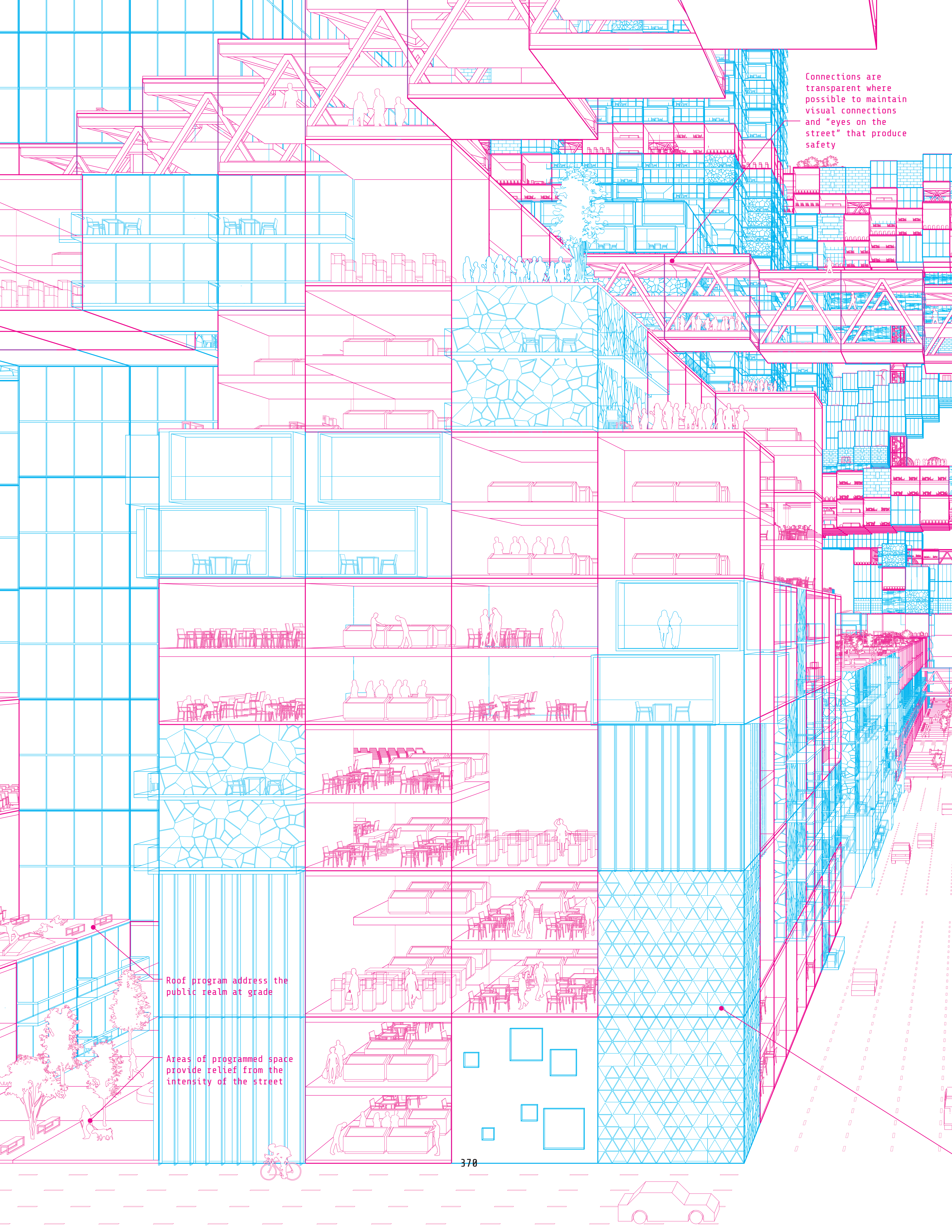

Clear wayfinding provides uninhibited navigation of the building network
Legible strata help to identify circulation
STRATA 2
QUADRANT D4
QUAD C5
GROUND
GROUND
PATH 3D
SYSTEM MAP
Pets and children can be polarizing in high-density environments, but public access to the building network maintains that no groups are excluded, not only because of their pets or children, but any other socio-economic criteria as well

Figure 16.03.f: Perspective view from inside a public sky-bridge in the proposed scenario, a vitality-driven volumetric city.




Connections are transparent where possible to maintain visual connections and "eyes on the street" that produce safety
Roof program address the public realm at grade
Areas of programmed space provide relief from the intensity of the street

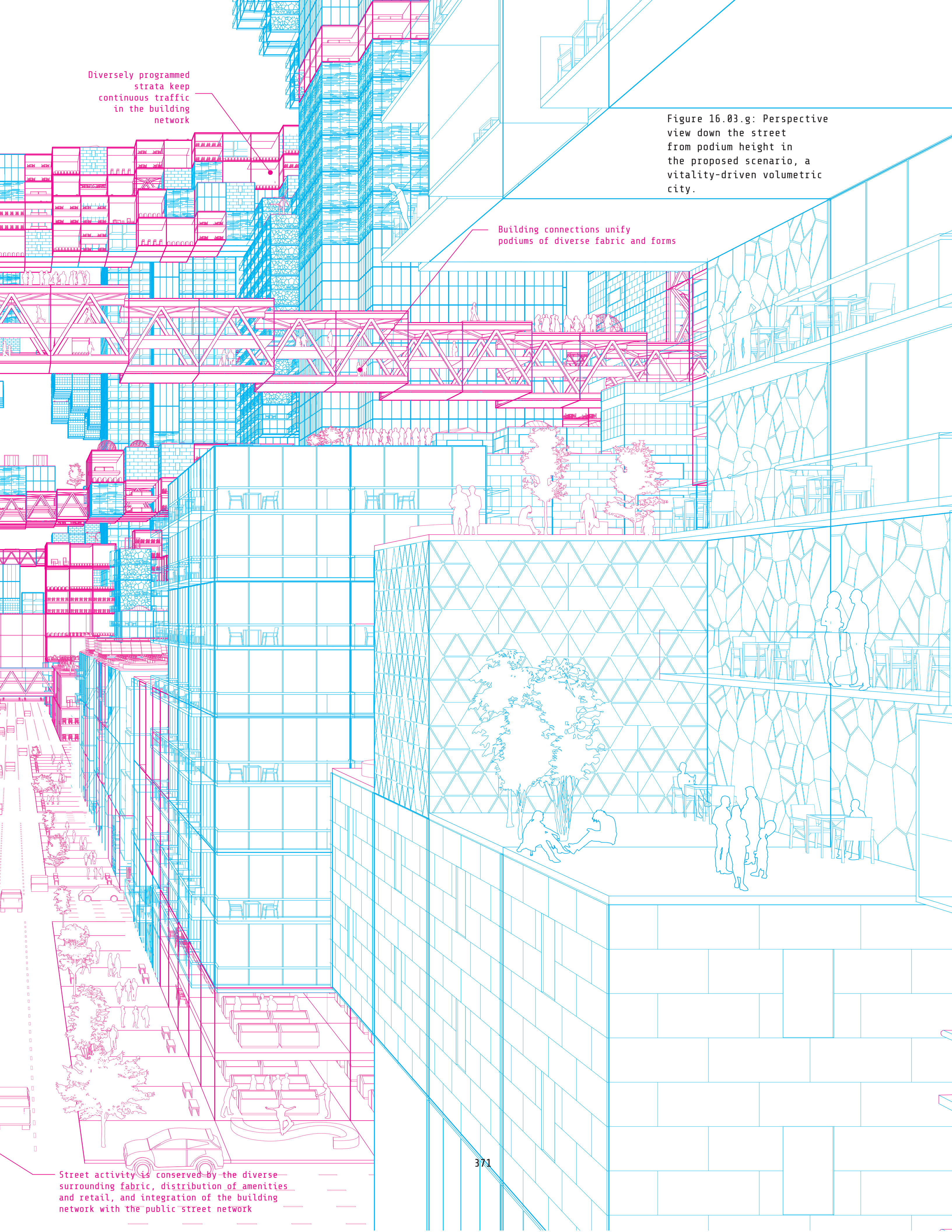
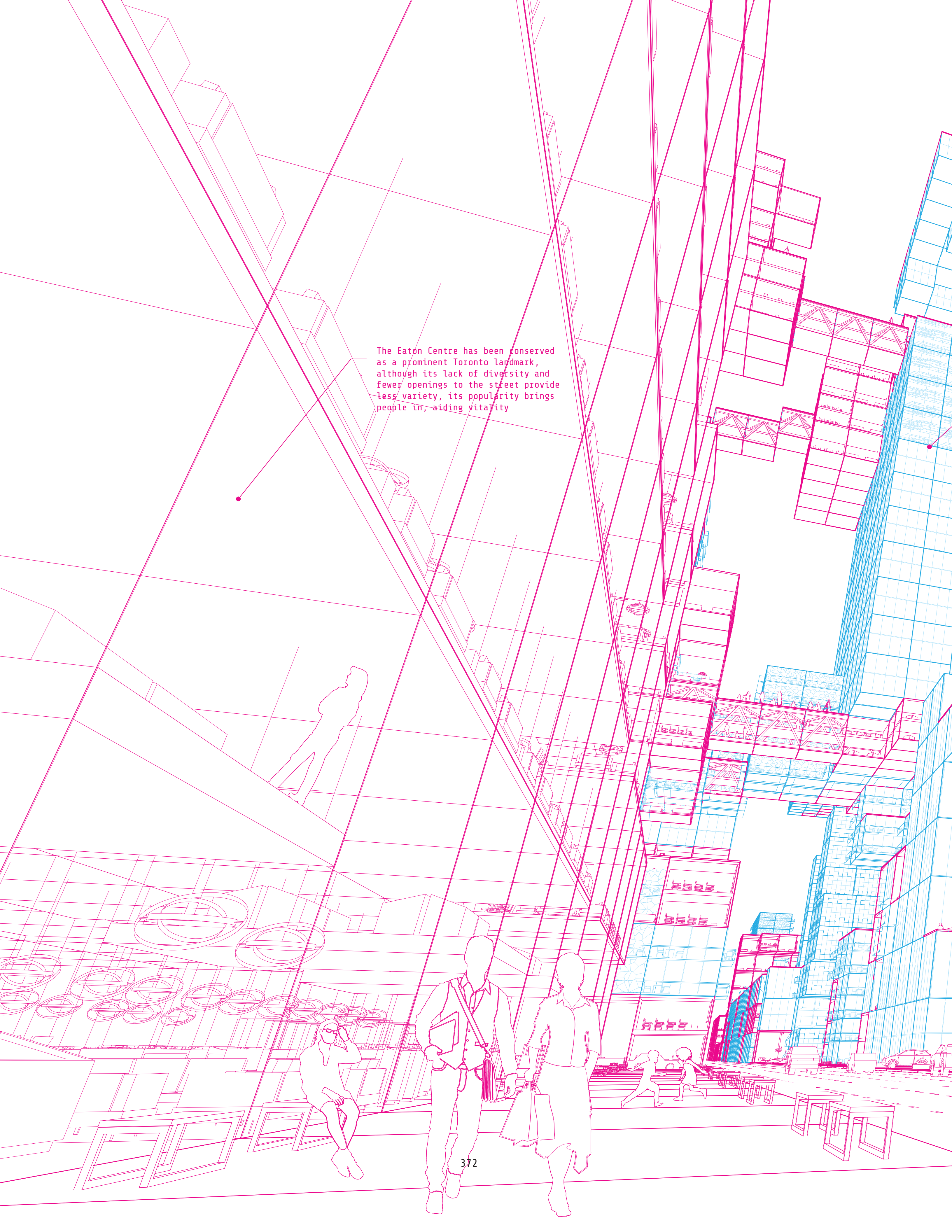


Figure 16.03.g: Perspective view down the street from podium height in the proposed scenario, a vitality-driven volumetric city.


The Eaton Centre has been conserved
as a prominent Toronto landmark,
although its lack of diversity and
fewer openings to the street provide
less variety, its popularity brings
people in, aiding vitality

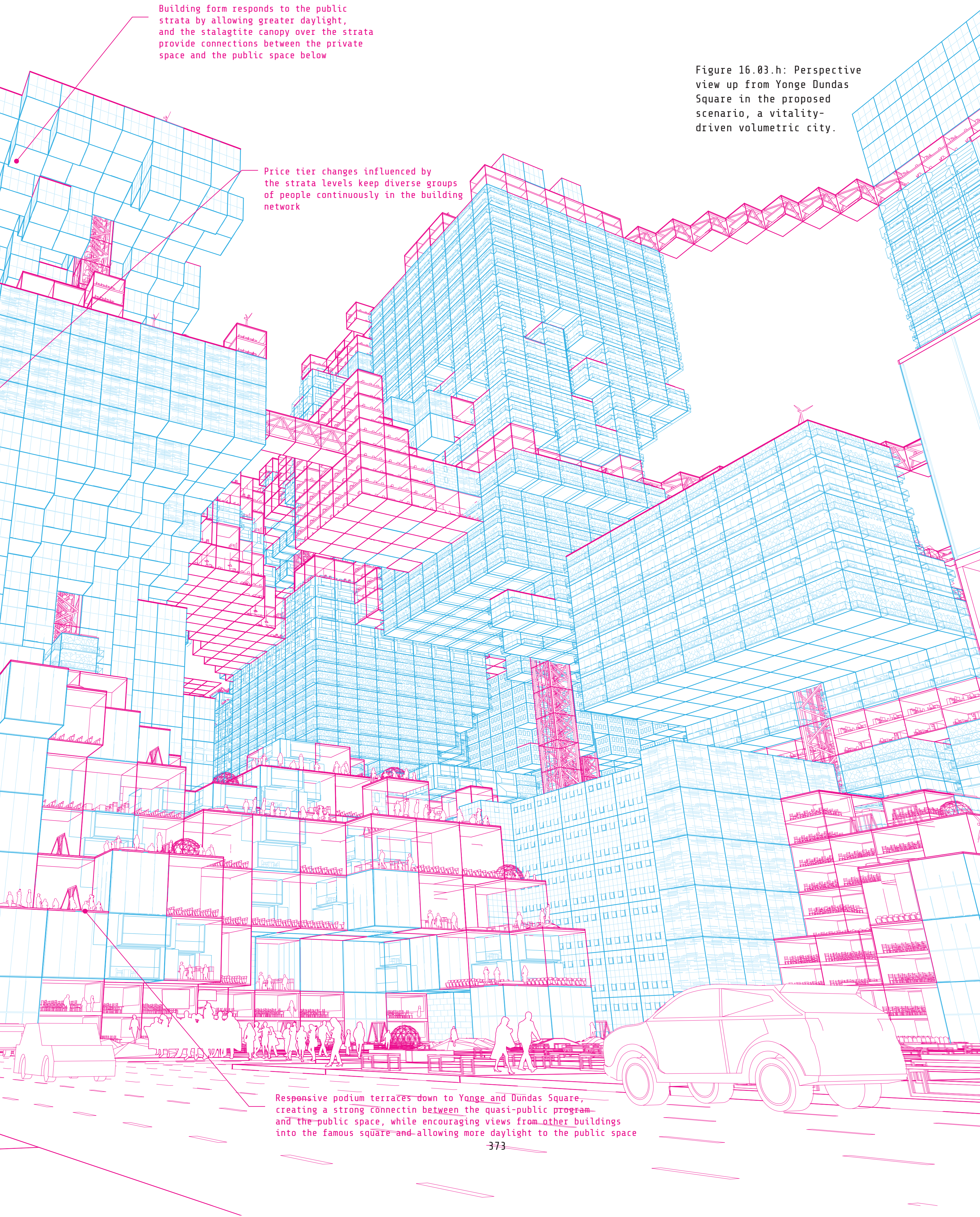


Figure 16.03.h: Perspective view up from Yonge Dundas Square in the proposed scenario, a vitality-driven volumetric city.

16.04 COMPARISON SCENARIO 1: THE PROFIT-DRIVEN VOLUMETRIC CITY

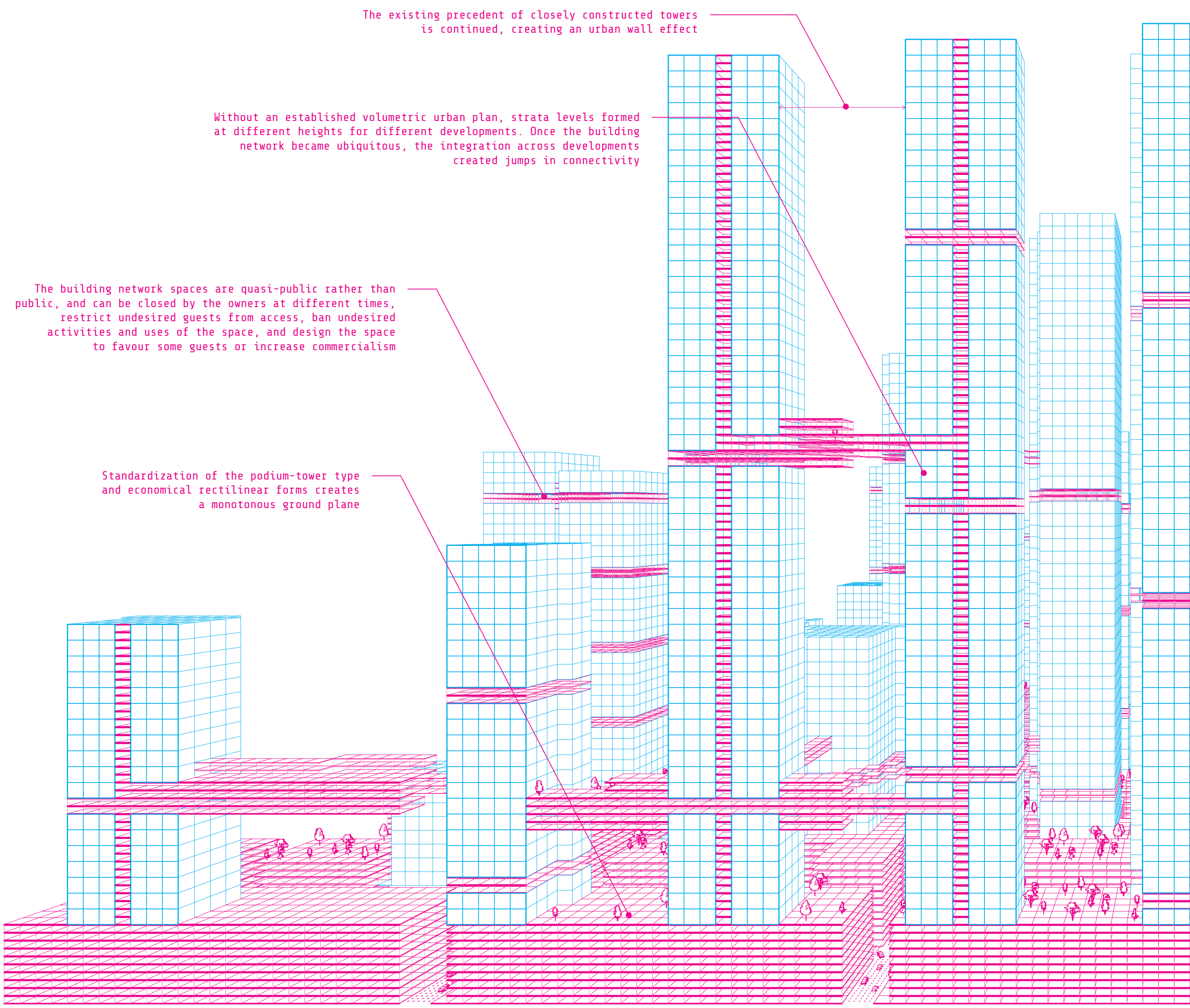
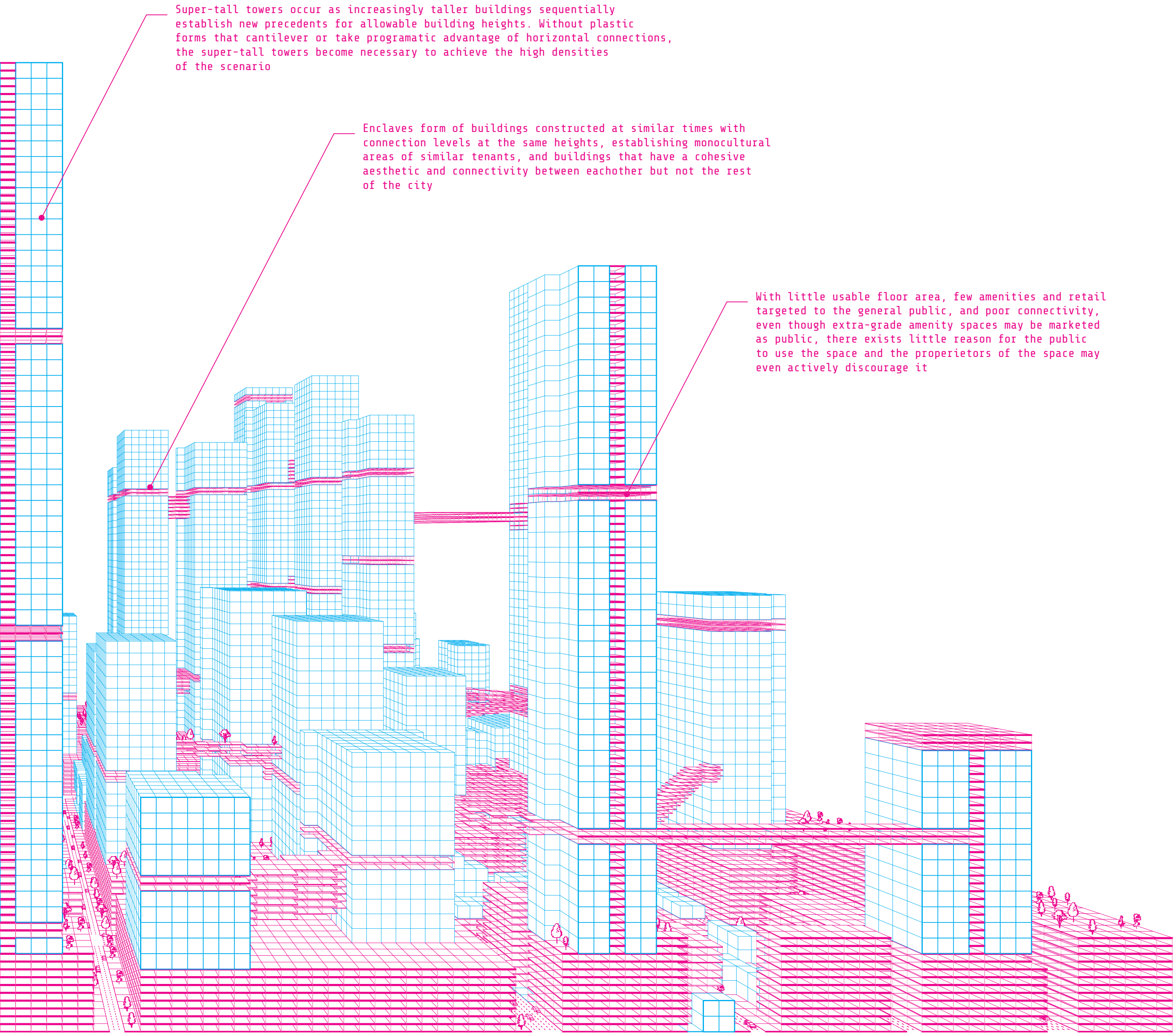
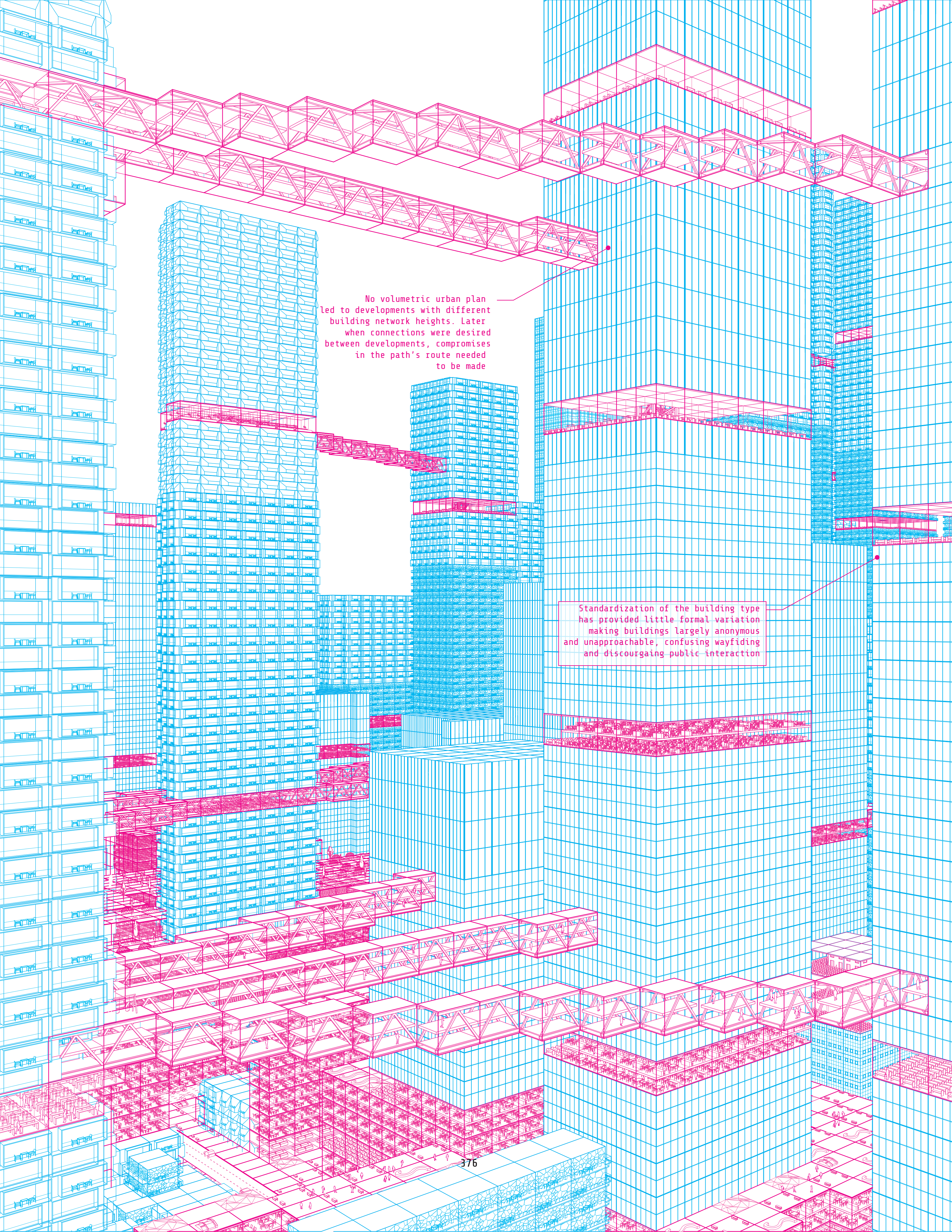


Figure 16.04.a: Section through one of two comparative scenarios generated, a profit-driven volumetric city, represented as generic voxels of either private program in cyan, or public and quasi-public program in magenta.




No volumetric urban plan led to developments with different building network heights. Later when connections were desired between developments, compromises in the path's route needed to be made
Standardization of the building type has provided little formal variation making buildings largely anonymous and unapproachable, confusing wayfiding and discourgaing public interaction

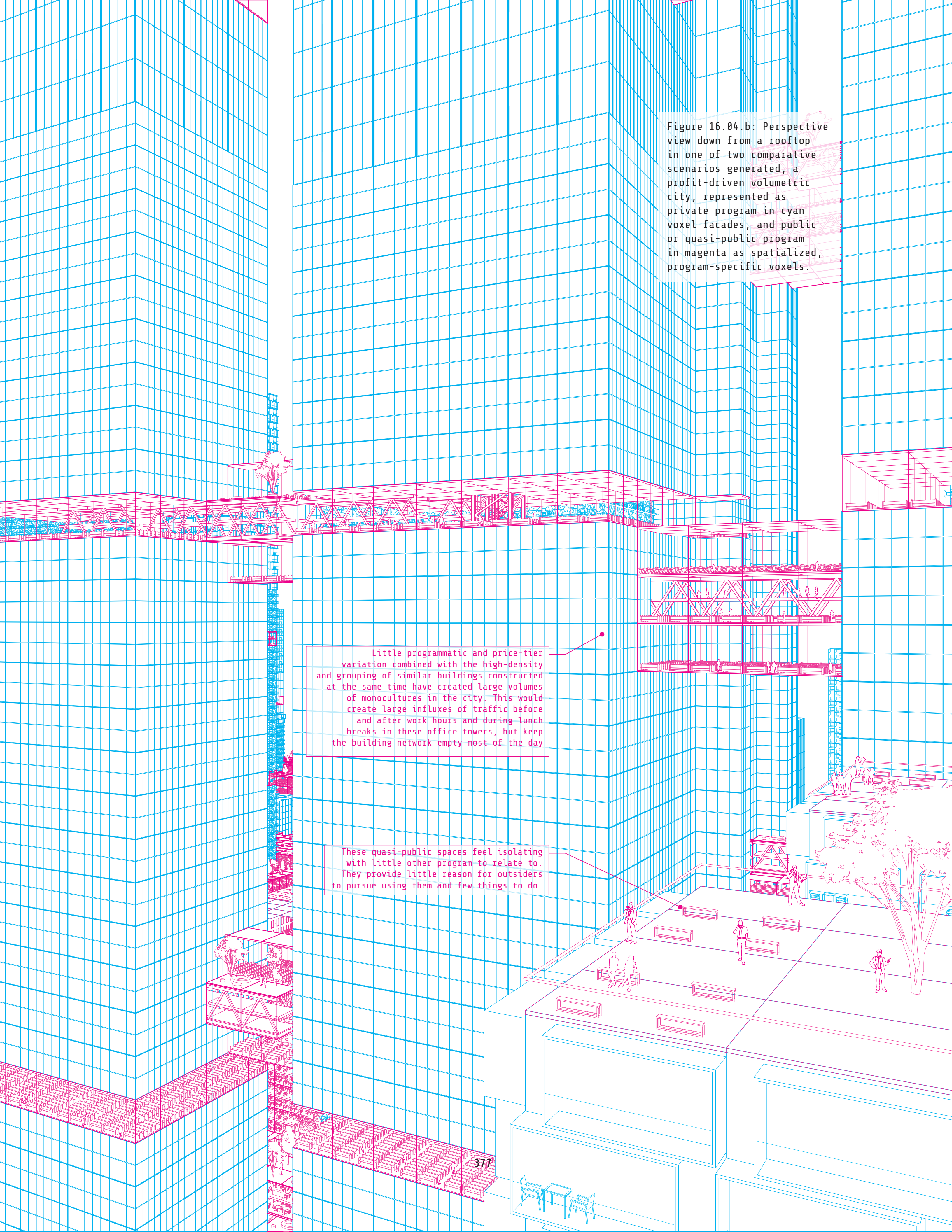
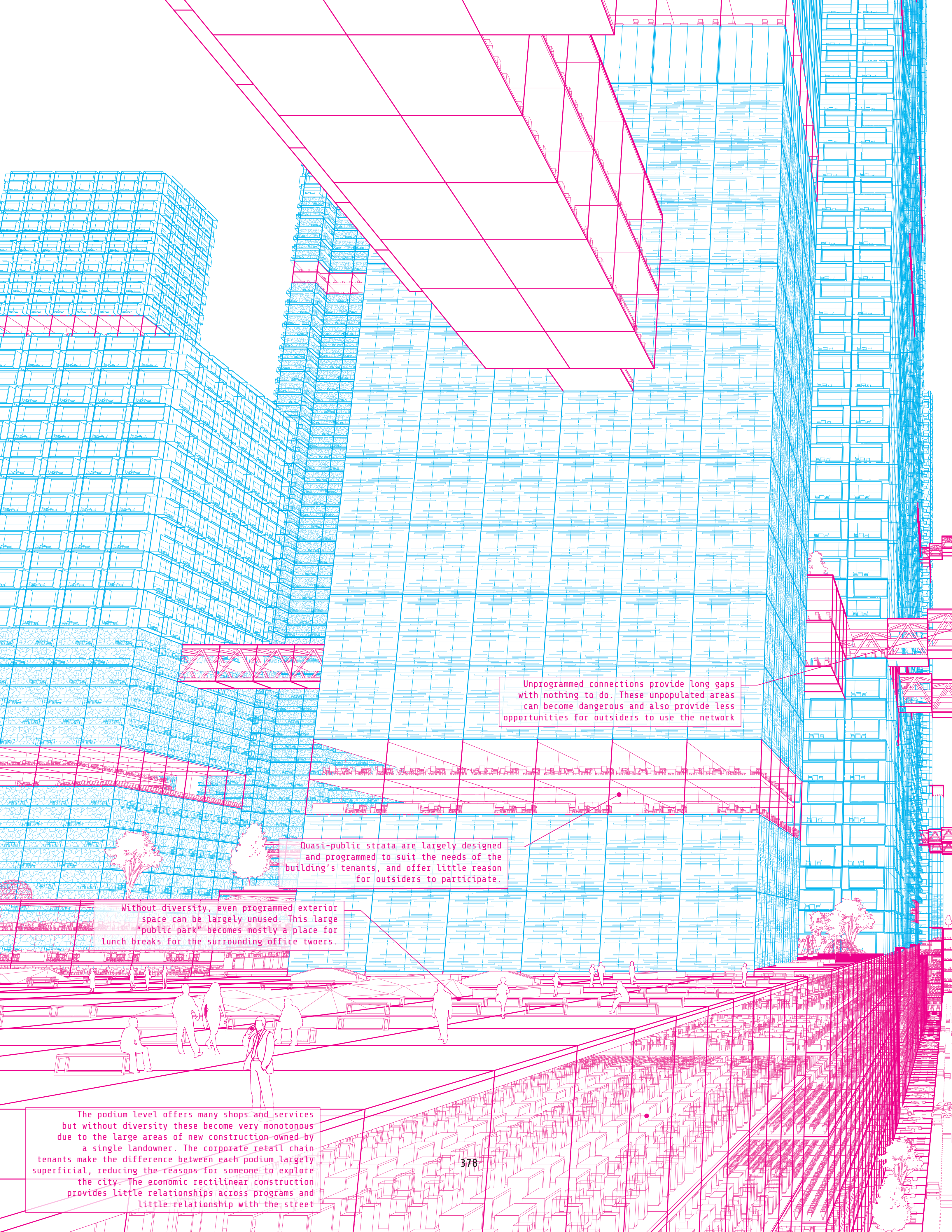


Figure 16.04.b: Perspective view down from a rooftop in one of two comparative scenarios generated, a profit-driven volumetric city, represented as private program in cyan voxel facades, and public or quasi-public program in magenta as spatialized, program-specific voxels.


Unprogrammed connections provide long gaps with nothing to do. These unpopulated areas can become dangerous and also provide less opportunities for outsiders to use the network
Quasi-public strata are largely designed and programmed to suit the needs of the building’s tenants, and offer little reason for outsiders to participate.
Without diversity, even programmed exterior space can be largely unused. This large “public park” becomes mostly a place for lunch breaks for the surrounding office twoers.
The podium level offers many shops and services but without diversity these become very monotonous due to the large areas of new construction owned by a single landowner. The corporate retail chain tenants make the difference between each podium largely superficial, reducing the reasons for someone to explore the city. The economic rectilinear construction provides little relationships across programs and little relationship with the street

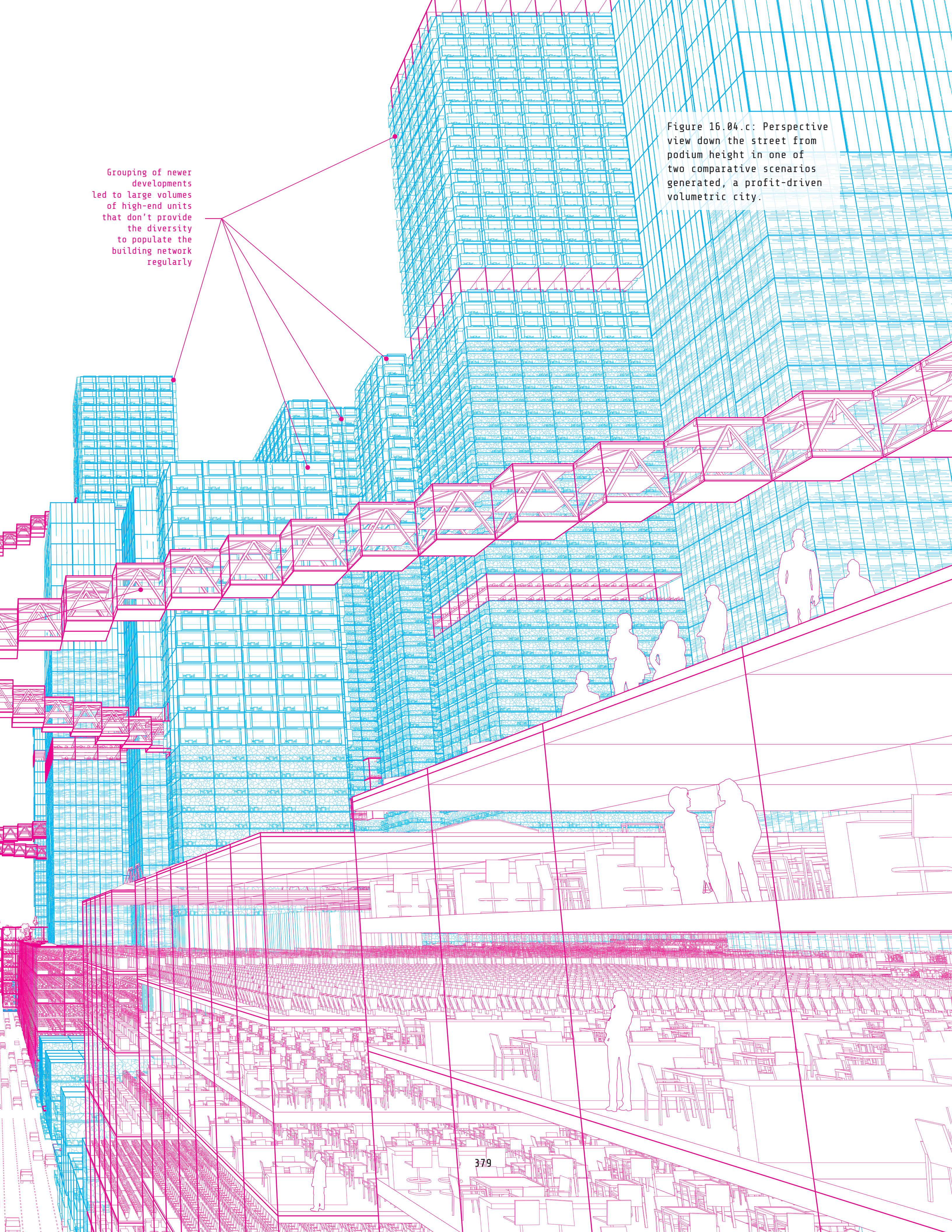


Figure 16.04.c: Perspective view down the street from podium height in one of two comparative scenarios generated, a profit-driven volumetric city.

