TOWARDS AN ECOCENE

An Architecture of Hyper-Ecology

Rutuja Atre

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An Architecture of Hyper-Ecology

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Master of Architecture 2022
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ABSTRACT

The Anthropocene epoch, at last, identifies the role of human activity in influencing the climate crisis. Buildings contribute significantly to society's current condition of 'unsustainability,' modifying the planet beyond their physical boundaries. As building impacts are vastly greater than performance energy, hyper-ecological architecture requires a fulsome tally of its embodied energy and externalized impacts, socially and ecologically. The current architectural discourse should consider first not to build, but to reclaim and reconnect. The thesis project takes a 1960's Brutalist science museum, exploring how we might approach the act of design, from one of demolition and reconstruction to one that preserves and enhances the existing built, natural, and social infrastructure. By re-envisioning the museum as a 21st-century environmental centre, the project becomes an educational instrument, demonstrating ecologically sensible design ideologies to undergo a paradigm shift from the Anthropocene - towards an ecologically aware and responsible era of the Ecocene.

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INTRODUCTION

What is Hyper-Ecological Architecture?

This thesis maintains that a hyper-ecological architecture is required to transition us towards an Ecocene by approaching the act of building and inhabitation through a truly holistic manner. Hyper-ecological architecture acknowledges that the contemporary act of building has detrimental global impacts beyond the boundaries of a site, making the awareness and consideration of the externalized energy, social, and environmental exchanges imperative in any design approach.

Society and the Climate Crisis

The built environment and architecture are considered as the physical manifestation of human culture, through which humans act upon the Earth. The creation of culture has modified the planet, resulting in a chain reaction disturbing our balance with nature.[1] While humans have achieved remarkable cultural innovations throughout history, each period of change has advanced society at the expense of ecology, with nature consistently manipulated and commodified.[2] The perception of readiness and disposability of the natural environment has resulted in extremely high carrying capacities. However, our exponentially increasing population poses challenges for the future due to the heightened strain on ecology from an ongoing demand for energy and material resources.[3] The recent increase in forest fires, flash floods, and droughts around the globe verify that the climate is changing, and it is changing fast, causing the irreversible destruction of Earth's ecology.[4]

Anthropocene

The significant consequences of exploitive human activity resulting in transformations to Earth's land, oceans, climate, and ecology is considered to have initiated a new geological epoch, the Anthropocene.[5]

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1 Blaine Brownell, Marc Swackhamer, Blair Satterfield, and Michael Weinstock, "Foreword/ Introduction," in *Hyper-Natural: Architecture's New Relationship with Nature* (New York, Princeton Architectural Press, 2015), p. 18.

2 Ibid*,* p. 16.

3 Ibid.

4 Timothy Morton, *The Ecological Thought* (Cambridge, MA: Harvard University Press, 2012), p. 98.

5 Paul J. Crutzen, "The 'Anthropocene,'" *Earth System Science in the Anthropocene*, n.d., pp. 13-18, https://doi.org/10.1007/3-540-26590-2_3.

Figure 1. Greece facing unprecedented wildfires in 2021.

Coined by chemist Paul Crutzen, the word Anthropocene has Greek origins, with *anthropo*, denoting “man,” and *cene* for “new.”[6] While the Anthropocene epoch is an unofficial unit of geologic time, the significant impact of human activity on the planet’s ecology within this period is undeniable. The term Anthropocene highlights the oppression of nature, where human culture has come to be the dominant force over the natural environment. Confronting the implications brought forth by the Anthropocene requires a re-evaluation of the place, role, and influence of humans within the larger context of the planet.

Agency of Architecture

The current global paradigm has served as an incentive to re-assess the preconceived notions of nature in the practice of architecture. Architecture has a

6 “Anthropocene.” *National Geographic Society*, (2019), https://www.nationalgeographic.org/encyclopedia/anthropocene/#:~:text=The%20word%20Anthropocene%20is%20derived,chemist%20Paul%20Crutzen%20in%202000.

significant role within the socio-political context and cultural systems.[7] Yet, "it has not until very recently, acknowledged itself as part of the earth's geology, despite the fact that it is a forceful geological agent, digging up, mobilizing, transforming and transporting earth materials, water, air and energy in unparalleled ways."[8] Buildings are responsible for over one-third of global energy consumption and nearly 40 percent of annual global greenhouse gas emissions.[9] In contemporary global architectural practice, the widespread act of demolition, material extraction, and reconstruction of the built environment results in high amounts of energy exertion, inflicting damage to both ecologies and human communities.

As human impact on Earth's climate and ecology becomes increasingly evident, the need for an alternative method of operation within the capacity of Earth's natural systems is intensified. As one of the key drivers of climate change, architecture has an obligation to present alternative methods of building, or not building, to accommodate society's current needs for growth while simultaneously minimizing the damage of human activity on ecosystems. Architecture in the Anthropocene must actively invent new models of coexistence to generate more authentic experiences, reintroducing nature as a foreground element. Every act of building must, therefore, be one that understands its ecological implications to operate within Earth's natural systems. Through architecture, humans can be made aware of the interconnected state of the planet.

Methodology

This thesis looks at architecture's complex relationship with nature, including romanticism, exploitation, separation, and energy conservation, to investigate the evolving human perception of nature and occupation of the natural world. It explores the emerging theories of interconnectedness against a selection of case studies that represent a more ethical approach to the act of design. The resulting exploratory architectural project investigates ways that we might build more consciously by viewing the act of building as an interlinked process that has an impact on the social and natural fabric of a place.

7 Etienne Turpin, *Architecture in the Anthropocene: Encounters among Design, Deep Time, Science and Philosophy* (Open Humanities Press, 2013).
8 Ibid.
9 Iea, "Buildings – Topics," IEA, July 27, 2021, https://www.iea.org/topics/buildings.

Design Project

Located within the city of Toronto, the research proposes a transformation of the Ontario Science Centre and its site. This building was conceived in the last wave of ecological awareness during the 1970s energy crisis as a drive-to experiential learning museum within Toronto's suburban ravine system. The intervention aims to utilize the existing built and natural infrastructure to explore their potential and convert the project into a twenty-first century environmental centre, local and regional community space, and parkscape.

Through conscientious material selection and the preservation of the existing Brutalist heritage building, the design employs a more fulsome understanding of embodied energy to reconceptualize the operation of the Centre. The master plan envisions a connected public realm through the layering of programs and activities and fosters connections between the site, its users, the local community, and the ravine and park context to expand the Centre's social role. The design reorients the site to pedestrians to support and integrate the adjacent low-income, multi-ethnic 'tower neighbourhoods' within this park and ravine context, creating a platform for education on climate change, cultural and community support, and environmental restoration.

The thesis examines the Anthropocene through a needed holistic ecological and architectural perspective, encouraging consciousness in humans and instilling a sense of agency within society through the proposed interactive, 'living laboratory.' The project creates impact by addressing its specific local context, catalyzing dynamic relationships between buildings, nature and the community. In achieving this, the following questions are investigated through research and design methodologies: How is 'hyper-ecological' architecture distinguished from contemporary sustainable architecture practices? What is the role of aesthetics in a hyper-ecological Architecture? What principles and strategies should drive ecological design in the twenty-first century to be proactive rather than reactive in halting the degradation of the natural environment?


Figure 2. Edward Burtynsky, Coal Mine #1.


Figure 3. Pruitt–Igoe apartments demolished with explosives in the mid-1970.

Human Agency

The Anthropocene poses a threat to society's current methods of operation. Timothy Morton, a contemporary philosopher and scholar whose work explores ecological studies, writes that "we are becoming aware of the world at the precise moment at which we are 'destroying' it— or at any rate, globally reshaping it."[10] He states that the end of the world has already happened. However, this is not the end of history-we are just witnessing its beginning.[11] "When your house is burning down, do you say, 'Well, I didn't start the fire, so I'm not putting it out?' or do you put it out because you can see that the house is being destroyed?"[12] You can see the house burning, but you cannot see climate change.[13] The immensity and scale of climate change has resulted in our negligence in addressing it. Caring for ecology requires forward-thinking. Therefore, taking accountability for climate change in all of our endeavours becomes an ethical position.[14]

Dichotomies in Shifting Towards an Ecocene

The thesis identifies two core dichotomies present in contemporary society. The first dichotomy is where the misconception that humans are separate from nature prevails, resulting in human domination over the natural environment. This is explored through a historical analysis of the human relationship with nature to redefine our understanding of nature and our role within the Earth's systems. The second dichotomy is a physical manifestation of the first, where culture (architecture in this case) exhibits the separation of humans from nature and exploits it in contemporary practice. Awareness and education of local ecological systems and non-exploitive methods of architectural design should begin to address this dichotomy, shifting the paradigm from the Anthropocene towards an Ecocene.

10 Timothy Morton, *The Ecological Thought* (Cambridge, MA: Harvard University Press, 2012), pp. 110.
11 Ibid.
12 Ibid, p. 99.
13 Ibid.
14 Ibid.

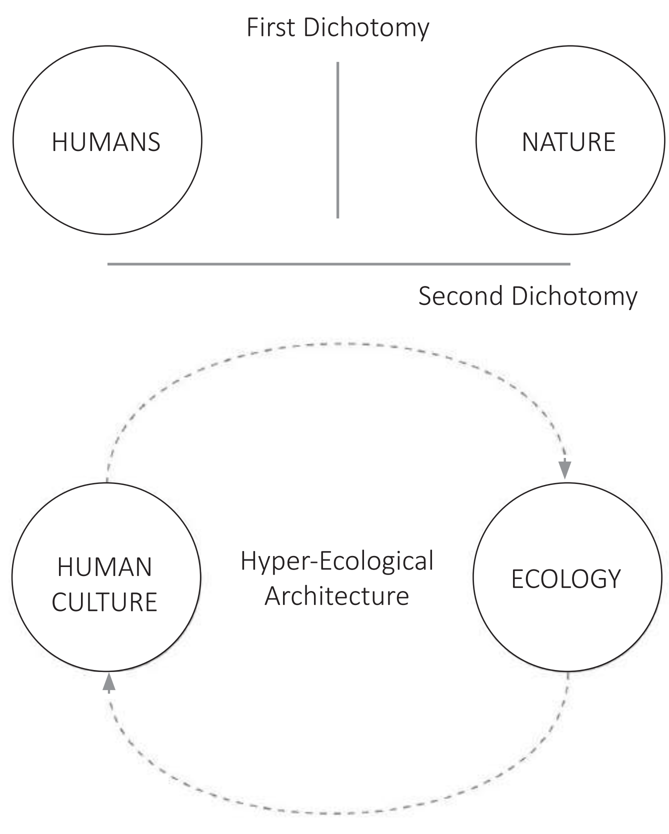

Figure 4. Dichotomies in shifting towards an Ecocene.