16.05 COMPARISON SCENARIO 2: THE VITALITY-DRIVEN PLANAR CITY

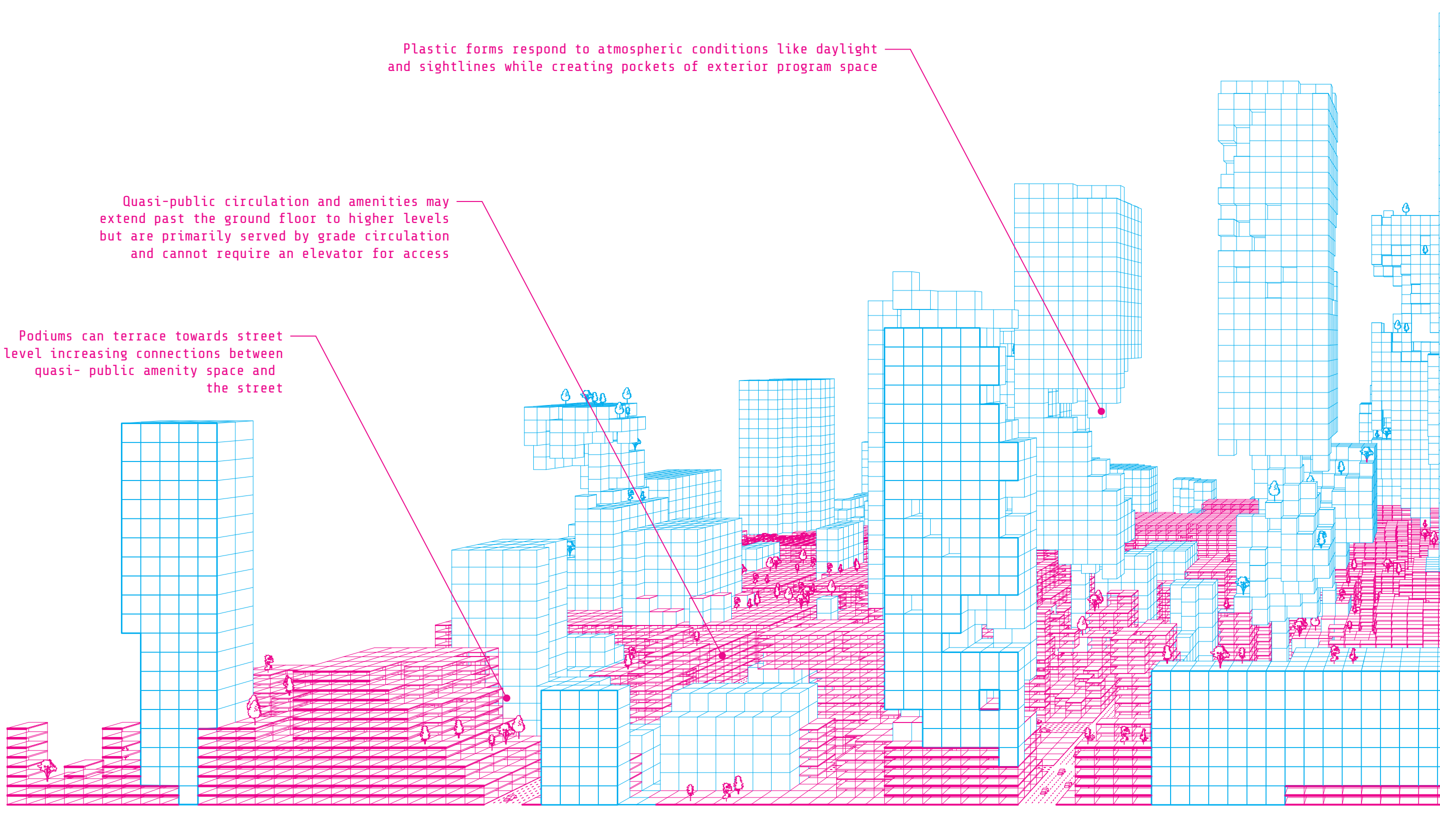
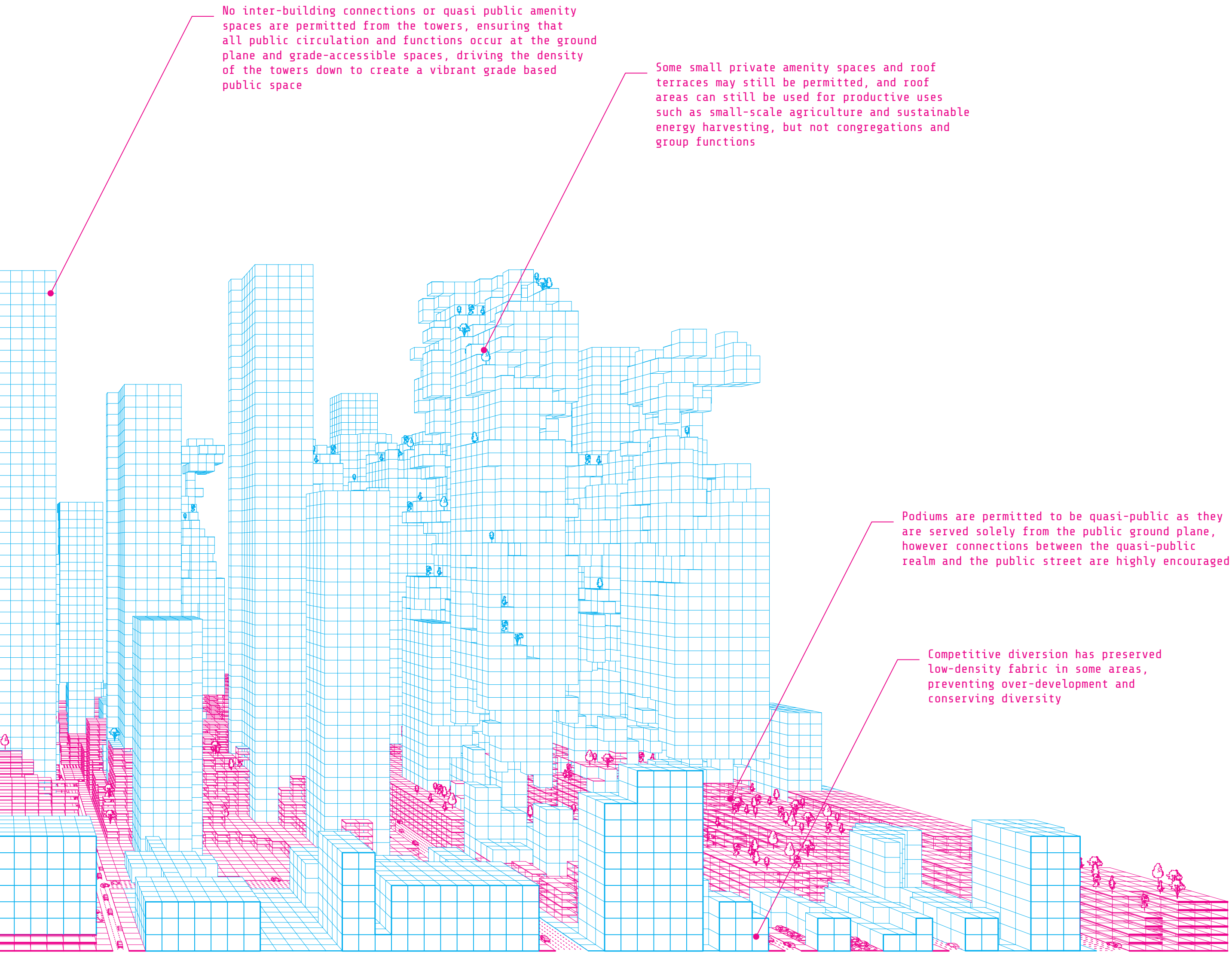
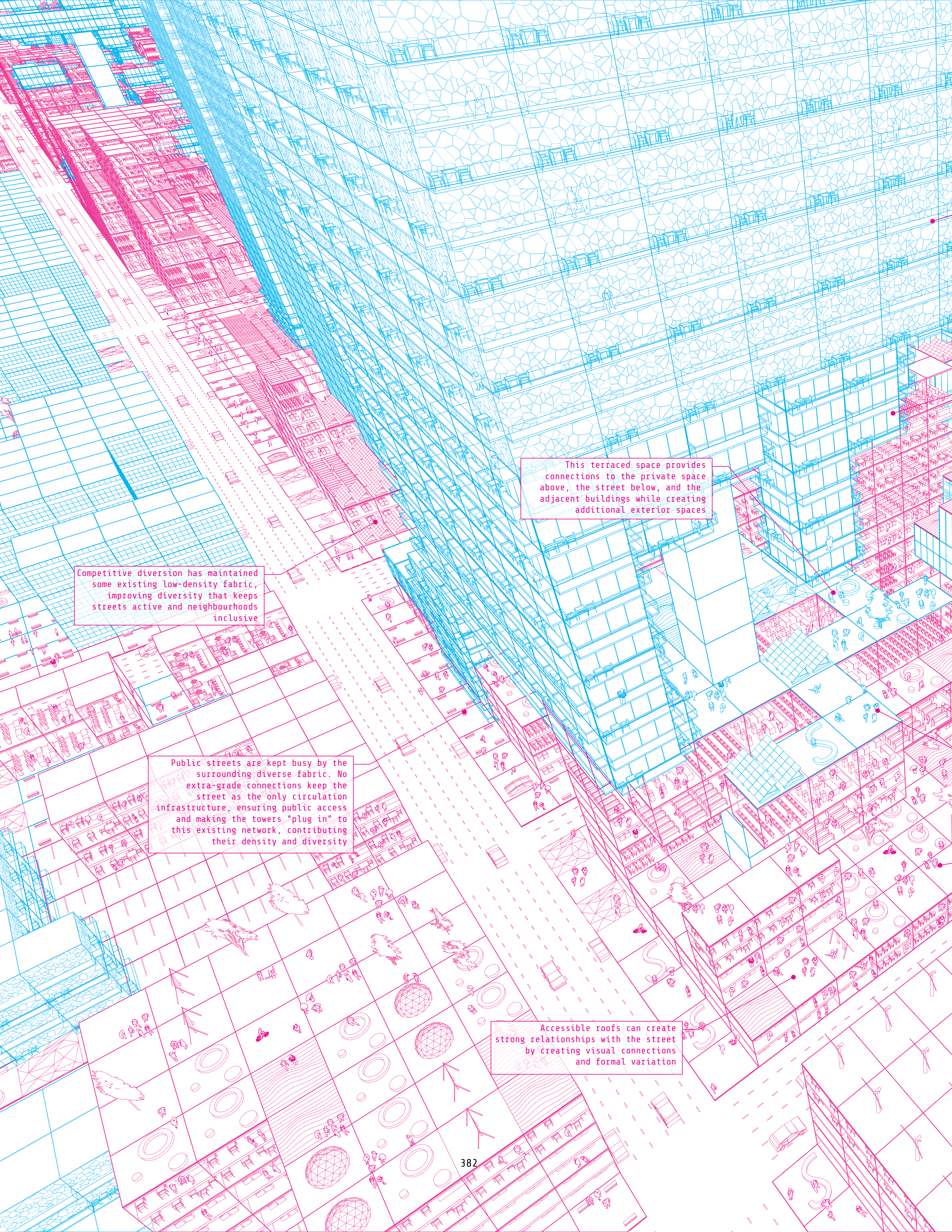


Figure 16.05.a: Section through one of two comparative scenarios generated, a vitality-driven planar city, represented as generic voxels of either private program in cyan, or public and quasi-public program in magenta.




This terraced space provides connections to the private space above, the street below, and the adjacent buildings while creating additional exterior spaces
Competitive diversion has maintained some existing low-density fabric, improving diversity that keeps streets active and neighbourhoods inclusive
Public streets are kept busy by the surrounding diverse fabric. No extra-grade connections keep the street as the only circulation infrastructure, ensuring public access and making the towers “plug in” to this existing network, contributing their density and diversity
Accessible roofs can create strong relationships with the street by creating visual connections and formal variation

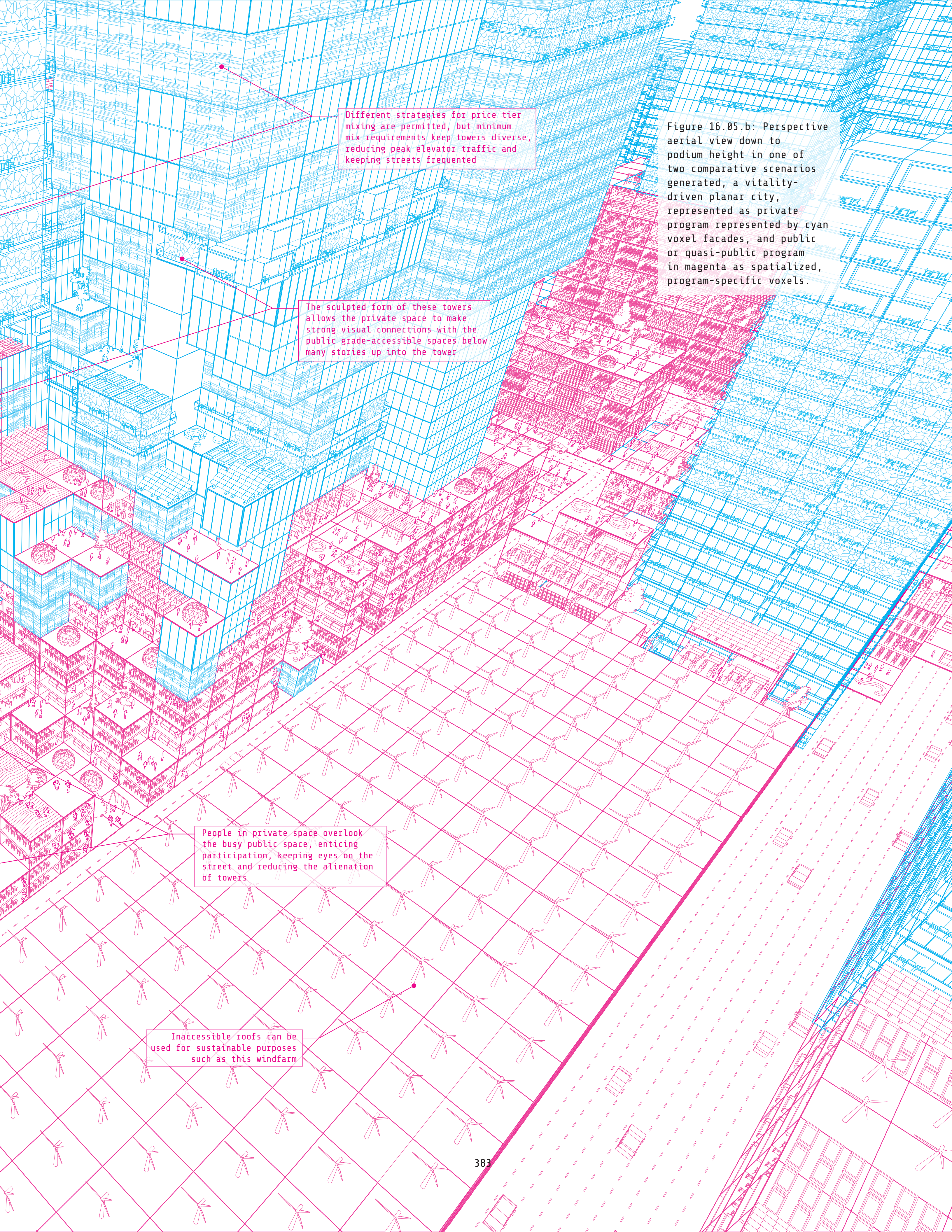


Figure 16.05.b: Perspective aerial view down to podium height in one of two comparative scenarios generated, a vitality-driven planar city, represented as private program represented by cyan voxel facades, and public or quasi-public program in magenta as spatialized, program-specific voxels.

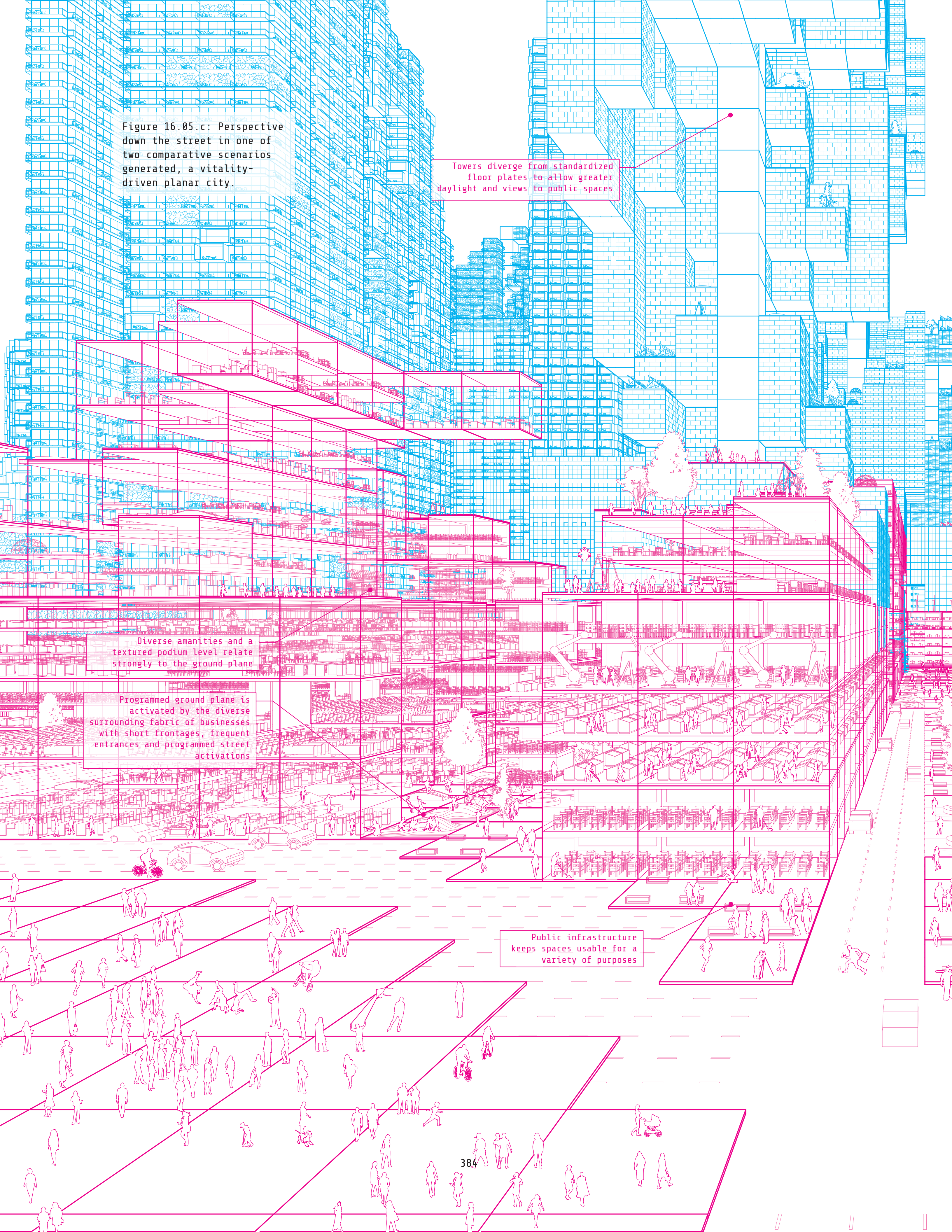
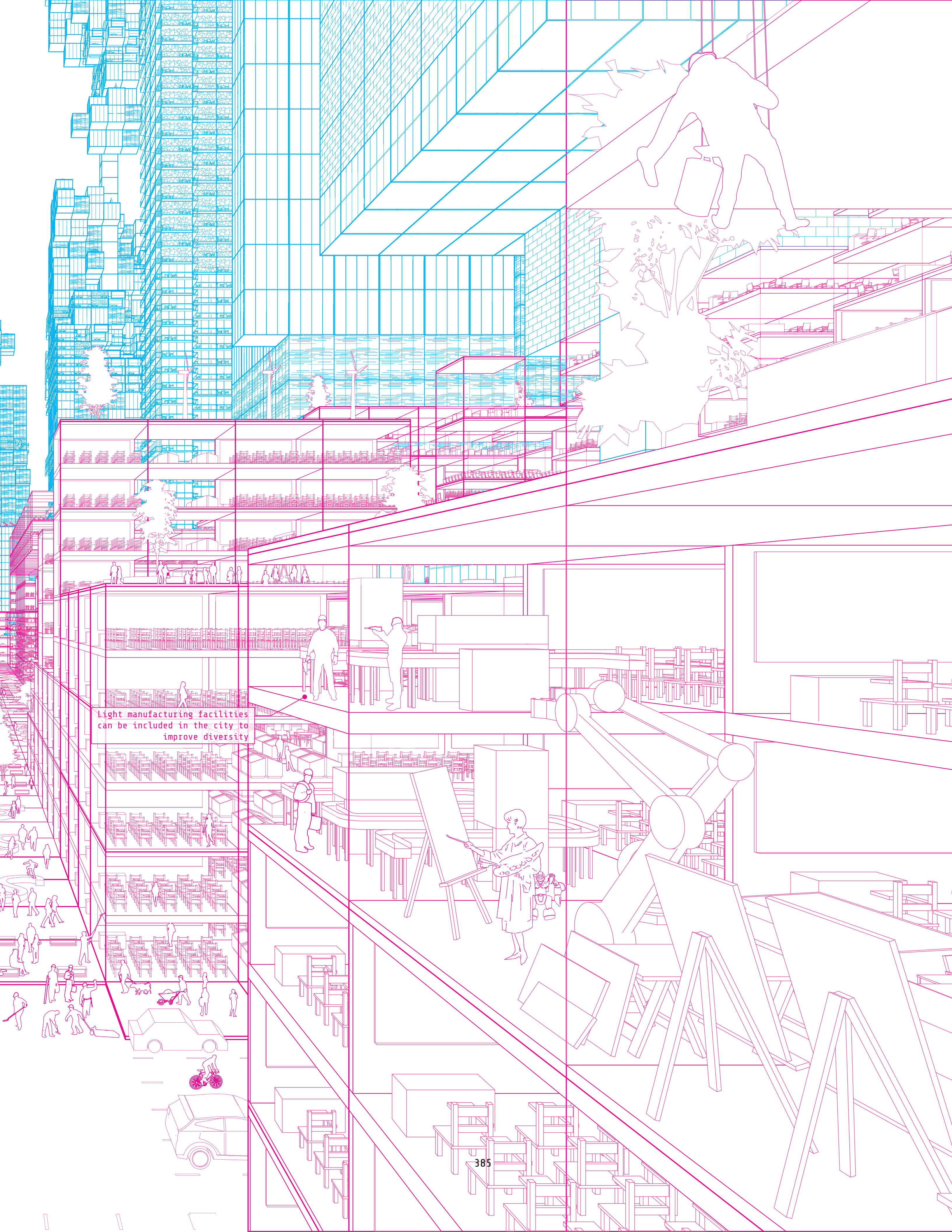


Figure 16.05.c: Perspective down the street in one of two comparative scenarios generated, a vitality-driven planar city.


Light manufacturing facilities
can be included in the city to
improve diversity

CHAPTER 17

THE SCENARIOS ARE ASSESSED THROUGH A METRIC ANALYSIS OF THEIR COMPOSITION AND URBAN RESOURCES

Now that all three scenarios have been generated using the parametric design tool and spatialized through a set of drawings, the generated geometry can be analyzed metrically by comparing graphs and visualizations of the statistics calculated about the composition and performance of each scenario. These include: the number and type of voxels, buildings, and cores; vitality performance and development scores; and building network composition. Since the parametric design tool records these statistics for each quadrant over time, the performance and composition of the building fabric model can be interrogated as they evolve over time throughout three-dimensional space.

17.01. Programmatic use

17.02. Price tier mix

17.03. Cores by network

17.04. Cores by degree of publicness

17.05. Building density

17.06. Areas prone to risk of vacancy

17.07. Other properties

17.08. Sectional progression by degree of publicness

17.09. Number of voxels by voxel properties

17.10. Network and building core properties

17.11. Building properties

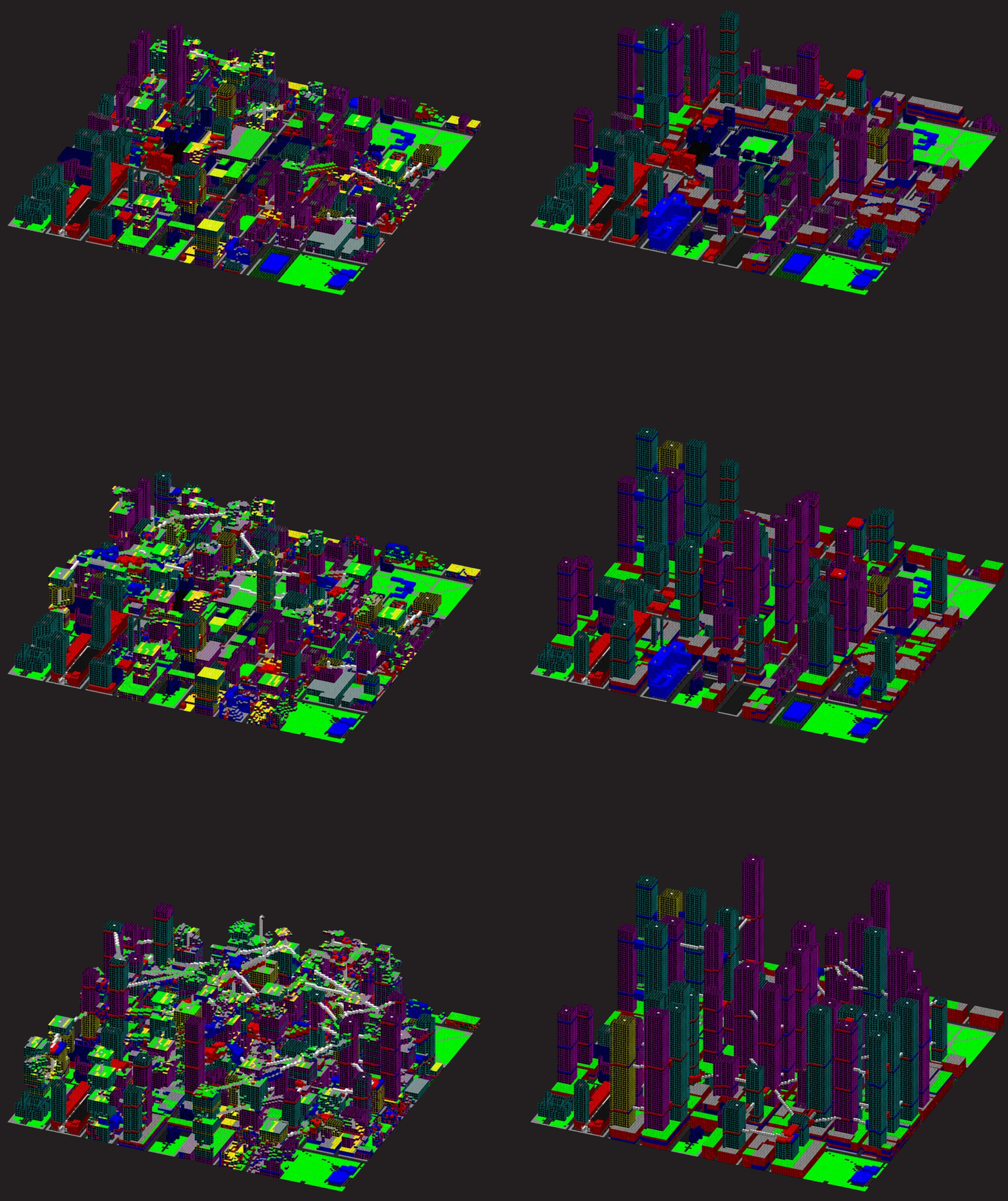
17.12. Performance scores

17.13. Performance scores by quadrant

17.01 PROGRAMMATIC USE

VITALITY-DRIVEN VOLUMETRIC

PROFIT-DRIVEN VOLUMETRIC

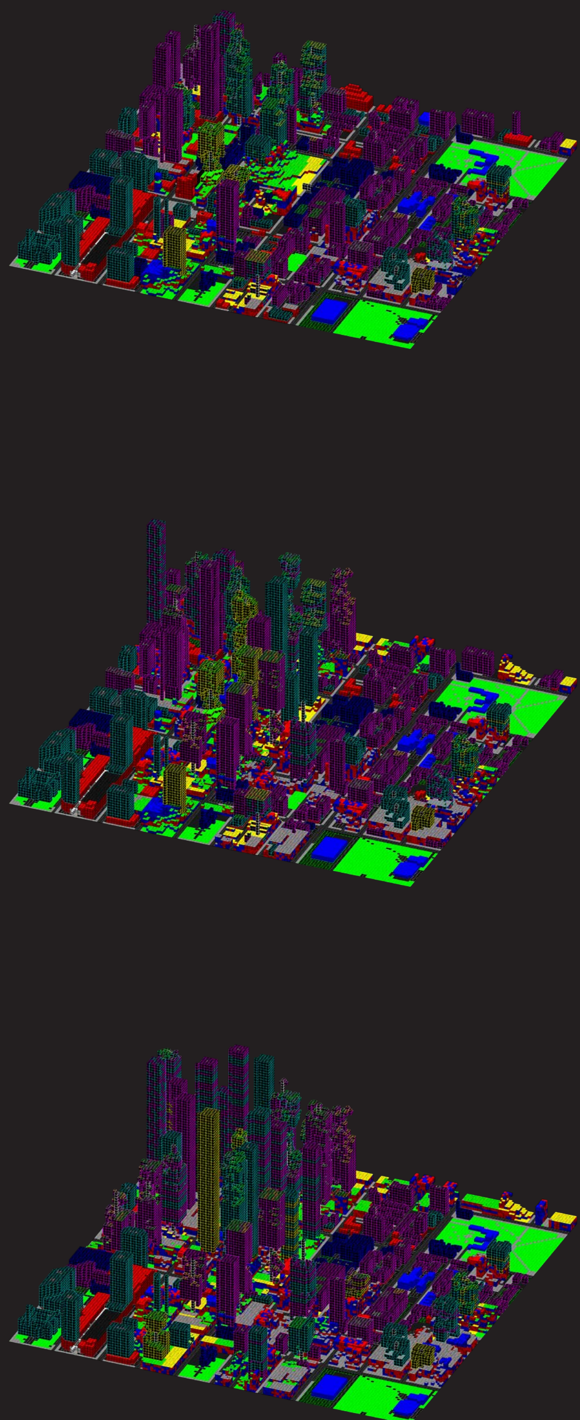


50 CYCLES

100 CYCLES

200 CYCLES

VITALITY-DRIVEN PLANAR



The vitality-driven volumetric scenario shows greater programmatic variation within the same building or building complex, indicating a greater response to local programmatic needs, greater walkability since different programs are closer together, and greater diversity since various programs are closely mingled.

The profit-driven volumetric scenario shows towers of entirely the same program, even when broken up by the horizontal strata. Buildings of the same program also tend to conglomerate, creating enclaves of similar user groups that could desolate the street and the building network at various times of day.

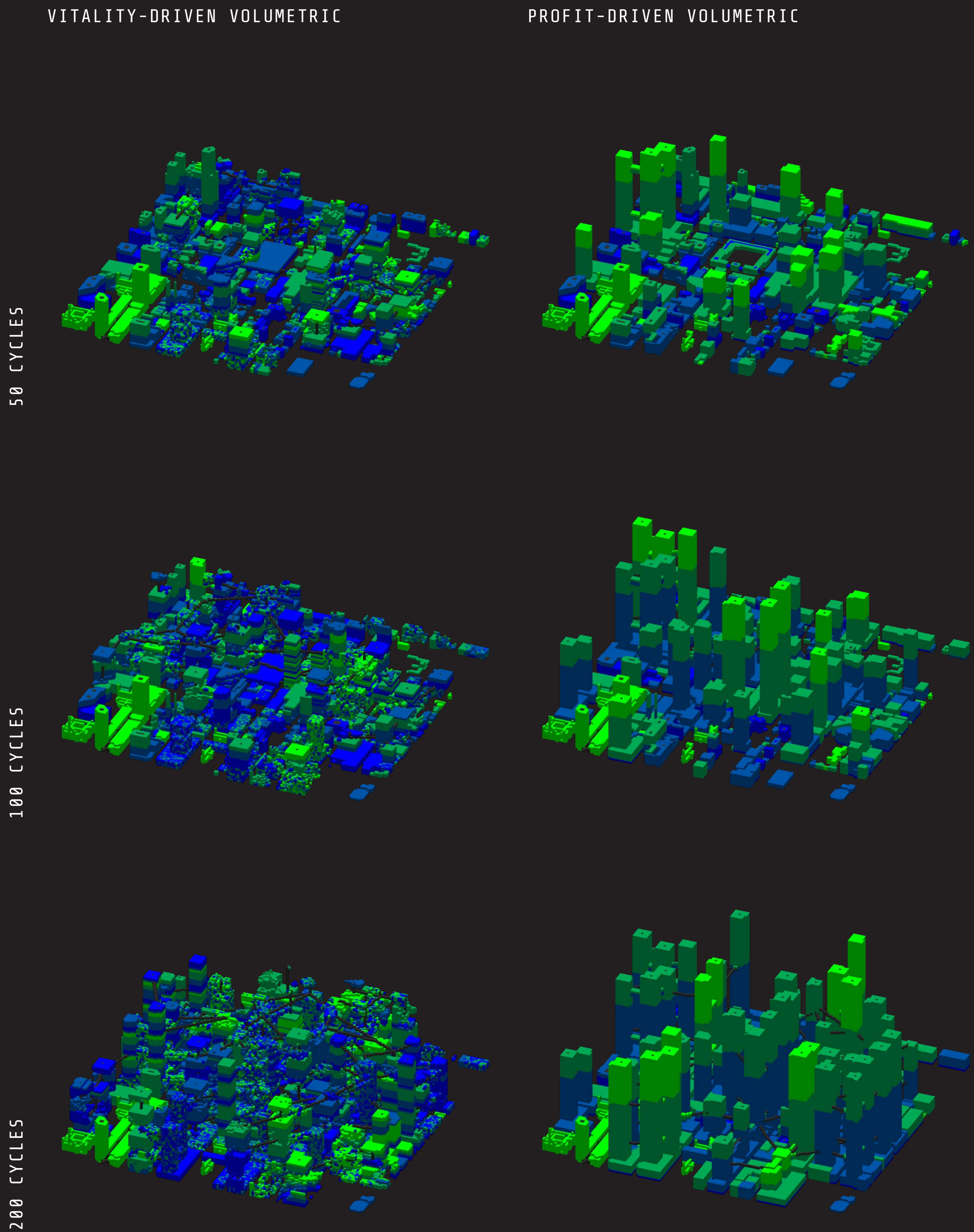
The vitality-driven planar scenario shows a similar programmatic mix to the vitality-driven volumetric scenario, but places all public and quasi-public program within access directly from grade level to maintain public access to all amenities and services without a building network.

LEGEND

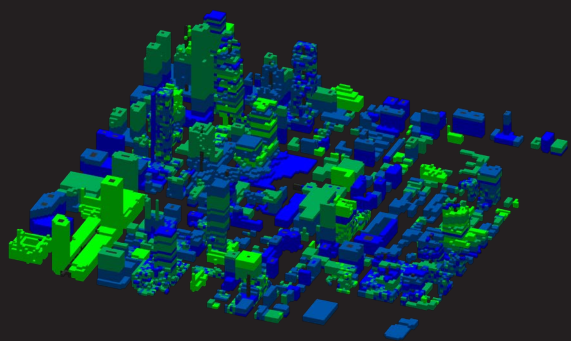
- Residential
- Office
- Production
- Retail/Amenities
- Institutions
- Vertical Cores
- Horizontal Cores
- Pedestrian Hardscape
- Pedestrain Softscape
- Vehicular Street
- Parking
- Public
- Quasi-public
- Private

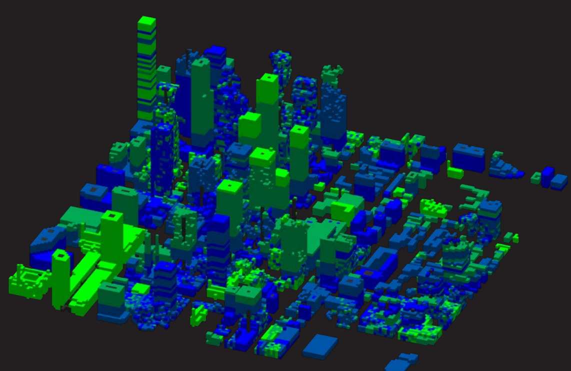
Figure 17.01 Spatial comparison of programmatic use assignments in the three scenarios generated, over time

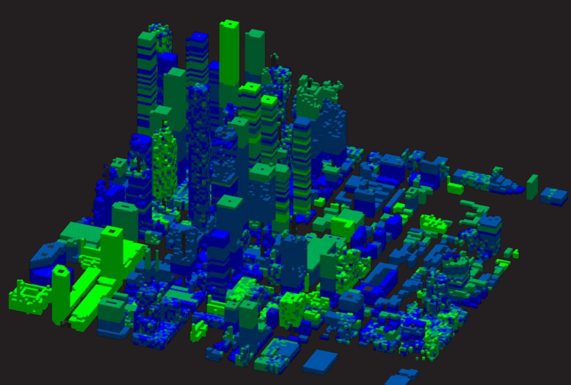
17.02 PRICE TIER MIX



VITALITY-DRIVEN PLANAR







The vitality-driven volumetric and planar scenarios show greater responsiveness to local needs with more affordable or market-rate priced floor area, and a greater mix of price tiers within buildings that increases the diversity of user groups. This mix within a building is crucial for the volumetric scenario, in which the public spaces and circulation within the building can isolate user groups. In contrast, user groups of adjacent buildings are immediately mixed at the ground plane in the planar scenario.

The profit-driven volumetric scenario shows buildings of large floor areas of the same price tier grouped in one area. This produces a visible turf that could create animosity to outsiders, and reduce building network traffic. Groups of buildings have been developed in an area simultaneously, and when they have aged their price tiers decrease together, creating polarized neighbourhoods of new luxury buildings distinct from groups of older, more affordable buildings. The scenario shows a general trend towards more luxury buildings with greater amounts of mid-high and high price tier floor areas.

LEGEND

- Unassigned
- Low Price Tier
- Low-Mid Price Tier
- Mid-High Price Tier
- High Price Tier

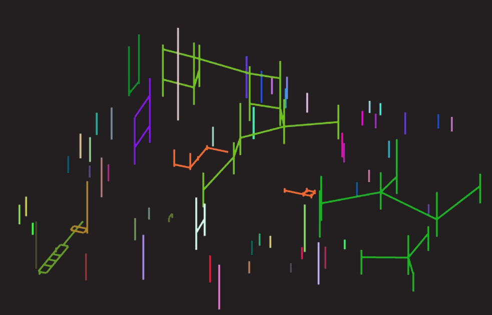
Figure 17.02 Spatial comparison of price tier assignments in the three scenarios generated, over time

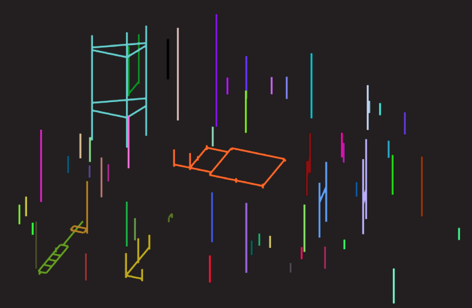
17.03 CORES BY NETWORK

VITALITY-DRIVEN VOLUMETRIC

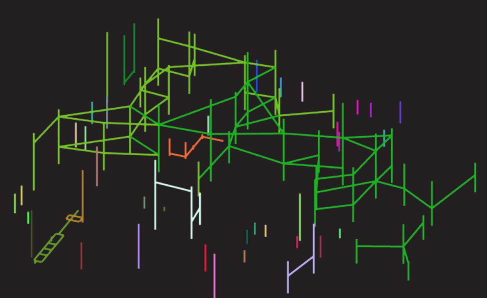
PROFIT-DRIVEN VOLUMETRIC

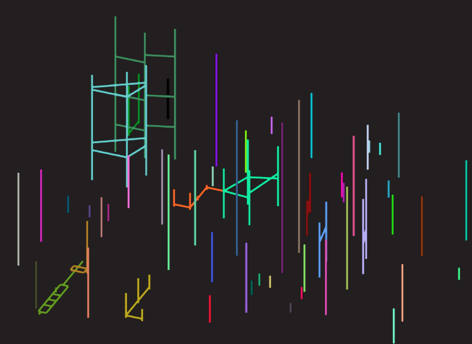
50 CYCLES



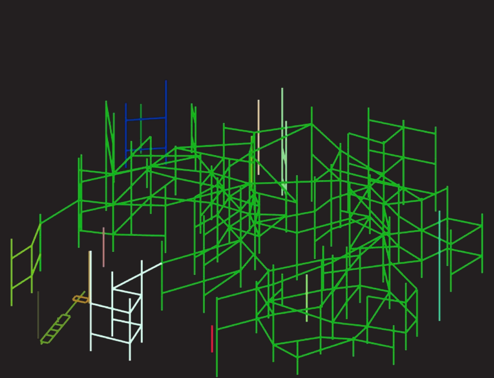


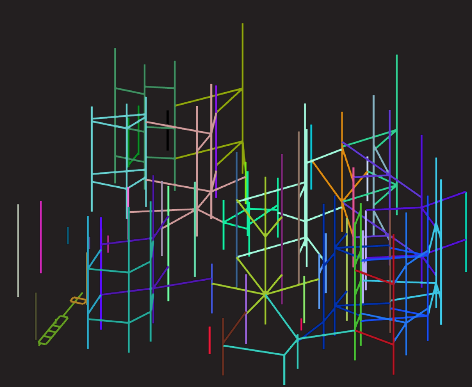
100 CYCLES



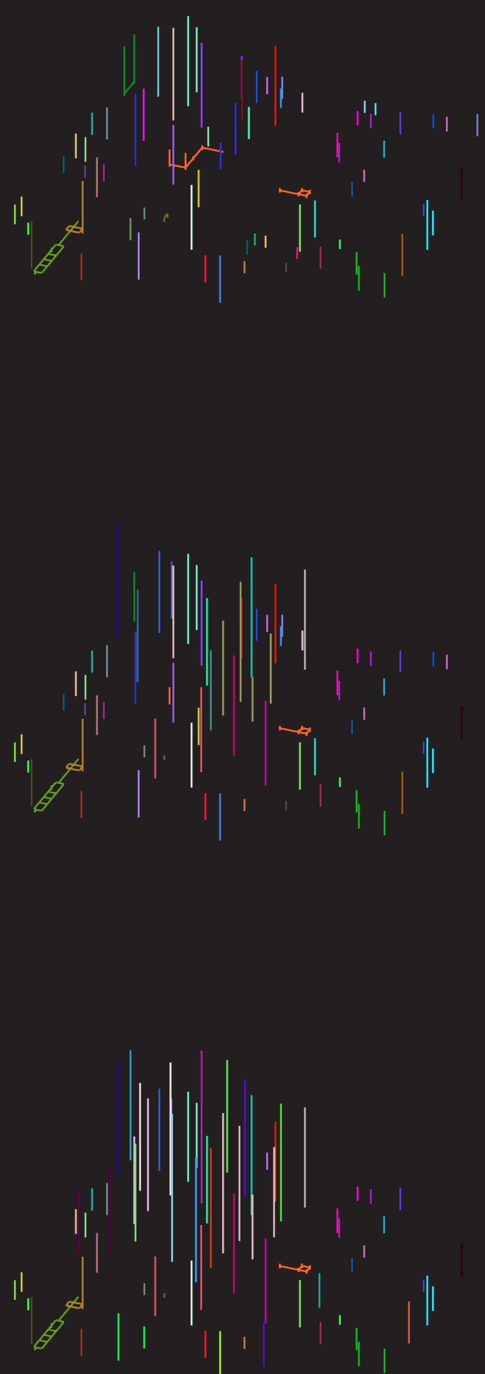


200 CYCLES





VITALITY-DRIVEN PLANAR



The vitality-driven volumetric scenario shows greater building network integration, as the planning for the network allows new buildings to anticipate future connections. The predetermined strata levels create connections at the same building heights, and disparate networks on opposite sides of the model can eventually become integrated into one unified system. The same colour indicates an adoption of a single network managed by the city.

The profit-driven volumetric scenario shows an initial slow growth of the network as connections can initially only occur between the same development until the pervasiveness of building connections allows for the integration of all building networks. At this time the strata levels for connections become fixed at an agreed upon height; however, many preexisting connections remain at unique levels, reducing the coherence of the network. The different colours of connections indicate the ownership of the network by distinct building owners that can result in different closing times, aesthetics, and route planning.

The vitality-driven planar scenario shows only preexisting building connections, as all new building cores are considered separate and served only by the street network.

Figure 17.03 Spatial comparison of unique building networks in the three scenarios generated, over time

17.04 CORES BY DEGREE OF PUBLICNESS

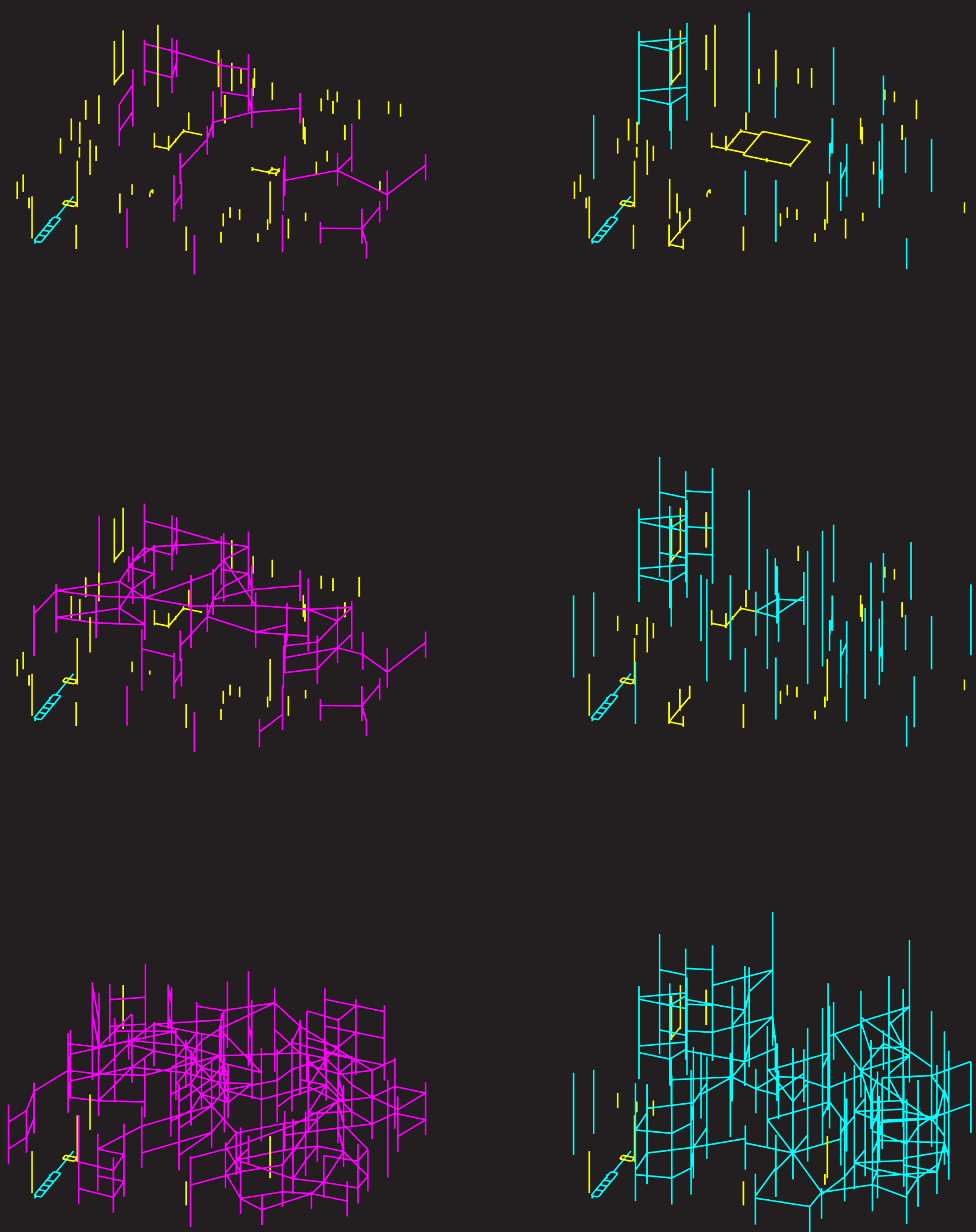
VITALITY-DRIVEN VOLUMETRIC

PROFIT-DRIVEN VOLUMETRIC

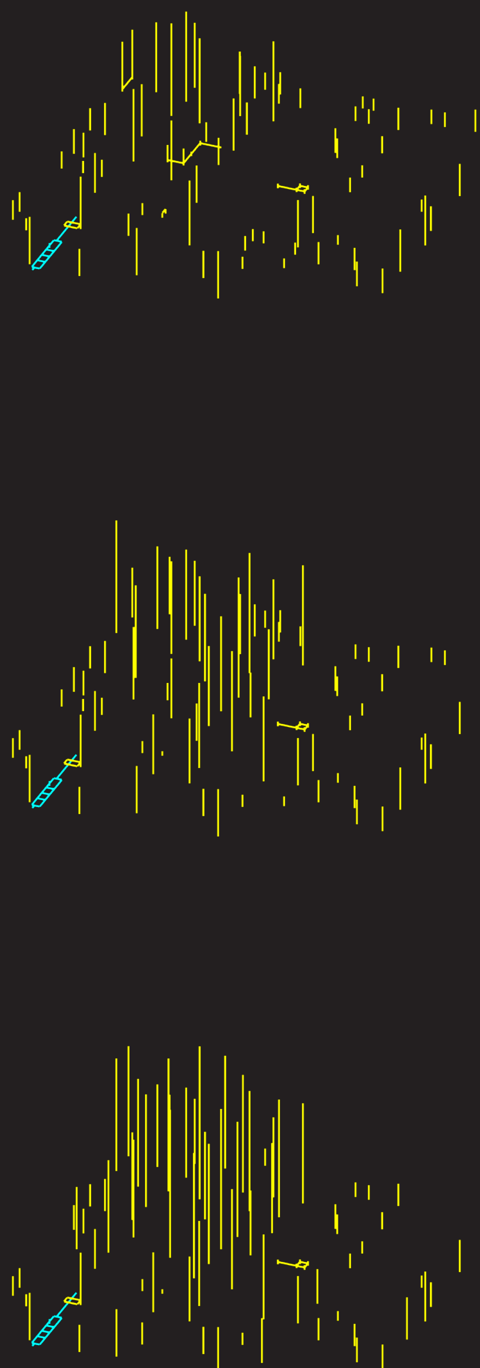
50 CYCLES

100 CYCLES

200 CYCLES



VITALITY-DRIVEN PLANAR



In the vitality-driven volumetric scenario, any building that becomes a part of the network must have public access and public regulation that can influence the path, access, aesthetics, and policing of the space—a strategy already implemented in volumetric cities which adopted the networks as public infrastructure.

The profit-driven volumetric scenario shows a network under private control with some degree of public access. This means that different owners of portions of the network control who has access to the network, and the businesses and residents allowed tenancy within this network. The result is the privatization of a secondary urban infrastructure which supplants the public street network, creating a spatial oligopoly run, designed, and managed by corporations.

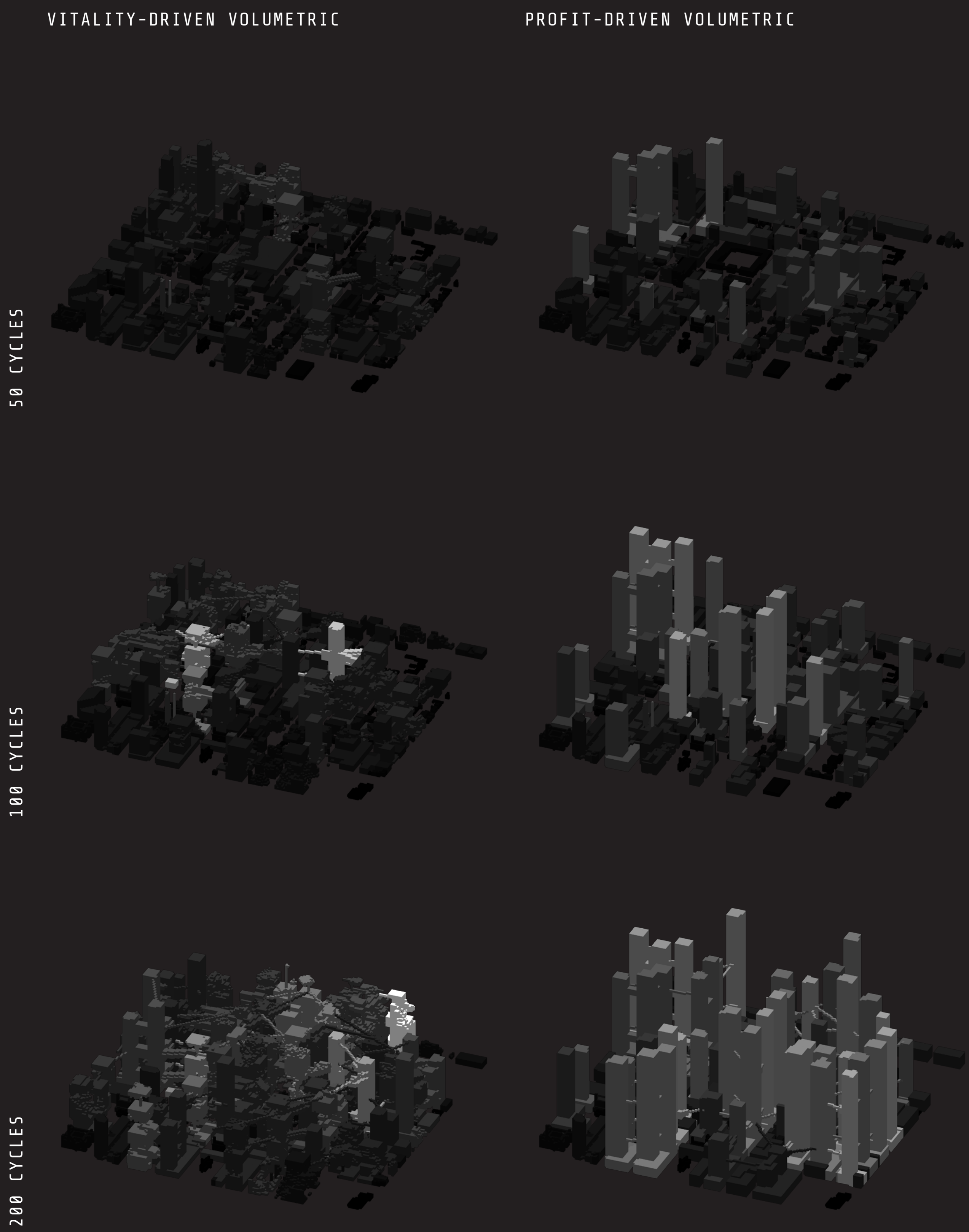
The vitality-driven planar scenario avoids these problems by enforcing all cores to be private and disallowing horizontal connections, thereby ensuring the commons and the city's circulation remain under public control as the city's public street network.

LEGEND

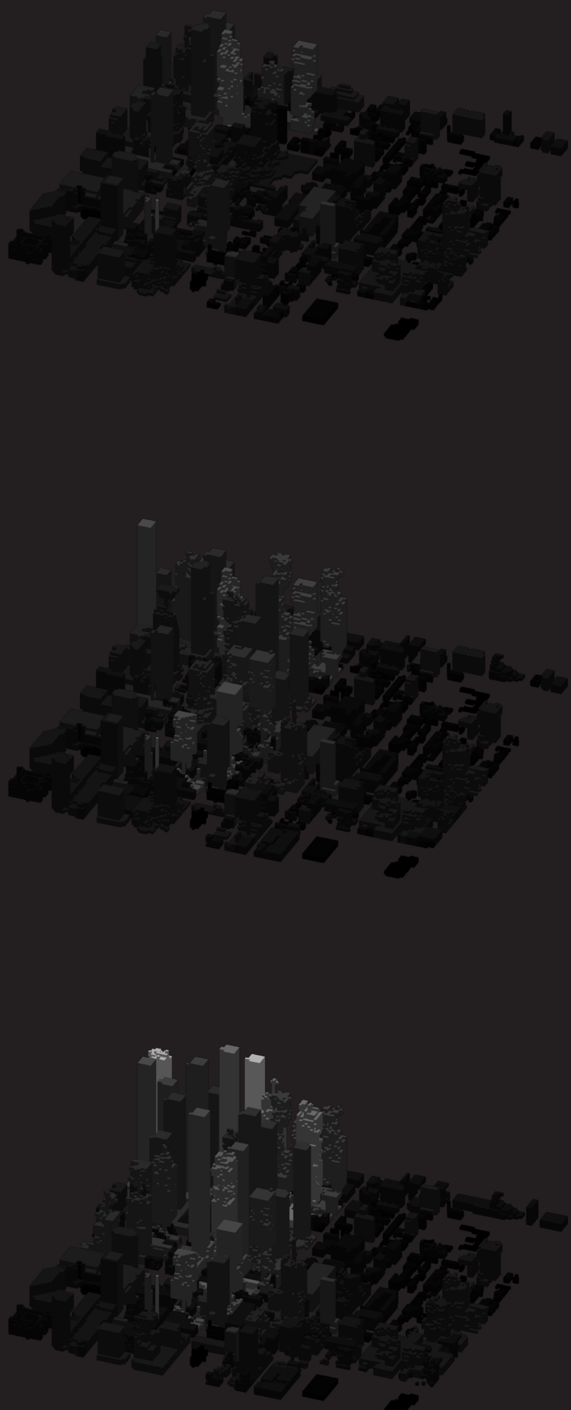
- Unassigned
- Public
- Quasi-public
- Private

Figure 17.04 Spatial comparison of the degree of publicness of the building network in the three scenarios generated, over time

17.05 BUILDING DENSITY



VITALITY-DRIVEN PLANAR



The vitality-driven volumetric scenario allows for incredibly high densities without super-high towers due to the horizontal structure that supports programmed building mass and the allowance of cantilevers over adjacent lots where daylight and sightlines are not impeded.

The profit-driven volumetric scenario relies heavily on the podium-tower type, creating only tenuous connections between buildings. High densities require increasingly tall buildings, while the lack of formal variation provides no opportunities to make provisions for daylight, sightlines, and design. Existing towers are dwarfed with buildings 2-3 times their height, only achieving modestly more density than the vitality-driven volumetric scenario while simultaneously producing standardized forms and an urban wall effect.

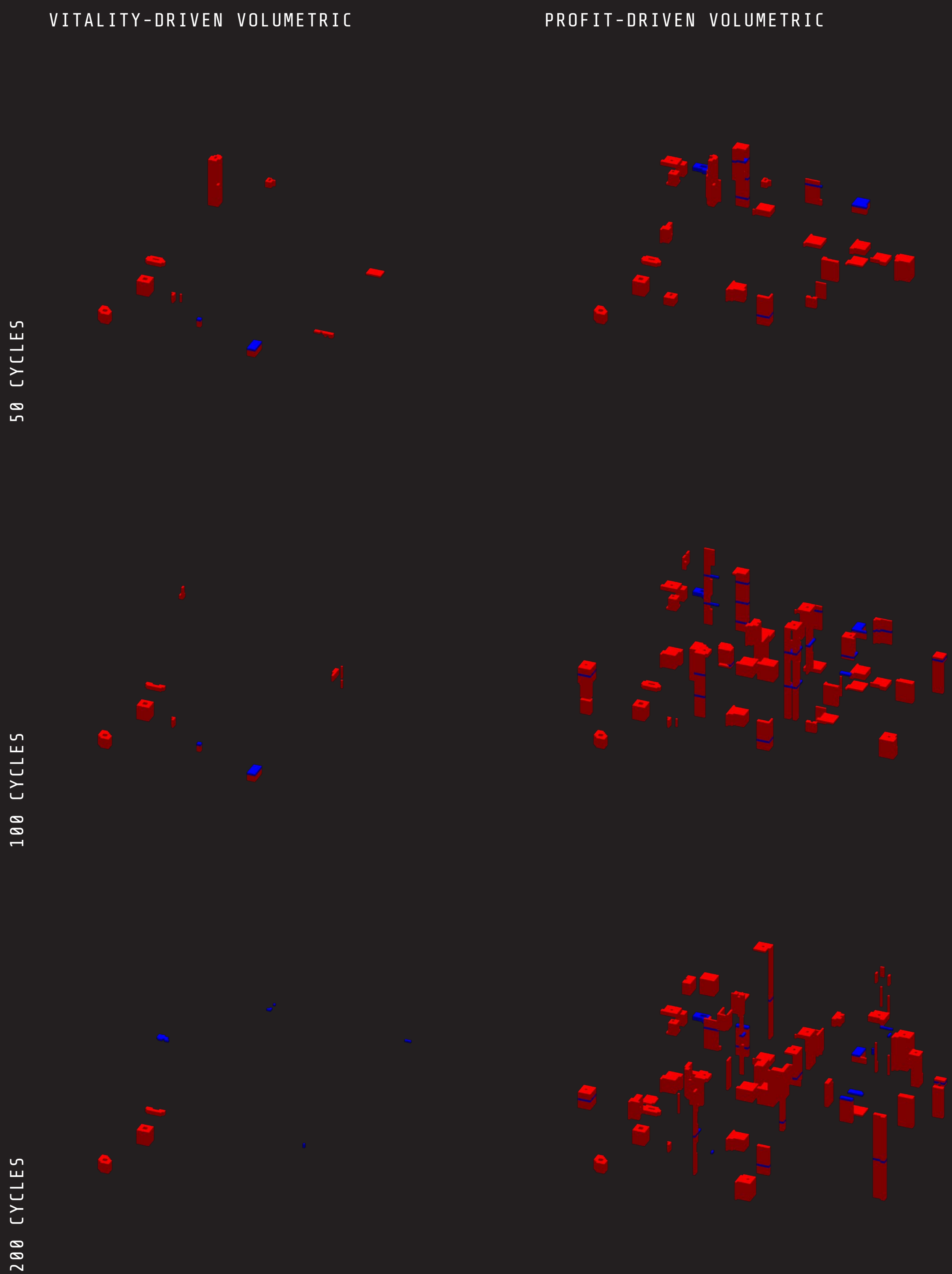
Without the horizontal connections, the vitality-driven planar scenario doesn’t achieve densities as high as either of the other scenarios, but towers are kept to more reasonable heights to maintain a stronger connection to the ground plane.

LEGEND

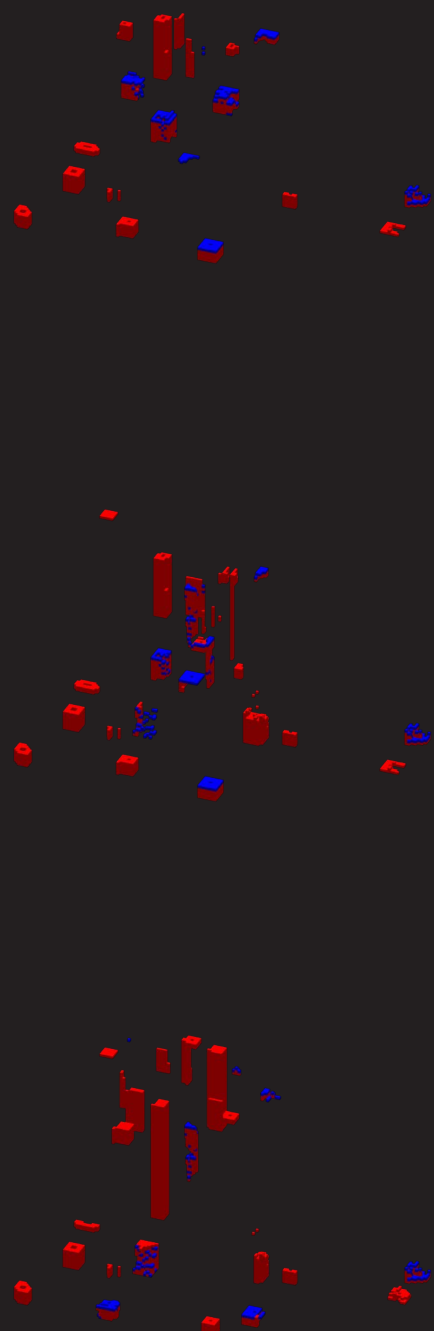
0.0 FAR
25.0 FAR
50.0 FAR
75.0 FAR
100.0 FAR

Figure 17.05 Spatial comparison of floor area ratios in the three scenarios generated, over time

17.06 AREAS PRONE TO RISK OF VACANCY



VITALITY-DRIVEN PLANAR



The vacancy risk shows that the highest floors have the least access to the beneficial qualities and movement of the city. Over decades, once the image of luxury has worn off, the disconnect from the city can cause vacancy or a drop in vitality and value.

The vitality-driven volumetric scenario shows a few problematic areas at the highest towers but minimizes the disconnect from the city over time with greater integration of the building network, amenities, and services.

The profit-driven volumetric scenario shows many problematic areas developing over time due to the inability for the network to adequately re-create the conditions of the city throughout the three-dimensional field. It has lower connectivity and lower access to the movement of the city at higher levels.

The responsiveness of the vitality-driven planar scenario shows better performance than the profit-driven volumetric scenario, but its reliance on the ground plane alone still shows a strong disconnect between the tallest buildings and the public realm of the city at grade.

LEGEND

Primary Use

Secondary Use

Figure 17.06: Spatial comparison of vacancy potential calculations in the three scenarios generated, over time

17.07 OTHER PROPERTIES

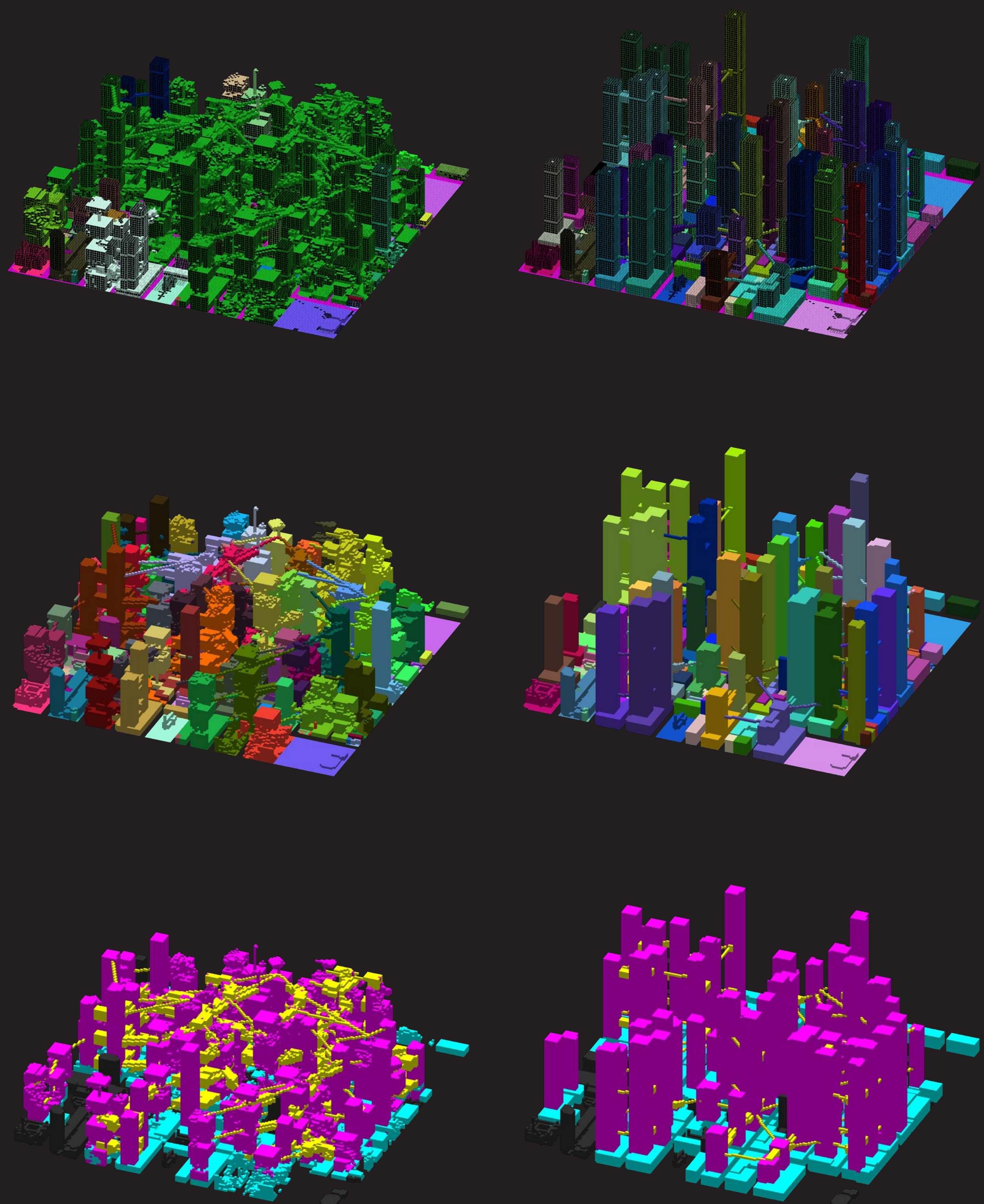
VITALITY-DRIVEN VOLUMETRIC

PROFIT-DRIVEN VOLUMETRIC

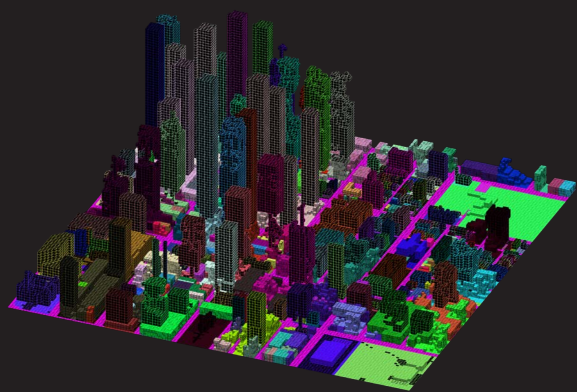
MASSING BY NETWORK INTEGRATION

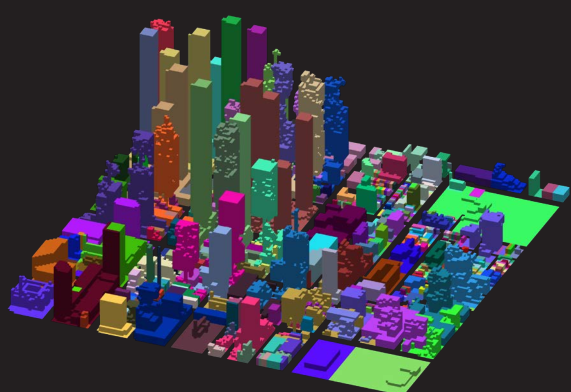
MASSING BY OWNERSHIP

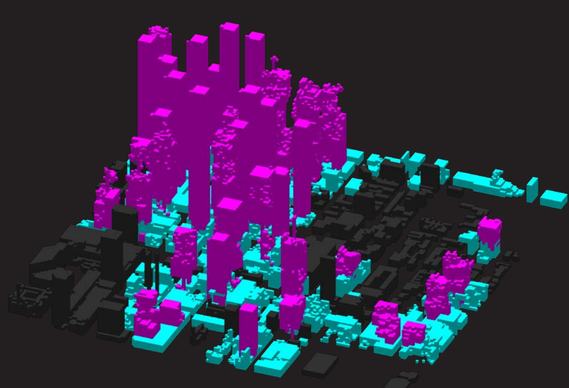
MASSING BY SUPPORT STRUCTURE



VITALITY-DRIVEN PLANAR







The vitality-driven volumetric scenario shows greater incorporation of building massing into a single network, allowing for open participation in the network. The profit-driven volumetric scenario shows distinct networks which can create enclaves of a few buildings with similar qualities and the same ownership. The vitality-driven planar scenario shows completely distinct buildings with no network integration, relying solely on the ground plane.

This is reinforced when ownership is viewed and both universal scenarios show a greater variety of stakeholders in one area. The elite scenario shows how large development complexes make it possible for only a few owners to control a sizable portion of the downtown, creating a spatial oligopoly.

When the massing is viewed by its support structure, it is shown that the vitality-driven volumetric scenario places the greatest emphasis on usable amenity and service space at network strata levels, providing residents with the most reasons to inhabit the network in daily life and keep it frequented at all times of the day.

LEGEND

- Grade Supported
- Vertical Core
- Horizontal Core
- Existing

Figure 17.07: Spatial comparison of building massing by network connection, ownership, and structural support type in the three scenarios generated, over time

17.08 SECTIONAL PROGRESSION BY PUBLIC LEVEL

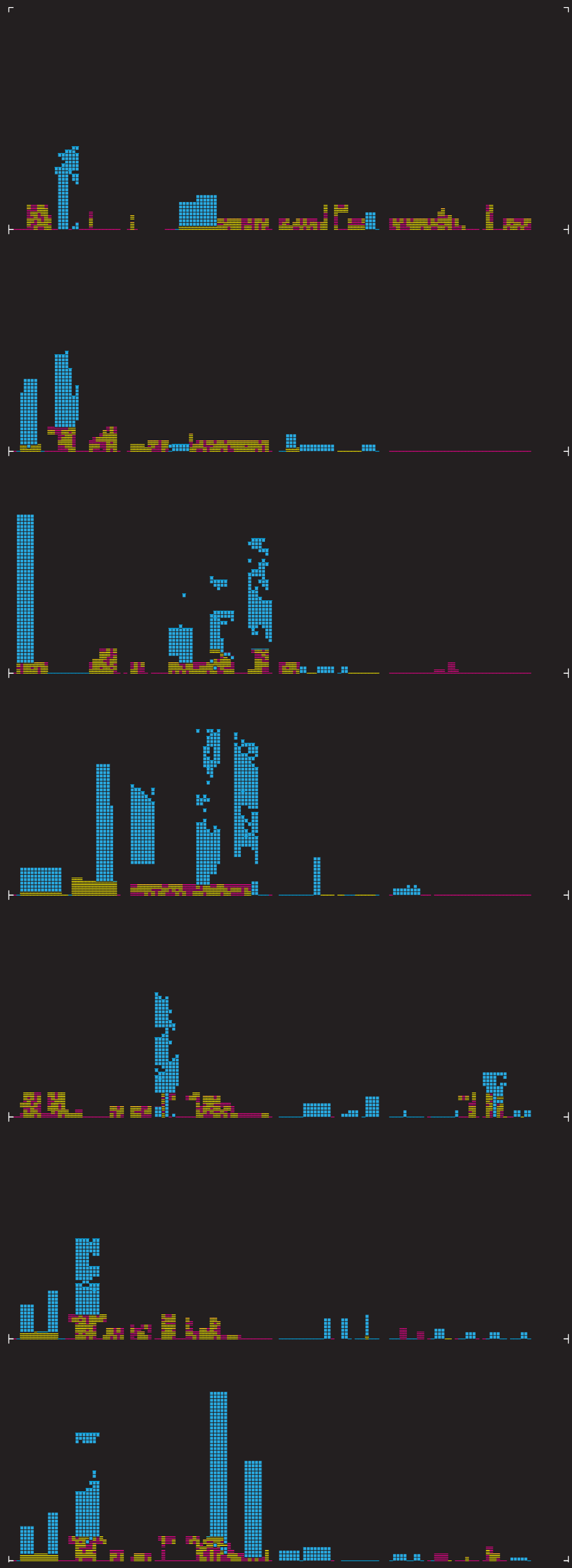
VITALITY-DRIVEN VOLUMETRIC

PROFIT-DRIVEN VOLUMETRIC

These sample sections cutting east-west show how the form of each scenario changes throughout the 1 km distance of the generated model. The vitality-driven volumetric scenario shows greater formal variation, with areas of private space closely packed around public and quasi-public spaces of amenities and services at designated network strata. The greater formal variety produces carved out spaces that allow private spaces to address public spaces, sightlines to be conserved, daylight to be optimized, and high concentrations of private space to receive the services and amenities needed to sustain its population within walking distance.

The profit-driven volumetric sections show the inflexibility of the podium tower type and how the quasi-public spaces provided at strata serve mostly to support the commercial interests of the building alone, with the main concentration of amenities intended for the public at grade, and the higher strata reserved for a more select group.

The vitality-driven planar scenario shows how a similar formal flexibility can create responsiveness while maintaining access for public and quasi-public spaces exclusively from the ground plane.



VITALITY-DRIVEN PLANAR

Public Space

Quasi Public Space

Private Space

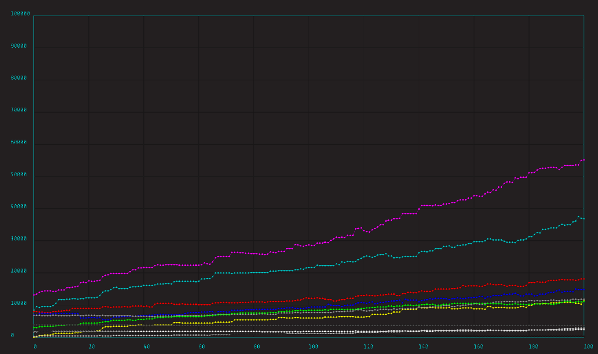
Figure 17.08: Spatial comparison of the sectional progression through the three scenarios generated by degree of publicness

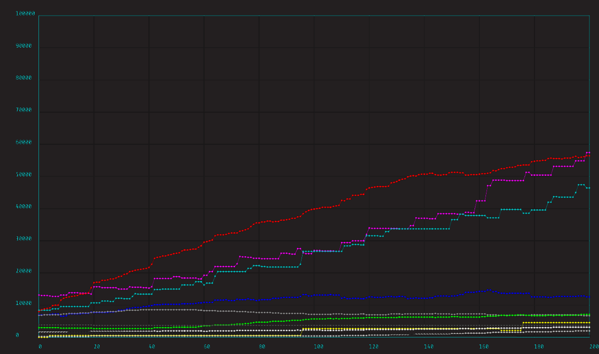
17.09 NUMBER OF VOXELS BY VOXEL PROPERTIES

VITALITY-DRIVEN VOLUMETRIC

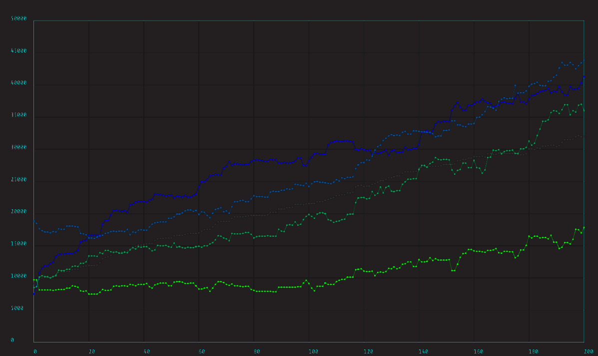
PROFIT-DRIVEN VOLUMETRIC

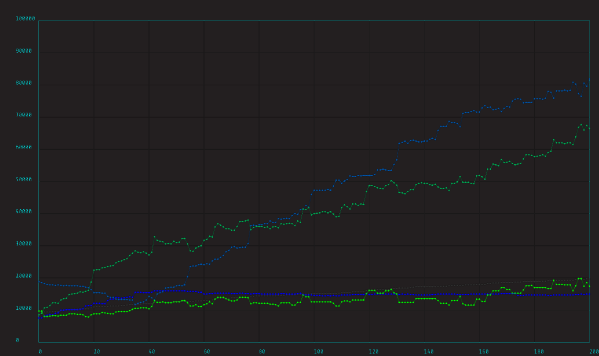
NO. OF VOXELS BY PROGRAM



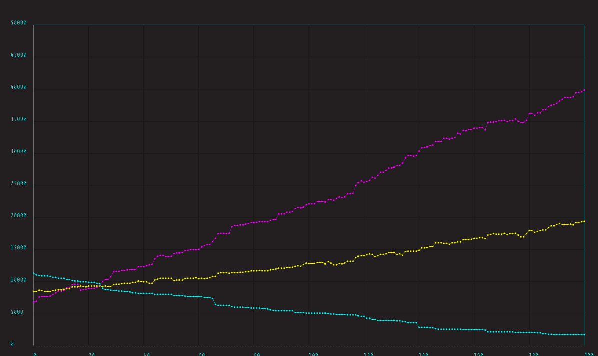


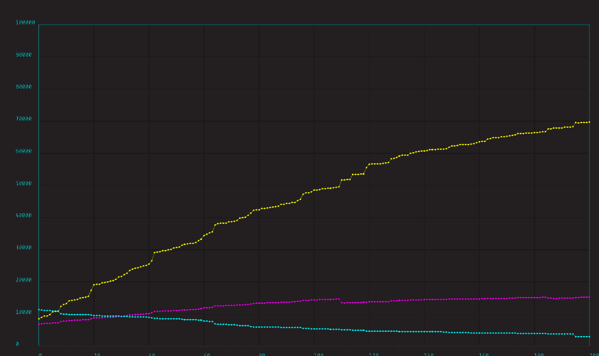
NO. OF VOXELS BY PRICE TIER

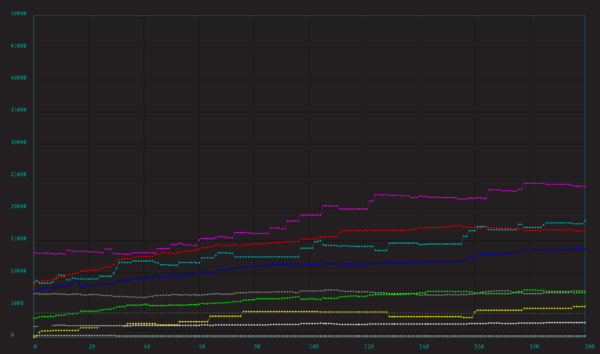


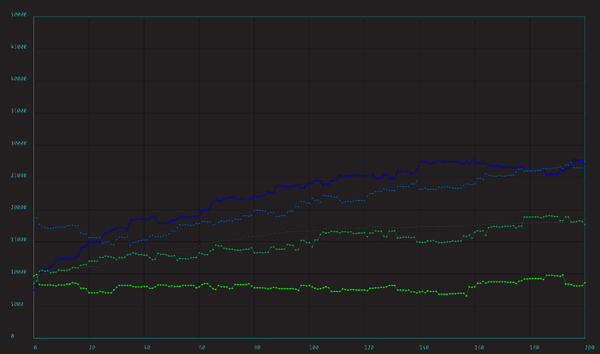


NO. OF VOXELS BY PUBLICNESS









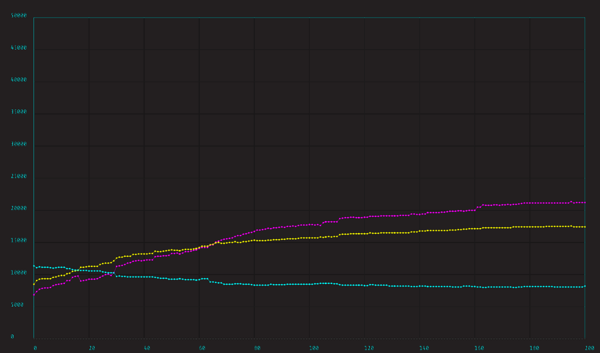


Figure 17.09: Number of voxels by program type, price tier, and degree of publicness in the three generated scenarios, over time

	VITALITY-DRIVEN VOLUMETRIC	PROFIT-DRIVEN VOLUMETRIC
NO. OF VOXELS BY PROGRAM	• General increase of institutional, productive, and amenity program in proportion to residential and office • Large increases in number of voxels, remains relatively consistent proportionally once the target ratio is established • Better ability to continuously have an adequate amount of amenities, institutions, services, and retail	• Huge increase in retail program provided by the added podiums and strata which prioritize commercial ventures • Small gains in institutions which are less likely to be selected for tenancy as they often require their own buildings and can be less profitable, and no gains in productive uses which hasn’t been permitted due to rigid zoning • Overall less ideal mix of programs
NO. OF VOXELS BY PRICE TIER	• Shows a large increase in affordable units as the lowest price tier overtakes the other price tiers • The two highest priced price tiers remain proportionally rather low, decreasing the trend for luxury housing in the downtown core as a result of the elimination of the domestic housing stock for use as a foreign investment tool	• High price tier voxels start and remain relatively high proportionally, but after buildings age, the progressive drop in price tier keeps the absolute numbers relatively constant • The middle two price tiers dominate with the most number of voxels, while affordable housing in the lowest price tier is substantially lower
NO. OF VOXELS BY PUBLICNESS	• Of the program types that can be public, the vitality-driven volumetric scenario shows a large increase in public voxels, almost doubling quasi-public voxels, and almost eliminating private voxels • The proportion of public voxels has likely been set too high in the scenario, but demonstrates that there is provision for enough public space	• Quasi-public spaces have increased dramatically with the addition of more podiums and quasi-public program at building network strata • Public program has made modest increases but much more is needed for the network to be considered publicly accessible, as a majority of the spaces are commercial spaces

VITALITY-DRIVEN PLANAR

- Similarly balanced to the vitality-driven volumetric scenario, yet with a greater emphasis on retail—likely due to the podiums of the planar scenario
- Overall shows greater ability to create programmatic mixes with responsive zoning, rather than isolating programs
- Similar to vitality-driven volumetric scenario, will create greater diversity and greater continuous street traffic

- The lowest two price tiers increase together, with the lowest price tier making the largest gains
- Mid-high price tier makes significant gains as well, while the highest price tier remains relatively constant
- This trend away from luxury real estate makes sense, given that most Torontonians have significant housing affordability problems and the demand for high-end housing is driven in part by investment practices

- Without the addition of network strata, the vitality-driven planar scenario shows less gains in public voxels
- Private voxels also have large gains over both other scenarios, since anything above podium height is considered private program and some amenities such as roof terraces and building amenities are permitted, but are given a private designation

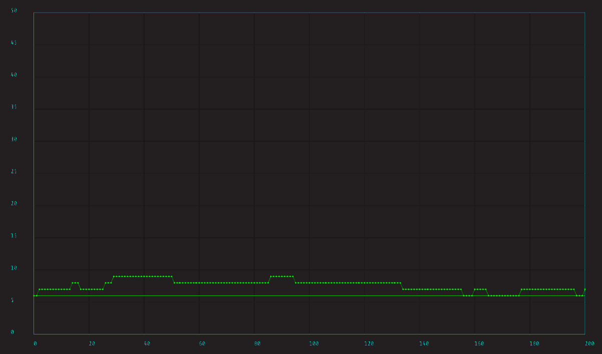
Note: The public level counts only include program which can be either public, quasi-public, or private. It, therefore, measures what proportion of possibly public program is made available to the public.

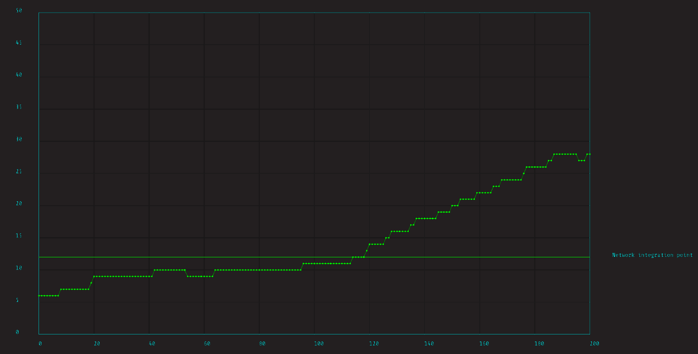
17.10 NETWORK AND BUILDING CORE PROPERTIES

VITALITY-DRIVEN VOLUMETRIC

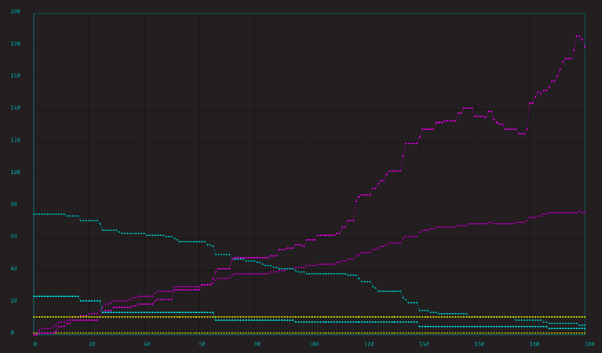
PROFIT-DRIVEN VOLUMETRIC

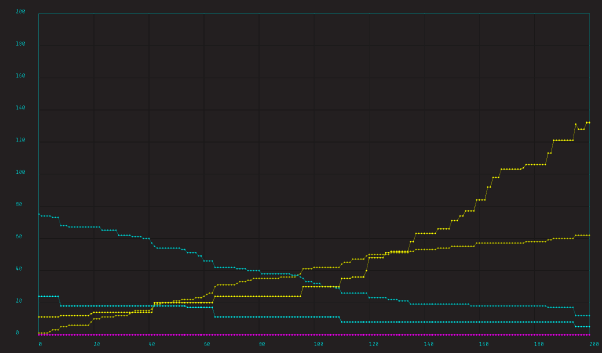
NO. DISTINCT NETWORKS



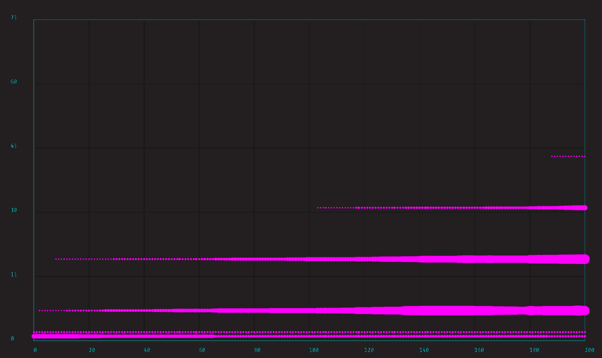


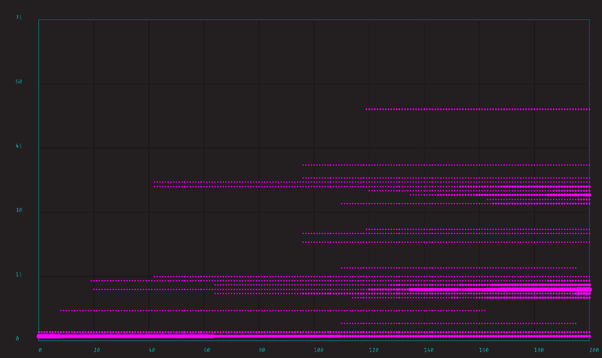
NO. CORES BY PUBLIC LEVEL

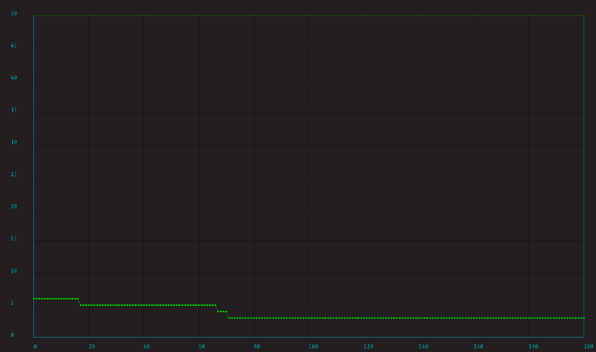




NO. CORES BY HEIGHT FROM GRADE

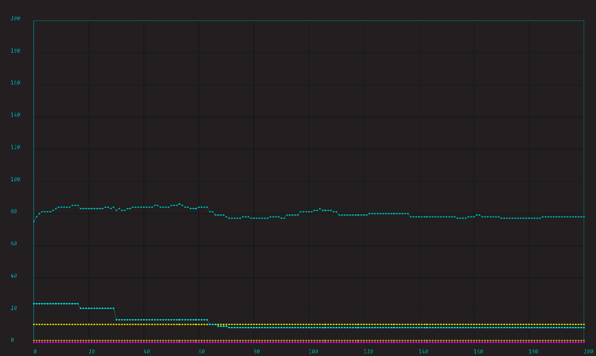






- Building networks

Note: The straight horizontal line represents the "network integration point" - a number the program uses to determine after how many unique building networks can the networks be integrated. The vitality-driven volumetric scenario shows a low integration point, meaning that the building network is planned from the beginning; the profit-driven volumetric shows a higher integration point, meaning that it will take more separate networks to accumulate before they can become integrated; and the vitality-driven planar scenario has a very high integration point to dissuade any building networks.