WESTERN IDEOLOGIES OF NATURE

Figure 5. The Primitive Hut is illustrated on the frontispiece of Marc- Antoine Laugier: Essay on Architecture.

Background

While humanity's relationship with nature has varied from one time period to another, ideologies and practices of domination and control over nature for the purpose of cultural - whether scientific, technological or capitalist neoliberal economic - development have been long established throughout history.[1] In the past, cyclical patterns of new architectural responses to the exploitation of the natural environment attempted to reconcile with nature, reacting to the immediate crises at hand. This developed the perceived dichotomies between humans and nature in contemporary architectural practice. While a complex and variable story, the separation of humans from nature in western culture can be traced back to historic attitudes towards nature. This phenomenon will be investigated through four main eras identified here as romanticism, exploitation, separation, and energy conservation, to investigate the evolving human perception of nature, significance of culture, and human occupation of the natural world since the dawn of civilization.[2] The history of human impact on the natural environment will be examined through the romanticism of nature during the European colonization of the Americas (1600-1700), the exploitation of the natural environment during the machine age (1700-1950), the separation from nature post World War II in a period of redistributed global resources (1950-1970), and energy conservation following the realization of society's complete dependence on non-renewable resources (1970-present).

The term ecology was first defined in 1866 as "an integral link between living organisms and their surroundings,"[3] leading to the definition of ecological design in 1996 as the "seamless integration of human activities with natural processes to minimize destructive environmental impact."[4] In the twenty-first century, the understanding of ecology and ecological design has evolved, questioning previously established presumptions through past movements and entirely reassessing the contemporary debates on the natural environment.

1 Lynley Tulloch, "Is Emile in the Garden of Eden? Western Ideologies of Nature," *Policy Futures in Education* 13, no. 1 (2015): pp. 20-41, https://doi.org/10.1177/1478210314566729.

2 Lydia Kallipoliti, "History of Ecological Design," Oxford Research Encyclopedia of Environmental Science, 2018, https://doi.org/10.1093/acrefore/9780199389414.013.144, pp 3.

3 Ibid, p. 1.

4 Ibid.

Dawn of Civilization

For thousands of years before the development of civilizations, humans were hunters and gatherers, using mobility as a survival strategy to find food, making long-term settlements impractical.[5] Human impact on the natural systems of the planet was negligible at the time due to the lack of permanent settlements. The first agricultural revolution in 10,000 BCE marked the emergence of agrarian communities that depended on their immediate natural environments and created structures of permanence using available materials.[6] It is believed that the creation of shelters, fire and the domestication of plants and animals for food altered the composition of the earth for the very first time.[7] From the dawn of civilization to the Renaissance in 1300 CE, settlements evolved through cycles of collapse and reconstruction.[8] Much later, around the mid-seventeen century, the theory of the primitive hut was defined by Marc-Antoine Laugier in his Essay on Architecture. Laugier's 'back to the land' philosophy romanticized the simple ideals of early structures and illustrated architecture's essential qualities derived from the natural environment. The primitive hut is an early example that explores the relationship between man and nature.[9]

Romanticism

In the sixteenth century, the development of virgin American land by European settlers formulated an opposition between nature and culture. When the bubonic plague spread in Europe, wiping out nearly 80 percent of its population, it shattered governments, undermined the authority of the Catholic Church, and stoked inflation in Europe.[10] During this time, the city was considered a place of evil associated with disease and overcrowding, encouraging European exploration and colonization.[11] The pastoral myth and

5 National Geographic Society, "Hunter-Gatherer Culture," National Geographic Society, September 9, 2018, https://www.nationalgeographic.org/encyclopedia/hunter-gatherer-culture/.

6 Ronald Wright, *A Short History of Progress* (Toronto, Ontario: Anansi, 2019).

7 "Stories from the Stone Age," DRO (Beyond Production, April 8, 2009), http://dro.deakin.edu.au/view/DU:30016217.

8 Darrell Jay Bricker and John Ibbitson, *Empty Planet: The Shock of Global Population Decline* (London: Robinson, 2020), p. 9.

9 Laugier, Marc-Antoine, Wolfgang Herrmann, and Anni Herrmann. *An Essay on Architecture*. Los Angeles: Hennessey & Ingalls, 2009.

10 Bricker and Ibbitson, p. 12.

11 Ibid, Diana Agrest, Patricia Conway, and Leslie Weisman, "The Return of the Repressed Nature," in *The Sex of Architecture* (New York: Harry N. Abrams, 1996), p. 50.

Figure 6. Thomas Cole's The Course of Empire-Pastoral State (1834).

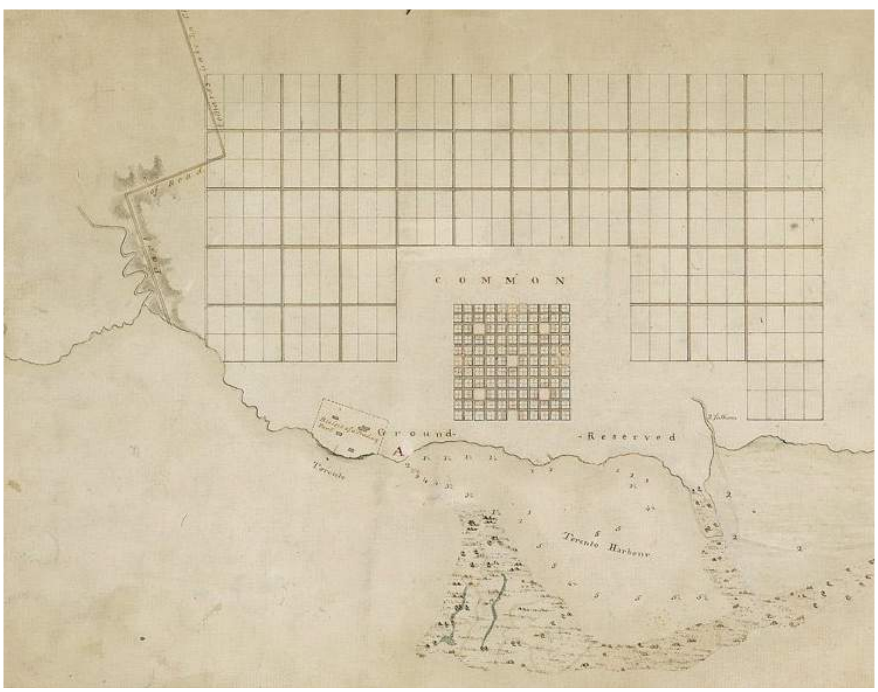

Figure 7. An early map of the survey grid for Toronto (1788).

the ‘garrison mentality’, coined by Northrop Frye refers to themes that emerge in Canadian literature representing ideologies of the romanticism of nature. Upon arrival, Americas were viewed as the possibility of a new beginning, and nature was equated with god and everything positive.[12] The pastoral myth envisioned a social ideal in harmony with the animal and vegetable world.[13] The untouched land and nature were romanticized as sublime and free of the terror that followed the plague. However, the garrison mentality presented a fear towards the threatening landscape. And as the European frontier pushed westward, and wilderness was conquered, the city, by necessity, was assigned a positive value.[14] Nature then came to represent the danger of the unknown.

Exploitation

The Age of Enlightenment in the seventeenth and eighteenth centuries was characterized by the rise of modern science that emphasized the individual and viewed the entire universe as a mechanism.[15] The invention of the steam engine by James Watt and the start of mechanized manufacturing accelerated productivity, causing rapid and sustained population growth.[16] A new economy formed based on an increase in trade, technological development, the use of non-renewable energies, and the formation of a working class.[17] The Age of Enlightenment resulted in the rise of capitalist exploitation and colonization. A global world meant that the scale of human impact transcended local boundaries and ecosystems. At this time, nature was viewed as feminine and passive - to be enslaved and put into service, whereas the active commodification of nature was considered masculine.[18] The narrative then became that nature was seen as either a nurturing mother, wild and chaotic or as the bearer of plagues and famines and therefore, it needed to be

12 Diana Agrest, Patricia Conway, and Leslie Weisman, “The Return of the Repressed Nature,” in *The Sex of Architecture* (New York: Harry N. Abrams, 1996), p. 50.
13 Carl Frederick Klinck, Literary History of Canada: Canadian Literature in English (Toronto: Univ. of Toronto Press, 1977).
14 Agrest, p. 51.
15 Agrest, p. 53.
16 Darrell Jay Bricker and John Ibbitson, *Empty Planet: The Shock of Global Population Decline* (London: Robinson, 2020), p. 14.
17 Lynley Tulloch, “Is Emile in the Garden of Eden? Western Ideologies of Nature,” *Policy Futures in Education* 13, no. 1 (2015): pp. 20-41, https://doi.org/10.1177/1478210314566729, p. 34.
18 Agrest, p. 53.

Figure 8. Factory Production causes carbon emissions in the age of Enlightenment.

enslaved. Diana Agrest notes that “this equivalence between nature and female is key to understanding the struggle for power... where power is gendered male, making possible the displacement of the double image of woman/nature,”[19] developing the search for power over nature. Agrest states that modernist urbanism translates the opposition between nature and culture into nature and object and it is further articulated in the form of nature vs. architecture.[20]

As a response to the dehumanizing effects associated with industrialization and machinery, the Arts and Crafts movement emerged in the mid-nineteenth century, favouring handcraft, local materials, and primitive forms in architecture.[21] The movement celebrated integrating the building with its context and location. Frank Lloyd Wright’s Organic architecture shared similar ideas in which buildings were made to be an extension of their environments,

19 Diana Agrest, Patricia Conway, and Leslie Weisman, “The Return of the Repressed Nature,” in *The Sex of Architecture* (New York: Harry N. Abrams, 1996), p. 53.
20 Ibid, p. 59.
21 Peter Davey, *Arts and Crafts Architecture* (London: Phaidon, 1995).