- Vertical, Public
- Vertical, Quasi-public
- Vertical, Private
- Horizontal, Public
- Horizontal, Quasi-public
- Horizontal, Private

- 1 Connection
- 5 Connections
- 10 Connections
- 15 Connections
- 20 Connections
- 25 Connections

Figure 17.10: Number of distinct building networks, number of building cores by degree of publicness, and height of horizontal building cores in the three generated scenarios, over time

	VITALITY-DRIVEN VOLUMETRIC	PROFIT-DRIVEN VOLUMETRIC
NO. DISTINCT NETWORKS	• The number of unique building networks in the model already surpasses the specified network integration point with the existing building fabric • New networks are added to the existing network whenever they are within reach • This keeps the number of unique and unconnected networks low	• Numerous new building networks are required before they can connect to each other and become integrated • After this integration, the networks may connect but the separate ownership continues to produce distinct networks even though they are connected together into a continuous path
NO. CORES BY PUBLIC LEVEL	• As the building network becomes more pervasive, over time the number of private cores diminishes and more building cores become public in order to be permitted to connect to the network • Some quasi-public cores from existing buildings remain	• Quasi-public cores increase as the building networks become more common; however, these cores are controlled access points and owners can specify their own rules for access
NO. CORES BY HEIGHT FROM GRADE	• The planning of specific strata levels for the building network at the outset of the simulation keeps all horizontal connection cores within approximately the same levels to increase network cohesiveness • Some small variation of horizontal core height is permitted	• The late consolidation of the network means that many horizontal connections have already been established at various core heights • After the network integration point, strata levels become specified and the connection heights slowly become more consistent

VITALITY-DRIVEN PLANAR

- The number of unique networks decreases over time as the existing building networks are destroyed and no new building networks are created

- No new horizontal cores are made
- The number of vertical cores remains relatively stable as new buildings destroy old buildings with cores and replace them with taller, higher density buildings with private vertical cores

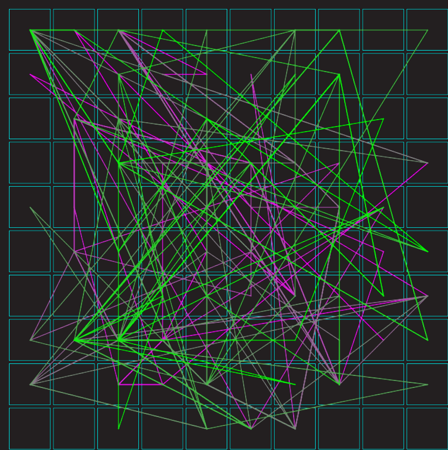
- No new horizontal cores are made
- Existing horizontal connection cores remain at levels closer to the ground

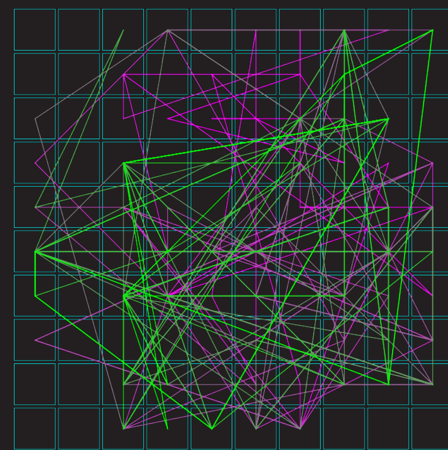
17.11 BUILDING PROPERTIES

VITALITY-DRIVEN VOLUMETRIC

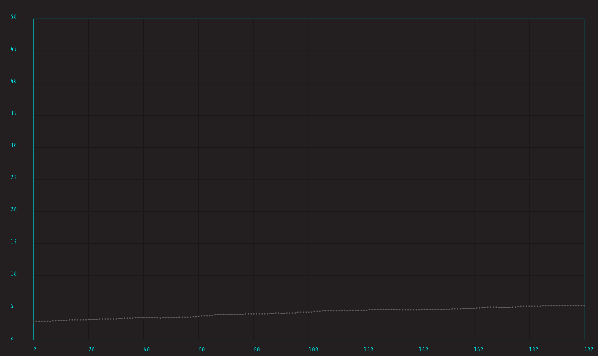
PROFIT-DRIVEN VOLUMETRIC

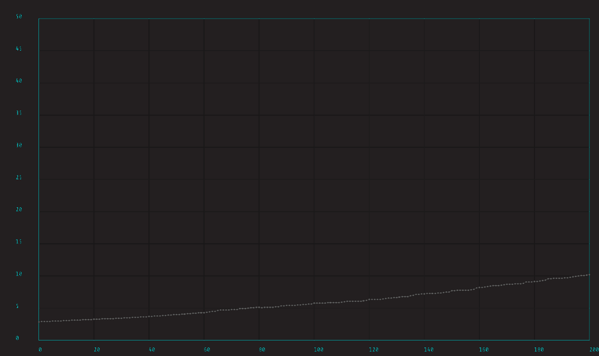
SITE SELECTION (QUADRANT PLAN VIEW)



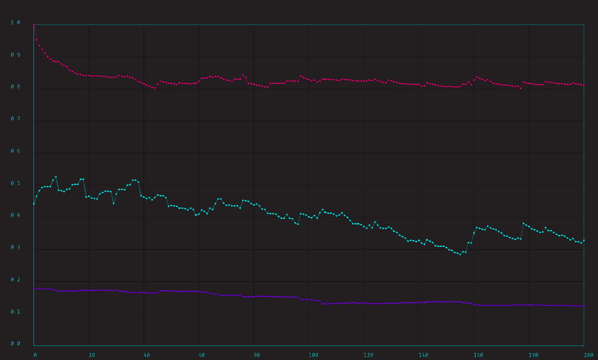


AVERAGE FLOOR AREA RATIO

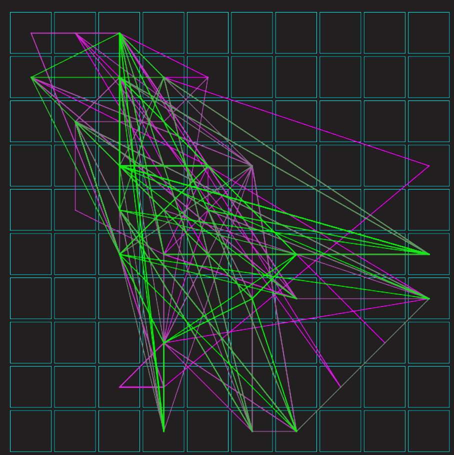




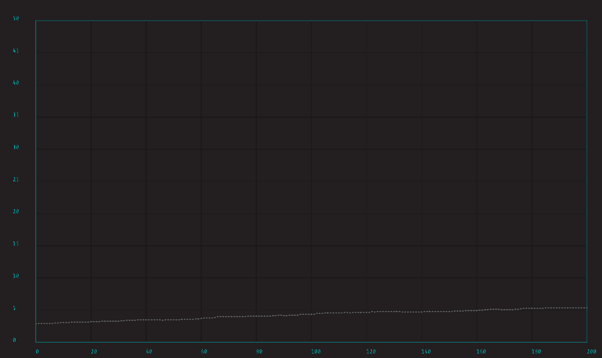
DEVELOPMENT POTENTIAL SCORES



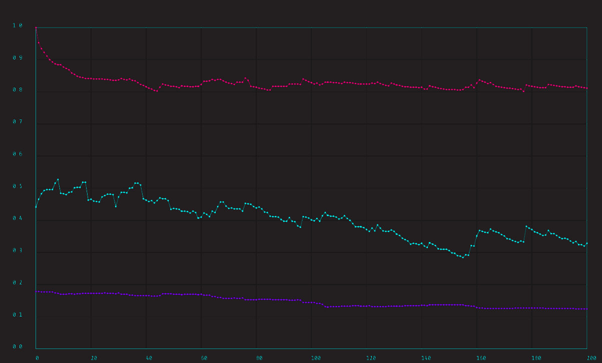
VITALITY-DRIVEN PLANAR



The site selection diagram shows which quadrant was selected each cycle in plan view, with green lines as the most recent, and magenta lines as the oldest. The vitality-driven volumetric scenario shows a large spread of development throughout time, indicating some consideration of Jacobs' rule of competitive diversion. The profit-driven volumetric view shows a greater concentration of development at any given time, creating a lower building age mix. The vitality-driven planar scenario shows highly concentrated development and could be explained by either an error in the implementation of competitive diversion in the settings used, or problematic areas in the model that the program continually tried to resolve by rebuilding the same area.



In terms of floor area ratio, the volumetric scenarios achieve similar densities until around the 120th cycle, at which point the taller building heights of the elite model create higher densities. The vitality-driven planar scenario looks similar to its volumetric counterpart; however, this is due to some very tall buildings balancing lower density areas, rather than the more uniformly dense volumetric scenario.

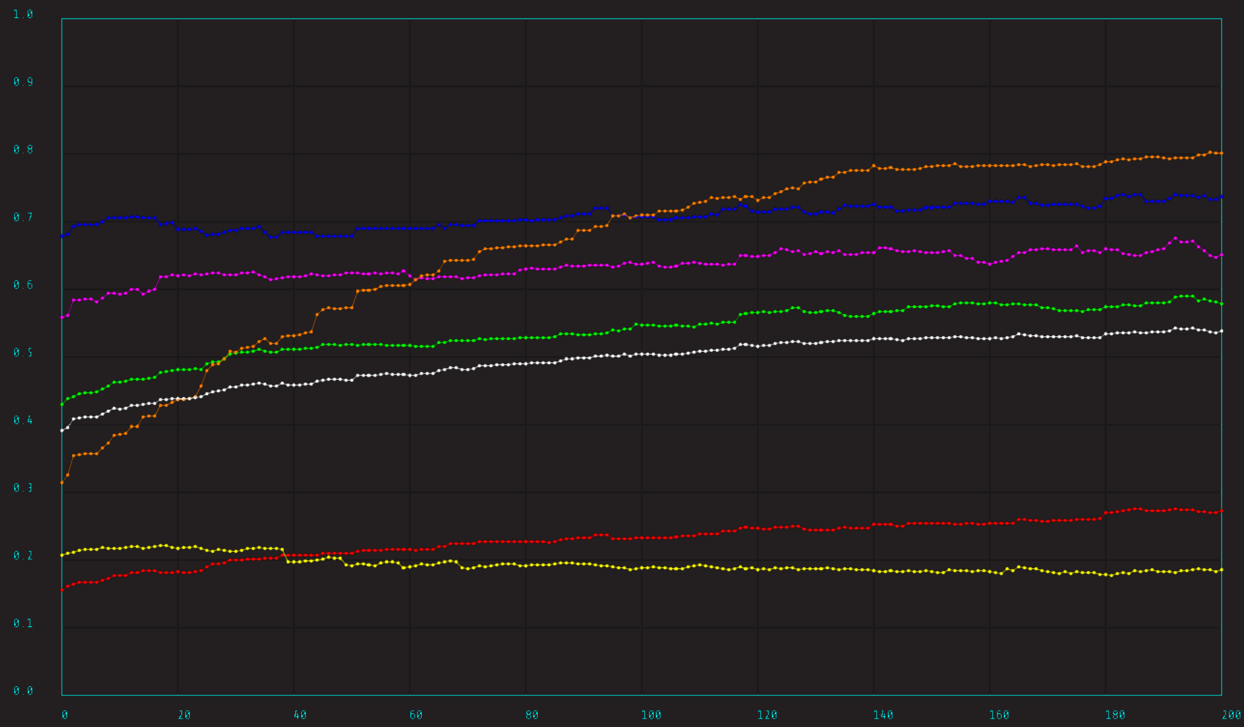


- Age Score
- Protected Score
- Vacancy Score

Figure 17.11: Site quadrant selection sequence, floor area ratio, and development potential scores in the three generated scenarios, recorded over time

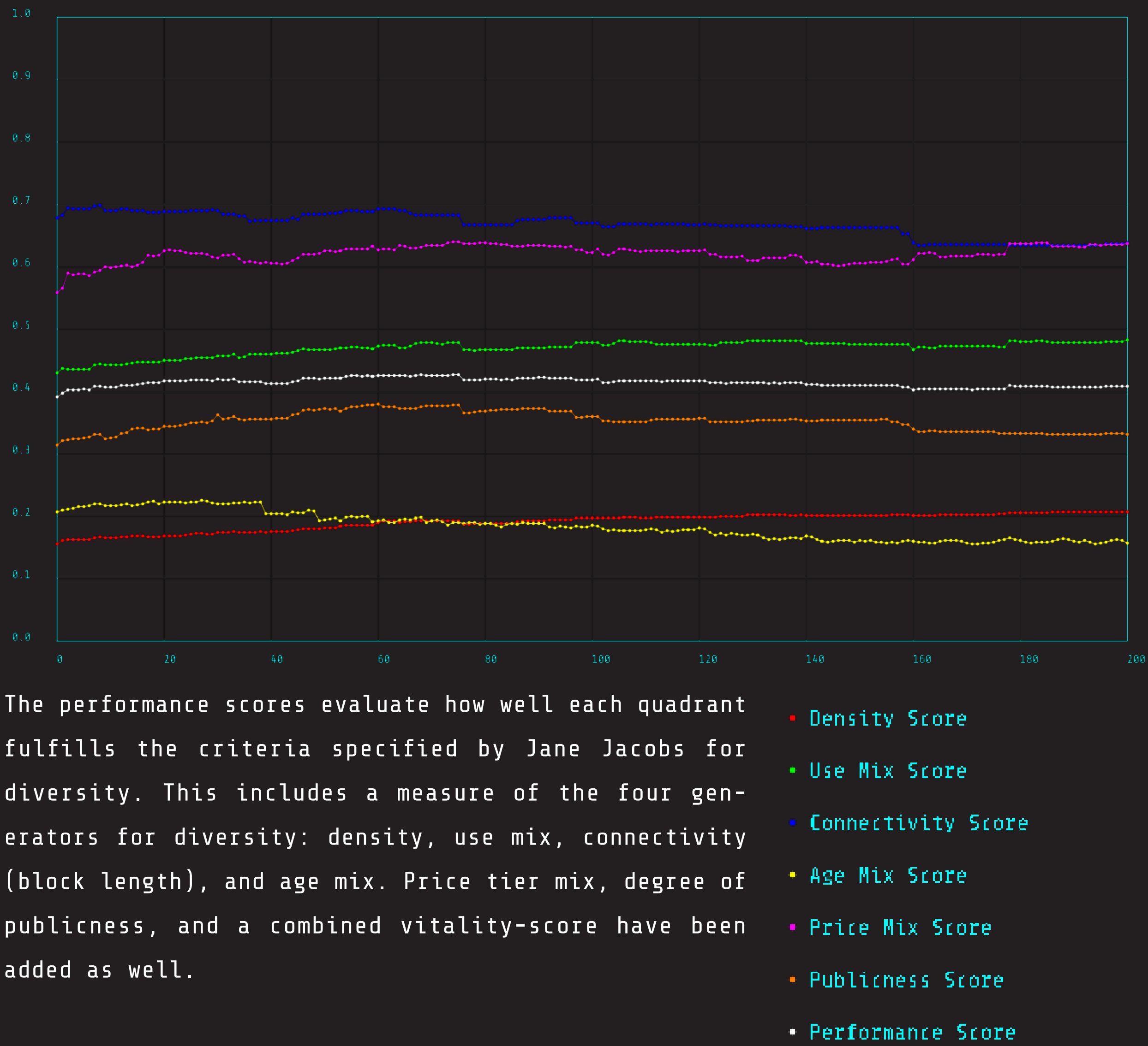
17.12 PERFORMANCE SCORES

VITALITY-DRIVEN VOLUMETRIC



PROFIT-DRIVEN VOLUMETRIC

VITALITY-DRIVEN PLANAR

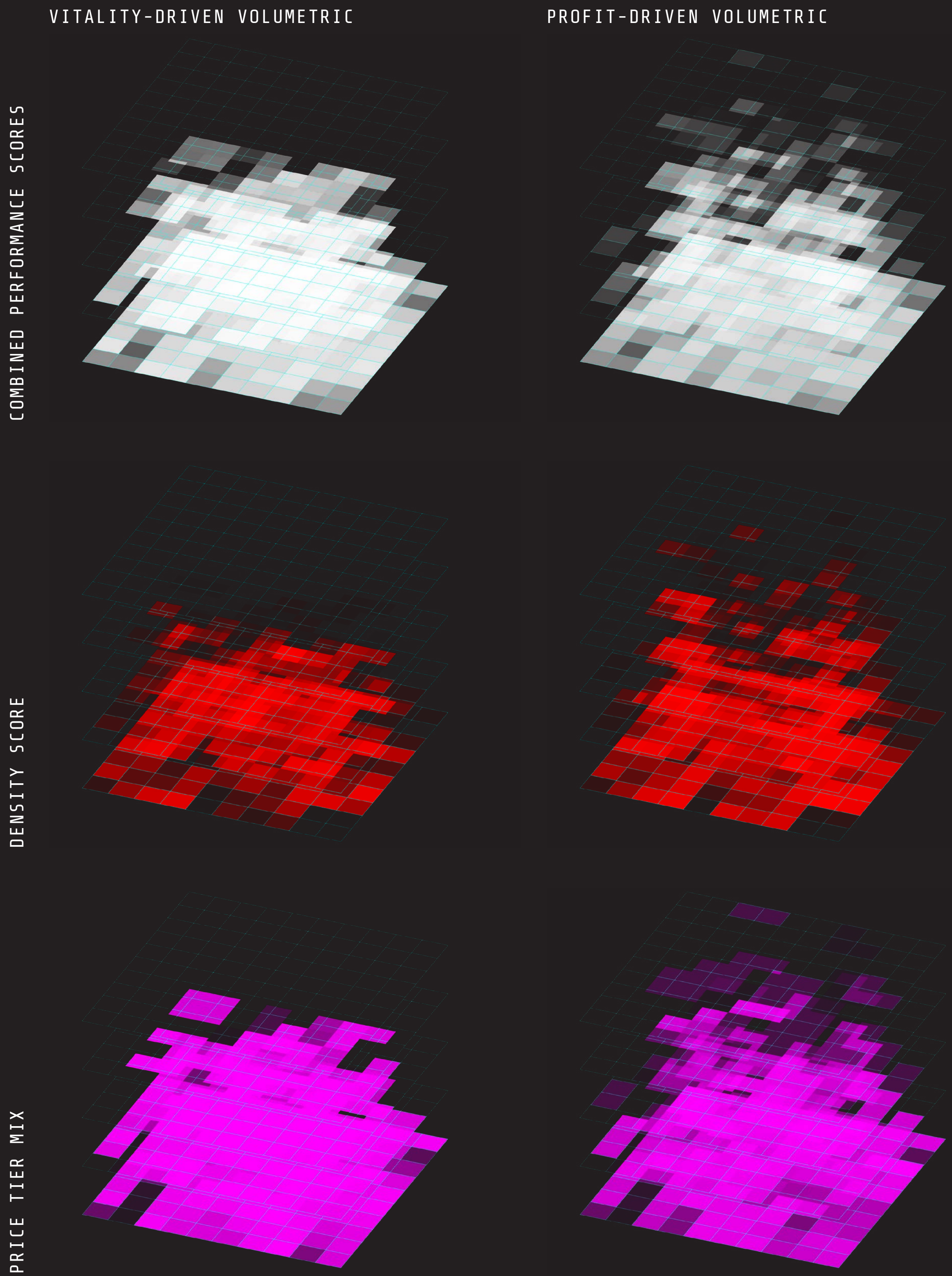


The performance scores evaluate how well each quadrant fulfills the criteria specified by Jane Jacobs for diversity. This includes a measure of the four generators for diversity: density, use mix, connectivity (block length), and age mix. Price tier mix, degree of publicness, and a combined vitality-score have been added as well.

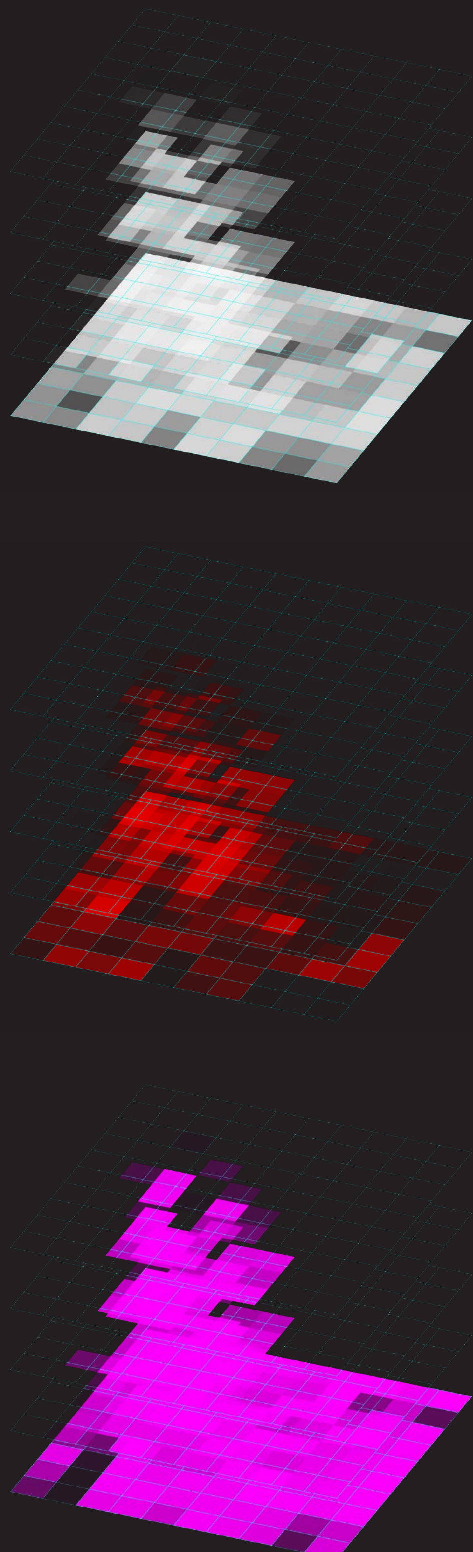
The vitality-driven volumetric scenario shows an overall trend of improved performance, except for age mix which decreases due to the increasing scale of buildings. The profit-driven volumetric scenario shows an overall negative trend, indicating a large decrease in diversity, street activity, and overall vitality. The vitality-driven planar scenario remains relatively consistent with its current performance, but does so while achieving much greater densities.

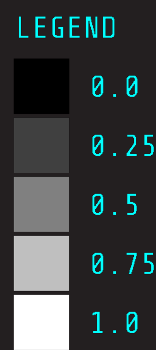
Figure 17.12: Vitality performance scores in the three generated scenarios, recorded over time

17.13 PERFORMANCE SCORES BY QUADRANT



VITALITY-DRIVEN PLANAR

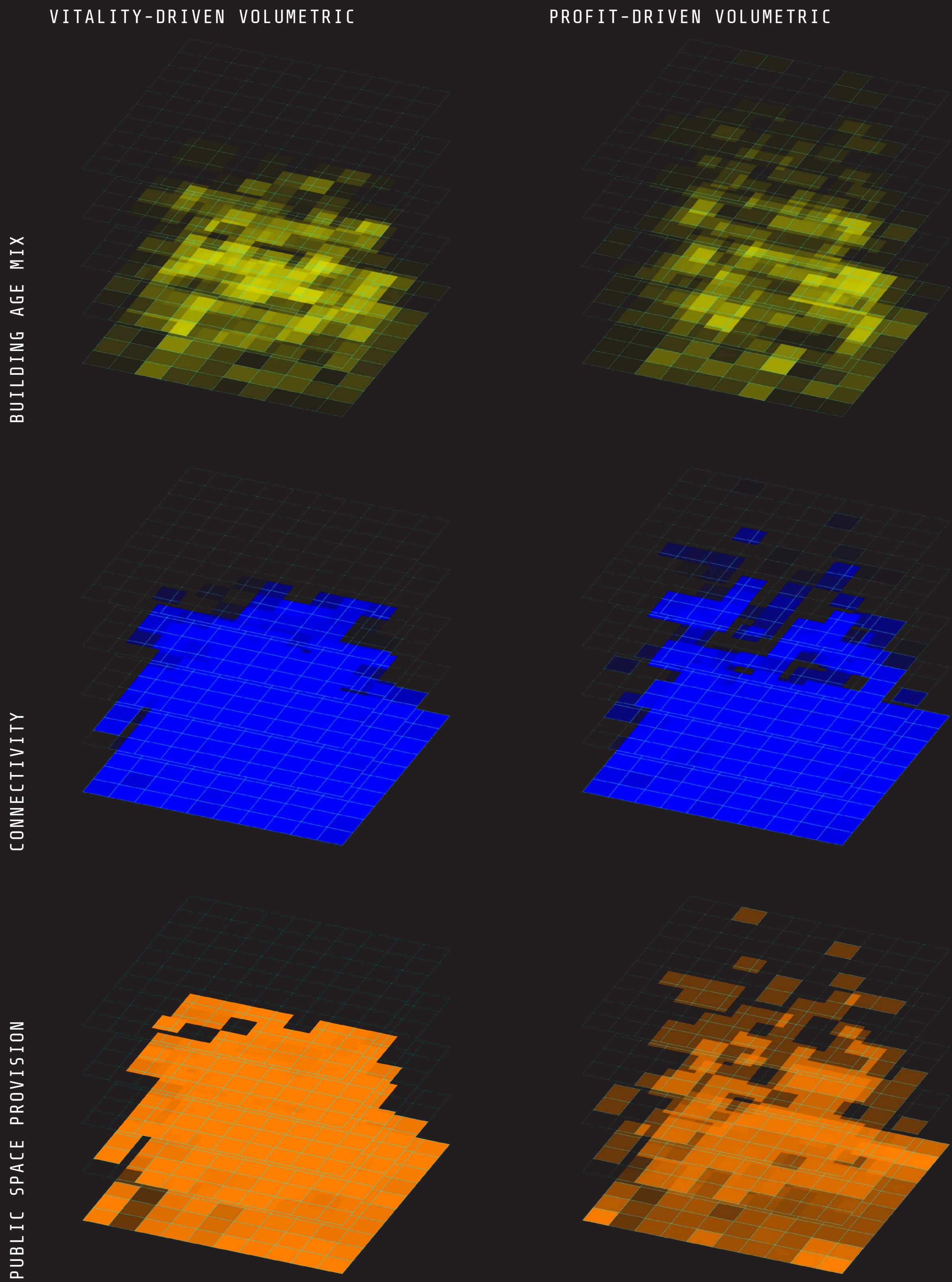




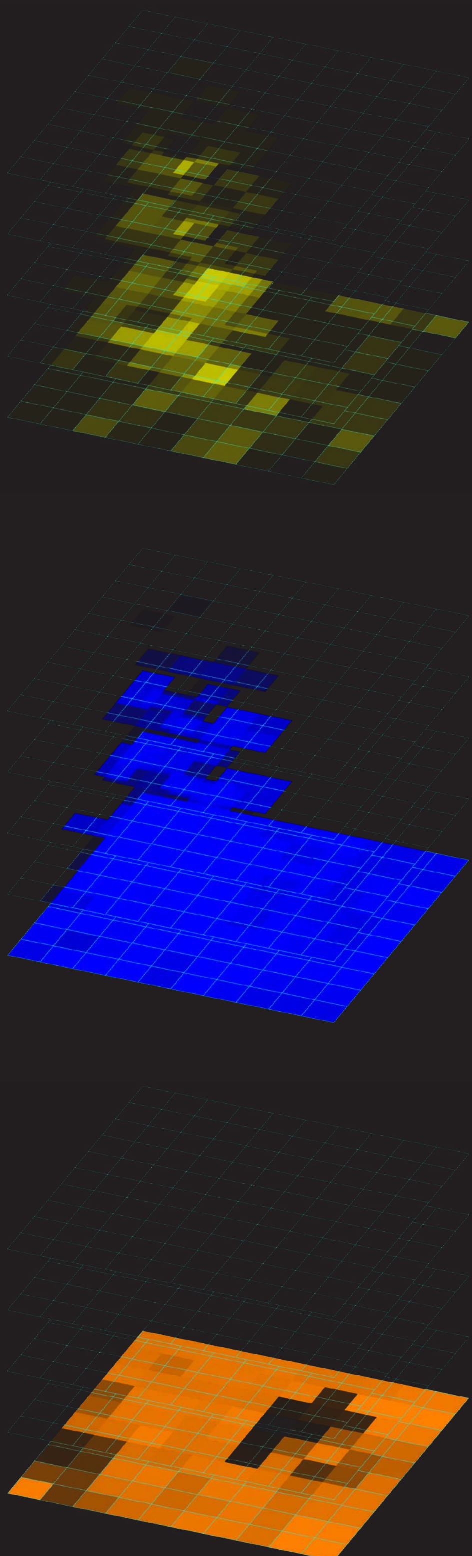
The performance score graphs only represented average scores for the entire environment. An important distinction has been made in the production of a volumetric city that performance throughout the three-dimensional field is a significant factor to the success of the volumetric city, and not just an overall average, or an average in reference to the ground plane. For this reason, it is important to not only look at the overall performance, but also the local scores of each quadrant in the three-dimensional field for each criterion.

Each square represents one of the quadrants in the model. The score is calculated by the composition of the voxels within the quadrant. All scores are mapped to a scale of 0.0-1.0 such that they can be compared.

Figure 17.13: Vitality performance scores in the three generated scenarios, recorded spatially and over time


VITALITY-DRIVEN VOLUMETRIC
PROFIT-DRIVEN VOLUMETRIC
BUILDING AGE MIX
CONNECTIVITY
PUBLIC SPACE PROVISION

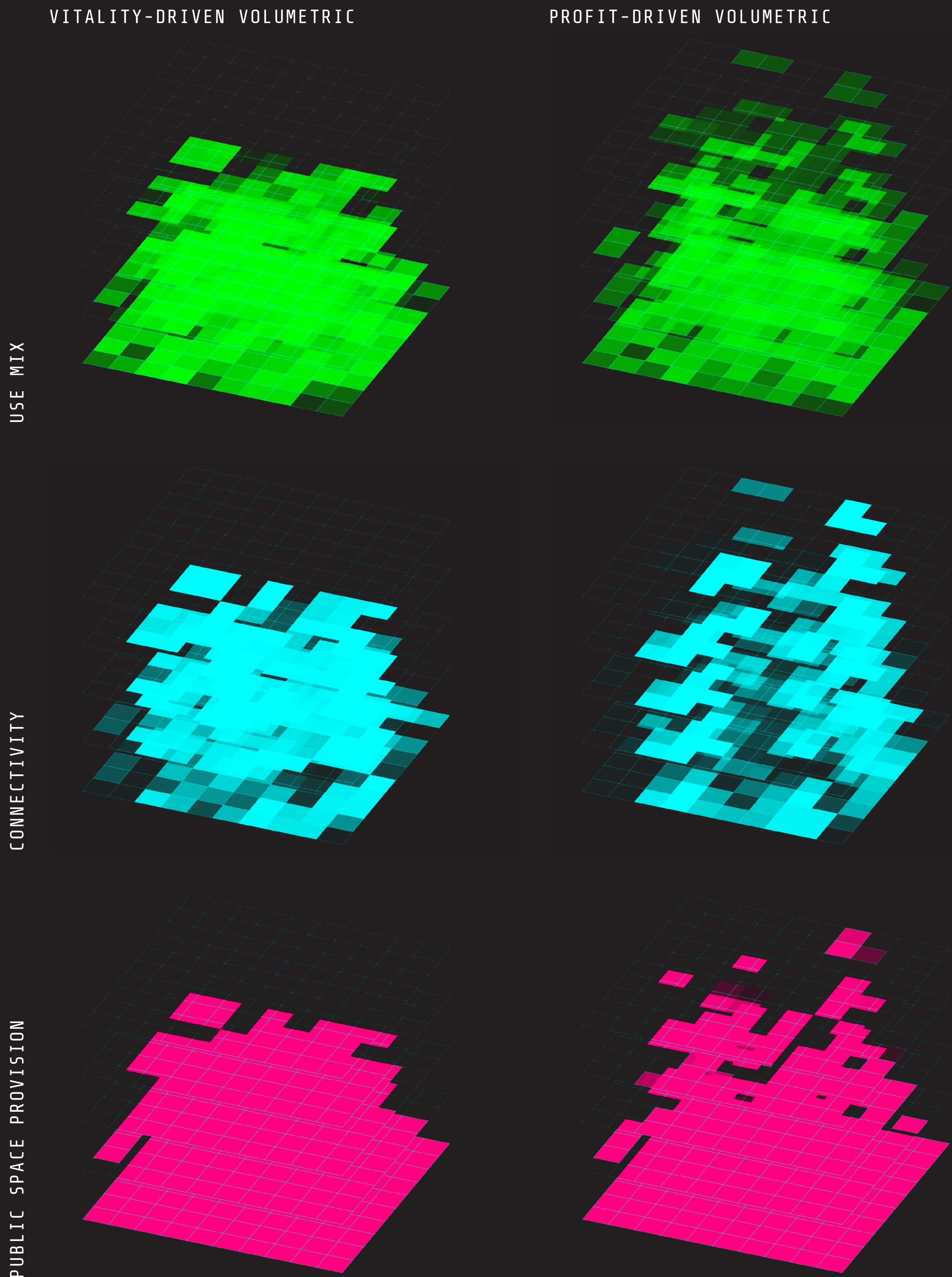
VITALITY-DRIVEN PLANAR



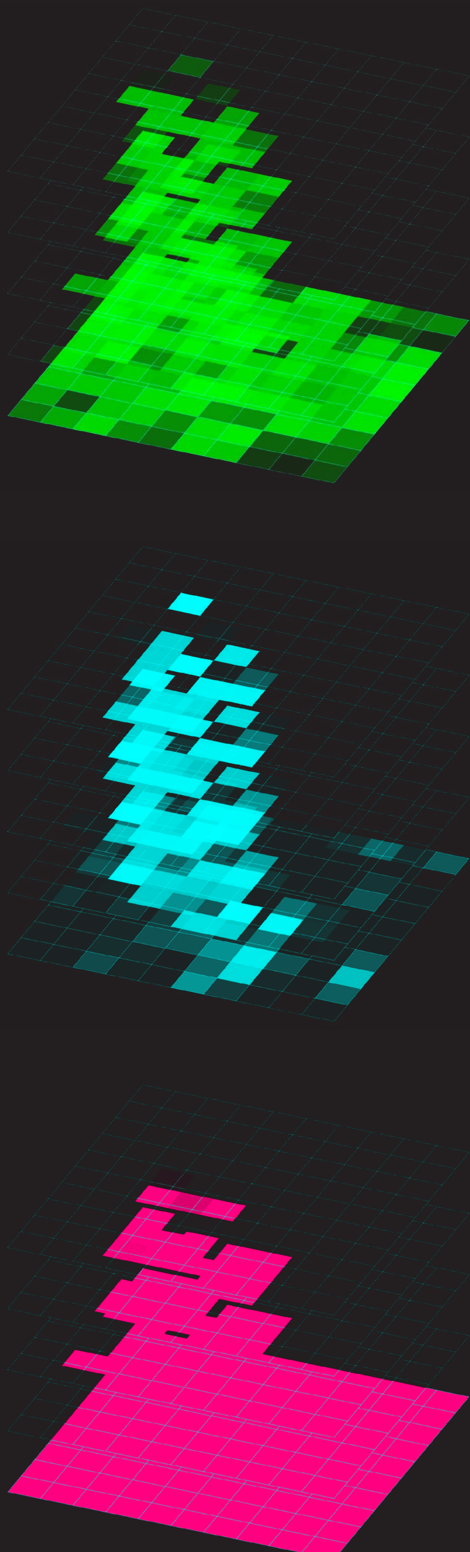
Completely transparent squares appear as black and have no score assigned to them, meaning there is no building massing within this quadrant. Brightly lit quadrants indicate a high score, while faint quadrants represent low scores.

The vitality-driven volumetric quadrant scores are largely uniformly high throughout the three-dimensional field, with the exception of the age mix score which suffers due to the increased building scale, the public level score which sees a dip around preserved quasi-public features in the model such as the Eaton Centre, and the density score which is reduced where parks have been preserved.

Figure 17.13 (continued)


VITALITY-DRIVEN VOLUMETRIC
PROFIT-DRIVEN VOLUMETRIC
USE MIX
CONNECTIVITY
PUBLIC SPACE PROVISION

VITALITY-DRIVEN PLANAR



The profit-driven volumetric scenario shows a much more varied composition of scores, indicating that some areas will be successful in achieving vitality, but there will still be various parts of the model spread throughout the three-dimensional field that will have low diversity, large swings in the amount of pedestrian traffic, and low vitality.

The vitality-driven planar scenario generally shows high scores at the ground plane, although not as high as the volumetric scenario due to its reduced flexibility. At higher levels the performance scores are all expectedly lower, as the buildings rely exclusively on the ground plan for public and quasi-public circulation as well as amenities.

Figure 17.13 (continued)

CHAPTER 18

THE SCENARIOS ARE COMPARED SPATIALLY AND NUMERICALLY TO EVALUATE THE EFFECTIVENESS OF VITALITY-DRIVEN VOLUMETRIC ARCHITECTURE

With the scenarios generated, rendered spatially by a set of drawings, and analyzed numerically for their content and performance, the scenarios may be compared to produce some evaluations of the strengths and weaknesses of each strategy, and the limitations of the tests performed.

RESULTS OF THE SCENARIO TESTS:

18.01 The vitality-driven volumetric scenario was largely successful in depicting the conditions necessary to create vitality throughout the building network

18.02 The profit-driven volumetric scenario portrays an intensive commercialization of the commons and the privatization of the city's circulation infrastructure

18.03 The vitality-driven planar scenario shows a median in which the results aren't as successful as the vitality-driven volumetric scenario, but don't come with all the struggles of a volumetric city

LIMITATIONS OF THE TESTS:

18.04 The work would benefit from a broader look at sources beyond Jacobs' *The Death and Life of Great American Cities*

18.05 The algorithms used to generate the model and the equations used to evaluate it have a limited amount of accuracy and could be improved with evidence-based study

18.06 The generation of urban resources in the scenario models doesn't guarantee street and building network vitality

18.07 In the study of the profit-driven volumetric scenario, the complete commercialization of the urban realm has been simulated and should serve as a warning

18.08 Creating a volumetric city likely still requires relatively large scale buildings, built relatively close together within a similar timeframe

18.09 The vitality-driven volumetric scenario adopts Jacobs' principles that public space can regulate itself in terms of safety, economic opportunity, and social protocol, but whether this would work effectively in a building network is not known

18.10 The greater network connections and greater formal responsiveness of the vitality-driven volumetric scenario can also create incoherence if connections become too abundant and building massing too free-form

18.11 The algorithm was mostly prescriptive by assigning price tiers and program types, rather than simulating the conditions that lead to different program types and price tiers

18.12 The strategies suggested tend to work against the forces of capitalist development

RESULTS OF THE SCENARIO TESTS

18.01 *The vitality-driven volumetric scenario was largely successful in depicting the conditions necessary to create vitality throughout the building network*

The vitality-driven volumetric scenario drawings depicted the most variation, including a high degree of mixing of programmatic uses, price tiers, and the close interaction between distinct private and public programs that would keep more eyes on the raised-street and entice more public interaction. The spatial relationships shown created greater connections between programs with more possibilities for lines of sight and interstitial spaces that allowed a variety people and programs to spill out of their enclosures. The more malleable forms allowed for greater conservation of daylight and sightlines, even at high densities; and the possibility for unconventional strategies such as cantilevers over adjacent parcels or public spaces, and building massing along horizontal structures, were less obtrusive to atmospheric quality. The encouragement of public connections at specified strata created a more cohesive network that integrated more of the building mass into the network and allowed complete public access, making it more inclusive. The program types and price tiers were selected by the needs within a quadrant, improving walking distances, and the selection of sites was spread throughout the model, ensuring the benefits of development were spread out and areas were not overdeveloped within a short time frame. Overall this manifested in the highest performance scores of the three scenarios studied, and when viewed throughout the three-dimensional field, exhibited consistently high performance within each quadrant, even at the top of the highest buildings.

Based on Jacobs' arguments, this high amount of programmatic use and price tier mix, even distribution of programs where they are needed, greater connectivity, and public access should create greater socio-economic diversity and greater walkability throughout the three-dimensional field that keeps the building network lively. The provision for a wealth of public amenities at extra-grade strata as well as interstitial spaces with public access give people a reason to frequent the building network, as well as a space to carry out their daily activities unimpeded by corporate rules. The variety of businesses and services accommodated for allows for the choice to support businesses that suit an individual's lifestyle. This unbiased provision for residents to carry out public life in their individual manner can be seen as the staging of possibility. The mix of people and businesses creates the possibility for interactions that create social and economic opportunities that would otherwise be restricted if the building network had limited people or businesses, or produced monotonous spaces with little interaction between the building program and the paths of the building network. It raises Lefebvre's concept of "habiting"[1] to the forefront of the building network, in which the movement of the city is stimulated by the architecture and citizens are enabled to access this movement without interference.

18.02 *The profit-driven volumetric scenario portrays an intensive commercialization of the commons and the privatization of the city's circulation infrastructure*

In contrast to the vitality-driven volumetric scenario, the spatial drawings of the profit-driven volumetric scenario make the building network appear almost unapproachable—despite having a comparable number of horizontal connections between buildings. The low mix of program and the anonymous forms dictated by podium towers create very little variation throughout the three-dimensional field, and little physical or visual connection between program types, private and public areas, or different price tiers that would create social interactions. With less priority devoted to developing building massing along the horizontal strata and less price tier and program type mixes, there exists little reason to visit the building network either incidentally, or as a destination. One gets the sense that the amenities exist to serve the buildings themselves alone, rather than the city as a whole.

The tendency for newer buildings to group together and to cater towards luxurious lifestyles that are more lucrative than the types of residences needed by most of the city's inhabitants can create a visible separation between the residents within the building network and older residences outside of it. The purchase of units by foreign investors can further support this market for high priced units beyond what the local market would support. In the interest of preserving their investments, tenants

1 Lefebvre, *The Urban Revolution*, 85.

may support the continuation of the image of luxury established by the developers through condominium boards which can rule over clusters of buildings and portions of the network. This control and private policing can easily, and legally, drive out social groups that are perceived to be detrimental to the value of the development. Simultaneously, the motivation for other social groups to visit this urban enclave would diminish, as the similarity of the shops and services, difficulty of access, and the visible demographic catered towards give most outside groups little reason to visit the network. Instead, the many residents or workers, confined to similar schedules, could cause the network to fill up past capacity at peak-hours—exacerbating elevator travel while desolating the network at off-hours. This produces the desolation that can: support crime or violence, even with private security or cameras; and the lack of steady customers from incidental passersby that are necessary to sustain what few independent businesses were permitted tenancy in the building network.

A reading of the scenario's composition based on Jacobs' propositions supports this unfortunate interpretation of the profit-driven volumetric scenario. All of these conditions manifest in the low performance scores which suggest that the model doesn't fulfill the criteria proposed by Jacobs to produce street vitality. When viewed by quadrant, it is seen that there are areas throughout the three-dimensional field that are performing well, interspersed throughout quadrants with lower performance scores. However, these flourishing areas will also be prone to over-development due to their desirability that results in a reduced investment risk and increased revenue potential.

Ultimately the result of the profit-driven volumetric scenario is the commercialization of the city's public sphere. By seizing control of the circulation infrastructure network through its own superimposed system, the owners are able to define the rules of the city's commons while the remaining public realm suffers from the loss of a contributing social group and its wealthiest demographic. Without a negative feedback system to constrain development, the result is not the social condenser that the building type promised, but rather the formalization of segregation, commercialization, and inequity. The street has been eliminated as a place of inhabiting and replaced with a place to pass through and consume. The consequences for the city can be described by recalling the words of Lefebvre: "The street is where movement takes place, the interaction without which urban life would not exist, leaving only separation, a forced and fixed segregation. And there are consequences to eliminating the street (ever since Le Corbusier and his *nouveaux ensembles*): the extinction of life, the reduction of the city to a dormitory, the aberrant functionalization of existence."[2]

18.03 *The vitality-driven planar scenario shows a median in which the results aren't as successful as the vitality-driven volumetric scenario, but don't come with all the struggles of a volumetric city*

The vitality-driven planar scenario shows similar promise to the vitality-driven volumetric city. Although not scoring as high in terms of performance scores due to the greater homogeneity of the towers, the lack of inter-building connections and extra-grade amenity spaces forces the activity of the building to be drawn out to the street level. At the street level, the city benefits similarly from greater programmatic and price tier mixes, the allowance of more public space, the usage of roof terraces near grade for public gathering and resource production, and greater formal experimentation that can create stronger relationships between various programs, improve daylighting, and conserve significant sightlines. Based on Jacobs' criteria, these factors should work together to create a diversely inhabited street throughout all times of the day and create a vibrant street life of economic and social opportunity, unbiased by the architecture itself.

The city may still suffer from the difficulties of high-density towers that create a disassociation from the ground plane and don't provide communal spaces and amenities throughout the height of the building. Instead, the scenario relies heavily on the efficiency of elevators and their ability to transport people to the ground plane in order to fulfill their needs for communal space and amenities. Overcoming this limitation could be greatly assisted by the greater diversity of social groups within the residential and business high-rises of this scenario, creating less rush hour traffic at elevators and more steady use. It may also require advances

2 Ibid., 18.

in elevator technology to be fully overcome. However, if the disconnect between the ground plane and the occupants can be mediated effectively, the scenario suggests the design and the socio-economic composition of the ground plane can adequately fulfill the needs of the city's residents without the need for a volumetric public realm created by a building network. This is significant as it means that the lessons learned about improving street vitality can be effectively applied at grade level, and the risks associated with the possible privatization of the city's circulation network can be avoided. Ultimately, the result is the staging of socio-economic possibilities at the ground plane alone, while the intensity of this vibrancy is supported by the diverse high-density towers which effectively "plug-in" to the public sphere at grade.

LIMITATIONS OF THE TESTS

18.04 *The work would benefit from a broader look at sources beyond Jane Jacobs'* The Death and Life of Great American Cities

Since the primary goal of the thesis is to investigate why street vitality struggles to exist within building networks and suggest possible resolutions, Jacobs' seminal work on street vitality is a logical point of departure. However, Jacobs' work is also limited by its anecdotal, rather than scientific, evidence to support her claims and by the amount cities have changed since the book was published in 1961. Although Jacobs' work is still incredibly influential, continued work on this topic would benefit from a broader study of how cities work, more recent work on modern cities, and stronger empirical evidence.

18.05 *The algorithms used to generate the model and the equations used to evaluate it have a limited amount of accuracy and could be improved with evidence-based study*

The simulations run using the parametric design tool were simplified for the purposes of a first look at how a volumetric city might grow. However, the small scale of the simulation (only 1km^2 of a 630km^2 city) means that qualities such as competitive diversion (the tendency not to overdevelop a single area) are limited. A simulation of the entire City of Toronto would show even slower development within the downtown core than the vitality-driven volumetric scenario showed by favouring development in under-developed areas first.

The processes simulated in the parametric tool recreate the most significant factors identified by Jacobs' in the development process for volumetric cities; however, many more processes and factors exist that could improve the accuracy of the simulation. The equations used, notably in the performance scoring, are also only a preliminary attempt at representing the performance of the building fabric based on Jacobs' criteria. These performance scores could be greatly improved by further research that substantiates the equations used with evidence of their real-world effects. Finally, the simulations were carried out with a limited number of iterations in a trial and error process, and through more trials better parameter settings could be found to represent each of the scenarios more accurately, and perhaps better strategies for creating a vitality-driven volumetric scenario could be found.

18.06 *The generation of urban resources in the scenario models doesn't guarantee street and building network vitality*

Although the anecdotal evidence presented in Jacobs' work likely means that implementing her theories in the volumetric city would drastically improve the vitality of the building network, the work has not yet established empirical evidence for a causal link between urban resources and vitality. The equations measuring the performance scores are self-referential, demonstrating only that the system is working as expected: the simulation of the vitality-driven volumetric city is trying to create diversity through a specific set of criteria, and the performance scores measured those same criteria to confirm their success. Since it is only a simulation, it isn't possible to determine what diversity is actually created, and therefore in order to prove vitality is created, the strategies suggested by the vitality-driven scenario would actually have to be implemented and vitality measured by some agreed upon metrics of success.

18.07 *In the study of the profit-driven volumetric scenario, the complete commercialization of the urban realm has been simulated and should serve as a warning*

The intent of this study was to show ways in which a vitality-driven model could improve the volumetric city by contrasting it with a scenario motivated purely by financial gains for the private sector. However, in producing this profit-driven scenario, what has also been shown is the ability to intentionally manipulate the urban fabric in order to increase profits. Although to an extent this already occurs through market research, risk assessments, and established business practices, the study alludes to the fact that it is possible to use parametric design to optimize revenue and risk assessments in order to improve the certainty of investments by strategically targeting vibrant portions of the city and disregarding the characteristics of the building fabric that create an inclusive, vibrant and equitable urban realm that serve society as a whole but do not generate immediate revenue. Such a strategy would likely have the inverse effect of the intention of this study and deepen commercialization in the public realm as well as segregation and inequality in the society affected.

18.08 *Creating a volumetric city likely still requires relatively large scale buildings, built relatively close together within a similar timeframe*

Even if the strong economic incentive to quickly add to the network is dissuaded through regulations, in order to prevent the building network from being very disparate throughout the city for long periods of time, it's likely that some large-scale buildings will need to be constructed within a short time-frame and within close proximity, which opposes Jacobs' suggestion of mixed building ages. This means that the qualities of Jacobs' *old city* can only be mimicked by prescribing minimum amounts of programmatic mixes and price tiers; and not replicated, as the scale and proximity of buildings from the same era won't permit sufficient programmatic and price tier mixes between buildings. The scale of the city has become so large, that the buildings themselves must be diverse, not just the city.

18.09 *The vitality-driven volumetric scenario adopts Jacobs' principles that public space can regulate itself in terms of safety, economic opportunity, and social protocol, but whether this would work effectively in a building network is not known*

Although Jacobs' presents convincing evidence for public space to regulate itself under the right conditions, whether or not this can immediately manifest within a building network remains a dubious proposition. The question of how public is too public will likely remain until a functioning, truly public building network is established. Society has grown accustomed to the idea that building cores are private, or at most quasi-public, and features such as private security guards, CCTV, and identification badges that control access points have become features to many large-scale buildings. With these measures privately controlled, or even publicly controlled in a biased manner, the building network will never be inclusive to all members and aspects of society. The motivation for the parts of society privileged enough to have private security measures to let go of them in favour of a self-regulated and government-policed space will likely not be substantial until the ability for this inclusive society to regulate itself is demonstrated and the benefits of its vitality proven. The question remains if buildings can or should still have private governance and private security measures, and if so, how they should be held accountable.

18.10 *The greater network connections and greater formal responsiveness of the vitality-driven volumetric scenario can also create incoherence if connections become too abundant and building massing too free-form*

Although more connections between buildings can create greater accessibility, and more free-form shapes can better respond to atmospheric and programmatic criteria, in a volumetric city these qualities can also become an inhibition if the intensity of the city becomes so great that it becomes less coherent or difficult to navigate. To an extent, this can be mediated by well-designed way-finding systems such as signage and cell phone-based mapping applications, but the spatial drawings of the vitality-driven volumetric scenario show that there is an approachable lack of coherence that can be caused by too many connections and overly plastic forms.

18.11 *The algorithm was mostly prescriptive by assigning price tiers and program types, rather than simulating the conditions that lead to different program types and price tiers*

Since the large-scale of buildings was deemed too great to provide adequate mixing of program and price tiers, the universal scenarios prescribed price tier and programmatic mixes according to the local needs of the adjacent quadrants and a variety of algorithms that provided different patterns for creating this mix. It is possible that prescribing a minimum amount of mix and types for each area is a viable strategy for creating the desired vibrant building fabric. However, it may be preferable to have most of these criteria resolved by higher-level factors such as a well regulated real estate market that keeps housing affordable, and taxing over-development to create a reasonable blend of price tiers within the city. In this case simulating these higher-level regulations and their effects would be more useful than prescribing the desired mixes of program and price tier types.

The strata of a volumetric city also presents an opportunity to introduce mixing by creating a new ground plane and a new penthouse level at each stratum. Beyond this, some amount of rent control and prescribed affordable housing may be enough to ensure adequate diversity. However, Lynch notes the difficulty in reducing the grain of North American cities, explaining: “to be effective, it requires a substantial interference with the real estate market, as well as legal moves, the application of large housing subsidies, and regional controls on development. It may well require much more radical measures, such as socialization of the land, making housing a free utility or the restriction of ownerships to life tenure."[1]

18.12 *The strategies suggested tend to work against the forces of capitalist development*

Many of the issues raised are a result of the tension between the strength of economic forces driving development and the volumetric city's fundamental aspiration towards a socialist society, originating from its inception as a social condenser. For this reason, it could be argued that the best method of creating the equitable volumetric public realm suggested by volumetric architecture would be the creation of a socialist society. However, in practice, volumetric cities are continually emerging within staunchly capitalist contexts, and in order to prevent the commercialization and segregation of these cities, it is likely that the volumetric city will have to be addressed at the city level through regulations, and the architectural level through design.

1 Lynch, *Good City Form,* 267-268.

CHAPTER 19

THE SCENARIO ANALYSIS IS USED TO MAKE CONCLUSIONS ON THE ROLE OF VOLUMETRIC ARCHITECTURE IN THE CITY

With the evaluations of the scenarios completed and the limitations of the tests established, these conclusions provide some closing thoughts on the lessons learned from this study of volumetric architecture and a summary of the work completed.

CONCLUSIONS:

19.01. Volumetric cities are a distinct urban typology that function differently than planar cities and require different criteria, regulations, tools, and theories

19.02. A building network is an auxiliary infrastructure network overlaid on top of the city's existing infrastructure

19.03. When a building network is privately controlled it is effectively the privatization of the city's circulation system and commons

19.04. The privatization of the commons is problematic as the commercial forces that shape the building network aren't required to meet the needs of the general public, only the ones that are commercially beneficial in response to a target market

19.05. Architects need to acknowledge the failures of past volumetric architecture before evoking its form or concepts and take steps to resolve them

19.06. While volumetric architecture may be appropriate in some, it is not suitable in all contexts

19.07. Since volumetric architecture brings the role and functions of the city into the building, it should be considered as much urbanism as it is architecture

19.08. The proposal is to re-create vibrant street conditions at extra-grade levels by catalyzing informal uses of public space through design and the design of regulations

19.09. The design strategies suggested would initially reduce short-term profits for the private sector, but can ultimately elevate the entire city economically and create greater market stability

19.10. A good strategy is to begin by focusing on improving the vitality of the street network before attempting to produce a vibrant building network

19.11. The likelihood for volumetric cities to emerge will become greater over time

19.12. A development initiated volumetric city would have an initial phase of slow, but critical, growth

19.13. A private transformation of the public realm will likely occur at a slow pace, making the cause hard to identify

SUMMARY:

19.14. The potential for a rise of under-regulated volumetric architecture in Toronto

19.15. Understanding the tension between profit-driven volumetric architecture and the vitality of the city

19.16. Establishing a new vitality-driven framework to address the tension between profit-driven volumetric architecture and the vitality of the city

19.17. Evaluating the effectiveness of a vitality-driven volumetric city through the comparison of future urban scenarios

CONCLUSIONS

19.01 *Volumetric cities are a distinct urban typology that function differently than planar cities and require different criteria, regulations, tools, and theories*

One of the biggest conclusions from this study is how different volumetric architecture functions from planar architecture, making it a distinct typology. The thesis has shown how the relationship between the building and the urban realm can change drastically when amenities and services that provide functions typical of the urban realm are placed away from grade throughout the building's volume. The result has the ability to alter connectivity and access, how the commons are used, who uses them, and in turn, alters how the public realm at grade functions as well.

19.02 *A building network is an auxiliary infrastructure network overlaid on top of the city's existing infrastructure*

Although volumetric architecture can begin as a stand-alone piece, and inter-building connections at first appear to be less of an urban feature and more a characteristic of a building—as the networks of buildings and grade-separated public spaces become more developed, they become increasingly influential on the city, eventually creating a new network of circulation, economic influence, and social sphere overlaid on top of the city's existing circulation infrastructure network. This auxiliary network ultimately functions as a piece of public infrastructure, and can either work with the existing street network to support the city's existing infrastructure—contributing to its functions, processes, informal uses, and movement—or detract from it by appropriating these qualities of the city for itself.

19.03 *When a building network is privately controlled it is effectively the privatization of the city's circulation system and commons*

Since contemporary volumetric architecture projects tend to be privately developed, by default the amenities, services, tunnels, and sky-bridges that they construct are under private ownership and control. As a city's commons becomes increasingly volumetric in nature and the building network further established, the result can effectively become the privatization of the city's commons, as businesses, services, and circulation relocate to this private infrastructure.

19.04 *The privatization of the commons is problematic as the commercial forces that shape the building network aren't required to meet the needs of the general public, only the ones that are commercially beneficial in response to a target market*

While privatization can be beneficial with market competition that improves services to users, as other forms of infrastructure such as telephone networks, film, cable, and broadcasting have demonstrated, this typically occurs only with strong anti-trust laws that prevent the formation of oligopolies.[1] This is further problematized for a building network by the fact that network ownership is tied to specific locations within the city, meaning that residents often won't have a choice between different networks, and the scale and clustering of building developments creates a maximum threshold on the number of networks that could be produced. Diverse network ownership is also not necessarily beneficial in this case, as it can lead to confusing way-finding and unsynchronized closure times. This means that if a building network isn't public, it will trend towards an oligopoly or disarray.

Unlike the public street network, which in diverse cases, through its public nature is inclusive to all residents and businesses, a privately owned building network only needs to fulfill the roles commercially beneficial to its stakeholders. This can inhibit informal uses of the building network that aren't accommodated for, reducing vitality. Furthermore, the intentional exclusion of social groups has at times been exploited for commercial benefit, as evidenced by the targeted marketing of suburban homes to middle-class white Americans, and more recently, the exclusion of specific social groups (such as families) by condominium boards that cater towards retired couples or young professionals.

The lack of a negative feedback system in cities, as diagnosed by Jane Jacobs,[2] means that these processes can perpetuate once established. Once an oligopolistic architecture has been built, the individual motivations of its investors (from building owners to residents), combined with the economic draw of businesses away from the street up into the building network, can sustain the oligopoly while the quality of life in the existing built environment deteriorates. This phenomenon explains how the downtowns of cities such as Baltimore and Cincinnati declined so significantly because of their building networks, that have since been largely demolished.

1 Tim Wu, *The Master Switch* (New York: Vintage Books, 2010), 257.
2 Jacobs, *The Death and Life,* 251.

This seizure of the public realm of North American downtowns during the modernist period was not incidental, but openly served to increase sales by increasing the connectivity, and difficulty of leaving, retail centres, while increasing productivity of office environments by streamlining commutes, coffee breaks, and lunch hours for workers—providing little services, circulation, or amenities for outsiders.

19.05 *Architects need to acknowledge the failures of past volumetric architecture before evoking its form or concepts and take steps to resolve them*

The failures of built volumetric city networks are well documented, and while architects continue to gravitate towards the optimism represented by these projects, contemporary volumetric architecture projects offer little suggestion as to how these problems can be resolved. A significant part of this process may be questioning whether a building creates a spatial oligopoly or the privatization of the city's circulation, and how this would affect the lives of the city's residents. Invoking the social condenser term on a privately owned and operated project is disingenuous to the term's origins in socialism and communism. In doing so, the true intentions and impacts of projects with commercial motivations in a capitalist society are obscured. In effect, this uses the form, visuals, and language of an optimistic architecture of equality and community as a means to promote a concept, product, or real estate, in which the space actually serves to further the commercial goals of its owners and investors. Even if the design goals of the project as a social equalizer are genuine, the design can be superseded by the socio-economic control of a large area of city space and the control of access.

19.06 *While volumetric architecture may be appropriate in some, it is not suitable in all contexts*

The programmatic and retail values of projects are largely dictated before an architect's involvement in the project. Because volumetric architecture has the ability to fortify existing commercialism, segregation, and inequality, this means that architects need to consider whether or not volumetric architecture is an appropriate strategy given the socio-economic composition of the building in relation to its context in the city. Even when considered at the architectural scale alone, a single building can have the effect of removing people from the street and redirecting social interactions and economic opportunities to a heavily commercialized environment. This could deprive the public realm of the benefits of new high-density buildings, while retaining the negative side-effects such as shading, over-loaded infrastructure and services, and setting a new precedent for building heights. The ability for volumetric architecture to catalyze other volumetric architecture projects also means that a single inter-building connection can initiate a city-wide network due to the economic draw of traffic relocated to the network, and floor area ratio or height bonuses that create more saleable floor area. For these reasons, in some cases, it may be preferable to rely on planar architecture to ensure the building contributes to, rather than detracts from, the public realm.

19.07 *Since volumetric architecture brings the role and functions of the city into the building, it should be considered as much urbanism as it is architecture*

Since the goal of volumetric architecture is to bring the city into the building, it also needs to bring the functions of the city into the building as well, making the building not only an architectural problem but also an urban problem. This is because the vitality of volumetric architecture is determined more by its relationship to the rest of the city than by its design or socio-economic composition alone. By considering the socio-economic composition of the building itself as a sizable portion of the building fabric, as well as in response to the local needs of the city, the building can create a greater dialogue with the public realm and build its own processes to achieve vitality.

19.08 *The proposal is to re-create vibrant street conditions at extra-grade levels by catalyzing informal uses of public space through design and the design of regulations*

The results of the vitality-driven volumetric scenario showed that by planning the city to produce the functions of the street within the building network, it may be possible to produce a volumetric city which generates vitality. When privately owned and regulated space takes the place of the city's commons, the city's urban realm becomes designed and controlled for commercial functions. Informal uses of public space that provide vitality fail to be supported, or can at times be prohibited. Therefore, in order to create vitality throughout the three-dimensional field, the informal uses of public space need to be designed and regulated into the building fabric throughout the three-dimensional field. This designs the possibility and potential for diverse events, movement, and opportunities to unfold.

19.09 *The design strategies suggested would initially reduce short-term profits for the private sector, but can ultimately elevate the entire city economically and create greater market stability*

The strategies suggested for creating a vibrant volumetric city resist several significant economic incentives. These include: limiting the scale of development in some cases; reducing over-development of any given neighbourhood by incentivizing development distributed more evenly throughout the city; reducing height gains granted for integration into the building network; introducing affordable units that reduce the total value of the building; reducing foreign investment ownership which artificially inflates the demand and cost of the housing market; reducing the single ownership of large areas of retail space; and encouraging more responsive designs than the most economical building type. These criteria are designed not to reduce the overall economic potential of the city, but to balance and stabilize the economic potential throughout the city as a whole. This can make economic potential accessible to more of its residents and contributors by keeping the fabric of the city competitive. If Jacobs' theories are correct, this creates a negative feedback system which over time, will not only improve the vitality of the whole city, but also increase economic potential for developers as more lots throughout the city become viable for construction, demand becomes stabilized, and risks associated with development are reduced.

19.10 *A good strategy is to begin by focusing on improving the vitality of the street network before attempting to produce a vibrant building network*

The vitality-driven volumetric scenario shows an ambitious strategy of many varied processes and stakeholders working together. While the spatial drawings show a more inhabitable space, they clearly present significantly more technical difficulties in their implementation than the simplicity of the profit-driven volumetric scenario. Furthermore, these strategies need to be implemented early in the development of the volumetric city, as once the building network has been established as private infrastructure and the architecture has been built, it is very difficult to reverse. Because of the economic incentives of privatizing the building network, the threat of privatizing the public network will always exist, as continued lobbying and changing governments can gradually introduce laws that reduce the protection of the public building network.

Due to the difficulties of creating an inclusive and vibrant volumetric city, the difficulty of conserving the public control of the infrastructure network, and the relative success shown of the vitality-driven planar scenario, it's possible that in most cases the city is not yet ready to implement a volumetric architectural language. The vitality-driven planar strategy showed impressively similar results to the vitality-driven volumetric scenario in both its spatial quality at the ground plane, as well as its performance for Jacobs' criteria for vitality. The scenario offers a viable possibility to improve the vitality and economic potential of the city, without the possible complications identified with the volumetric city. If the city can be designed and regulated to successfully create vitality at the ground plane, this would establish a precedence that can later be applied directly to the volumetric city. Therefore, a good strategy would be to create regulations which restrict volumetric architecture, and focus on buildings which improve the quality of the urban realm at street level, until these issues can be resolved.

19.11 *The likelihood for volumetric cities to emerge will become greater over time*

As cities are densifying and features such as sky-lobbies become necessary for the elevators of more buildings, extra-grade amenities become more common for tall buildings, grade space becomes more limited, and inter-building connections become more feasible. These factors will make the city's commons increasingly volumetric. Over the span of decades or centuries, many cities may see an increasingly volumetric urban realm that causes slow changes, that ultimately can become significant shifts to how public space works. Given the past precedence of corporations strategically implementing building networks in order to increase their influence on urban centres, the significant economic benefits of creating a volumetric building network may create the demand for a variety of new volumetric city master plans in the near future.

19.12 *A privately initiated volumetric city would have an initial phase of slow, but critical, growth*

The profit-driven volumetric city scenario initially showed pockets of volumetric architecture developments spread throughout the city until the connections between buildings became so ubiquitous that developments began to connect across to each other. This means that it's likely volumetric architecture will be less overt than a city-wide building network for a period of time during the initial phase of the city's volumetric growth. First, a few developments of volumetric pseudo-public space will become built throughout the city. These pockets of volumetric architecture could have a local impact of diminishing street vitality by reducing participation in the public realm. Once volumetric architecture becomes prevalent enough that connecting between adjacent developments is economical, these buildings will have already laid down significant legal precedence for private network ownership, regulation, and control, as well as pivotal physical infrastructure. The disparate building networks can begin to connect into an integrated network, however, the unplanned paths and strata levels of existing buildings would complicate wayfinding.

19.13 *A private transformation of the public realm will likely occur at a slow pace, making the cause hard to identify*

In the case of a private building network such as in the profit-driven volumetric scenario, the effect of this privatization of the commons may also be a gradual transformation. In some cases, the loss of street vitality may escalate to the visible social problems Jacobs' describes, from gentrification and the persistence of slums, to street violence and the deprivation of the local economy. However, the processes Jacobs' work discusses take both time to build up, and time to be destroyed through the course of many small events over an extended period. Small changes to a person's route may change the retail businesses they support along the way. Spaces that formerly supported a variety of informal uses may see specific user groups discouraged from the area as one type of business caters the space towards their clientele. Communities of diverse people may be sorted apart by market rates, condominium boards, targeted marketing, and the specialized amenities of new developments. These factors produce a continual force that subtly reinforces the oligopoly in place. These small shifts may be enough to change how people live, or what businesses succeed, slowly influencing the public space towards supporting the dominant owner of the building network. For this reason, it may be valuable to look at the urban resources of a neighbourhood, or what urban resources a new development proposal would contribute to the urban fabric, rather than the existing social conditions. Evaluating whether or not a neighbourhood has the urban resources to enable informal uses of public space, and whether a new building development contributes urban resources or depletes them, could be a significant indicator of the future vitality of the area.

SUMMARY

19.14 *The potential for a rise of under-regulated volumetric architecture in Toronto*

In summary, the thesis has shown that due to the contemporary popularity of the volumetric architecture type within the architecture community, combined with existing and planned works of volumetric architecture in Toronto, the city may see an influx of buildings which re-create some of the functions of public space and public infrastructure at levels beyond grade. Despite the optimism of the typology's progenitor, the Soviet Union's social condenser, volumetric architecture has a long history of segregation, commercialism, and inequity, that it has yet to overcome. In Toronto, this could be particularly problematic since the political climate has diminished the city's ability to control and regulate development in the city, and volumetric architecture provides greater agency to control the urban commons.

19.15 *Understanding the tension between profit-driven volumetric architecture and the vitality of the city*

Since the volumetric city's primary proposition is the creation of a new public realm throughout three-dimensional space, Jane Jacobs work has been used to understand how the volumetric city can achieve street vitality throughout a volumetric building network. What is found is that the vitality of city streets comes from informal uses of public space that can be either catalyzed or inhibited by the composition of the building fabric (urban resources). The economic factors driving large-scale buildings already diminish these qualities of the building fabric because of their ability to decrease diversity and atmospheric quality when an area becomes over-developed. Volumetric architecture has the potential to deepen this problem by removing more people from public streets, creating larger buildings that diminish diversity further, and shifting control of the urban commons to private ownership that can benefit from exclusivity.

19.16 *Establishing a new vitality-driven framework to address the tension between profit-driven volumetric architecture and the vitality of the city*

The failures of previous volumetric cities notwithstanding, the type provides new design and economic opportunities, as well as ways of mediating the difficulties of high-density living such as the lack of community, shortage of amenities, and disconnect from the ground plane. For this reason, future scenarios of the city have been developed to compare a volumetric city designed for vitality, to a volumetric city designed for profit, and a planar city designed for vitality. In order to rapidly test a variety of configurations that can represent each of these three scenarios at the urban scale, a parametric design tool has been herein developed and coded to simulate the growth of the city over an extended period of time.

The parametric design tool is designed to recreate real-world processes with a large amount of flexibility in order to implement different regulatory and design conditions. For this reason, the tool has user-defined variables for each of the major processes of the algorithm that generate a model of the building fabric. The major processes of the tool include: the creation of a digital modeling environment, analysis of an imported model of the existing city, selection of a site, analysis of the site, the location of building cores, and the creation of the building massing. These processes repeat as a cycle to simulate the process of individual buildings being constructed over time.

19.17 *Evaluating the effectiveness of a vitality-driven volumetric city through the comparison of future urban scenarios*

The vitality-driven volumetric scenario shows a city with a fully traversable three-dimensional field. With a large amount of diversity throughout 3-D space, open access, high connectivity, program distribution that improves walkability, and responsive sectional variation, the scenario is designed to keep the entire building network active and enable informal uses that can accommodate all of the city's inhabitants.

The profit-driven volumetric scenario shows a city of similar connectivity. However, driven by economic forces and existing regulations alone, the increasing scale of buildings has wiped out a large amount of the city's diversity without generating new diversity itself, and the city's building network, composed of numerous distinct networks from different owners, reduces access and coherence of the city's circulation infrastructure. Without a suitable amount of diversity of people and amenities to populate the network, little reason exists for outsiders to use it, or for resident citizens to linger, forming a collection of urban enclaves that separate the population and support a commercial agenda.

The vitality-driven planar scenario provides similar benefits to the vitality-driven volumetric scenario, but instead of a traversable volumetric public space, provides instead a rich ground plane of diversity, vitality, and inclusiveness, with high-density towers that "plug in" to the ground plane to provide the density and diversity that keeps street vitality high. Its major weakness is at the highest parts of the towers which rely on the elevator as their single tether to the ground. Albeit, this condition is still improved by the added diversity within the building that reduces elevator wait times, and the greater vitality and diversity of the ground plane which provide adequate services and a sense of community.

Ultimately, the simulations of these scenarios offer a proof of concept that Jacobs' strategies to generate street vitality can be applied throughout the three-dimensional field to create a vibrant volumetric building network that works against commercialism, segregation, and inequality. However, while this may be possible, it also comes with substantial technical, economic, and political challenges in which the strategy eschews traditional building techniques and municipal regulations. Due to the added risks of commercialization and segregation for volumetric architecture without strong regulations in place, these significant challenges to creating a vibrant and inclusive volumetric city mean that a viable alternative is to discourage volumetric architecture until adequate measures are put in place that can protect the city's vitality and inclusivity. This would mean developing a scenario such as the vitality-driven planar city in order to improve the fit of the ground plane for the city's residents until the occupation of higher strata becomes necessary. At this point, the regulations to create vitality in the volumetric city will have largely been established at the ground plane and can be adapted to the pursuit of a volumetric city.

Ultimately, the design of volumetric architecture requires the recognition of the shortcomings of previous volumetric architecture projects and taking measures to design for vitality throughout the project's three-dimensional space. Since the quintessential concept of volumetric architecture is to bring the city into the building, this means that the building must both integrate with the city, and be designed as a microcosm of the city itself.

"You're completely missing the point," her mother countered, shaking her head disapprovingly. "You can't have your cake and eat it too. Or at least you shouldn't." "Why not? We've reached a stage of technological advancement that we can have streets upon streets, and thriving ones at that. The traditional perception of above and below doesn't make sense anymore because the ground can be both at the same time, creating a new web of density. Mind you, this is fundamentally different from the old utopic visions of bridging between buildings, where the bridge remains the secondary element, a singular thing that one could spot from the ground. Now, there's a slippery ambiguity between not only above and below, but also boundaries between ground and building." "I think we still need thresholds," her mother replied, "not to mention how new neighborhoods like the "Upper-upper west" are rather ridiculous sounding." "No thoughts?" They looked at her. Funny how two people who seemed to hold opposite views on everything could so suddenly join ranks. She shrugged, and reached over to grab the vegetables. She disliked getting in between her parents, and so kept her lips sealed on the matter. After all, who knew if this was the physical democratization of the city or simply power-hungry developers having hit the jackpot?

—New Office Works[a]

[a] New Office Works, "NYCityVision," New Office Works, accessed October 20, 2017, http://www.newofficeworks.com/nycityvision.html.

BY CREATING A PRIVATE MICROCOSM OF THE CITY, VOLUMETRIC ARCHITECTURE CAN COMPROMISE THE NEUTRALITY OF THE URBAN REALM. THIS EXCHANGE OF SPATIAL RIGHTS FROM DIVERSIFIED PUBLIC CONTROL TO PRIVATE CONTROL BY A CORPORATE OLIGOPOLY CAN DISRUPT THE PROCESSES OF THE CITY, INHIBITING VITALITY IN THE BUILDING NETWORK. THE STUDIES CONDUCTED BY COMPUTATIONALLY SIMULATING THE GROWTH OF THE URBAN FABRIC DEMONSTRATED THAT WITHOUT A NEGATIVE FEEDBACK MECHANISM, THE FORCES THAT DRIVE DEVELOPMENT CAN DESIGN OUT THE CONDITIONS THAT GENERATE VITALITY—PRODUCING AN ARCHITECTURE OF COMMERCIALISM, SEGREGATION, AND INEQUITY. HOWEVER, BY DESIGNING AND REGULATING THE BUILDING NETWORK AS A SHARED URBAN SPACE, HOLISTICALLY RESPONSIVE TO THE DIVERSE SET OF NEEDS OF THE CITY, THE VOLUMETRIC CITY CAN WORK TOWARDS AN INCLUSIVE AND VIBRANT URBAN REALM THROUGHOUT THE THREE-DIMENSIONAL FIELD.

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APPENDIX

A POTENTIAL EXTENSIONS OF THE THESIS WORK

The thesis work begins to develop several new concepts about the relationship between the building and the city. This appendix suggests that the work can be expanded with: a new type of three-dimensional urbanism; predictive parametric modeling tools that assist designers, governments, and the public; quantifying the value dividends of urban resources to be used as a device to defend street vitality; and a defense against private spatial oligopolies in the built environment.

A.01. Establishing a theory of three-dimensional urbanism, best practices, and evidenced-based solutions

A.02. Developing a new, predictive, and n-dimensional parametric design tool

A.03. Defending vitality by using urban resources as a metric analysis of the vitality potential for the city

A.04. Defending spatial neutrality in the city

A.01 *Establishing a theory of three-dimensional urbanism, best practices, and evidenced-based solutions*

Although work such as Yoos and James' recent *Parallel Cities* begins to identify some of the strengths and weaknesses of volumetric architecture, few sources provide contemporary design strategies for three-dimensional urbanism beyond conceptual schematic designs. Due to the recent rise in volumetric architecture projects, the economic potential that volumetric architecture can create, the optimistic social goals of volumetric cities, and the small body of published work on the topic—the work presented here could be expanded into new theories of how this unique typology can function and be designed. Because of the negative impact volumetric architecture has had on urban centres, it will be pivotal that this work is evidence-based and suitable for the contemporary context.

A.02 *Developing a new, predictive, and n-dimensional parametric design tool*

The parametric design tool was developed to look specifically at the condition of volumetric cities; however, the software is among an emerging set of new programs that simulate urban growth as the result of regulations and the economic forces of development, including ESRI's CityEngine,[1] and UrbanSim, a former subsidiary of AutoDesk.[2] Software which simulates urban development can not only be used to assist with form-finding, but also to make intelligent decisions that anticipate future conditions, creating pro-active responses to issues that would otherwise arise years later from construction that took decades to assemble. Therefore, the use of the parametric tool to develop a variety of scenarios studies not only the city as a three-dimensional composition changing through the fourth dimension of time, but also the various scenarios of a potentially limitless number of alternative dimensions—creating not only a three-dimensional city, but an *n-dimensional city*. Kevin Lynch anticipates this shift in the design of cities in 1984, explaining that through simulation, "changes can be foreseen that may happen if one or another public policy is carried out, or if some uncontrolled external event occurs."[3]

1 ESRI, "City Engine," ESRI, accessed November 10, 2017, http://www.esri.com/software/cityengine.
2 Paul Waddel, "Our Story," *UrbanSim*, accessed November 10, 2017, http://www.urbansim.com/new-page/.
3 Lynch, *Good City Form*, 337.

This anticipatory planning through simulation can significantly impact the city in three ways. First, it can justify and prove what Jacobs refers to as, *penny foolish pound-wise* policies such as competitive diversion and staunchness of public buildings. These principles, in the short term, would reduce capital gains for both the private developer and the municipality by not pursuing the full land value of properties in high-demand areas. However, by preserving the character and diversity of neighbourhoods, and by spreading out the beneficial effects of development while reducing the negative effects of over-development, eventually the land value of the city can be raised holistically. Without this simulation, the strategy can present a big risk that would dissuade politicians and developers from pursuing it in favour of the immediate profits of further development. The simulation of the city can also be used to create the responsive regulations that would enforce concepts such as Jacobs' competitive diversion and mixed uses. Since the concept of competitive diversion is to implement a higher development tax on over-developed neighbourhoods while encouraging development in areas that would benefit from more development, the determination of which areas to prioritize, as well as how much each area should be taxed, would need to be determined by a variety of conditions that can be computationally assessed.

Simulating alternate dimensions of the city can also help to democratize the process of urban planning. It allows the outcomes of regulations to be understood and visualized through the lens of all stakeholders involved, including the general public. Implementing the simulation as a computer program with user-editable parameter settings such as those the parametric design tool in this study included would allow anyone to open the program, alter settings to their liking, and generate their own ideas about how the city could be designed and regulated, thus improving the *fit* of the city. Ultimately this could be used to give weight to the arguments of citizens groups who organize to oppose the plans of developers or urban planners—groups such as those Jacobs rallied to preserve Toronto's Annex, or New York's Greenwich Village. Although recognizing its caveats, Lynch offers that: "a highly decentralized decision process, in which the immediate users of a place make the decisions about its form, is a powerful ideal. It reinforces their sense of competence, and seems more likely to result in a well-fitted environment, than if they are excluded."[4] Although not granting individuals the complete power to remake the city, this democratization of the decision process can move the city further away from an authoritarian, top-down organization, towards the more *bottom-up* approach advocated by Lefebvre.

A.03 *Defending vitality by using urban resources as a metric analysis of the vitality potential for the city*

While the development industry is able to use market studies that identify target demographics, economic analysis to determine the value of the quality of life in a neighbourhood and the access it provides, the city lacks similar tools that quantify the value of characteristics such as diversity or atmospheric quality lost, or contributed, by new developments. Jacobs' work extensively identifies the qualities of the built fabric that don't traditionally have an economic value of their own accord, and connects them with land value and retail potential through the vitality of the city. Part Two of this thesis identifies that codifying the relationship between these qualities illuminates how the building fabric enables a diverse array of social and economic activities that create value. Extending this proposition by verifying and quantifying all of the social and economic dividends produced by urban resources would mean that their value to the general public can be defended, and their existence preserved. For instance, a new development which can demonstrate the benefits of its added density, diversity, and amenities to the area can achieve less opposition from residents and the city who can identify the vitality that it will bring them. In contrast, a development that reduces diversity, blocks sunlight and views, removes valued businesses and services, or reduces street activity to local businesses can be argued against by citizens or city planners that can identify and substantiate how the loss of street life or diversity would reduce vitality (such as depriving local businesses, decreasing street safety, or degrading the atmospheric quality, all of which would drive real estate prices down and cause other losses of value).

4 Lynch, *Good City Form*, 44.

A.04 *Defending spatial neutrality in the city*

The ability for the urban realm to be manipulated by the presence of an oligopoly controlling the building network can be seen throughout the volumetric cities built in the modern era. While spatial neutrality is particularly relevant for volumetric architecture because of the increased agency provided by the additional infrastructure, this concept is also applicable to other urban typologies. As cities densify, smaller lots once intended for low-rise buildings become amalgamated into larger parcels that can accommodate high-density towers with little economic incentive to later break-up these lots into smaller parcels. This creates a general trend towards larger-scale buildings, that ultimately would result in significant areas of the city coming under the ownership of a single corporation. The economic incentive for a company to use this control of space to leverage the urban fabric to their advantage has already been established by precedent volumetric cities, which exhibited unsuitable increases in salable floor areas, artificially inflated unit prices, decreases in accessibility, and the elimination of competing businesses—all to the detriment of the general public. As the scale of projects continue to increase, and the fine grain of the city becomes increasingly replaced with large-scale buildings, city centres would display an increasing amount of corporate influence due to their control of urban space. This spatial control can be used to influence individuals choices, including the businesses they support, the services they receive, the routes they may take, and the people they may encounter. For this reason, it is important to consider whether the city's commons produces an inclusive and equitable space because of its distribution of spatial control amongst its many stakeholders, or if the presence of an oligopoly has compromised the neutrality of the space.

APPENDIX

B OPERATING THE PARAMETRIC DESIGN TOOL

The following screen captures document the parametric design tool designed and written by the author for this thesis work. They illustrate the software in operation over the course of a single building cycle—a process that is repeated iteratively on successive building sites in order to simulate the growth of the city. The elements shown on screen are only some of the most relevant components to each stage, as the use of the program involves more calculations, references to objects, and assignments of properties that are best viewed by the animated feedback in the building environment view window of the software itself due to the variety of data layers and camera modes it has available.

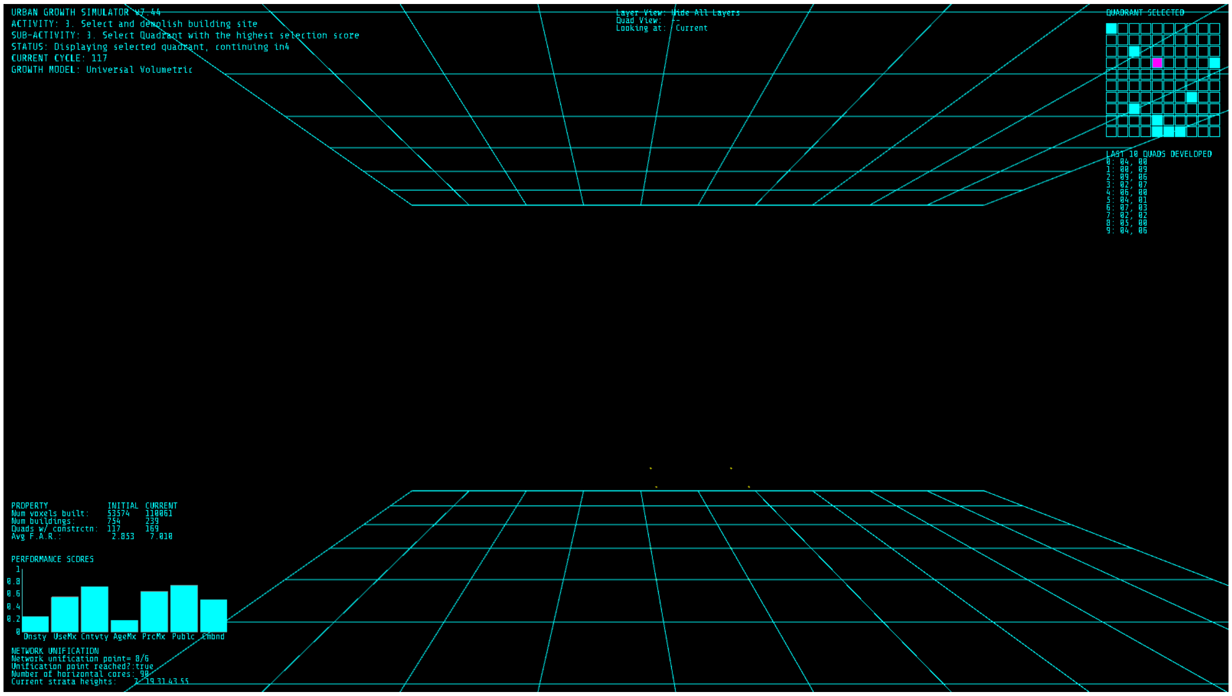

Figure B.01:
Site Selection
Quadrant selected indicated by yellow points. The surrounding quadrant grid is drawn for context, however the rest of the building fabric model has been hidden for clarity.

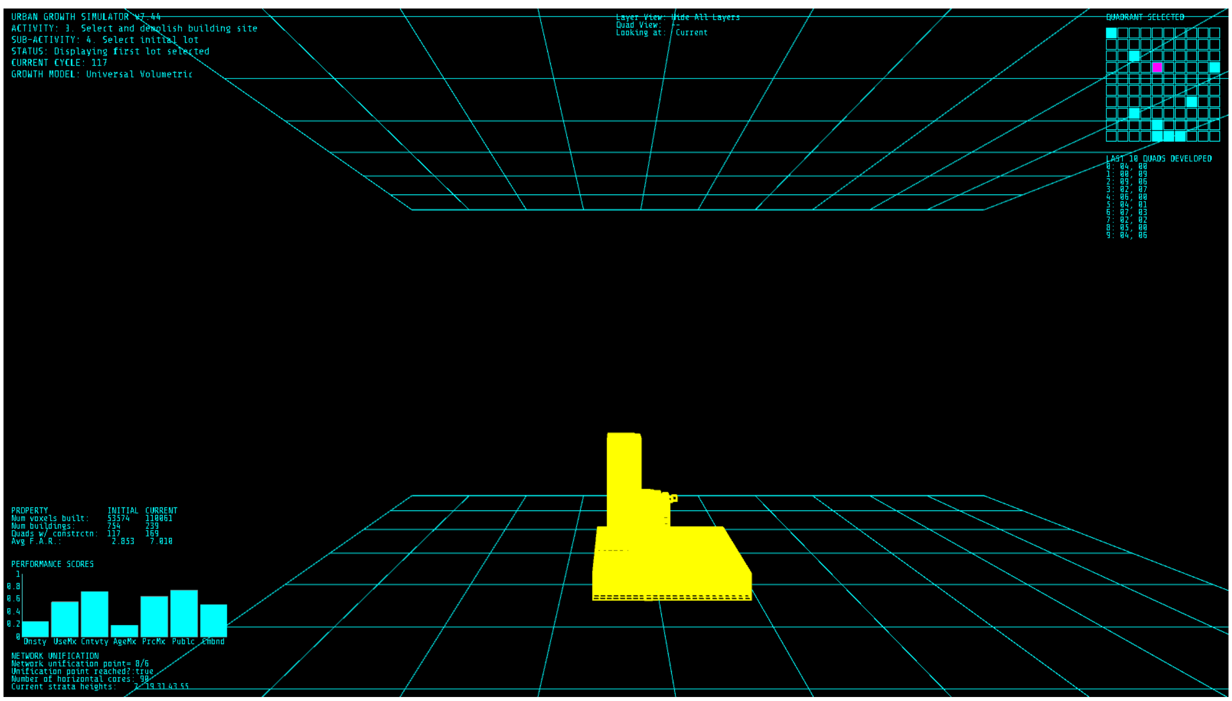

Figure B.02:
Site Selection
Initial lot selected based on building age and density, shown in yellow stroke.