Figure 9. Fallingwater by Frank Lloyd Wright emerges from its environment.

exemplified by his famous Fallingwater Residence.[22] The character of the building was to be derived from the nature of the place where “the simple laws of common sense—or of super-sense if you prefer—determining form by way of the nature of materials.”[23] Wright believed that nature entails divine qualities and referred to nature with a capital N, similar to God,[24] “and thought of architecture as subservient to its magnitude”.[25]

Separation

In the postwar period, the Americas and the developed world underwent a period of rapid growth. At this time, there was a realization that the rate of industrialization and urban development brought forth severe environmental costs. To solve this problem, environmentalists looked to the management of the environment, believing that the isolation of human culture from nature would aid in combating the environmental degradation. Architect and theorist

22 James Wines and Philip Jodidio, *Green Architecture* (Hong Kong: Taschen, 2008), pp 22-23.

23 Frank Lloyd Wright, *An Organic Architecture: The Architecture of Democracy* (London: Lund Humphries, 2017), p. 3.

24 Lydia Kallipoliti, “History of Ecological Design,” *Oxford Research Encyclopedia of Environmental Science,* 2018, https://doi.org/10.1093/acrefore/9780199389414.013.144, p. 15.

25 Ibid.

Buckminister Fuller was at the forefront of these efforts with inventions that formulated new methods of inhabiting the planet, which he viewed as ‘Spaceship Earth’. Like other environmentalists of the time, Fuller argued that the natural environment was being rapidly destroyed, and Earth’s collapse was inevitable.[26] He addressed environmental issues by examining global resources as interconnected systems that could be redistributed.[27] His philosophy contended that in order to survive, the planet’s finite resources must be properly managed and humanity must advance technology to create abundance whilst causing little to no harm.[28] Fuller’s 1960 proposal of the Dome over Manhattan exemplified his belief that isolating human culture through advanced systems management was the solution to the critical condition of the planet, alleviating many of the problems of the rapidly urbanizing world at the time.[29]

Figure 10. Buckminister Fuller’s Dome over Manhattan separates the interior environment from the exterior.

26 R. Buckminster Fuller and Jaime Snyder, *Operating Manual for Spaceship Earth* (Zurich, Switzerland: Lars Müller Publishers, 2019).

27 Lydia Kallipoliti, “History of Ecological Design,” *Oxford Research Encyclopedia of Environmental Science,* 2018, https://doi.org/10.1093/acrefore/9780199389414.013.144, p. 15.

28 Fuller and Snyder, *Operating Manual for Spaceship Earth*.

29 Ibid.

Ian McHarg was another key figure with a similar line of thinking. He was the first to view the Earth as an autonomous system on the verge of total destruction, "explaining ecosystems by parallels between the Earth and human processes."[30] Both Fuller and McHarg's arguments for world planning as a means to reduce human impact on the natural environment by de-coupling it from natural resource reliance promoted ideas of separation from nature. Their ideologies disregarded that humans are inherently connected to nature and that complete separation from Earth's resources is neither attainable nor beneficial. While technological invention is necessary to achieve efficiency, it is crucial that humans are mindful of our resources and embrace natural systems rather than be isolated from them completely. While Fuller and McHarg's popularizing global view on allocating resources furthered the fledgling environmental movement, their work emphasized the human-nature divide entrenched in contemporary culture.

This period also marked the grassroots environmental movement inspired by Rachel Carson. The movement instigated the rise of eco-awareness with her 1962 publication Silent Spring. The text documented the adverse environmental effects caused by pesticides "alert[ing] the American conscience to the ongoing harm to the natural world as a result of human activity."[31] She argued that human domination over nature is a destructive act that disrupts natural systems and in turn hazards humans as well.[32] She contended that human domination of nature was an unsuitable response for the future of the planet.[33] Awareness of human impact on the natural world was a new concept highlighted by the 'Green Revolution' and it was quickly gaining momentum following Carson's influential work.

Energy Conservation

By the latter twentieth century, the environmental complexity of the planet was becoming a global concern. The oil embargo of 1973 and the 1977 oil shortages

30 Kallipoliti, p. 18.

31 Lydia Kallipoliti, "History of Ecological Design," *Oxford Research Encyclopedia of Environmental Science*, 2018, https://doi.org/10.1093/acrefore/9780199389414.013.144, pp. 23.

32 Rachel Carson, *Silent Spring* (Mariner Books (Houghton Mifflin), 2002).

33 Kallipoliti, p. 23.

brought awareness of society's complete dependence on non-renewable energy resources. The energy crisis instigated the creation of North American Energy codes, defining sustainability for contemporary architectural practice as energy efficient buildings. By the late 1980s, architectural practice was on the verge of full consciousness of the energy impacts of modern buildings, with efforts to promote sustainable development quickly becoming a force. Shortly after the formation of the U.S. Green Building Council, the rating system LEED- Shorthand for Leadership in Energy and Environmental Design was developed in 1998 for the growing interests in the sustainability industry.[34] Energy-efficient buildings that employed clean energy sources for their operation and reduced performance energy were widely viewed as the way toward decreasing carbon emissions and slowing climate change.[35] LEED gained popularity and developed the sustainability discourse present in architectural practice today. The rating system spurred a market transformation, expanding an ecosystem of green commerce.

This led to the rise in popularity of high-tech Eco architecture like Foster + Partner's 30 St Mary Axe project in London which emphasized new building technologies and advanced materials, shifting focus away from the more passive environmental roots of the movement.[36] High-Tech Eco architecture projects tend to acknowledge the "do more" aspect of Buckminister Fuller's philosophy while disregarding the more necessary, "with less" aspect.

While such buildings may perform well from an energy performance standpoint, their high embodied energy, global carbon footprints, and cost of construction using extensive technologies and high-end products makes them exclusive and unrealizable in the larger market. The current sustainability discourse must prioritize a more holistic and conservationist approach that can be impactful at scale by addressing foremost our existing vast inventory of existing underused and under-performing buildings.

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34 Brian Barth, "Is LEED Tough Enough for the Climate-Change Era?," Bloomberg.com (Bloomberg, June 5, 2018), https://www.bloomberg.com/news/articles/2018-06-05/reconsidering-leed-buildings-in-the-era-of-climate-change.

35 Barth, "Is LEED Tough Enough for the Climate-Change Era?"

36 Phineas Harper, "'High-Tech Is Ever Edging Away from Its Ecological and Humanistic Roots,'" Dezeen, November 21, 2019, https://www.dezeen.com/2019/11/21/high-tech-architecture-environment-sustainability/.

EPISTEMOLOGICAL ERROR

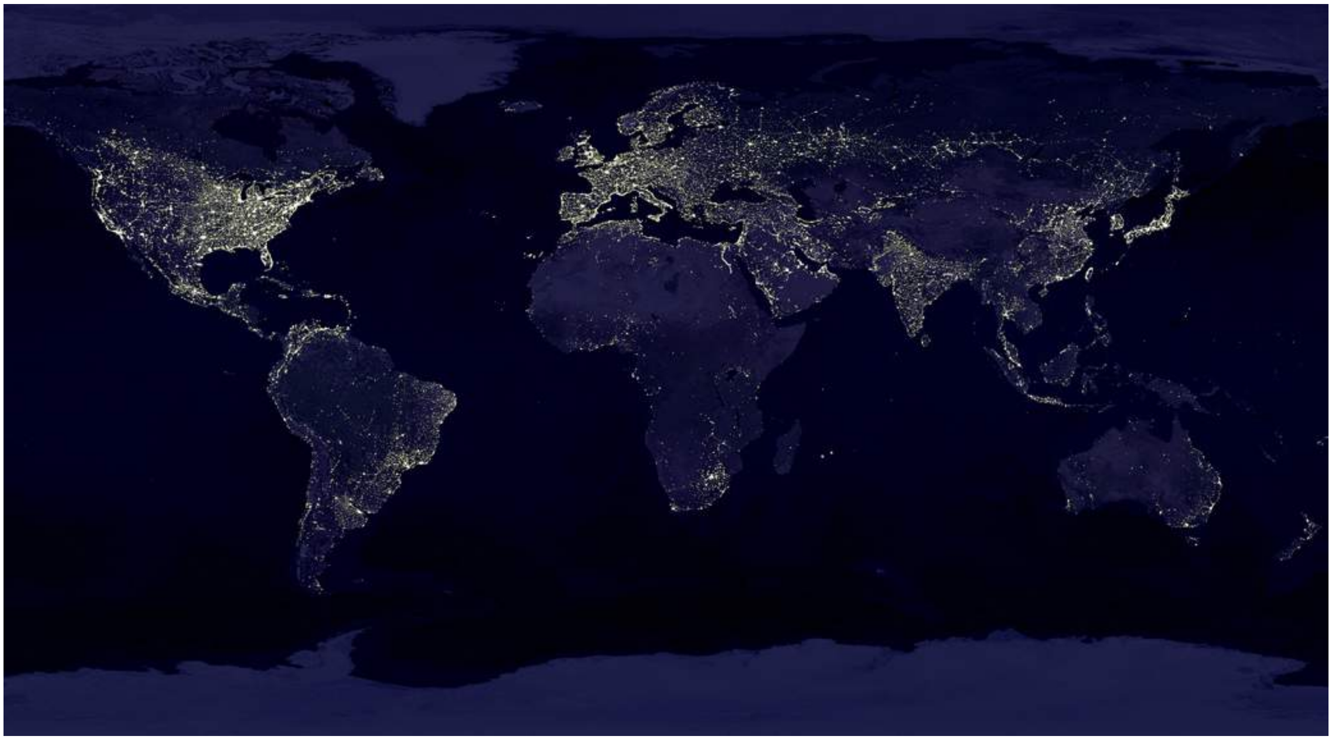

Figure 11. Satellite image of Earth's city lights by NASA (1994).

Modern Environmentalism

Rachel Carson's writings from the 1960s influenced a new era of modern environmentalism that instigated a transformation of society's understanding of ecosystems, ecology, and humans' place in nature. In the 1970s, a revolutionary theory titled the Gaia hypothesis was proposed by chemist and inventor James Lovelock after the Greek goddess of Earth that changed the way the planet was perceived. The theory posits that "Earth and it's biological systems behave as a huge single entity. This entity has closely controlled self-regulatory negative feedback loops that keep the conditions on the planet within boundaries that are favorable to life."[1] Bruno Latour, in his text, *Facing Gaia: Eight Lectures on the New Climatic Regime* states that the arrival of the Anthropocene demands a new understanding of nature, that was previously defined by humans through ideas of theology, politics, economics, and science.[2]

While a it is recognized as a single entity, Holling and Goldberg, *Projective Ecologies,* highlight that Earth's ecological systems are not in a state of delicate balance as they have endured shocks as a result of geophysical processes for thousands of years before humans appeared.[3] However, a key factor of the resilience is that unexpected changes are able to be absorbed, defined by a limit of stability.[4] With current practices based on the exploitation of ecology for the benefit of the economy, the "series of incremental changes accumulate or a massive shock is imposed such that the resilience of the system is exceeded, generating dramatic and unexpected signals of change."[5]

Modern environmentalism acknowledges the complexity of ecological systems, where ecosystems are "characterized not only by their parts but also by the interaction among these parts."[6] As such, traumas that are inflicted on one part of the ecosystem have the ability to deteriorate the entire ecosystem through a series of successional stages.

1 Sven Erik Jørgensen, Brian D. Fath, and P J. Boston, "Gaia Hypothesis," in *Global Ecology: A Derivative of Encyclopedia of Ecology* (New York: Elsevier, 2010).
2 Bruno Latour, *Facing Gaia: Eight Lectures on the New Climate Regime* (Polity: United Kingdom, 2017).
3 Chris Reed et al., "Ecology and Planning," in *Projective Ecologies* (Actar, 2014), p. 107.
4 Ibid.
5 Ibid.
6 Ibid.

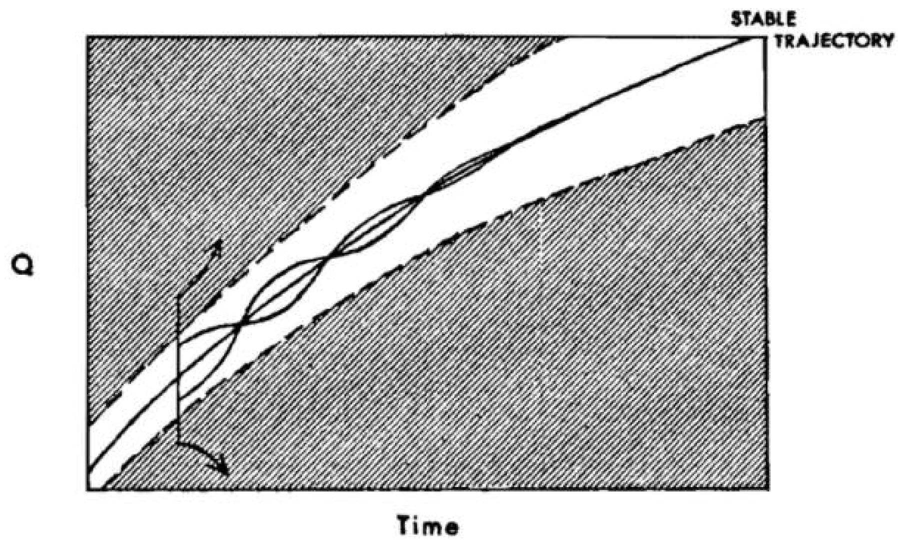

Figure 12. An example of a bounded stable trajectory analogous to ecological succession.

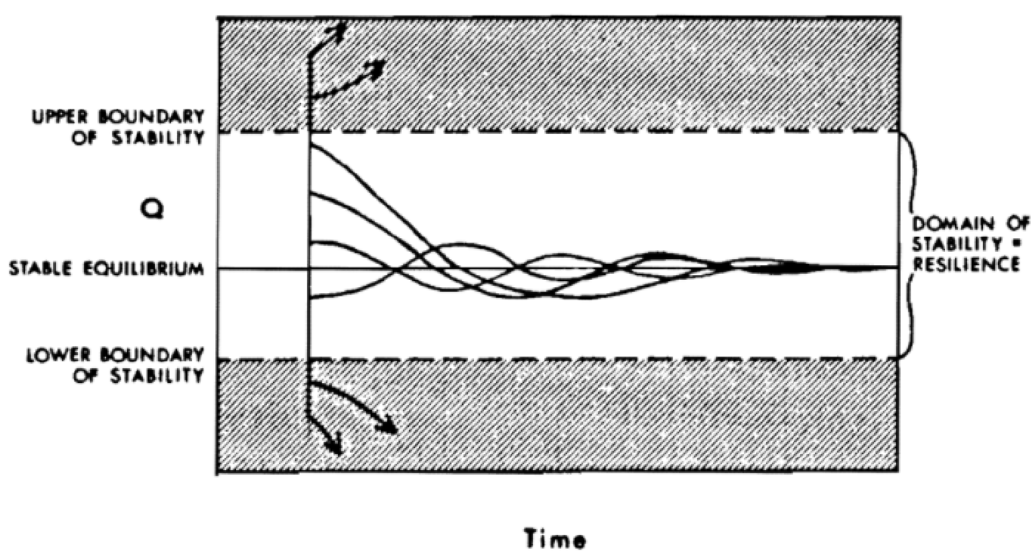

Figure 13. An example of a system with a stable equilibrium where stability is possible within distinct boundaries.

Ecological Thinking

Shortly after the Gaia theory gained momentum, the philosopher Arnae Næss distinguished the difference between the two paradigms of the time: 'shallow' and 'deep ecology', sparking current conversations on ecological thinking.[7] Naess argued that while the 'shallow' *ecology* movement is a "fight against pollution and resource depletion"[8], for the benefit of the affluent in developed countries, the 'deep ecology' movement maintains a "biospheric egalitarianism"[9] view, identifying that all forms of life have an intrinsic value, regardless of their role or benefit to other.[10]

Timothy Morton furthers the 'deep ecology ideology,' identifying the contemporary 'ecological thought' as the realization that all forms of life, living and non-living, are connected in a vast, entangling mesh, and are of equal value and significance.[11] Morton's 'ecological thought' advocates an approach to ecology that underscores the importance of the human experience of life within nature and recognizes humans as intrinsically connected to the Earth, as identified by the 'deep ecology' theory.[12] He argues for solidarity with non-humans, to overcome the current anthropocentric worldview of the planet.

This brings up the argument that the act of naming *nature* itself separates the physical world of danger and wilderness from the human world, reinforcing the domestication that enables humans to exploit it.[13] Morton asserts that in a mesh "everything is interconnected, [and] there is no definite background and therefore no definite foreground."[14] As such, the theory opposes the current hierarchical method of operation. However, current society views

7 Zeke Benshirim, "Daring to Care: Deep Ecology and Effective Popular Environmentalism," Harvard University Sustainability (Harvard University, February 23, 2017), https://green.harvard.edu/news/daring-care-deep-ecology-and-effective-popular-environmentalism.
8 Ibid.
9 Ibid.
10 Benshirim, "Daring to Care: Deep Ecology and Effective Popular Environmentalism,"
11 Timothy Morton, *The Ecological Thought* (Cambridge, MA: Harvard University Press, 2012), p. 8.
12 Lydia Kallipoliti, "History of Ecological Design," *Oxford Research Encyclopedia of Environmental Science*, 2018, https://doi.org/10.1093/acrefore/9780199389414.013.144, p. 24.
13 Chris Reed and Nina-Marie Lister, "Ecology and Design: Parallel Genealogies," *Places Journal*, no. 2014 (2014), https://doi.org/10.22269/140414, p. 7.
14 Morton, p. 30.

nature as a background element, and in an age of global warming, the background will soon cease to exist, and without it, we cannot survive. Therefore, Morton notes that the idea of people as single, independent entities should be demolished as it separates the human from the rest of nature.[15]

Morton presents climate change as one of the largest hyper-objects of the Anthropocene, defined as an entity so massively distributed in time and space that it transcends locality.[16] He criticizes the laissez-faire mentality of no interference as it assumes that human activity has no responsibility for the natural environment and therefore humans should feel no guilt in continuing its exploitation.[17] He describes how capitalism restricts 'ecological thought', as some crude economic ideologies believe that ecological progress will hinder the economy.[18] To accept global warming, means to give up the fantasy that capitalism is an automated process that must continue without intervention.[19] Morton believes that the current operation of capitalism is a reactive rather than proactive approach, and combating it requires collective thinking and understanding ecology as not simply a vessel of resources but as intricate interconnectedness and consideration of others.[20] He states that 'ecological thought' is a method in which the world should be understood and that the mode of thinking expands humanity's perception of our place in nature:

> "*It forces us to invent ways of being together that don't depend on self-interest ... [compelling] us to imagine collectivity rather than community ... The ecological thought can be highly unpleasant. But once you have started to think it, you can't unthink it. We have started to think it. In the future, we will all be thinking the ecological thought. It's irresistible, like true love.*"[21]

15 Timothy Morton, *The Ecological Thought* (Cambridge, MA: Harvard University Press, 2012), p. 119.
16 Ibid, p. 131.
17 Ibid, pp. 128-129.
18 Ibid, p. 121.
19 Ibid, p. 129.
20 Ibid, pp. 121-122.
21 Ibid, p. 135.

Ecology and Design

In the 2015 text *Hyper-Natural: Architecture's New Relationship with Nature* Michael Weinstock writes on natural and cultural evolution, He notes that "it is clear that the world is within the horizon of a systemic change and that transitions through multiple critical thresholds will cascade through all the systems of nature and civilization."[22] The knowledge of our interdependence with other beings redefines a previous assumption of the separation between humans and nature. Latour writes that "In Gaia we are just another species, neither the owners nor the stewards of this planet. Our future depends much more upon a right relationship with Gaia than with the never-ending drama of human interest."[23] The new understanding of ecology calls for a change in humans' relationship with nature and forces a revolution in human thought, where preconceived notions of nature as a secondary background element are required to be redefined according to the current geologic age. By reconsidering the breadth of the term ecology, the scope of architecture is widened, questioning presumptions that may have been previously established through past movements and entirely reassessing the role of architecture in the Anthropocene.