Figures B.01-46: Screen captures of the parametric design tool that was designed and coded for this thesis work by the author, in operation for one building cycle.

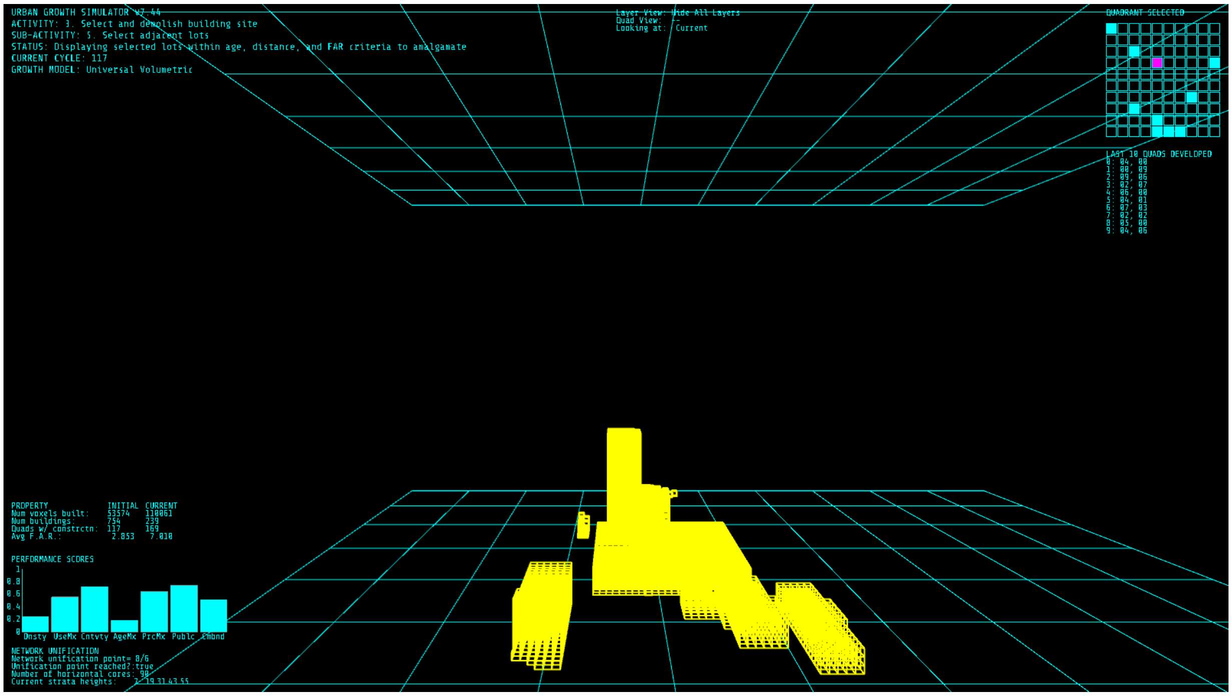

Figure B.03:
Site Selection
Adjacent lots within density and age criteria selected, shown in yellow stroke.

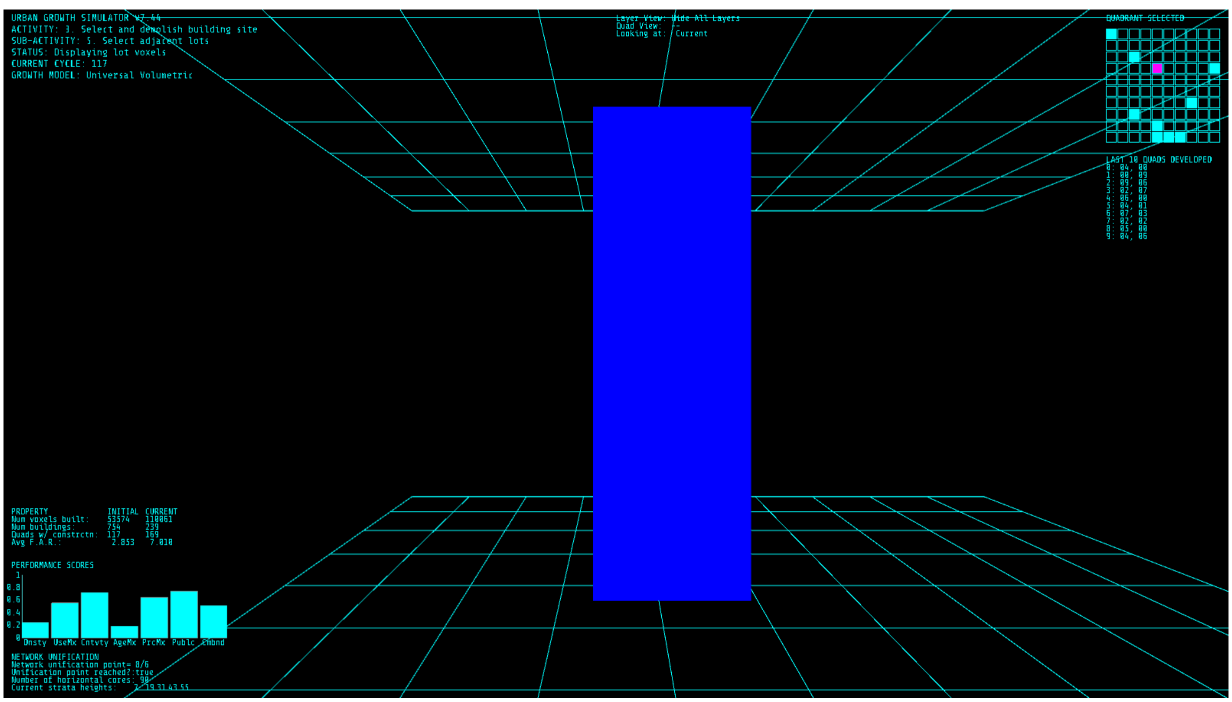

Figure B.04:
Site Selection
Voxels within lot boundary, shown in blue fill.

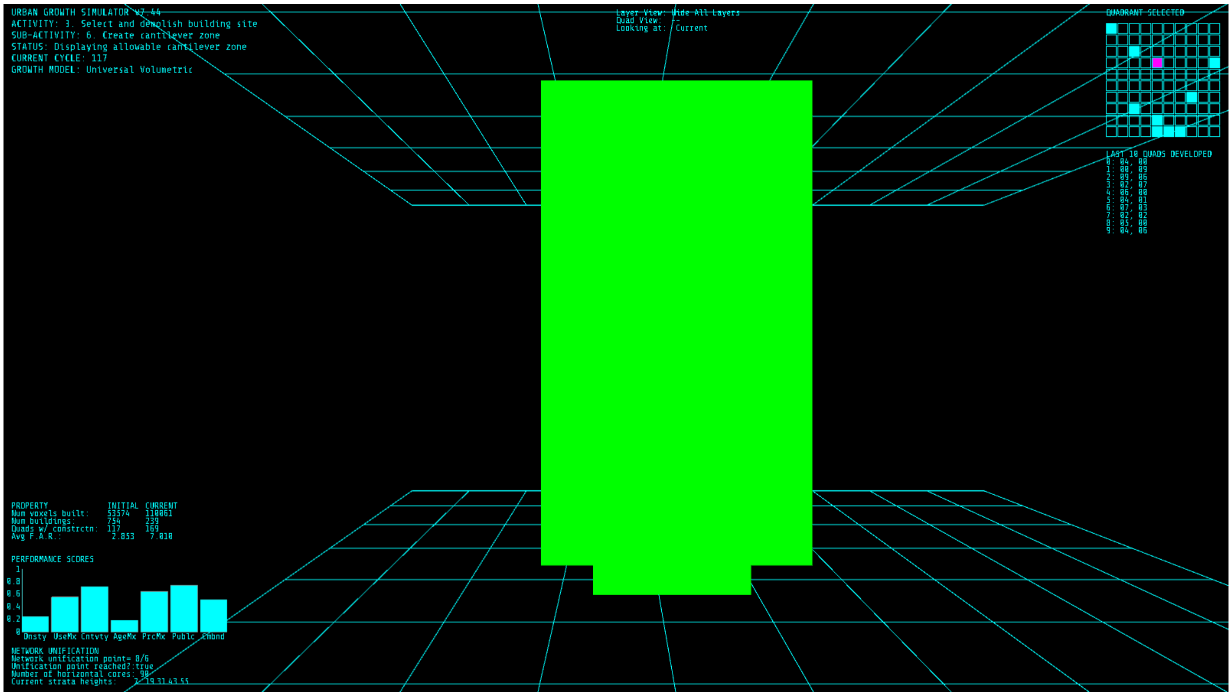

Figure B.05:
Site Selection.
Voxels within allowable cantilever envelope, shown in green fill. With all voxels on site recorded, site analysis can begin. Site analysis occursoccurs sequentially by plane, beginning with all voxels in the lowest plane at z=0. Each plane is calculated separately, scanning from bottom to top, up to the maximum bounds of the model at z=74.

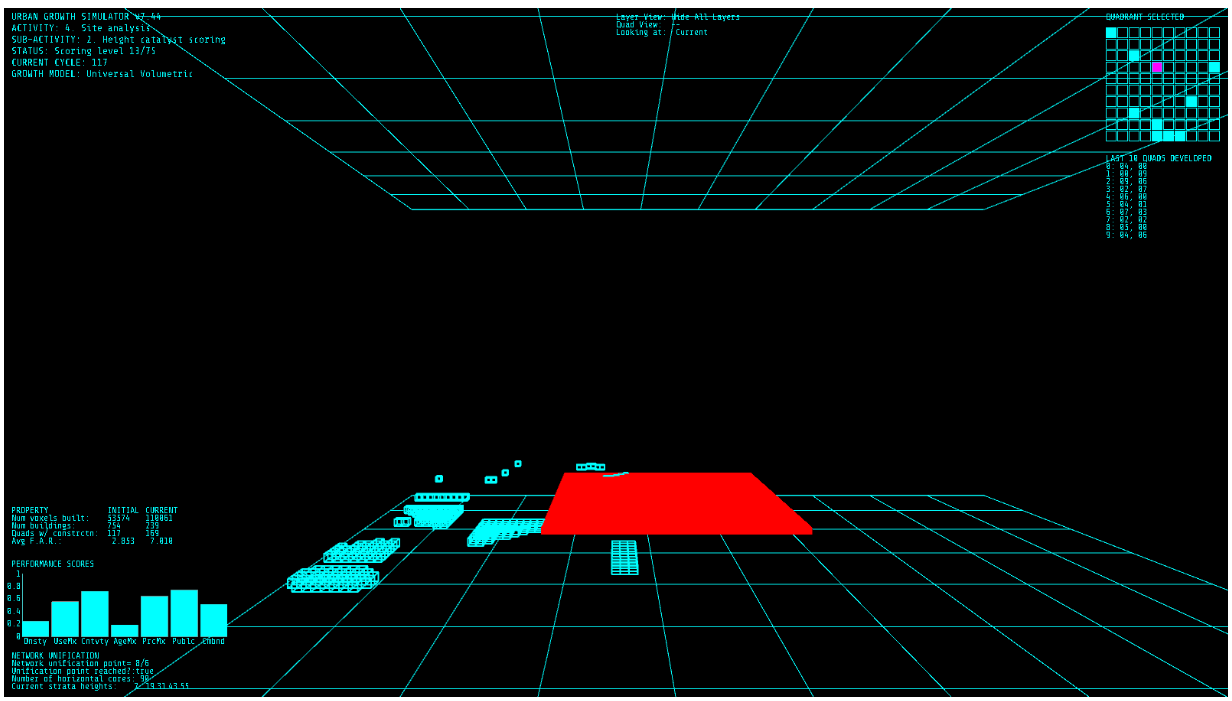

Figure B.06:
Site Analysis
Maximum adjacent building height detection. Cyan indicates the highest point of adjacent buildings and red indicates the maximum building height score. The red filled voxels show the character enevelope score at one specific z-height, in this case z=18. The software will move to the next highest z-position (z=19) in the next frame, creating an overview of the scoring for all voxels by animating the process from bottom to top over 75 frames in total for this calculation.

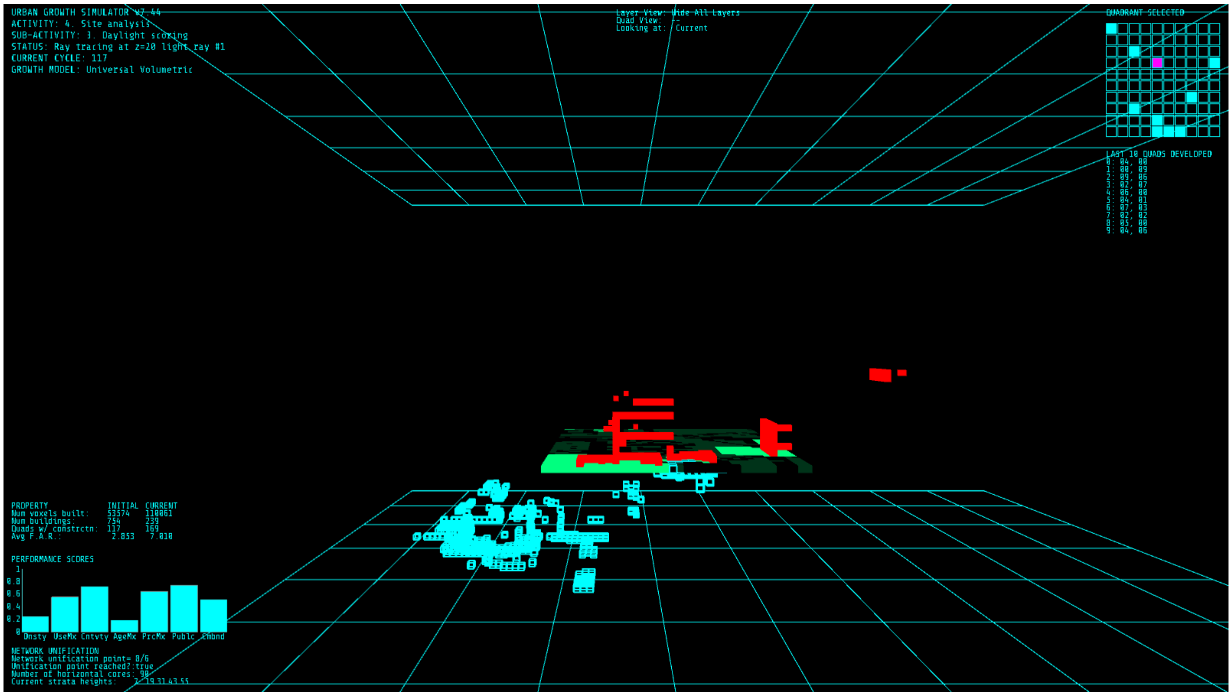

Figure B.07:
Site Analysis
Solar ray tracing analysis. For each voxel postion within the site boundary, sun rays are traced for the equinox, and solstices at three different times of the day. Existing massing that shades the voxel on site is indicated in red, and contributes a high score to the voxel. Existing public massing that would be shaded by new construction is indicated in cyan stroke and contributes a low score to the voxel.

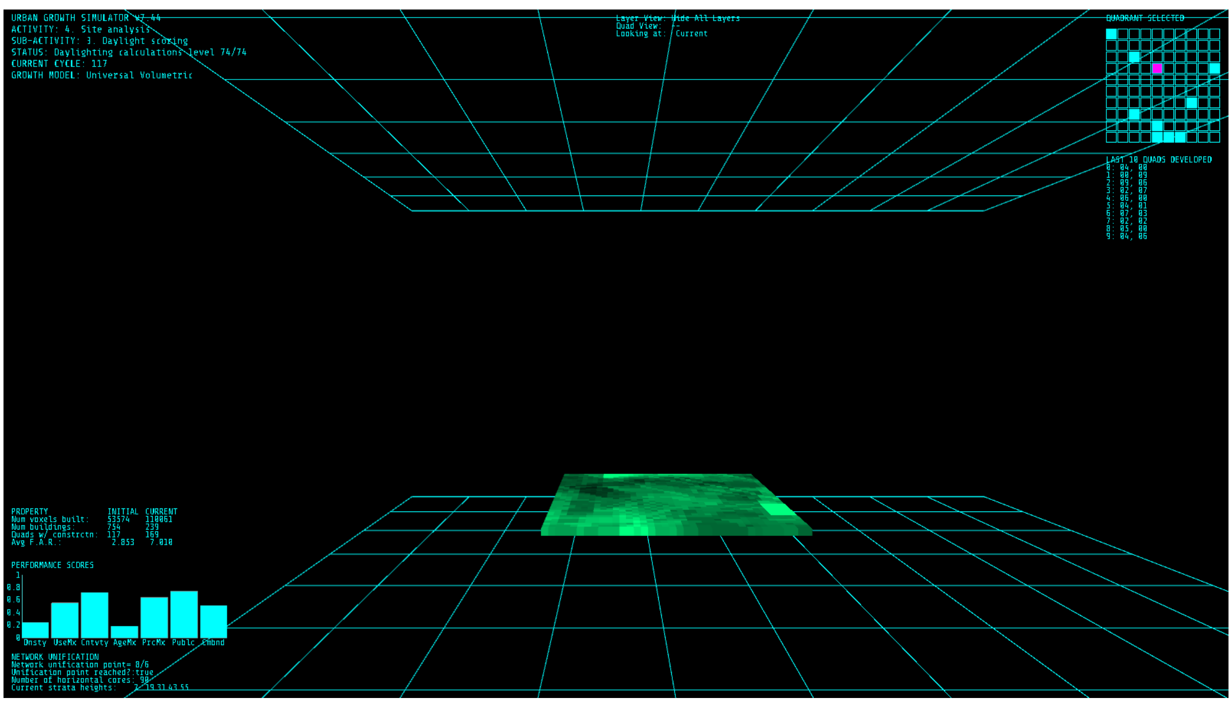

Figure B.08:
Site Analysis
Solar ray tracing analysis. The nine total ray-tracing scores are combined to create an average daylighting score for each voxel on site. The scores are indicated in green fill, with brighter green voxels having high scores that mean their location is already heavily shaded and won't impact daylight areas beyond, and darker green voxels having public space beyond that would be shaded by new building massing in the indicated location.

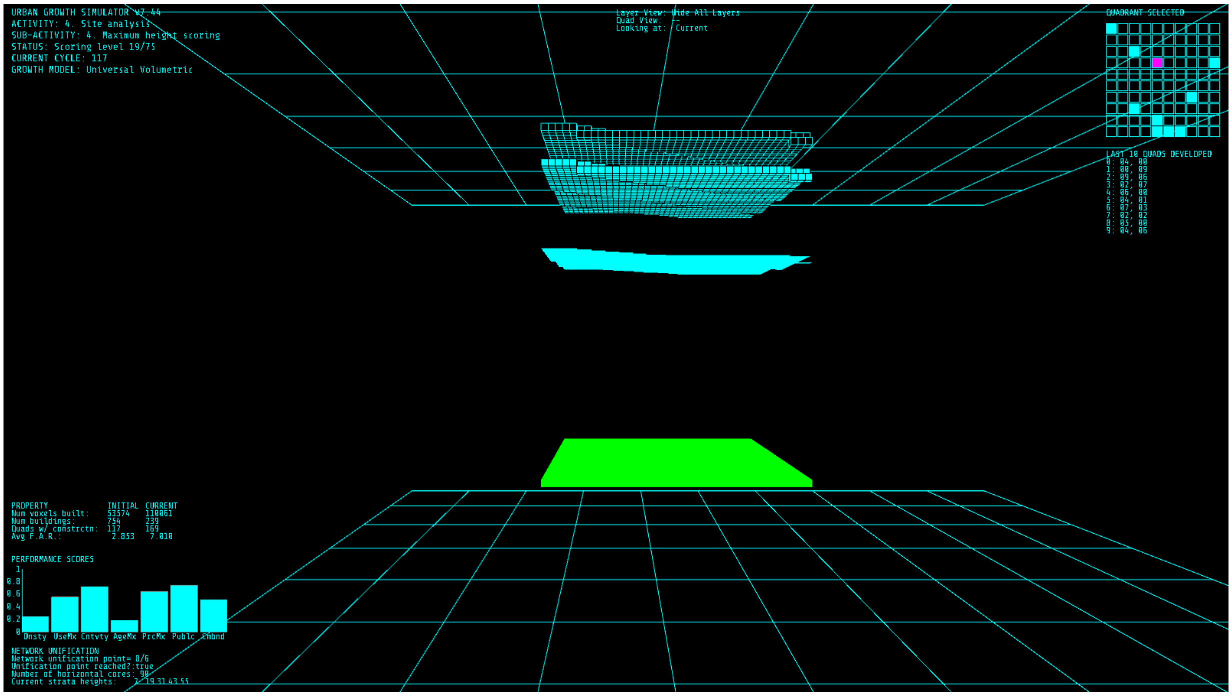

Figure B.09:
Site Analysis
Skyline profile response. The skyline profile character envelope score at the given z-height is shown in green, with the skyline profile shape above in filled cyan and black outline, with a reduction factor within the cyan fill bellow.

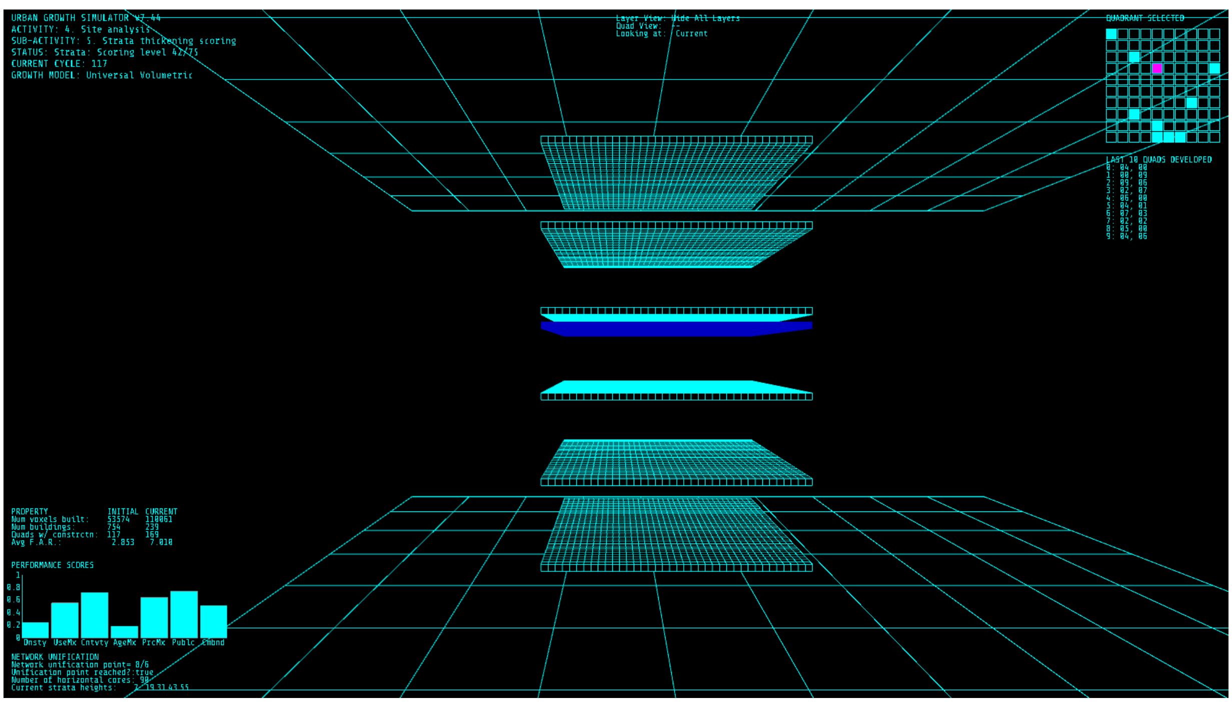

Figure B.10:
Site Analysis
Strata height response. The blue fill indicates the strata height character envelope score at a given z-height, the cyan outlines indicate specified strata levels.

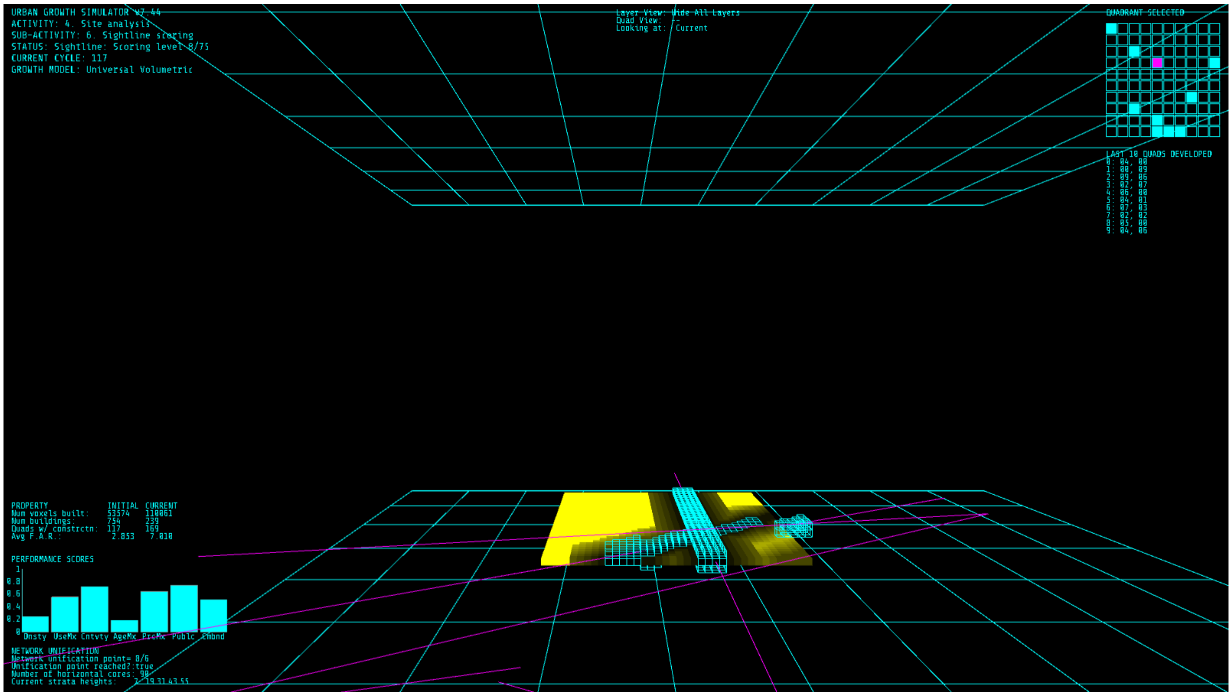

Figure B.11:
Site Analysis
Significant sightlines response. Sightlines are indicated in magenta, voxels on site within the sightline are indicated in cyan, and the sightline character envelope score is indicated in yellow.

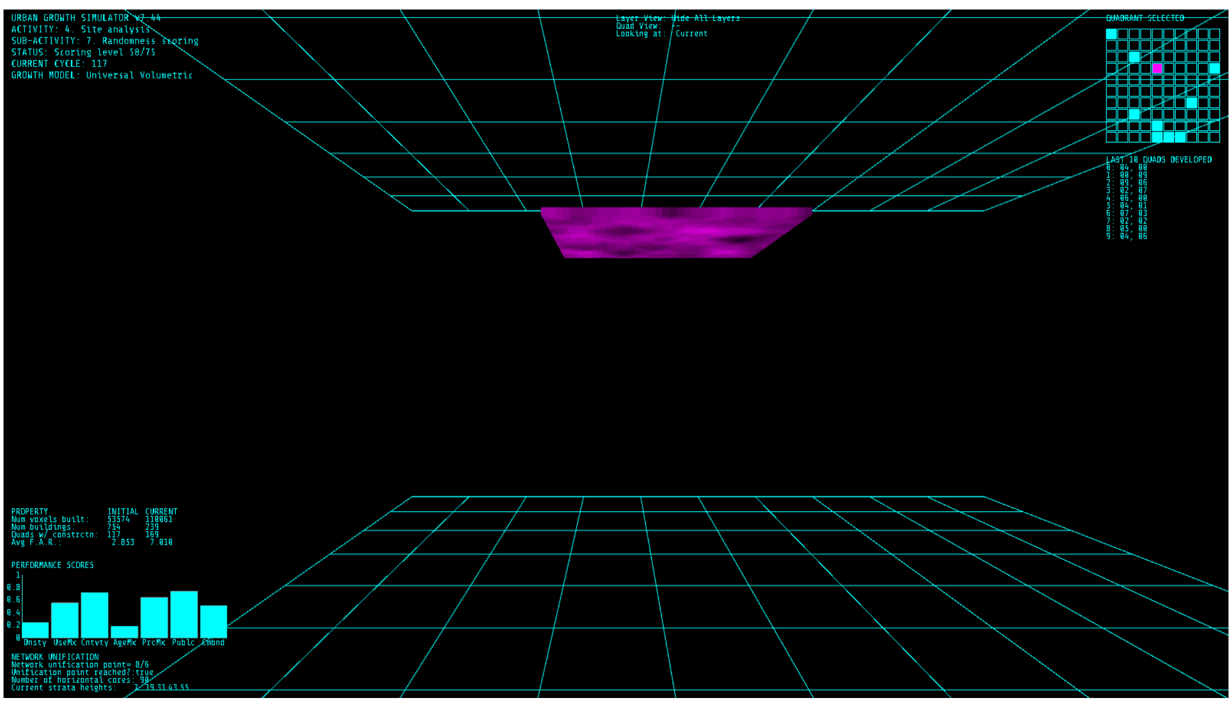

Figure B.12:
Site Analysis
Facade articulation response. Facade articulation voxels scores at a specific z-height are indicated in magenta.

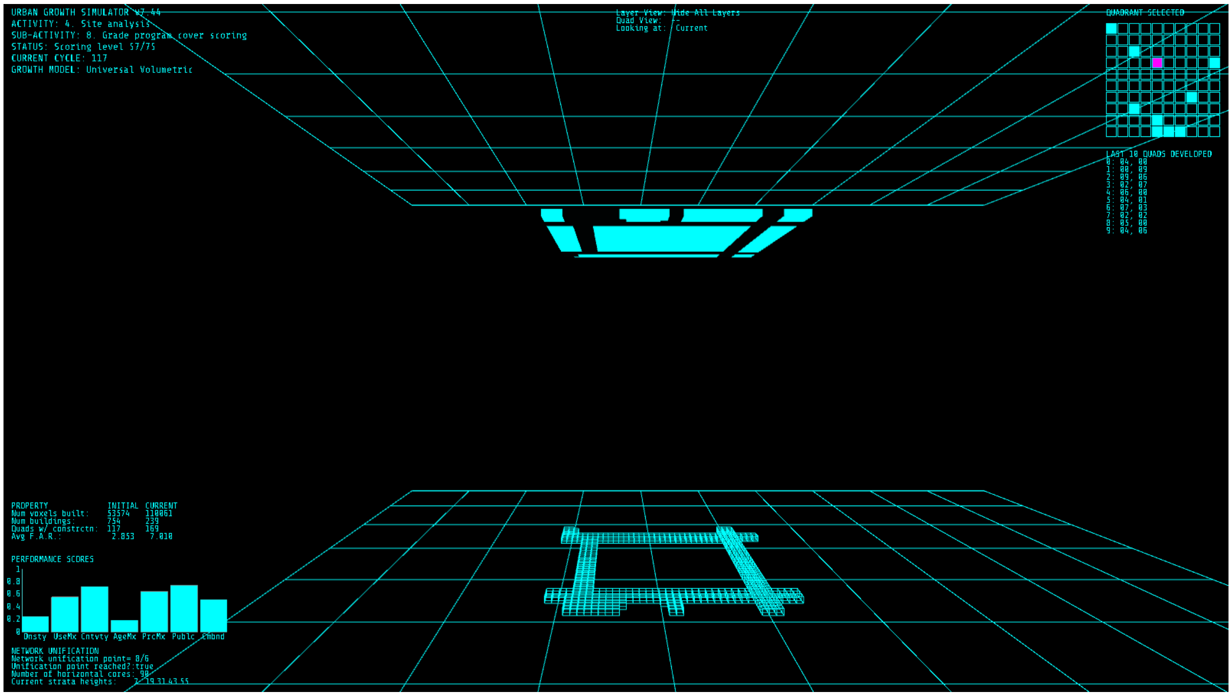

Figure B.13:
Site Analysis
Grade program cover response. Identified public program voxels at grade are outlined in cyan. Grade cover character envelope scores are indicated in filled cyan.

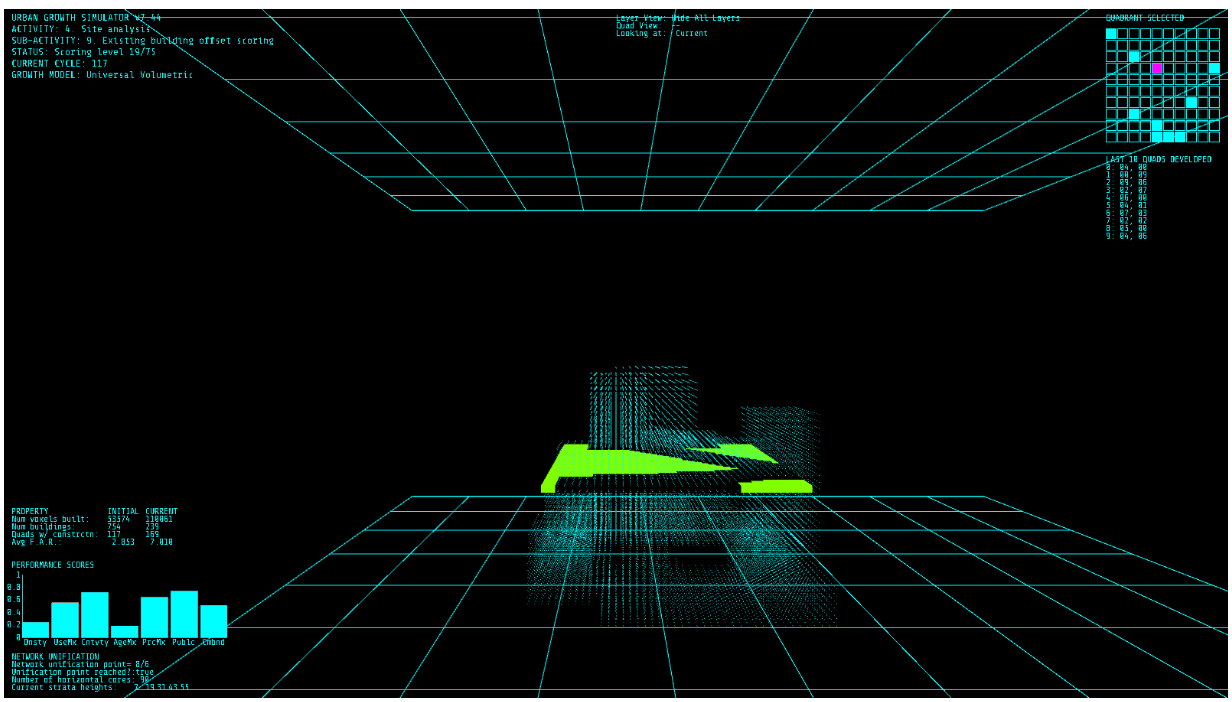

Figure B.14:
Site Analysis
Building offset response. Identified adjacent building voxels are indicated with a cyan point, the building offset character envelope score at this height is indicated in green.

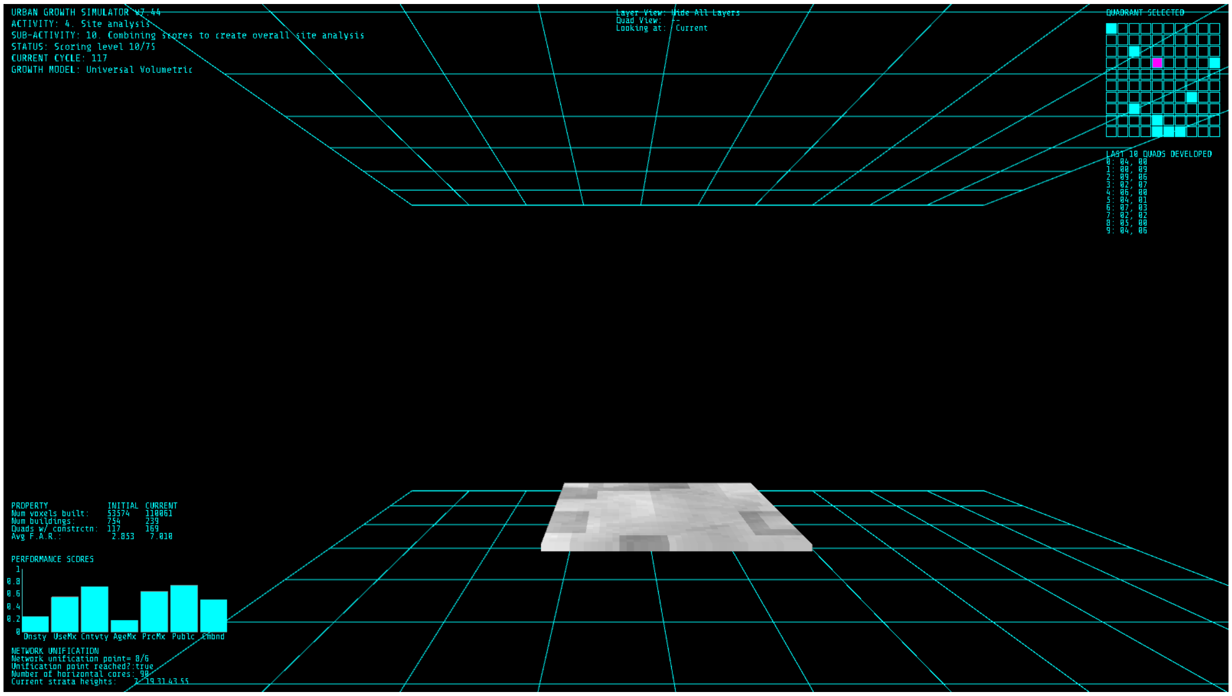

Figure B.15:
Site Analysis
Combined character envelope after weighting the site analysis character envelopes and adding them together. The shades of white indicate the value of the combined character envelope score at this z-height.

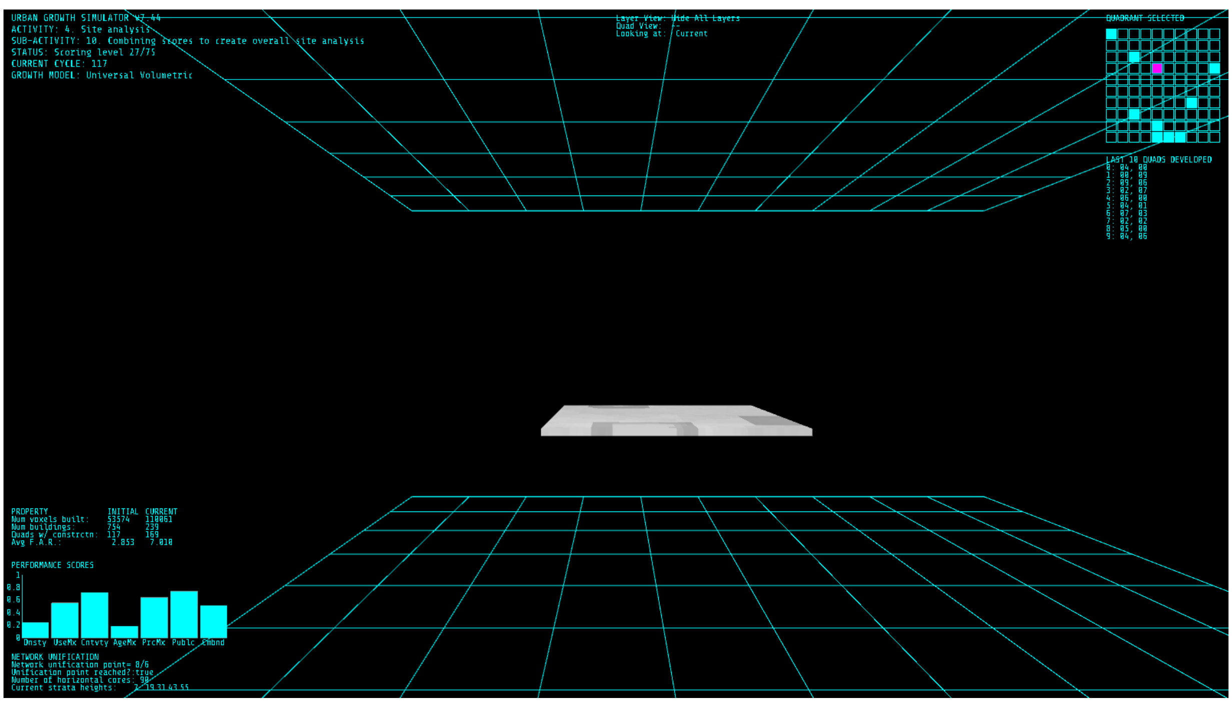

Figure B.16:
Site Analysis
Combined character envelope at a higher z-height on the site.

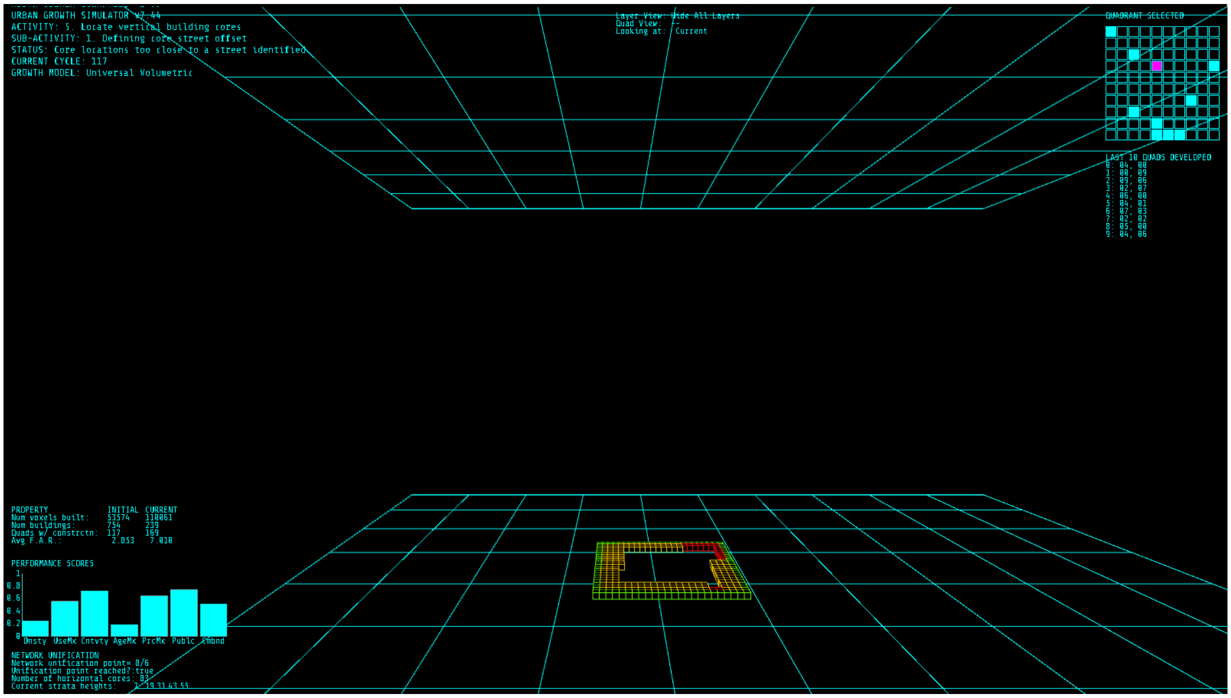

Figure B.17:
Core Location
Voxels on site that are too close to the street edge to support a vertical core are identified and indicated in red.