It is crucial that humans reconsider the way we design interventions. Nina Marie Lister and Chris Reed in the 2014 article *Ecology and Design: Parallel Genealogies,* write "The challenge of the paradigm shift toward complex systems thinking is to realize that we cannot manage whole ecosystems; rather, we can manage ourselves and our activities."[24] With this realization, we must shift the way we design from a principally economic perspective to managing human actions within ecosystems.[25] The new understanding of ecology presents a mode of operation that attempts to halt the rapid destruction of the ecosystems and move towards an ecologically aware and responsible era of the Ecocene.

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22 Blaine Brownell, Marc Swackhamer, Blair Satterfield, and Michael Weinstock, "Foreword/ Introduction," in *Hyper-Natural: Architecture's New Relationship with Nature* (New York, Princeton Architectural Press, 2015), p. 17.

23 James Lovelock, *The Ages of GAIA: A Biography of Our LIVING EARTH* (Oxford: Oxford University Press, 2000).

24 Chris Reed and Nina-Marie Lister, "Ecology and Design: Parallel Genealogies," *Places Journal*, no. 2014 (2014), https://doi.org/10.22269/140414, p. 5.

25 Ibid.

BECOMING HYPER-ECOLOGICAL

Figure 14. Mies van der Rohe's Toronto Dominion Centre epitomizes the standardization of architecture.

Aesthetics of Modernism

Modernism gained momentum in the twentieth century by providing a cheap, functional and fast alternative to construction. This transformed architecture's emphasis to new materials and standardized construction technologies, placing nature and site-related concepts in the background.[1] Pioneered by Le Corbusier, the new movement featured standardized facades, plans and forms powered by mechanical systems to artificially heat or cool the building. Detlef Mertins describes Mies' infamous project epitomizing standardization as "a melancholic contemplation of the 'idea' of the 'modern' arising from the acceptance of a condition resolutely divided from nature, a contemplation of black furnaces producing intense heat and light along with new artificial materials, of the infinite horizon of steel rails and telephone lines, of the elemental units produced by machines and or machines."[2]

Modern architecture had separated itself from the environment to the point of isolation and complete reliance on mechanical systems. Reyner Banham, in the 1969 text *The Architecture of the Well-Tempered Environment* writes, "As the progress of Le Corbusier's thinking shows, it would have been necessary to invent air-conditioning around 1930 had it not existed already."[3] Architecture was no longer shaped by or responsive to the natural environment it was contextualized within, allowing standardization to become a celebrated international style. Glenn Hill, in *The Aesthetics of Sustainable Architecture,* writes:

> *"Since the inception of modernity, architecture has increasingly become both a primary site of commodity accumulation and one of its most significant commodities. This process has implicated architecture in ever-increasing patterns of energy and resource use, contributing significantly to what is now viewed as a global condition of unsustainability."*[4]

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1 James Wines and Philip Jodidio, *Green Architecture* (Hong Kong: Taschen, 2008), pp. 25.

2 Kiel Moe, *Unless: The Seagram Building Construction Ecology* (Barcel: Actar, 2021), p. 222.

3 Reyner Banham, *The Architecture of the Well-Tempered Environment* (Sydney: Steensen Varming, 2008), p. 171.

4 Sang Lee and Glen Hill, "The Aesthetics of Architectural Consumption," in *Aesthetics of Sustainable Architecture* (Rotterdam: 010 Publishers, 2011), p. 26.

The invention of heating and cooling technology created the current global condition where buildings in warm climates such as South Asia appear visually similar to those in contrasting contexts like North America. With the rise of the international style, the often more ecologically sensible vernacular and local building practices became less prominent. Modern architecture sold a uniform image regardless of context, and architecture quickly lost connection to materials, building practices, and the cultural identity of the project.

The commodification of architecture has increasingly led to its contribution to unsustainable resource consumption. Hill states that the term aesthetics is tied with modernity, where "there is neither commitment to a geographic place nor acceptance of placement within a social order."[5] This results in an aesthetic economy based on constant production required to meet the needs of endless consumption rather than aesthetics based on moral reasoning.

In his 2002 text, Rem Koolhaas writes that "Junkspace is what remains after modernization has run its course or, more precisely, what coagulates while modernization is in progress, its fallout."[6] He critiques contemporary architecture stating that "all theory for the production of space is based on an obsessive preoccupation with its opposite: substance and objects."[7] His critique on image-obsessed architecture, can be applied to many contemporary projects:

> *"'Masterpiece' has become a definitive sanction, a semantic space that saves the object from criticism, leaves its qualities unproven, its performance untested, its motives unquestioned. Masterpiece is no longer an inexplicable fluke, a roll of the dice, but a consistent typology: its mission to intimidate, most of its exterior surfaces bent, huge percentages of its square footage dysfunctional, its centrifugal components barely held together by the pull of the atrium."*[8]

5 Sang Lee and Glen Hill, "The Aesthetics of Architectural Consumption," in *Aesthetics of Sustainable Architecture* (Rotterdam: 010 Publishers, 2011), p. 27.
6 Koolhaas, Rem. "Junkspace." October 100 (2002): 175–90. http://www.jstor.org/stable/779098, p. 175.
7 Ibid, p. 176.
8 Ibid, p. 184.

Figure 15. The Gherkin by Foster and Partners has achieved LEED platinum certification featuring high tech solutions for performance energy savings.

The iconic and cutting edge has become a common occurrence where a shiny new building replaces the last, feeding into the consumption of resources with poorly designed and built construction that is required to be replaced often.[9] Such architecture is often built with the consideration that it will be replaced, resulting in the misuse of Earth's finite resources.

In contemporary practice, ecological design has become a commodity and technological achievements are used as a selling point. Lydia Kallipoliti, in the *History of Ecological Design* exemplifies this approach through the Foster + Partner's 30 St Mary Axe project, more commonly known as 'The Gherkin.' "The Gherkin successfully bridges a perceived gap between sustainability initiatives and economic growth and sells a certain kind of ecology to the public, even though its sustainable features in operation actually fall short of achieving its touted energy performance."[10]

The difficulty in identifying good environmental design practices and bad ones enables buildings to appear green while being a construct of destructive environmental practices. The term green-washing was first introduced in the 1980s to describe corporations and industries that falsely advertise their products as environmentally sensitive while imploring their customers to do their part in saving the environment. The problem with some 'sustainable' buildings is that they attempt to appear sustainable without putting in the effort to actually be sustainable.[11] An Architectural Review article addressing the green delusion in the industry states that "the idea of green building design combined with the business of green building certification poses the wrong question: whether to make a green building or not."[12] The label turns the project into a marketing tool for corporate agenda, marginalizing the intentions and efforts of real

9 Mette Aamodt, "Junkspace and the Death of Architecture: Slow Space Finds Its Nemesis," Slow Space, April 9, 2019, https://www.slowspace.org/junkspace-death-of-architecture-nemesis/.

10 Lydia Kallipoliti, "History of Ecological Design," *Oxford Research Encyclopedia of Environmental Science*, 2018, https://doi.org/10.1093/acrefore/9780199389414.013.144, p. 35.

11 Phineas Harper, "Outrage: Greenwashing Risks Giving Dirt a Filthy Name," Architectural Review, July 12, 2021, https://www.architectural-review.com/essays/outrage/outrage-greenwashing-risks-giving-dirt-a-filthy-name.

12 Pascal Hartmann, "The Green Delusion," Architectural Review, July 9, 2021, https://www.architectural-review.com/today/the-green-delusion?tkn=1.

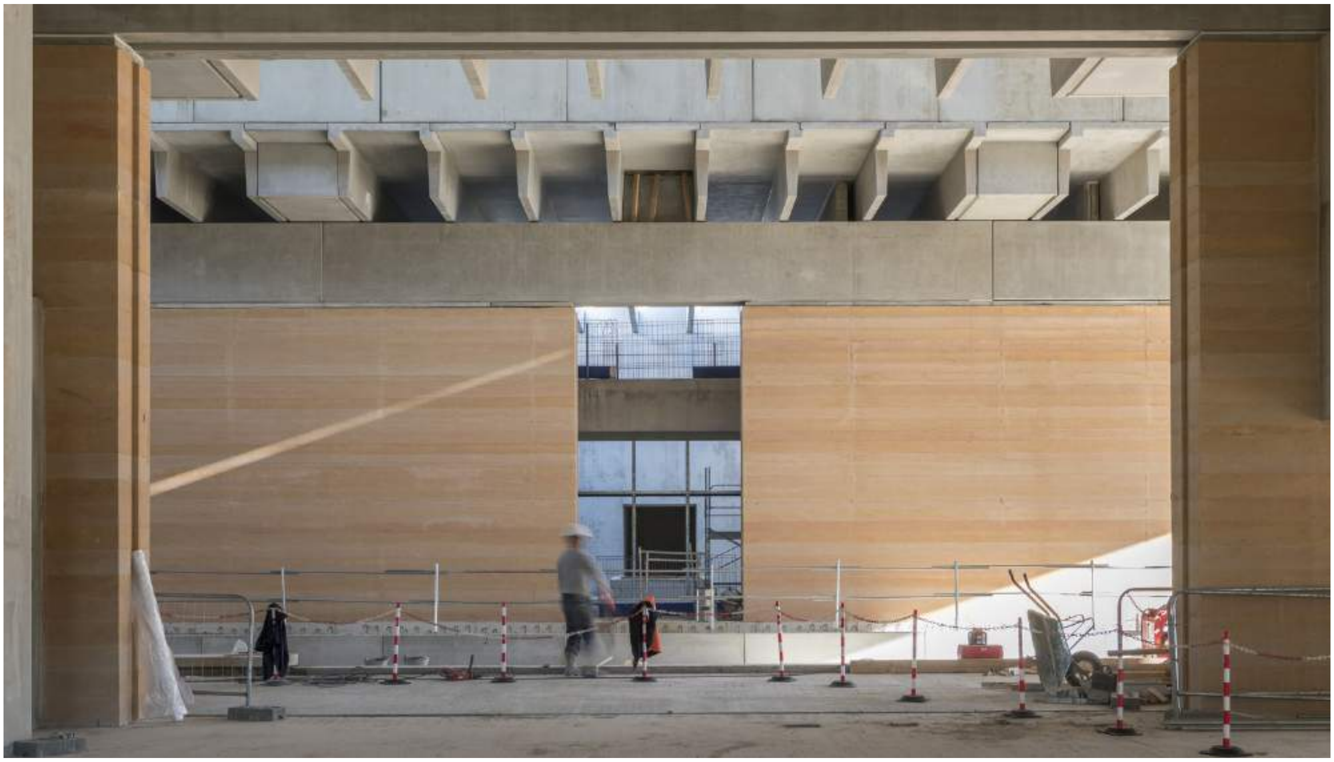

Figure 16. The walls of the Musée Régional de la Narbonne Antique in France, appear to be the environmentally sensitive material of rammed earth but are in fact, a steel-reinforced earth composite with just slightly less cement than a concrete wall.

environmentally sensitive architecture.[13] Instead, the question should be how much can architecture limit its impact on the natural environment and how can architecture be regenerative? Buildings need not be construed as commodified image-driven products with ‘sustainable’ applications pasted onto them as symbolic gestures to further corporate agenda. Rather, Edward Winters in his book *Architectural Aesthetics* defines a more ecological approach to design with the concept of ‘moral aesthetics’. He states that moral ideas, based on a holistic understanding of energy, for instance, can define the materials, form and organization of a building to create aesthetic pleasure. He adds that for such architecture, the ideas of moral design come from within, rather than adding features as an afterthought.

13 Pascal Hartmann, “The Green Delusion,” Architectural Review, July 9, 2021, https://www.architectural-review.com/today/the-green-delusion?tkn=1.

Hyper-Ecological Architecture

As conversations on human impact on the changing climate become increasingly urgent, the need for design and construction of buildings to operate within ecological limits has shifted from a nascent movement to a primary objective. Learning from previous movements of romanticism, exploitation, separation, and energy conservation illustrated by past and present 'green' architectural practices, hyper-ecological architecture notes that 'green architecture' can take a variety of forms and is extremely broad in its viewpoints, strategies and intentions.[14] Simon Guy and Graham Farmer identify the six competing logics of 'green architecture'.

Logic	Source of Environmental Knowledge	Building Image	Technologies	Idealized Concept of Place
Eco-technic	technorational scientific	commercial modern future oriented	integrated energy efficient high-tech intelligent	Integration of global environmental concerns into conventional building design strategies. Urban vision of the compact and dense city.
Eco-centric	systemic ecology metaphysical holism	polluter parasitic consumer	autonomous renewable recycled intermediate	Harmony with nature through decentralized, autonomous buildings with limited ecological footprints. Ensuring the stability, integrity, and "flourishing" of local and global biodiversity.
Eco-aesthetic	sensual postmodern science	iconic architectural New Age	pragmatic new nonlinear organic	Universally reconstructed in the light of new ecological knowledge and transforming our consciousness of nature.
Eco-cultural	phenomenology cultural ecology	authentic harmonious typological	local low-tech commonplace vernacular	Learning to "dwell" through buildings adapted to local and bioregional physical and cultural characteristics.
Eco-medical	medical clinical ecology	healthy living caring	passive nontoxic natural tactile	A natural and tactile environment which ensures the health, well-being, and quality of life for individuals.
Eco-social	sociology social ecology	democratic home individual	flexible participatory appropriate locally managed	Reconciliation of individual and community in socially cohesive manner through decentralized "organic," nonhierarchical, and participatory communities.

Figure 17. The six competing logics of sustainable architecture.

14 Simon Guy and Graham Farmer, "Reinterpreting Sustainable Architecture: The Place of Technology," *Journal of Architectural Education* 54, no. 3 (January 2001): pp. 140-148, https://doi.org/10.1162/10464880152632451.

The six logics of green architecture define various approaches that are based on the viewpoints' image of space or the environment, leading source of environmental knowledge, perception of building, the technologies involved, and the viewpoint's concept of an idealized place for humans. This thesis accepts the differing perceptions of what 'green architecture' is conceived as, treating the concepts as relative rather than definitive. The thesis argues that an appropriate way to engage with our Earth's ecological systems is to find a place where humans coexist with nature rather than dominate it by minimizing the degradation of ecosystems caused by human culture, specifically architecture. Through an understanding of systemic ecology and metaphysical holism, hyper-ecological architecture is an approach for limiting the ecological footprints of buildings to ensure the stability and resilience of ecosystems are not compromised. It confronts the perception of buildings as isolated entities separate from the natural environment from which they extract resources, while reconciling people with nature for socially aware and responsible communities.

The thesis draws from the work of Architect and researcher Kiel Moe, whose research focuses on a more ecologically and architecturally ambitious approach to design. In his 2017 book, *Empire, State & Building*, he brings into conversation the otherwise externalized material geographies to reveal information on the efficacy and impact of the creation of architecture. His work presents architecture as a manifestation of interconnected energy systems and large scale cultural networks. This ideology is translated into the formation of a hyper-ecological architecture that views the building as influential beyond its physical boundaries. The architecture, conceived as an open system of energy and social exchanges, recognizes the influence of a building on the larger context.

As an architecture of an open system of energy exchanges, it acknowledges that the building is linked to multiple bio-geophysical flows of energy and intake supply chains of building matter that have social, political, and ecological ties elsewhere. Social exchanges highlight the influence of architecture within the community and the larger cultural context creating a widespread impact through awareness and exposure to nature through participatory programming. Recognizing the *social and energy exchanges* that are inherent, yet often

Figure 18. Artist Olafur Eliasson's Ice Watch conveys messages of climate change.

Figure 19. Artist Olafur Eliasson's Weather Project conveys messages of climate change.

overlooked in architecture, presents a methodology for sensitive inhabitation of the planet. As such, humans can find our place in nature where we operate within the limits of our ecosystems, rather than dominating them beyond their point of resilience.

For the conception of the thesis, hyper-ecological architecture is devised as a community-focused intervention within the city of Toronto to create awareness of our problematic relation to nature, and to present a holistic architectural methodology that is sensible and responsible in this climate crisis. This proposed hyper-ecological intervention will take a local perspective to its cultural, social and ecological location to generate a much needed discourse to enhance and empower the shifting paradigm toward an ecologically aware era.

An Architecture of Social Exchanges

An architecture that is conceived as an open system of social exchanges acknowledges the flow of knowledge that occurs through buildings. Smaller interventions at the building level, therefore, have the ability to inform wider social effects and influence culture. Late architect and educator Samuel Mockbee often discussed the choice between fortune or virtue, which he contended was a decision of value and principle. Repulsed by the idea of the architectural profession becoming entranced by consumer-driven commodification, and architecture that falls victim to corporate influence, he advocated for architects to embrace their position as leaders and teachers, “offering their ’subversive leadership’ for the shaping of environment, breaking up social complacency and challenging the power of status quo.”[15] If architects fail to observe and address the contemporary issues of rapid environmental degradation, questioning the role of both architects and architecture, they will continue to mimic and reproduce the existing environmentally destructive architectural practices. Architecture, as a manifestation of human culture, has the ability to express the perspectives, ideologies, and ambitions of humankind, influencing the future role of architecture.

15 Aalam, Iqbal. “Samuel Mockbee, Rural Studio.” Iqbal Aalam, September 8, 2013. https://iqbalaalam.wordpress.com/2013/09/08/samuel-mockbee-rural-studio/.

Architecture as an Educator

To many people living in urban contexts, the impact of a changing climate and environmental depredation is a distant concern separate from daily existence. Artist Olafur Eliasson, known for his installations on climate change topics, firmly believes that "we have a better ability to translate our critical enquiry into action once we have a physical relationship with the world." He says, "Bringing an experiential narrative to knowledge ... gives you a certain empowerment."[16] Timothy Morton writes that Eliasson's work such as *the Ice Watch* "emits time,"[17] as viewers physically interact with the ice forms that absorb their body heat, creating a serene atmosphere for contemplating climate change. A book review of Timothy Morton's *Being Ecological* by Jonathan Skinner affirms that art is the primary mode for ecological advice, helping us access the "uncanny valley into which we have put all the ambiguous lifeforms, neither entirely like us nor entirely different, opening rather onto a 'spectral plain.'"[18] He states that "In expanding our sense of beauty, we might expand democracy to include nonhumans."[19] The physical and material component of architecture provides opportunities to educate society by creating bodily experiences that are different from hearing stories or reading about the urgency of climate change and the need to protect our natural world. Architect Sean Lally, whose work focuses on humanity's manipulation of the environment, states that "the boundaries constructed within an environment influence behavior both directly, by physically interacting with the body, as well as culturally, through constructed social norms."[20] Immersive experiences formed through architecture can aid in mending the contemporary disconnect of the built context from the natural world. Architecture can generate awareness of our interconnectedness with the planet to form compassion within the community, that is otherwise disjointed in urban contexts.

16 Temujin Doran and Thomas Page, "Olafur Eliasson on What Art Can Do to Fight Climate Change," CNN (Cable News Network, August 29, 2019), https://www.cnn.com/style/article/olafur-eliasson-in-real-life/index.html.

17 Timothy Morton, *Being Ecological* (MIT Press, 2019), p. 79.

18 Jonathan Skinner, "The Serious Play of Being Ecological," The Ecological Society of America (John Wiley & Sons, Ltd, December 14, 2018), https://esajournals.onlinelibrary.wiley.com/doi/full/10.1002/bes2.1496.

19 Ibid.

20 Sean Lally, "The Shape of Energy," in *The Air from Other Planets: A Brief History of Architecture to Come* (Zürich: Lars Müller Publishers, 2014), p. 218.

Figure 20. Timber Connect pavilion by author provides shaded rest area and educates visitors on the carbon benefits of wood construction along a walking trail in the renaturalized site of Tommy Thompson Park, Toronto.

Architecture and Influence

As a facilitator of social exchanges, architecture encompasses the power to proactively assert virtues and design methodologies for buildings to operate sensibly within the planetary limits. The design and construction of architecture also provides an opportunity to educate the public on the influence of buildings on Earth's natural systems. Architecture can bring consciousness to our environmentally destructive architectural practices and our current understanding of interrelatedness within nature to foster a collective worldview by providing educational and immersive experiences. An architecture open to social exchanges strives to draw connections with nature, rather than separate from it, to instill an understanding within society that nature actively exists beyond neo-liberal capitalist purposes of social and material exploitation.