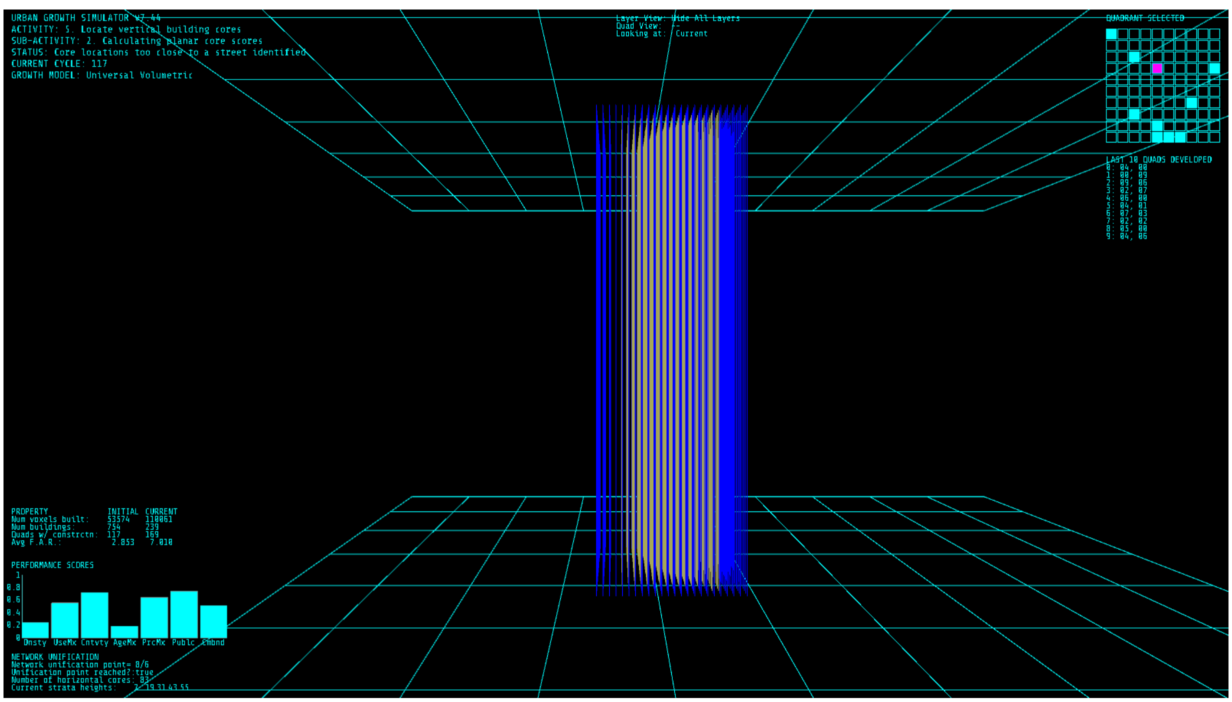

Figure B.18:
Core Location
The combined site analysis character envelope scores are used to score potential building core locations.

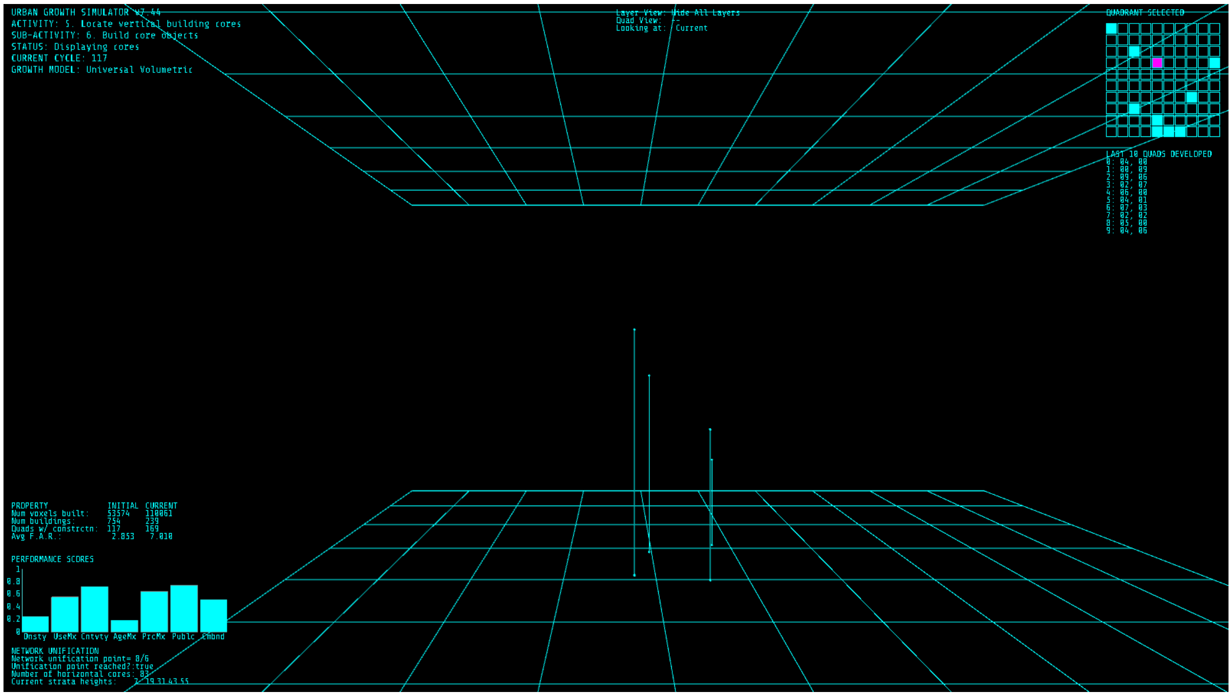

Figure B.19:
Core Location
Vertical cores are selected by the highest scoring locations, a specified number of cores per lot area, minimum core to core distance, and minimum height variations.

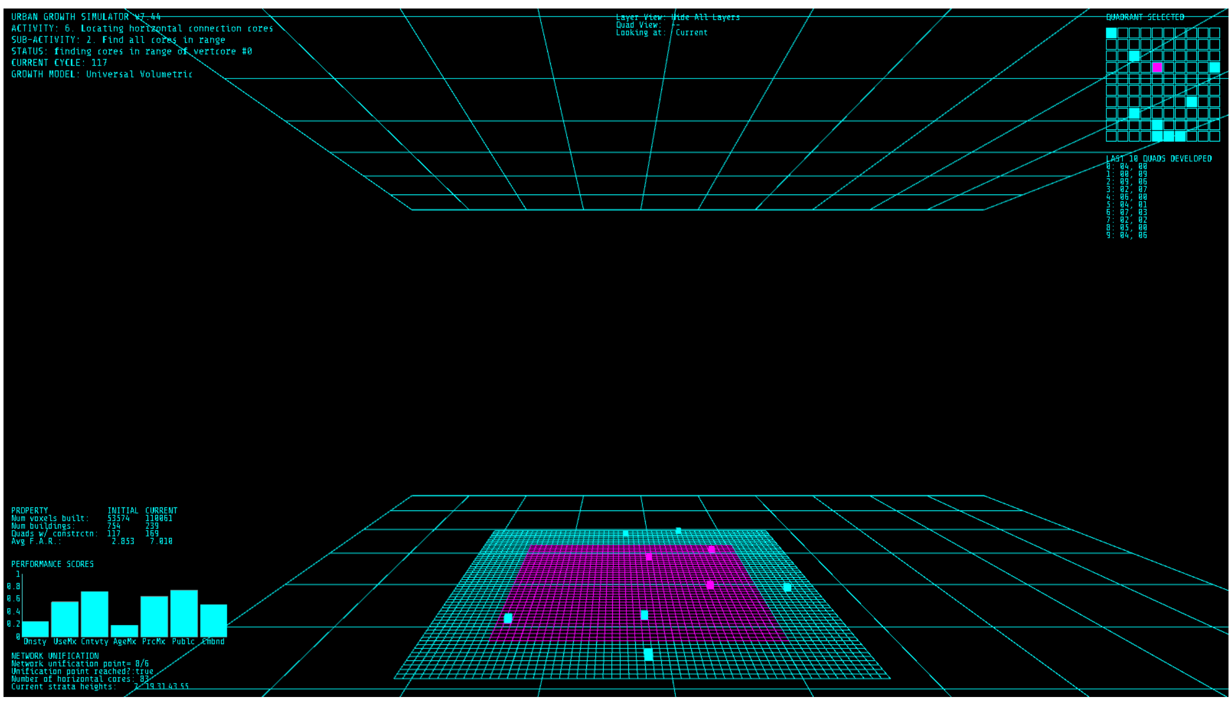

Figure B.20:
Core Location
For each vertical core, all adjacent cores are queried for possible horizontal inter-building connections. The magenta grid indicates the maximum connection distance from the current core to other cores within this development, whereas the cyan grid indicates the maximum connection distance to adjacent developments. The filled voxels indicate the location of a potential core connection found.

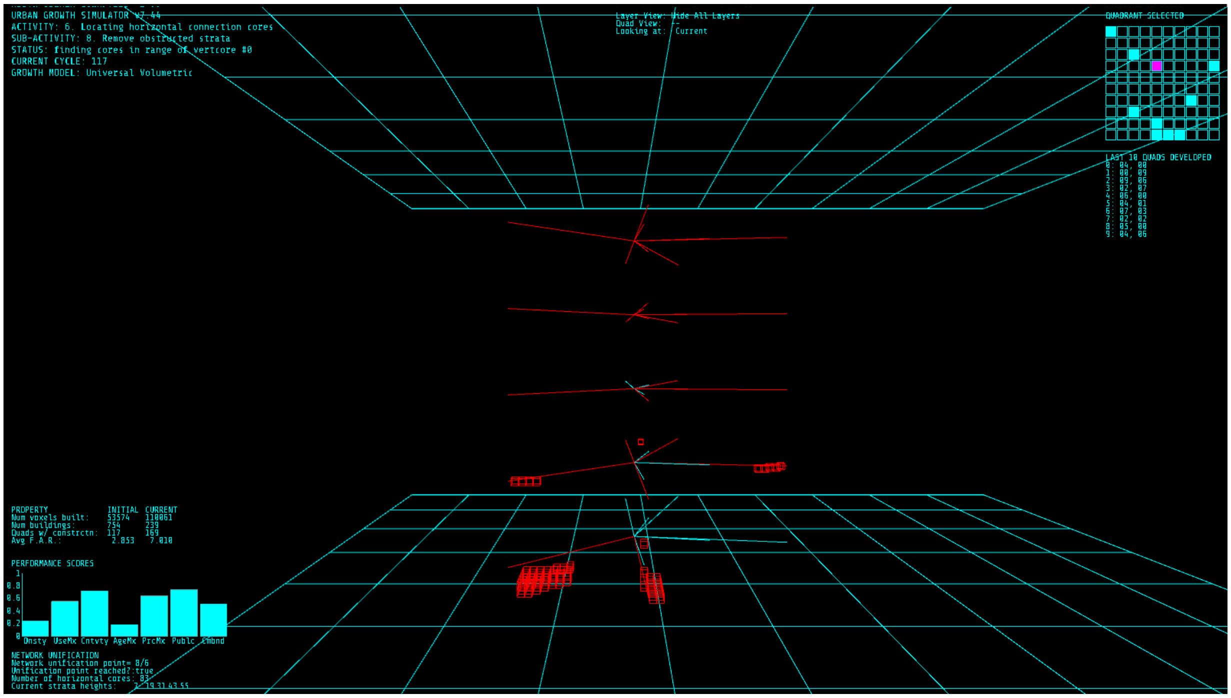

Figure B.21:
Core Location
Queries are made for all possible connections at the specified strata heights. Successful horizontal connections are drawn in cyan, while those drawn in red show unsuccessful connnections due to either the height of the vertical cores, or obstructing voxels that are indicated in red outlines.

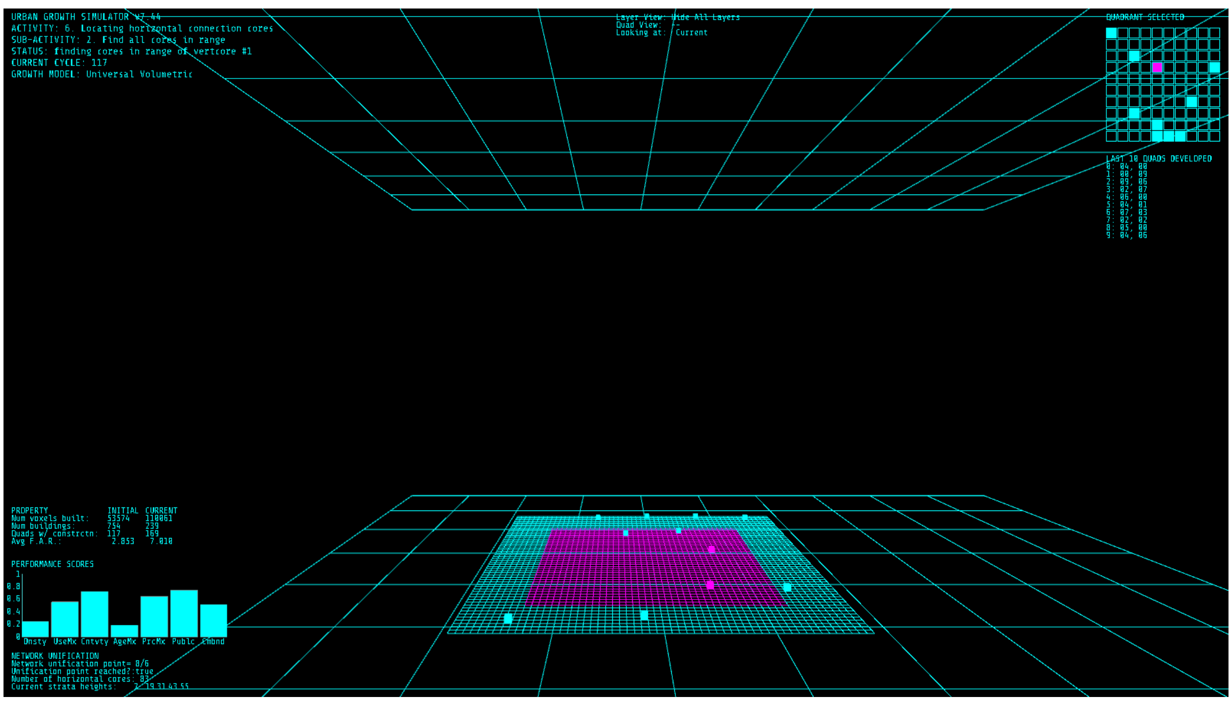

Figure B.22:
Core Location
The horizontal core queries are made for each remaining vertical core in the current development.

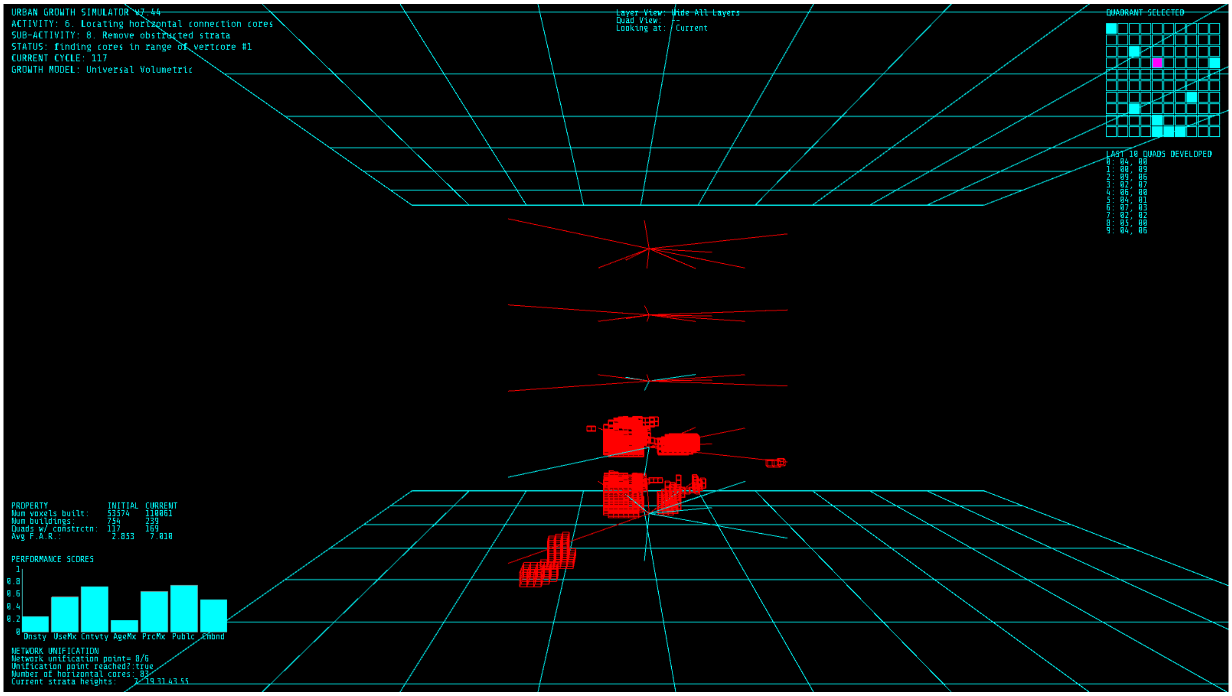

Figure B.23:
Core Location
Queries are made for all possible connections at the specified strata heights for a second core in this development.

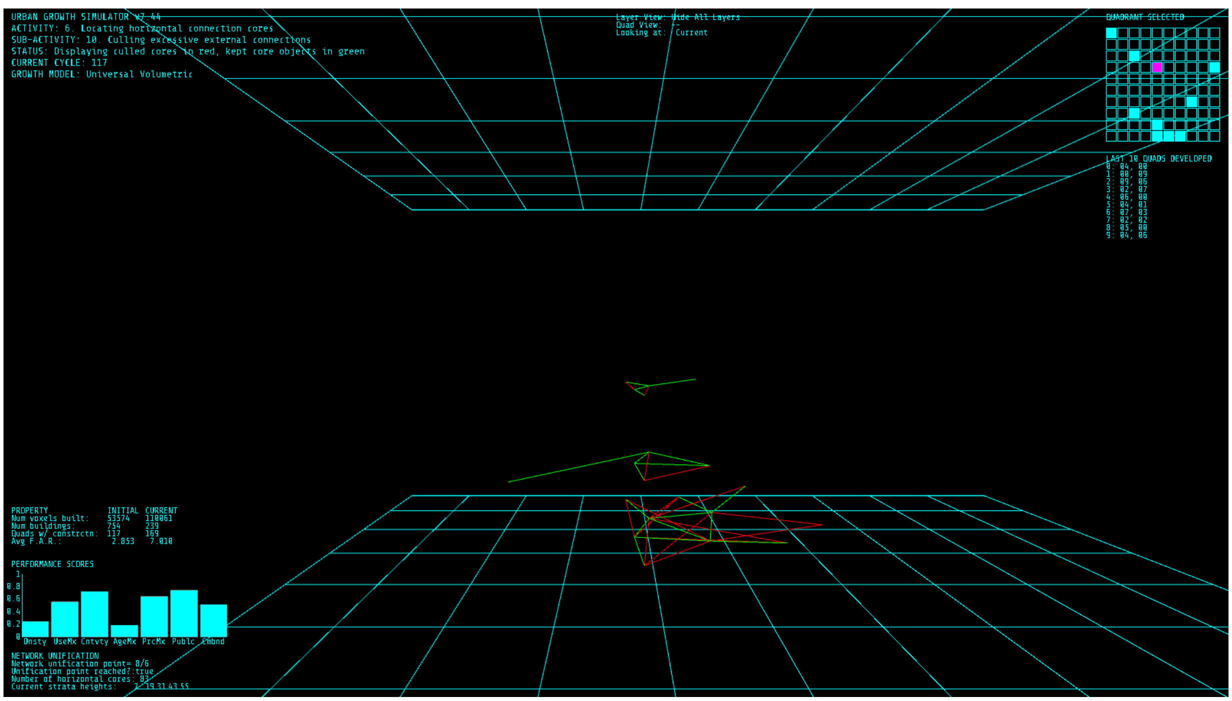

Figure B.24:
Core Location
The final composition of the current development's horizontal building cores in green and nullified cores in red.

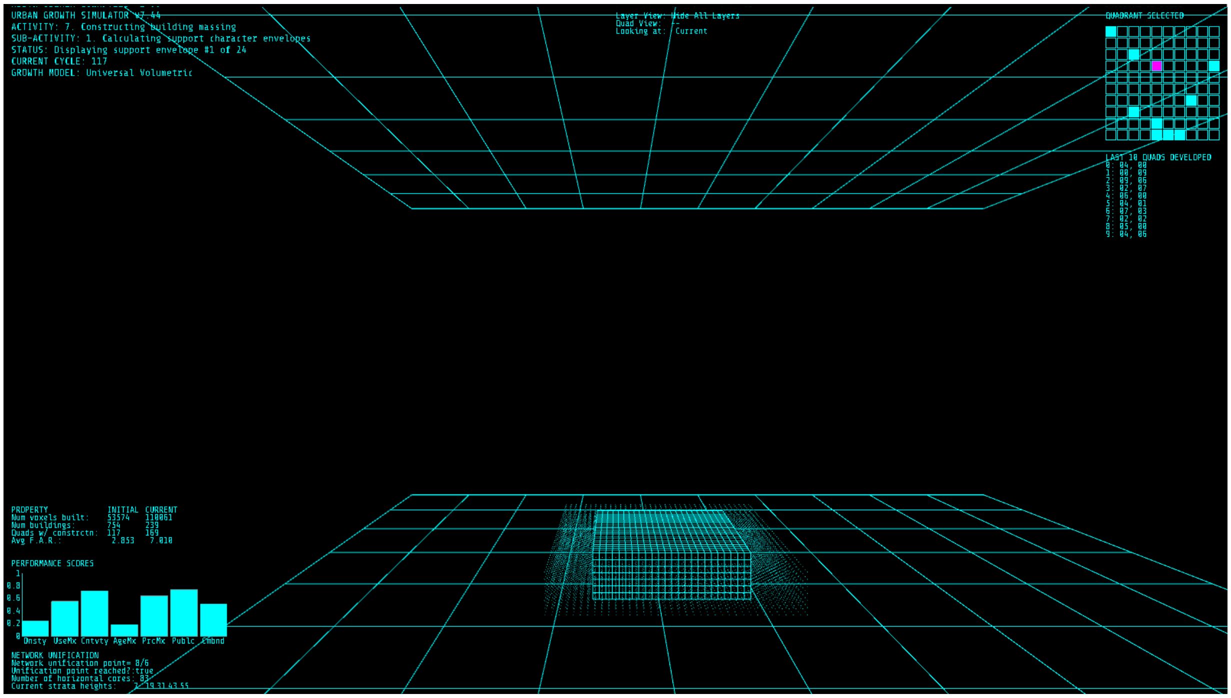

Figure B.25:
Building Massing
Structural support character envelope from grade. Structural support envelopes are determined for each structural element. Here the grade support envelope is shown, which supports massing up until a specified height. Cyan outlines show supported voxels, while cyan points indicate obstructed areas that can't be built.

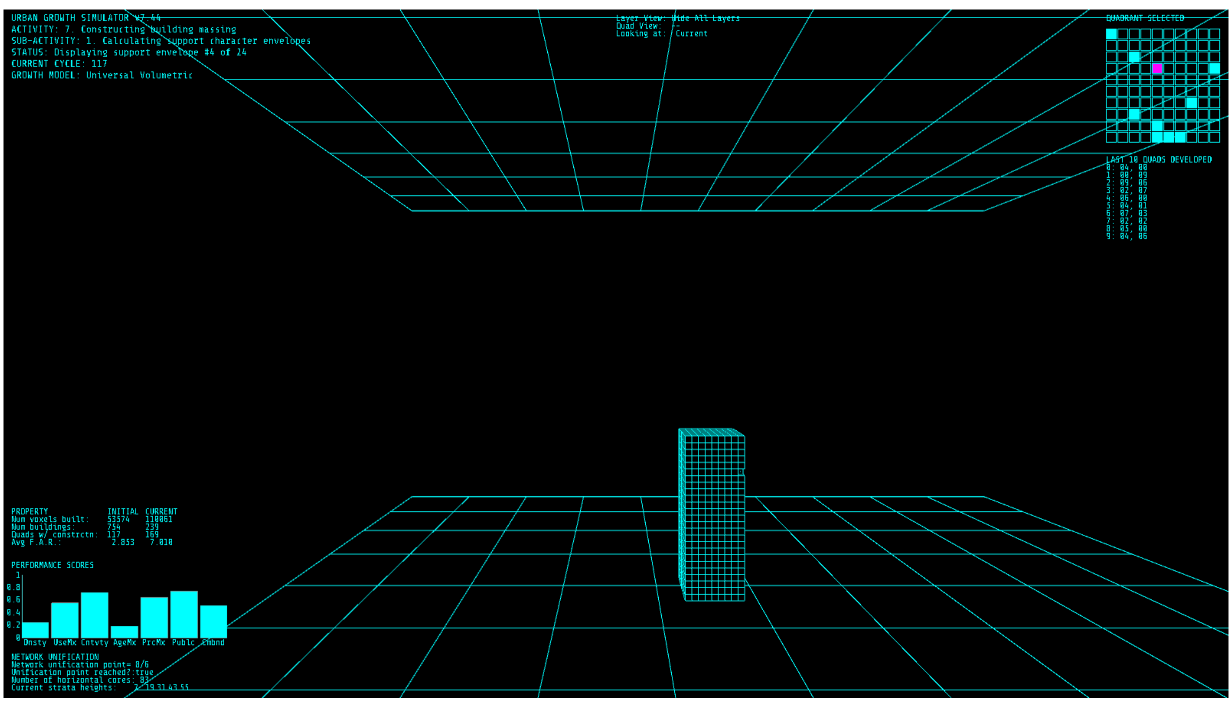

Figure B.26:
Building Massing
Structural support envelope for a vertical core.

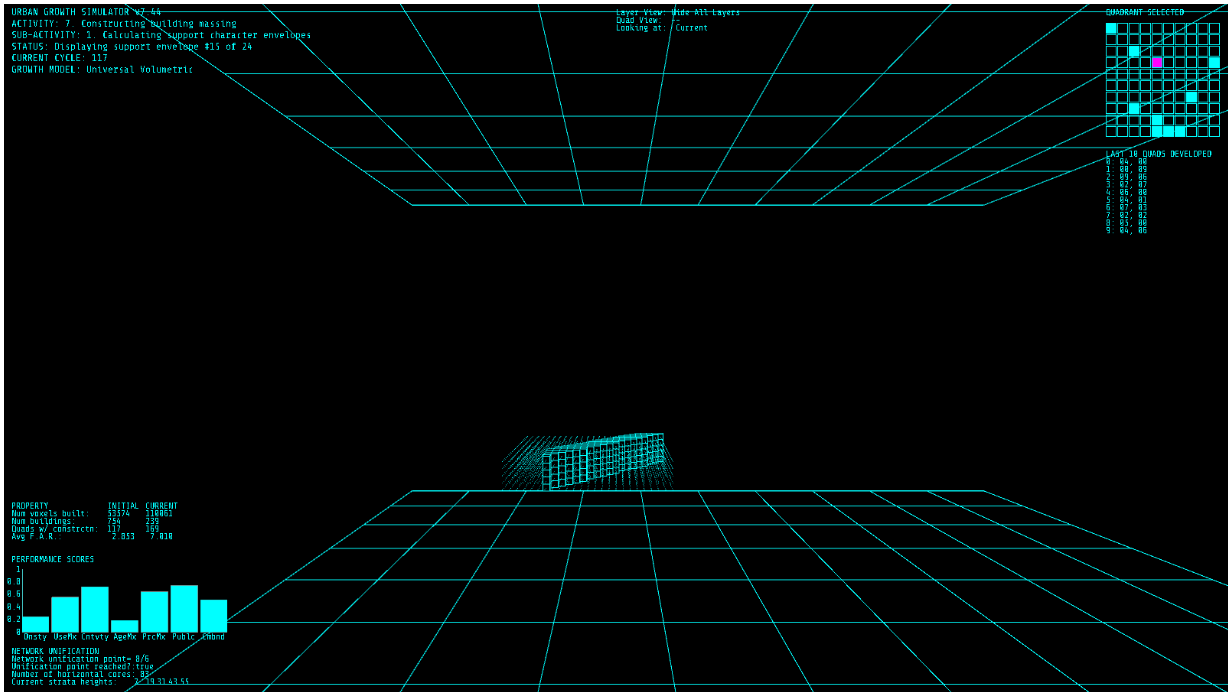

Figure B.27:
Building Massing
Structural support envelope for a horizontal core.

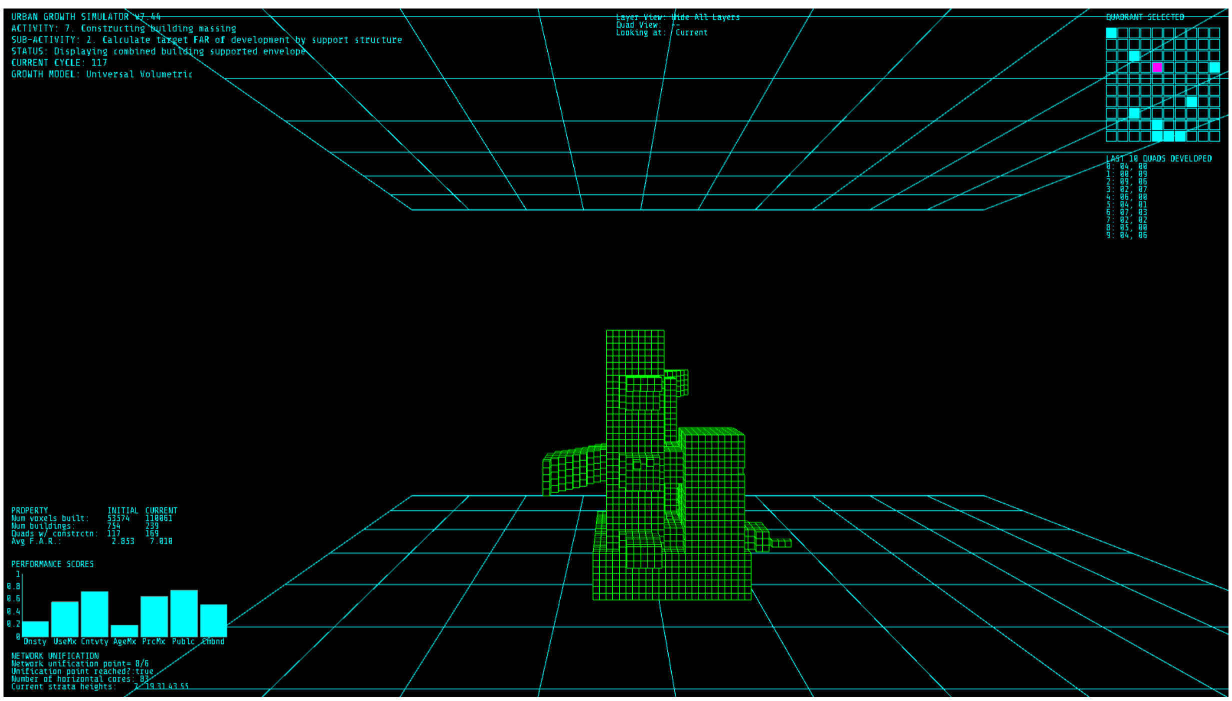

Figure B.28:
Building Massing
Combined structural support envelope for all structure elements. This is the maximum possible building massing that is considered supported by the building structure, but is not necessarily all going to be built.

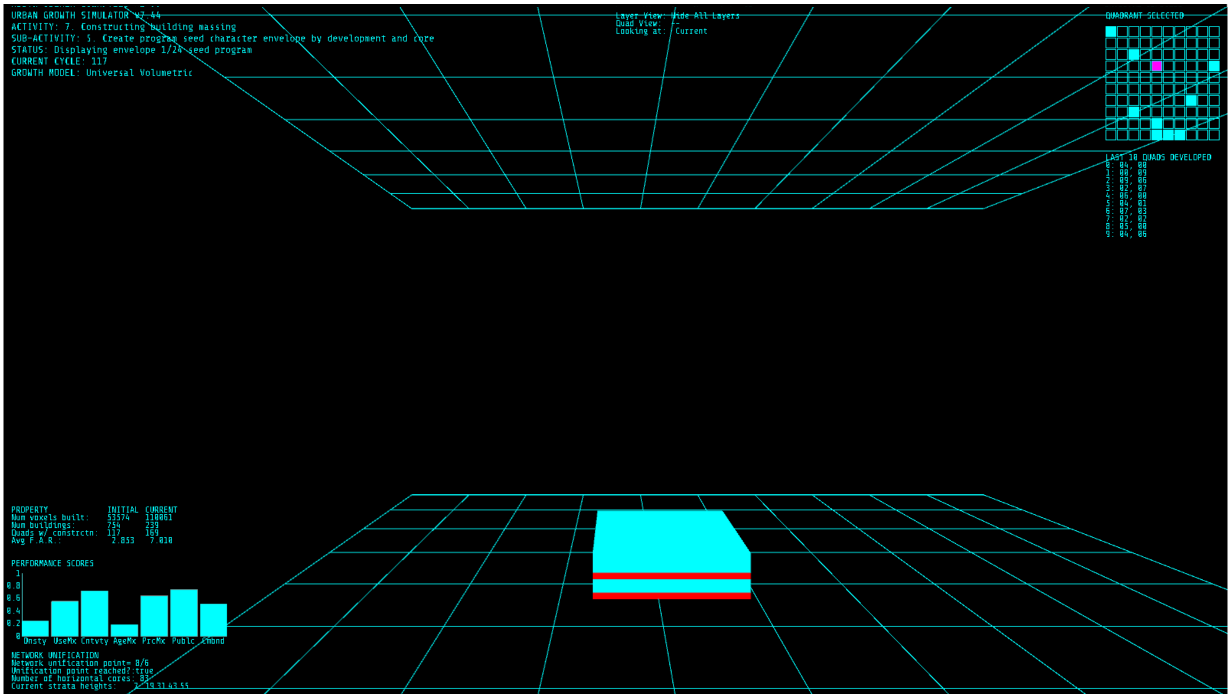

Figure B.29:
Building Massing.
Programmatic use character envelope for potential grade massing. Programmatic use can be specified for structural element individually with a locally responsive programmatic use distribution and various placement algorithms. The colour indicates the program assignment selected for the voxel. Here the grade-supported programmatic use character envelope is shown.

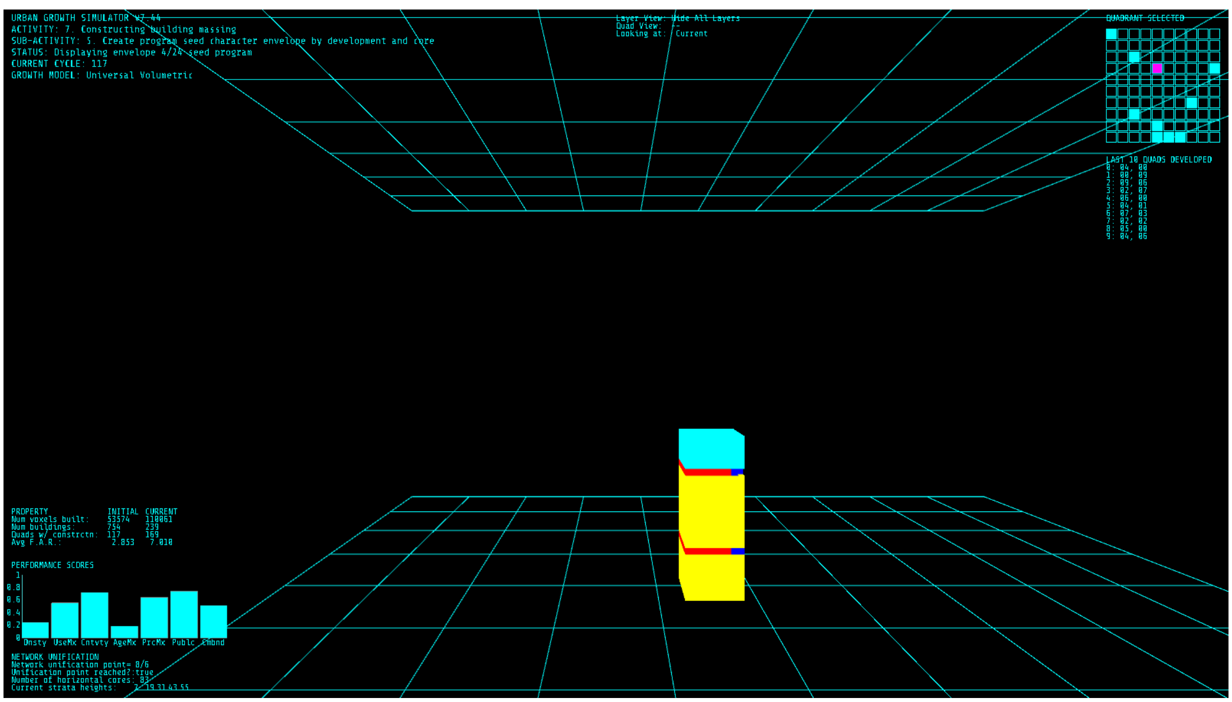

Figure B.30:
Building Massing
Programmatic use character envelope for potential vertical core massing. The programmatic uses are selected based on the needs of the surrounding building program to balance out the existing fabric, and assigned based on the structural support element and a placement algorithm.

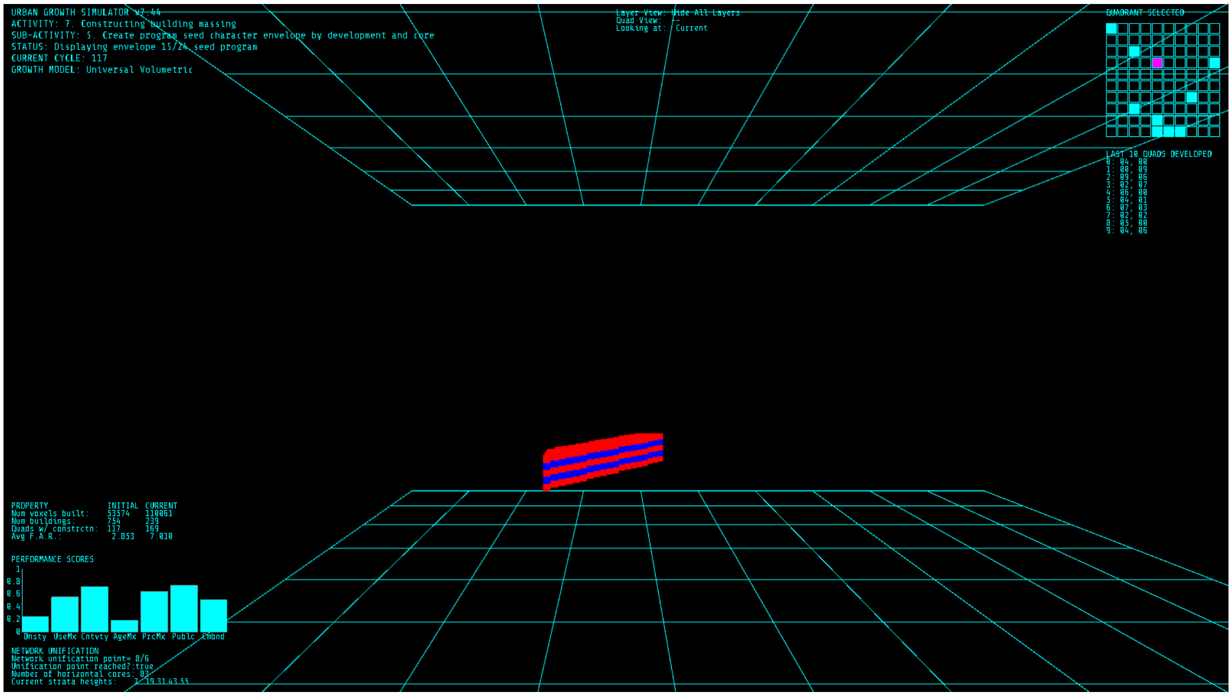

Figure B.31:
Building Massing
Programmatic use character envelope for potential horizontal core massing. Here the selected program types are noticeable different from the vertical core, and includes more public program similar to grade because of the horizontal core's connective role.

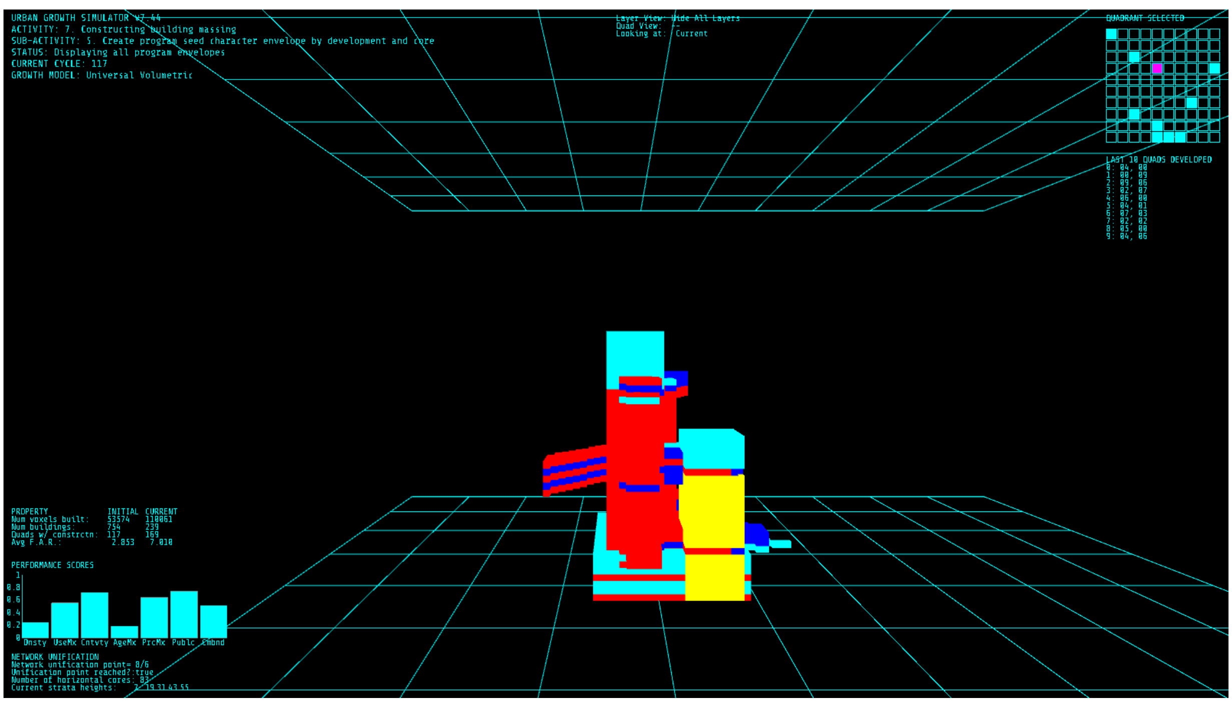

Figure B.32:
Building Massing
Programmatic use character envelope for all structural elements.In this case, a sligtly coarse grain of programmatic use mix has been selected that divides the program at floor levels or strata, but different algorithms may be selected for each structural element including program specification by development, structure, strata, floor, or sub-floor grains.