An Architecture of Energy Exchanges

It is anticipated that the building industry will add 230 billion square meters of new construction worldwide in the next 40 years.[21] Given the scale of impact of the building industry on the changing climate, the total energy of building construction must be considered in the design of all future architectures. Kiel Moe, in his book *Unless: The Seagram Building Construction Ecology*, examines the Seagram Building, the epitome of standardization, to critically assesses Modernism's lack of sensitivity to material ecologies and environmental loads, and conceptualizes energetics as a material, geological and ecological artifact. He declares that "Unless architects begin to describe buildings as terrestrial events, processes, and artifacts, architects will... continue to operate outside the key environmental and political dynamics of this century."[22] As opposed to the predominating energy discourses in contemporary practice, Moe states that the concept of 'net-zero energy' buildings is not only impossible to achieve, it also severely misguides architectural ambitions in technical, social, and formal ways.[23] Due to the energy exerted in material extraction and transport and labour associated with construction, demolition and decomposition, architecture cannot achieve a 'net-zero energy' design. He defines energetics of architecture as "not a linear balance of different quantities of energy. Instead [energetics] reflects a far more nuanced and dynamic sport of different quantities of different qualities of energy."[24] He notes:

> *"This is not a minor technical claim about energy: both the qualities and qualitative effects of energy have far-reaching consequences for architecture, from what we assume causes the appearance of buildings to how we construe the constitution of building and how, through design, we ultimately might best live together in this century."*[25]

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21 Anthony Pak, "Embodied Carbon: The Blindspot of the Buildings Industry," *Canadian Architect*, July 17, 2019, https://www.canadianarchitect.com/embodied-carbon-the-blindspot-of-the-buildings-industry/.

22 Kiel Moe, *Unless: The Seagram Building Construction Ecology* (Barcel: Actar, 2021).

23 Kiel Moe, "Not-Zero Energy," in *Embodied Energy and Design: Making Architecture between Metrics and Narratives*, ed. David N. Benjamin (New York, NY: Columbia University GSAPP, 2017), p. 142.

24 Ibid.

25 Ibid.

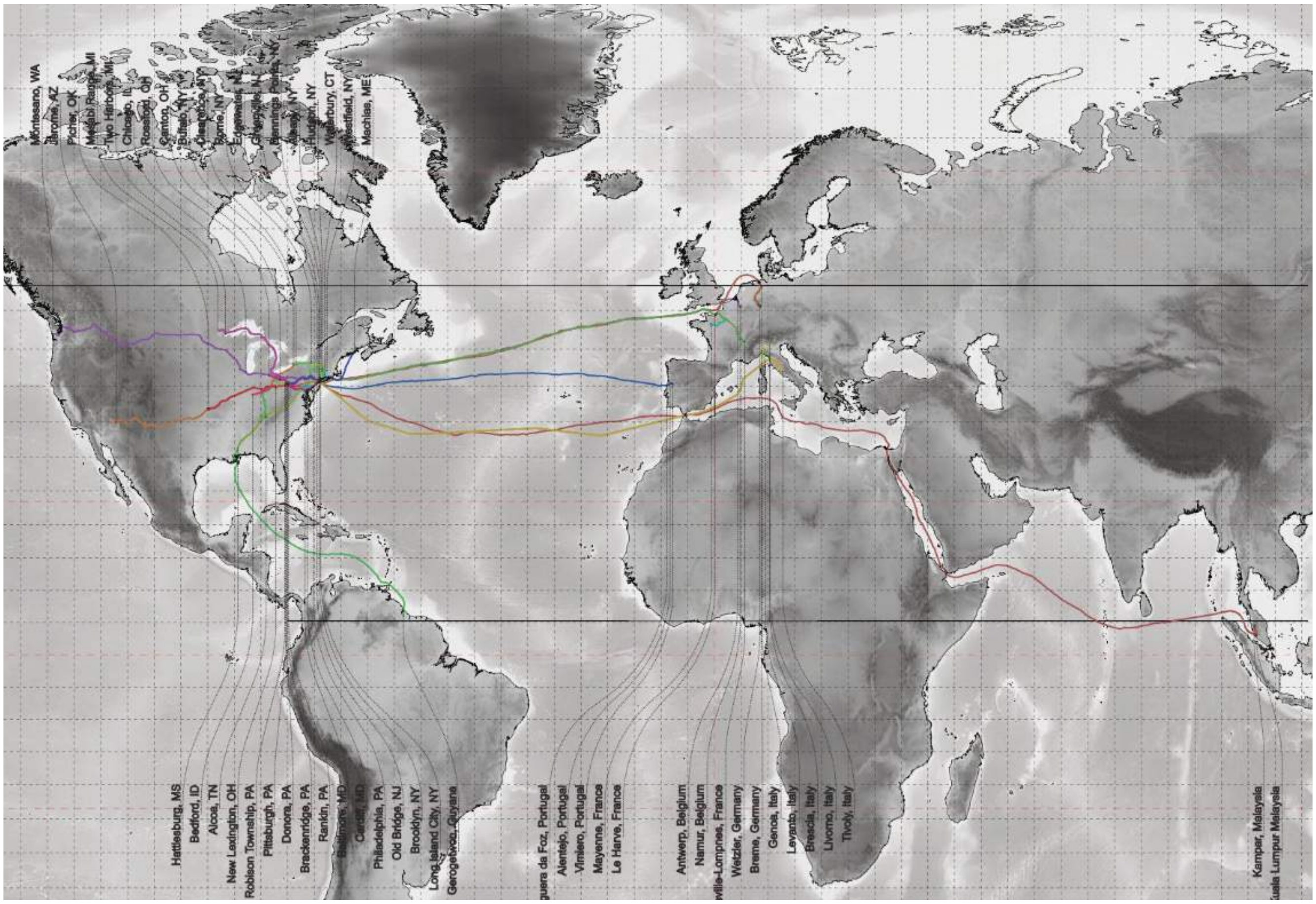

Figure 21. Kiel Moe tracks the global material geography of the Empire State Building.

To better understand architecture's capacities, flows of energy and matter must be considered inherent to design, including the effects of material extraction, embodied energy of materials, and material life-cycles. Understanding the qualities of energy will radically transform our understanding of energy in architecture. Moe states that energy in architecture is often associated with the consumption of fuel, which he declares as high-quality concentrations of energy.[26] These high-quality forms of energy are in short supply and, therefore, fuel efficiency concerns are prioritized in contemporary practice and transferred to architecture without considering energy.[27]

26 Kiel Moe, "Not-Zero Energy," in *Embodied Energy and Design: Making Architecture between Metrics and Narratives*, ed. David N. Benjamin (New York, NY: Columbia University GSAPP, 2017), p. 142.
27 Ibid, p. 143.

"Generally, around 80 percent of the systematic energy associated with a building is concerned with extraction and construction, manufacture and maintenance, demolition and decomposition; the remaining 20 percent is associated with lifetime operations like cooling and lighting."[28] By prioritizing low-quality and quantity heat transfer in building envelopes through high quality and high quantities of materials, the significant energetic qualities of the materials such as the common envelope are externalized.[29] Moe argues that the "high-quality energy required for the mitigation of low-quantity, low-quality heat transfer is ecologically inexplicable."[30] By considering the ecological complexities of construction materials, the architectural practice is required to challenge the perception of buildings as autonomous entities. It is crucial that architecture views materials not as isolated products but as a collection of energy that has roots elsewhere in the world, connected to other landscapes and ecosystems.

Building as Artifact

The rapid urbanization of the planet requires new models of building, or not-building, to limit our impact on the Earth's natural systems. Through an understanding of the various qualities of energy, specifically embodied energy, the act of resisting new constructions is identified as the most ecologically sensitive practice for current architecture. Viewing the existing built infrastructure as a material, geological and ecological artifact that is open to adaptation presents a methodology to limit demolition that contributes to construction waste and excessive energy exertion. However, modernity's readiness to deconstruct and rebuild, grounded on the idea of aesthetic consumption, has led to the perception that the old is inherently of lesser value than the new.[31] For this reason and others, the "Average life spans of buildings in the developed world are declining, to around 70 years in America and as few as 30 years in Japan."[32]

28 Thomas de Monchaux, "A New Idea in Architecture? No New Buildings," Metropolis, September 9, 2021, https://metropolismag.com/viewpoints/new-idea-architecture-no-new-buildings/.
29 Kiel Moe, "Not-Zero Energy," in *Embodied Energy and Design: Making Architecture between Metrics and Narratives*, ed. David N. Benjamin (New York, NY: Columbia University GSAPP, 2017), p. 142.
30 Ibid.
31 Sang Lee and Glen Hill, "The Aesthetics of Architectural Consumption," in *Aesthetics of Sustainable Architecture* (Rotterdam: 010 Publishers, 2011), pp.27.
32 Monchaux, "A New Idea in Architecture? No New Buildings," Metropolis, 2021.

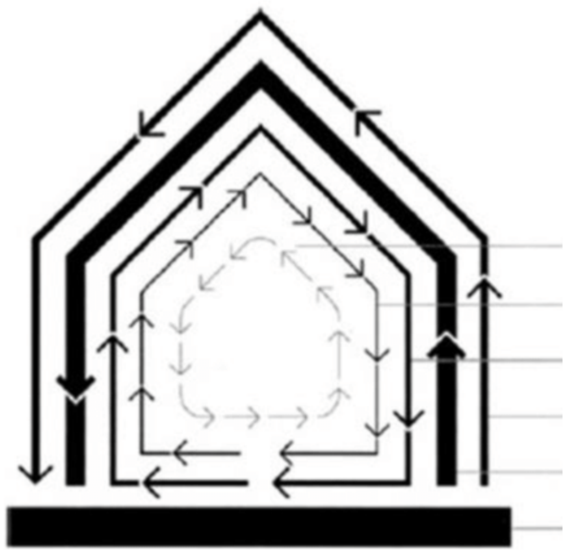

Figure 22. Shearing building layers of change.

For the concept of preservation to be adopted by contemporary architectural endeavours, society must accept repair as an intrinsic factor of architecture to maintain operation and extend the lifespan of buildings. Stewart Brand, in his book *How Buildings Learn*, notes that buildings are able to adapt to the evolving needs of users, challenging the proposition of architecture as fixed and incapable of change. He discusses the various lifespans and rates of change through the layers of a building, including site, skin, structure, services, space plan, and stuff.[33] The conceptual model views each layer to have a unique longevity that can be maintained and upgraded as required increasing the lifespan of the overall building. In this way, a building that is maintained to allow for years of continuous use is more ecologically responsible than a new construction that is replaced in a short span. While demolition is presented as an easy solution in modernity, it is irreversible, destroying large amounts of material resources.[34] The energy embodied in the built environment must be perceived as a critical resource to be preserved and utilized with care.