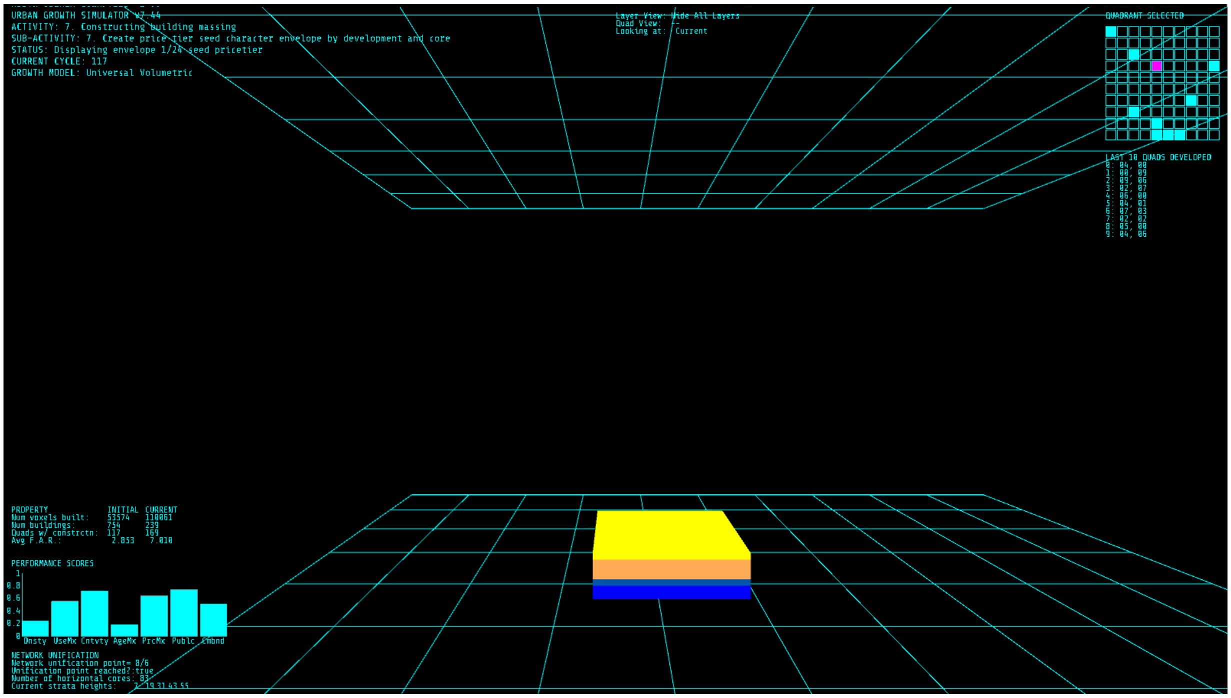

Figure B.33:
Building Massing
Price tier character envelope for the grade supported structural element. The amount of each price tier can be determined in response to the surrounding building fabric, or the desired value of the building. Blue represents lower price tiers, while green represents higher price tiers.

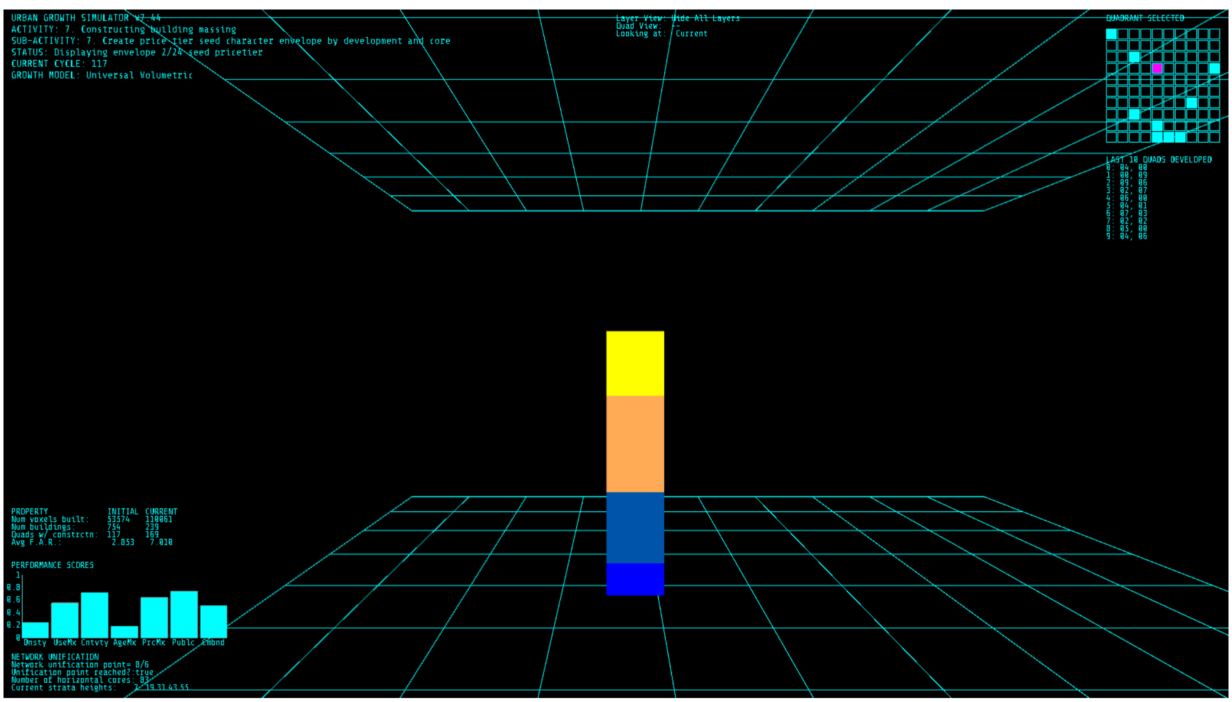

Figure B.34:
Building Massing
Price tier character envelope for vertical core structural element. Similar to the programmatic use assignment algorithm, price tier mixes can be defined by various grain sizes, including by development, by structural element, by strata, by floor, or by sub-floor grain. In this case a grain of mix is determined by the building height within the structural element.

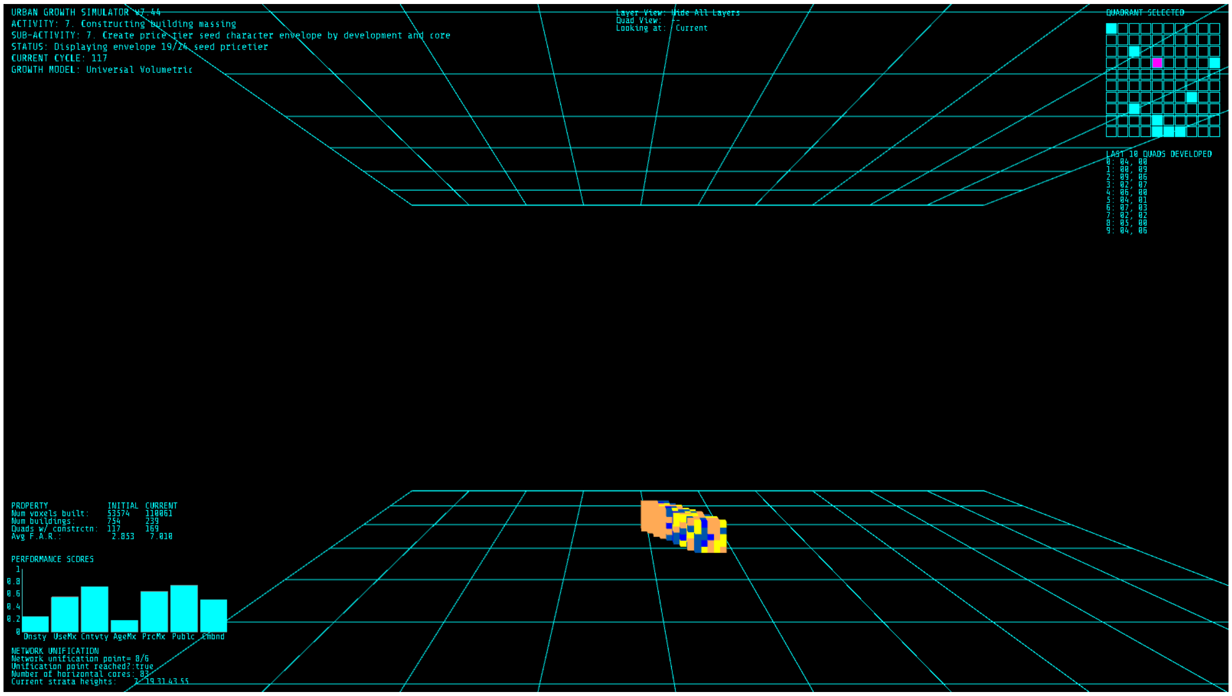

Figure B.35:
Building Massing
Price tier character envelope for a horizontal core structural element. In this case a sub-floor grain size has been selected, creating greater variation.

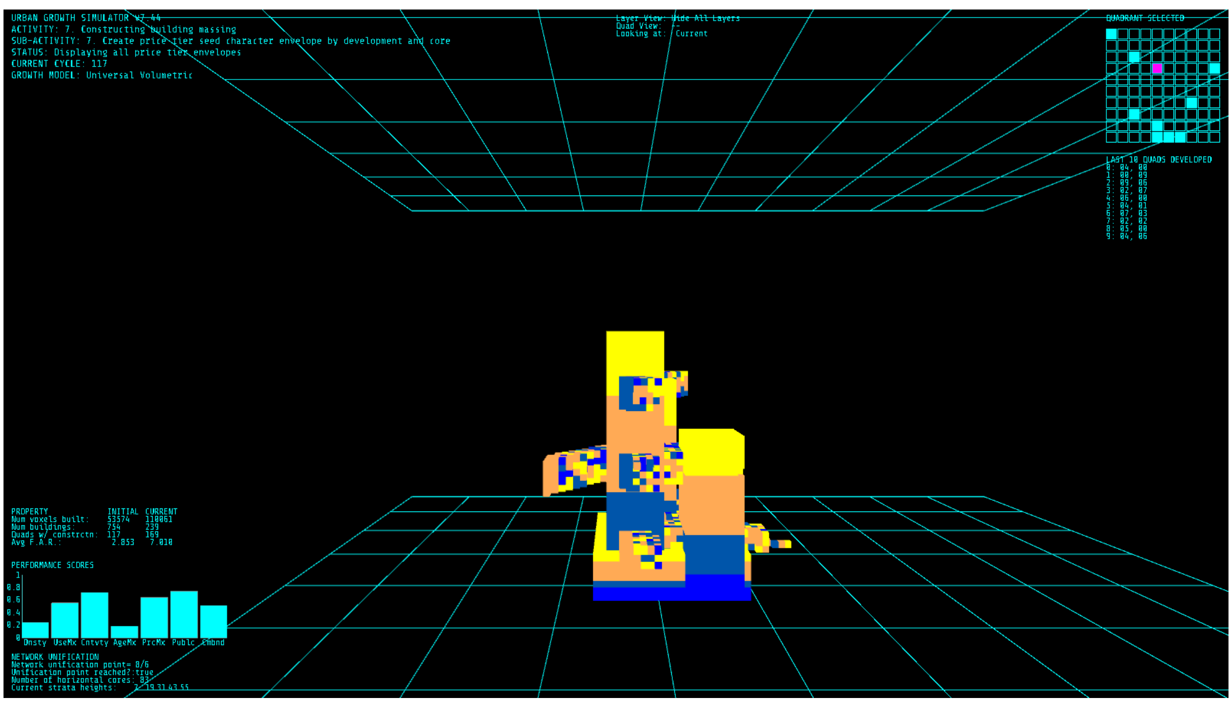

Figure B.36:
Building Massing
Price tier character envelope for all the structural elements of the building. The affect of different placement algorithms can be seen by the varying patterns of price tier indicators.

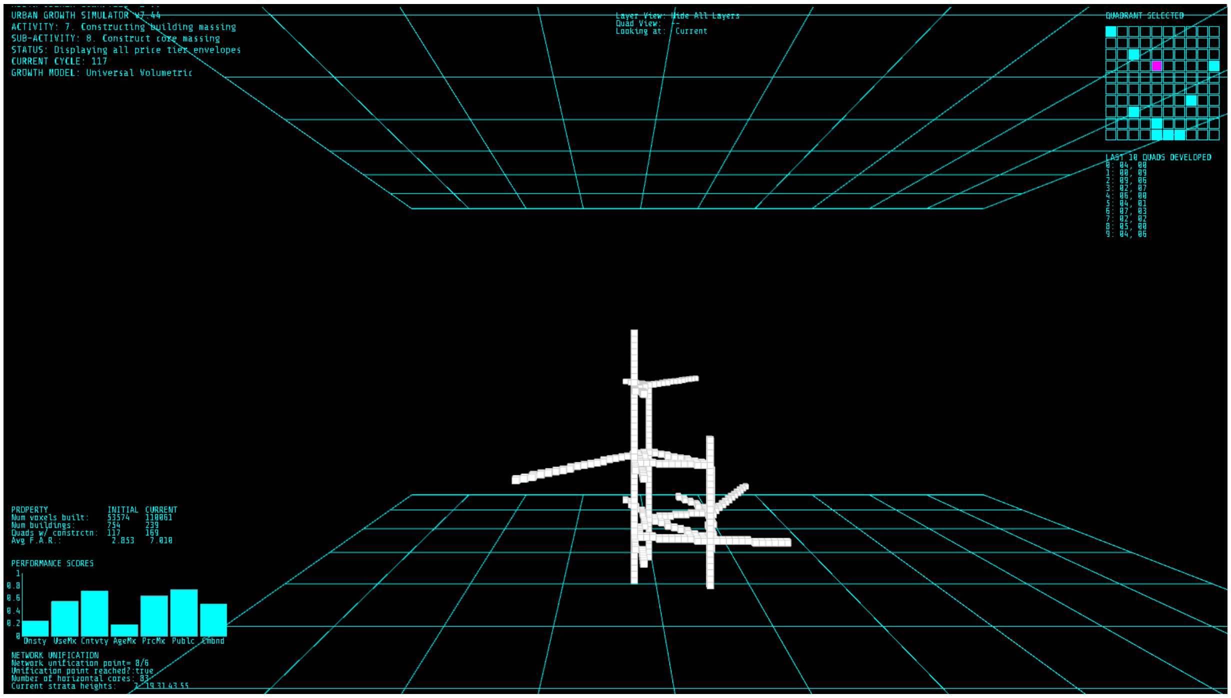

Figure B.37:
Building Massing
The massing of the structural elements in the development are constructed. In this case a horizontal connection to an existing building core from an adjacent development is visible on the left of the building.

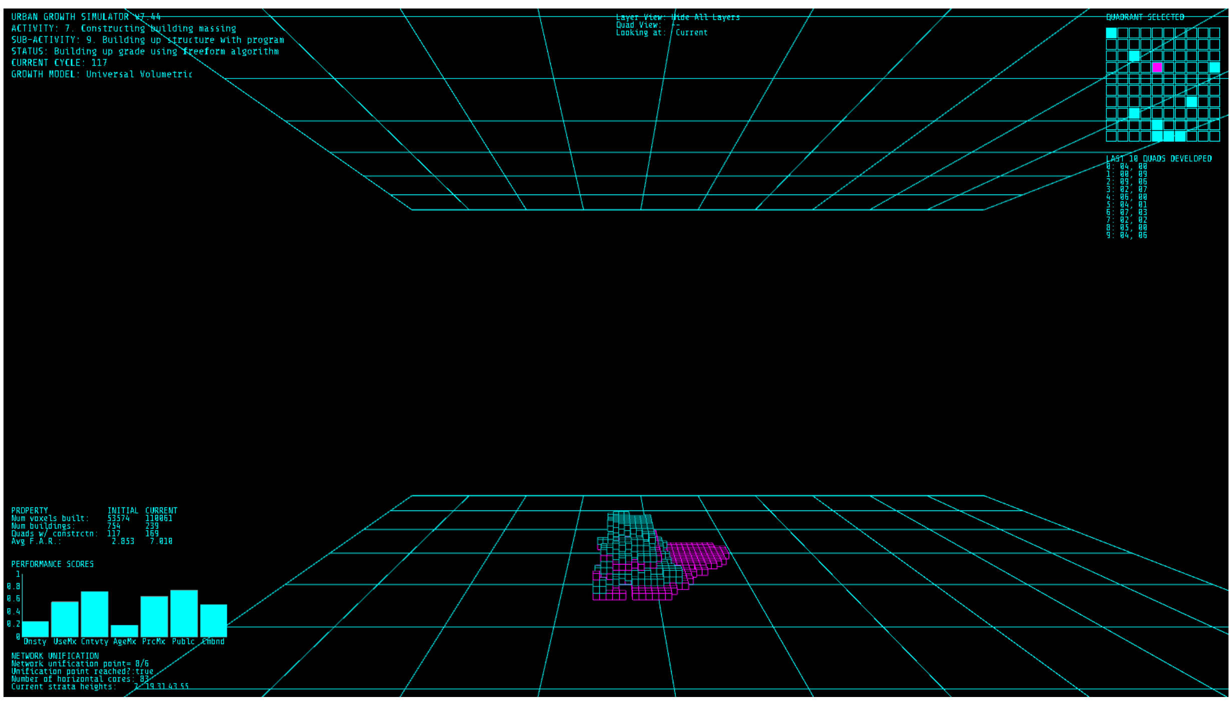

Figure B.38:
Building Massing
Massing for each structural element is constructed. In this case the grade-supported massing is constructed using the free-form algorithm from the ground up.

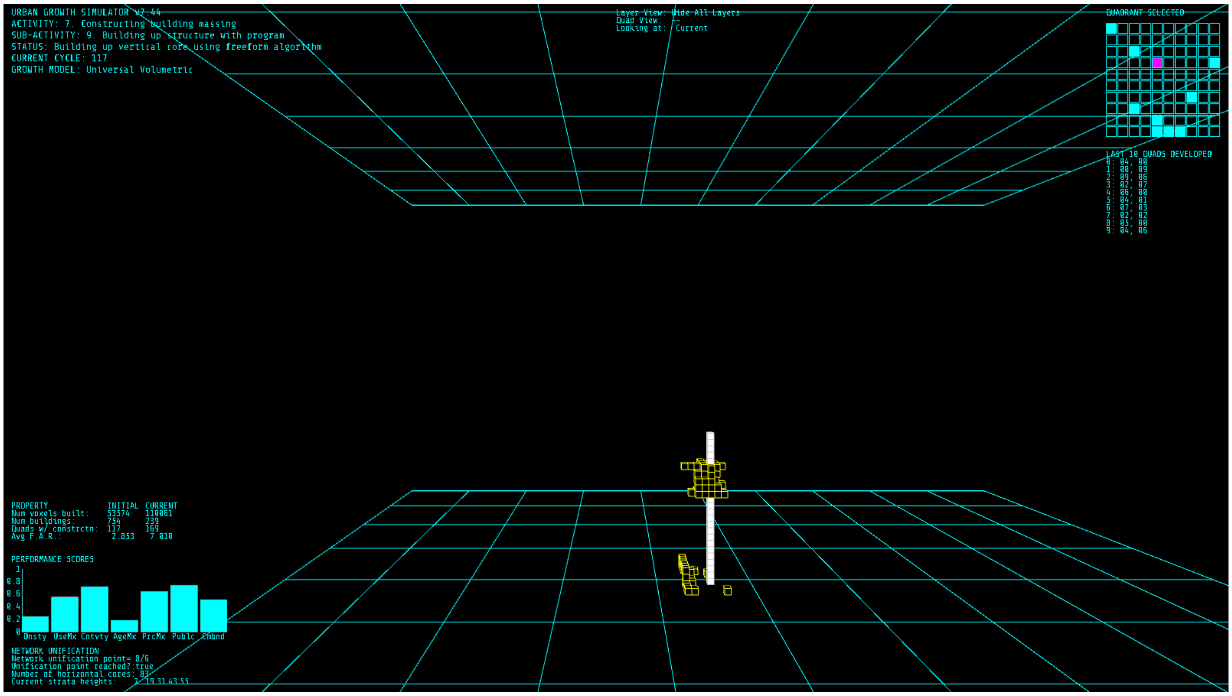

Figure B.39:
Building Massing
Early stages of a free-form massing algorithm in operation on a vertical core, which constructs massing in the highest scoring locations according to the combined site analysis character envelope score.

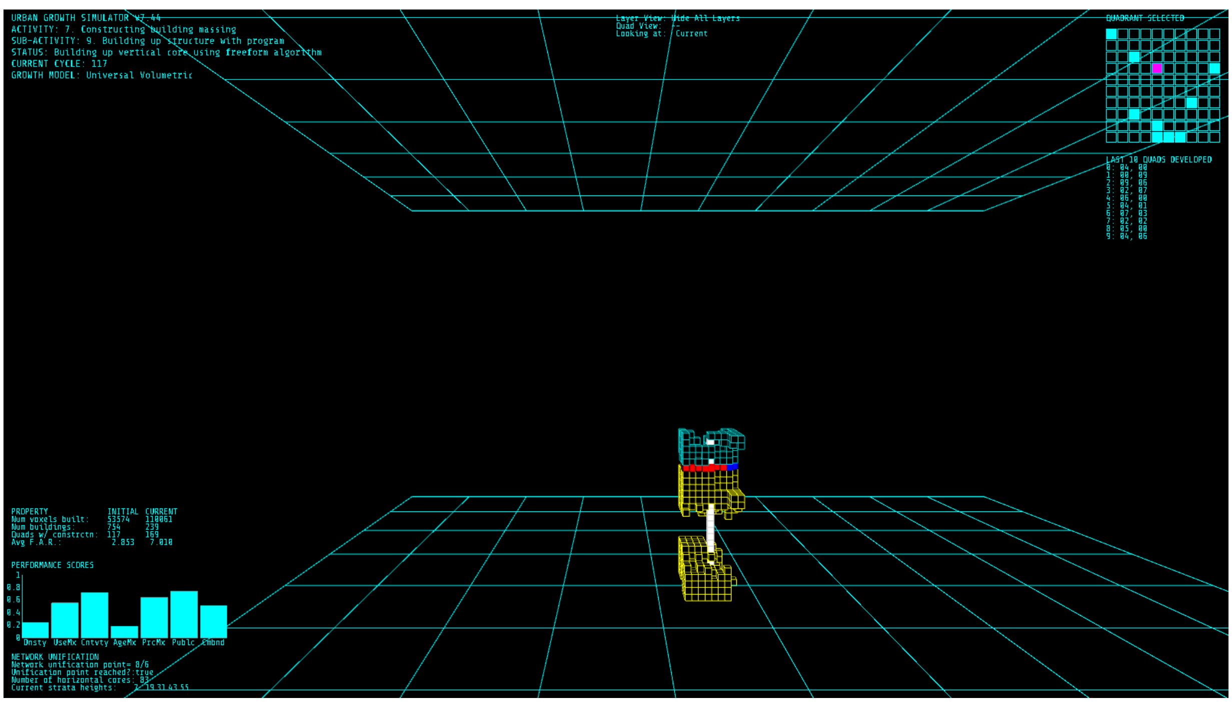

Figure B.40:
Building Massing
Completed free-form massing for the vertical structural core.

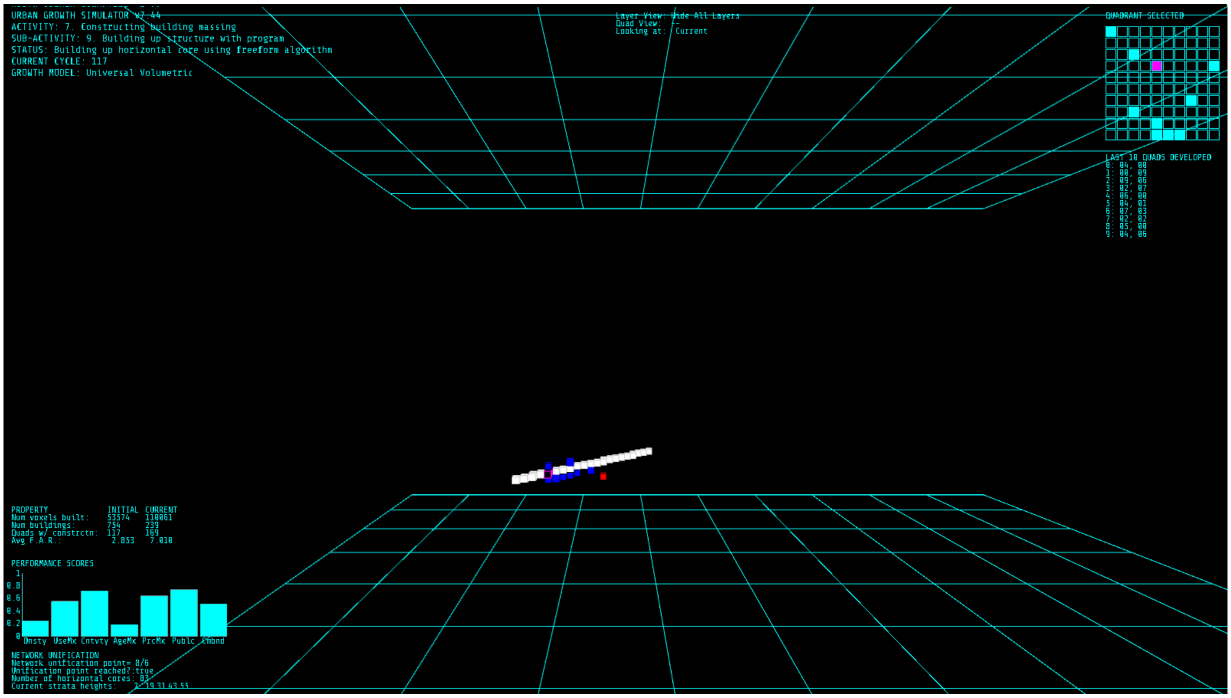

Figure B.41:
Building Massing
Early stages of a free-form massing algorithm operating on a horizontal core.

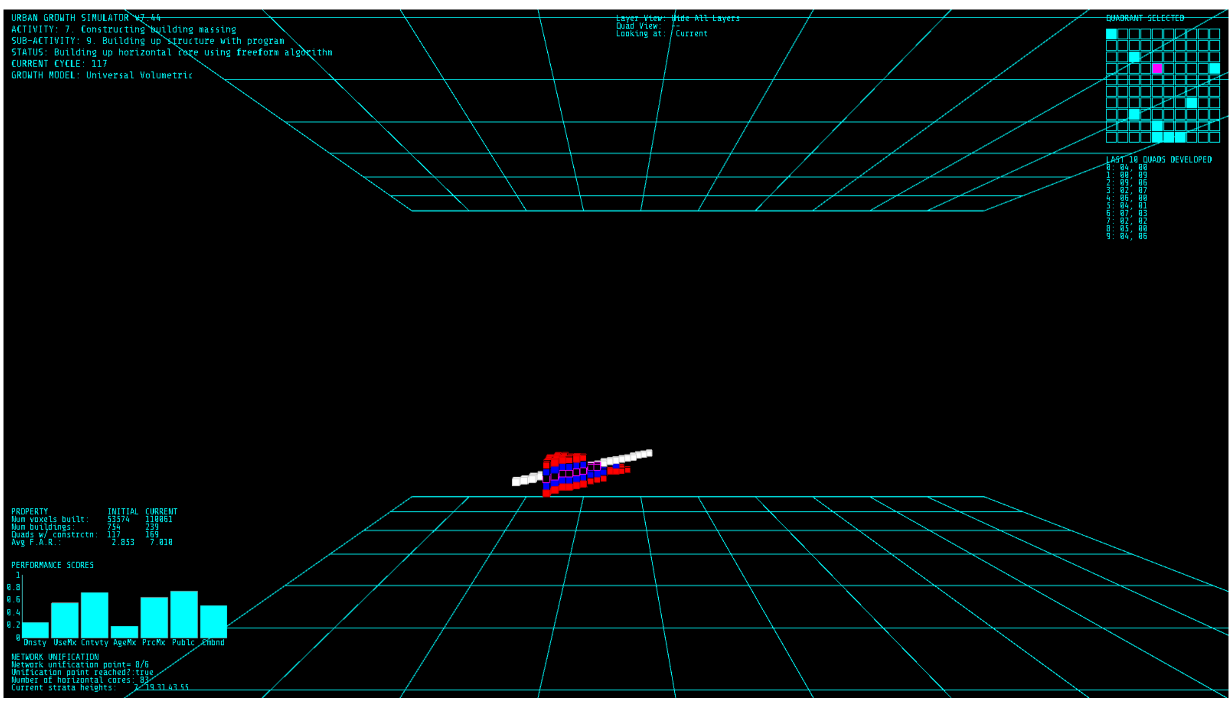

Figure B.42:
Building Massing
Completed free-form massing for the horizontal structural core.

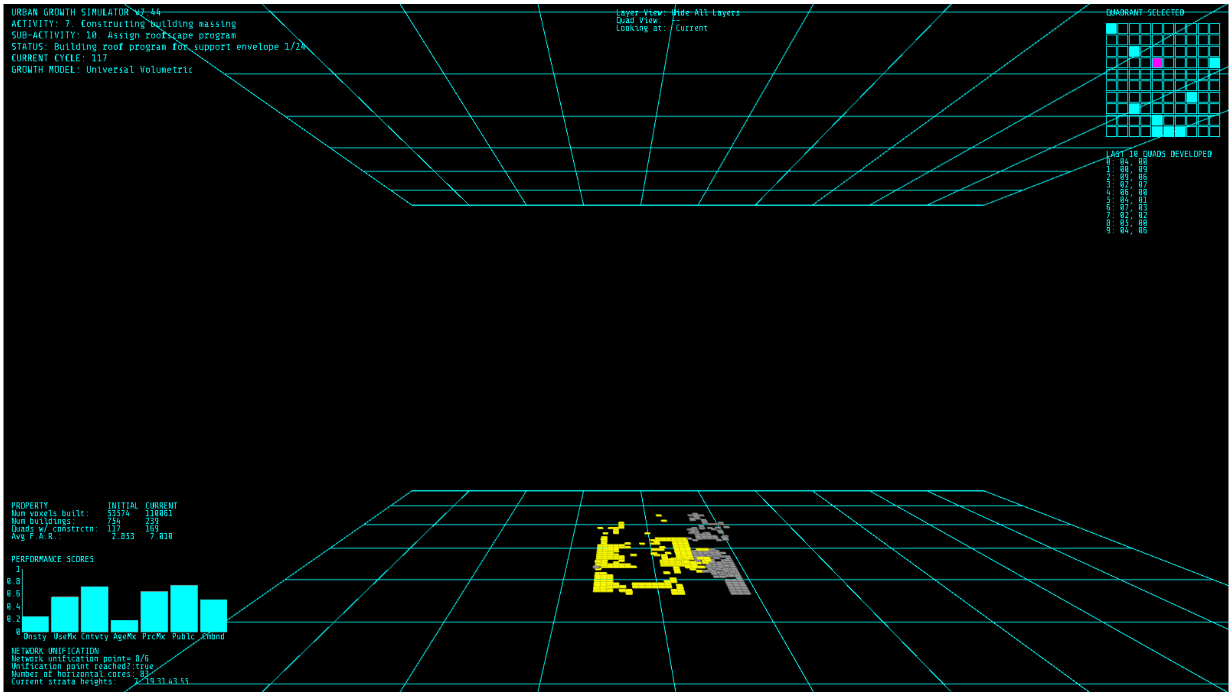

Figure B.43:
Building Massing
Roof program assignment for the grade-supported massing. Roof program can be selected based on the needs of the surrounding building fabric and assigned various programmatic use mix grains and degrees of publicness.

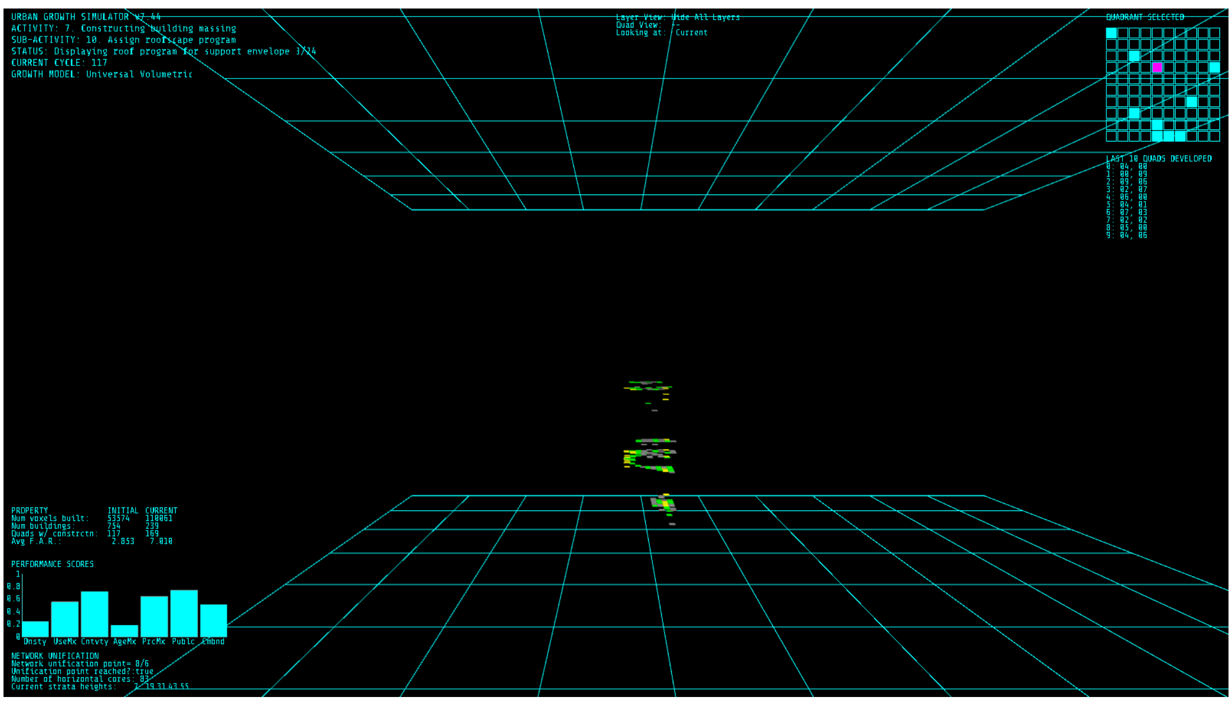

Figure B.44:
Building Massing
Roof program assignment for a vertical core's supported massing.

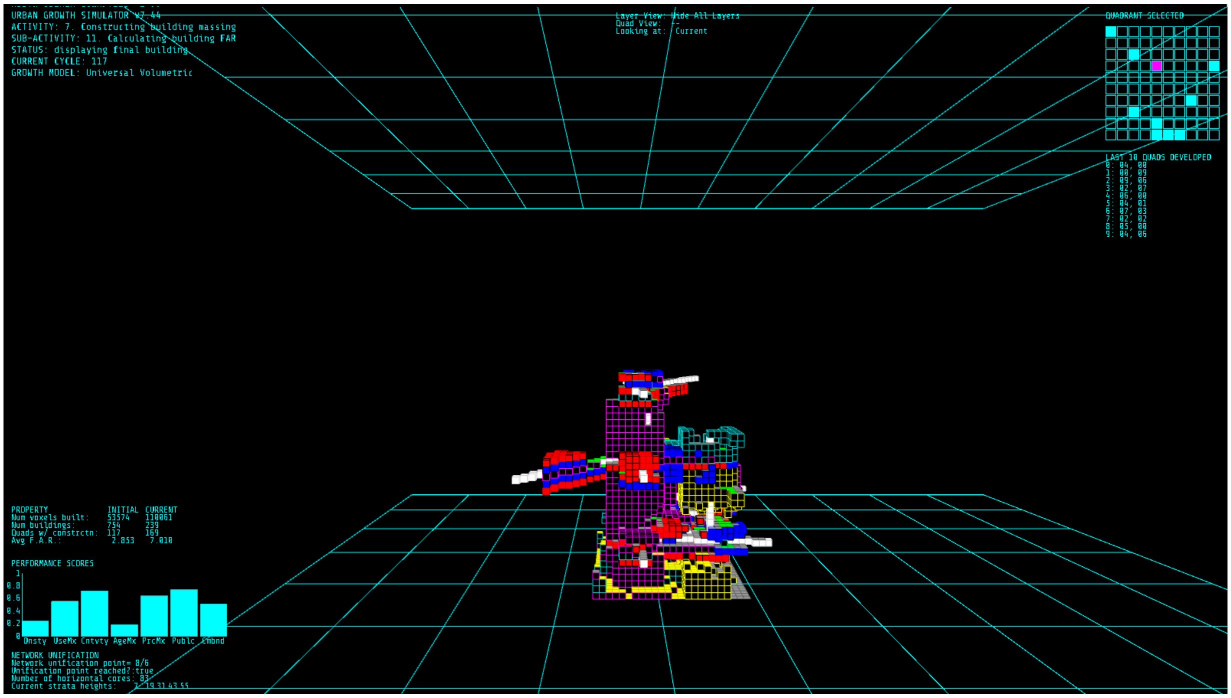

Figure B.45:
Building Massing
The completed building composition including structural elements, connections to existing developments, site responses, programmatic use mixes, price tier mixes, and roof program. It's significant to note that this isn't a prescriptive design, but rather an extrapolation of one possible instance of a site responsive building design within the specified criteria.

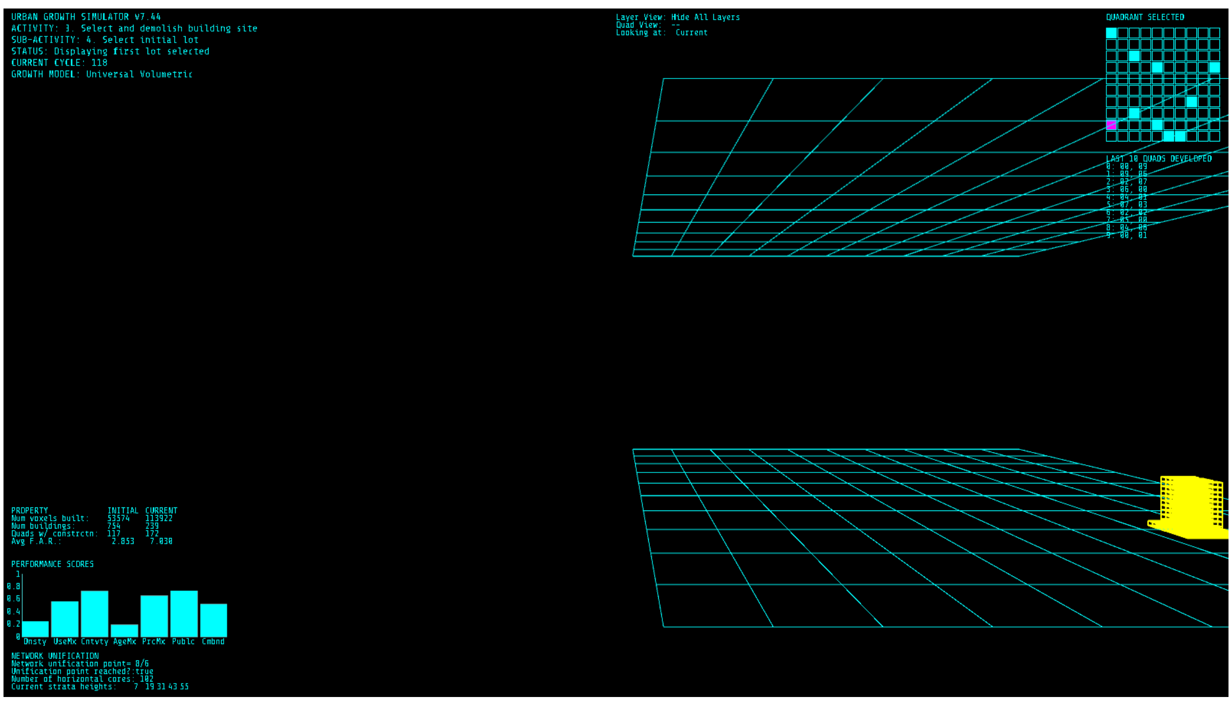

Figure B.46:
Site Selection
The algorithm begins again with the selection of a new quadrant to develop. Sites are selected based on either the development potential or vitality needs for the area, but a limit to the frequency each quadrant can be selected is also assigned.

GLOSSARY

ARCHITECTURE TERMINOLOGY

Quasi-Public Space

The term is adopted from its use in *Parallel Cities: The Multilevel Metropolis*. Quasi-public spaces are those with amenities, gathering spaces, or circulation that create qualities of the urban realm; however, the spaces, are controlled by their owners, operators, or stakeholders.[1]

Inter-building Connections

Any form of extra-grade connection between buildings. Commonly referred to as "sky-bridges" above grade and tunnels below grade.

Building network

A building network, commonly referred to as a "sky-way" when above grade, is a network of multiple inter-building connections which enables circulation independent from grade level.

See also: grade-separated pedestrian systems (GSPS), sky-way, sky-walk, tunnel network

Stratification

The term stratification is used to refer to the physical division of the city into horizontal strata as a result of a collection of inter-building connections at the same height forming a significant datum.

Planar Architecture

Planar architecture is any building, structure, or architectural element which has all of its public or quasi-public spaces exclusively at levels within the immediate vicinity of the ground floor. A planar city is a city in which the public sphere is exclusively accessed from grade level.

1 Vincent James and Jennifer Yoos, *Parallel Cities: The Multilevel Metropolis,* ed. Andrew Blauvelt (New York: Distributed Art Publishers, 2016), 15.

Volumetric Architecture

Volumetric architecture describes buildings and structures which recreate aspects of the public realm's functions and infrastructure throughout the three-dimensional space of a building's volume, rather than solely at the ground plane. This is commonly described as "bringing the city into the building" or "a city within a city," and can manifest as sky-bridges, tunnels, roof terraces, extra-grade amenities, and connected towers.

See also: multi-level city, parallel city, three-dimensional city, hyper-building, vertical village, streets in the sky, double-ground, raised streets

Volumetric City

A city composed of a significant amount of volumetric architecture elements that produce a notably volumetric urban realm.

Urban Resources

Urban resources are the quantifiable physical conditions of the building fabric which create informal uses of public space and have both quantitative and monetary value. The term extends the definition of "new resources in an urban age"[2] established by Harvey S. Perloff in *The Quality of the Urban Environment* to emphasize man-made features of the urban environment as well as natural features of the urban environment by drawing on the work of Jane Jacobs' in *The Death and Life of Great American Cities*.

Sectional Demographics

A term coined by Jennifer Yoos and Vincent James in *Parallel Cities: The Multi-level Metropolis* to describe, "the tendency for multi-level urban environments to reinforce social and economic divisions."[3]

Spatial Oligopoly

A condition in which the spatial rights of a space within the commons are granted to a small group of stakeholders, often as a result of the increasing size of the building parcel grain, or the acquisition of public infrastructure. The result is a biased space that can be altered through formal or informal means to influence its occupants.

2 Harvey Perloff, *The Quality of the Urban Environment: Essays on "New Resources" in an Urban Age* (Washington: Resources for the Future Inc., 1969), vi.

3 James and Yoos, *Parallel Cities,* 152.

COMPUTATION TERMINOLOGY

Voxel

A portmanteau of *volume* and *element*, referring to the smallest unit of volume recognized by a system as a method of abstracting three-dimensional space into a grid of point locations.

Class

A class is a group of objects of the same type that have been predetermined in a coding environment to have the same set of assignable properties and functions.

Object

An object is a specific instance of a class. It can have its own unique properties and be called individually to perform methods.

Methods

Functions of a class that give objects a set of predetermined actions.

Environment

The term used to denote the entire three-dimensional bounds of the computer simulation and all of the objects created within it. It is the simulated world within the program.

Generative Algorithm

An algorithm is the process followed in a problem-solving operation. Here, the term generative algorithm is used to specify the entire combination of processes used by the parametric tool to produce models of the urban fabric.