33 Stewart Brand, *How Buildings Learn: What Happens after They're Built* (London: Penguin Books, 2012).

34 "2021 Laureates Anne Lacaton and Jean-Philippe Vassal 2021 Laureates - Ceremony Acceptance Speech," The Pritzker Prize, 2021, http://www.pritzkerprize.cn/sites/default/files/inline-files/2021%20Pritzker%20Prize%20Media%20Kit.pdf.

Lacaton & Vassal - a French practice whose commitment to restorative architecture awarded them the 2021 Pritzker Prize believe that "any building can be transformed, reused:"[35]

> *"Transformation is the opportunity of doing more and better with what is already existing... The demolishing is a decision of easiness and short term. It is a waste of many things – a waste of energy, a waste of material, and a waste of history. Moreover, it has a very negative social impact. For us, it is an act of violence."*[36]

The existing built fabric has the potential to be re-envisioned, reinterpreted, and reorganized to create new spaces, opportunities and uses through the renewal of the architecture. With strategies of adaptive reuse and retrofit, projects can begin to occupy existing irreversible footprints and take advantage of the energy that is already embodied in the built environment. Working with the existing, by enhancing, extending, or retrofitting, as opposed to demolition and reconstruction, is a more ecological approach that minimizes environmental degradation through creative solutions. In the shifting paradigm, society must acknowledge the ecological benefits of adaptive reuse and the value of the existing built context, viewing it as an important resource for future constructions.

Material Reuse

The exhaustion of natural resources for the purpose of production and consumption, results in the excessive exertion of energy and fabrication of waste. The concept of extending the life of a building to use its embodied carbon as a resource can also be applied to materials and their life-cycle. In contemporary society, buildings are likely to be demolished or retrofitted within the span of fifty years, creating 548 million tons (497 million metric tonnes) of construction

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35 "2021 Laureates Anne Lacaton and Jean-Philippe Vassal 2021 Laureates - Ceremony Acceptance Speech," The Pritzker Prize, 2021, http://www.pritzkerprize.cn/sites/default/files/inline-files/2021%20Pritzker%20Prize%20Media%20Kit.pdf.

36 Tom Ravenscroft, "Anne Lacaton and Jean-Philippe Vassal Win Pritzker Architecture Prize," Dezeen, March 17, 2021, https://www.dezeen.com/2021/03/16/anne-lacaton-jean-philippe-vassal-pritzker-architecture-prize-2021/.

and demolition debris per year, in the U.S. alone.[37] Therefore, it is pertinent to maximize the longevity and lifespan of building materials. Considering the ecological complexities of materials, it is crucial that architecture views them not as disposable, isolated products, but as a valuable collection of energy. The circular economy model critiques the world's current mode of operation that is largely based on the linear 'take–make–dispose' processes. These processes exploit natural resources to create large quantities of cheap materials and energy. In the building industry, raw materials are extracted, transported, processed, assembled, used, and later demolished and disposed of in waste landfills. Instead, a circular economic system operates within the limits of Earth's natural systems. The Ellen MacArthur Foundation builds on William McDonough's 'cradle to cradle' concept to explore the principles of a circular economy based on closed loops and flows to maximize the value of materials and products at every stage of their life cycle.

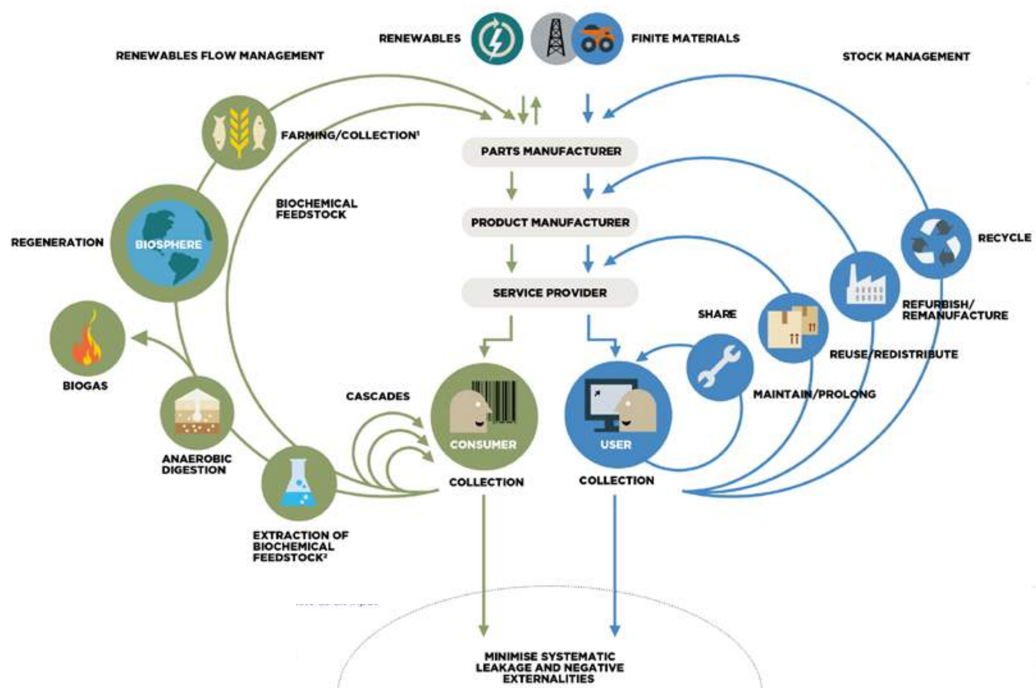


Figure 23. Ellen MacArthur Foundation's circular economy diagram based on Braungart & McDonough's 'Cradle to Cradle' separates materials for their management.

37 Caroline O'Donnell and Dillon Pranger, *The Architecture of Waste: Design for a Circular Economy* (New York, NY: Routledge, 2021), p. 192.

The circular economy system affirms that all materials have value beyond the traditional produce, use and dispose cycle. As a means to reduce waste, it considers each product or material as useful in regards to the technical or biological nutrients it contains and with careful re-purposing efforts, they can be brought back to usefulness. Where biological nutrients can be decomposed at the end of their life cycle, technical nutrients must be recycled to be used again. Specifically, the high-embodied energy materials such as steel and concrete that are left as artifacts in our natural environment - unable to degrade or decompose.[38] Building from construction 'waste' for a circular economy includes the reuse, repair, and recycling of materials, returning them to global energy flows and prolonging their use as much as possible. By harvesting components from demolition projects, and recovering, reusing and recycling materials,

Figure 24. Rural Studio's Glass Chapel reuses car windows salvaged from a scrap yard.

38 Elizabeth Fazzare, "After Architecture Believes Natural Waste Is the Future of Construction," Cultured Magazine, March 9, 2021, https://www.culturedmag.com/after-architecture-believes-natural-waste-is-the-future-of-construction/.

buildings can resist the energy exertion associated with virgin materials and divert construction waste. However, buildings in current practice are largely designed with formal aesthetics, paying little regard to material life cycle and deconstruction. Therefore, many building projects are not inclined to reuse waste materials. Future architecture must be designed and constructed with holistic ideas of circular economy and cradle to cradle. The reuse of building materials presents an ecologically sensible method for architecture, decreasing the environmental degradation associated with the extraction and production of virgin single-use materials, as well as the waste of valuable materials.

The reuse of materials also includes the transformation of unconventional materials into building components. New materials are rapidly emerging to reduce waste sent to landfills. These alternative materials are explored in the book *Building from Waste: Recovered Materials in Architecture and Construction*, by Dirk E. Hebel, Marta H. Wisniewska, and Felix Heisel. The book categorizes the materials according to the processes that convert the waste into products for construction: Densified, Reconfigured, Transformed, Designed, and Cultivated. Such materials are low in embodied energy as they are repurposed rather than extracted new.

Bio-Materials

Bio-Materials also offer new approaches to construction with their renewable and carbon-sequestering properties. For this reason, natural materials such as timber, straw, cork and hemp are steadily gaining popularity within the building construction industry in recent years. While traditionally deemed as low-tech materials, they have recently been realized as better performing in ecological terms than the conventional carbon-heavy alternatives when derived from local contexts. Natural materials are part of the biological cycle and therefore can be safely composted after end-of-life use. Cultivated from organic waste, Mycelium is a new material in this category. It is defined as a micro-element, not only is it renewable, but it is also self-growing. Natural, fast-growing, low-cost, and low-waste biodegradable materials have tremendous opportunities for the future of architecture to reduce the environmental impact inflicted by the act of building.

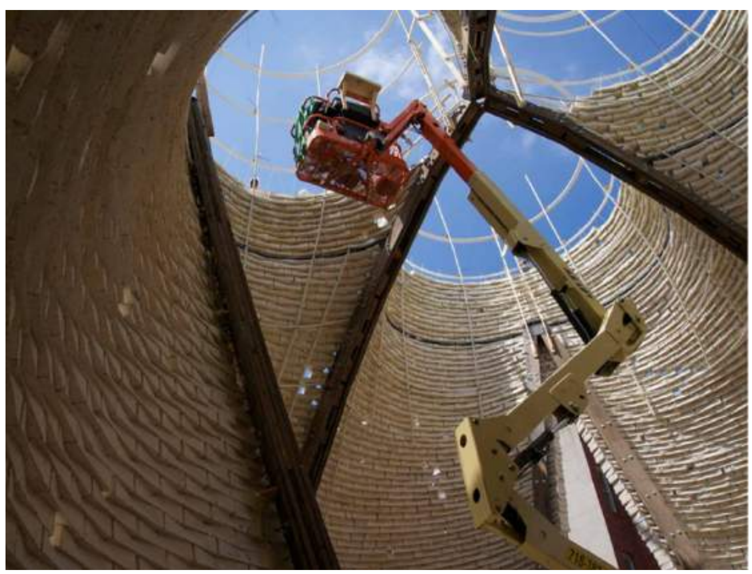


Figure 25. Hy-Fi pavilion is constructed with low energy mycellium bricks for hosting cultural events, after three months the structure was disassembled and composted.

Architecture and Energy

Buildings and their materials produce significant ecological footprint through the embodied energy associated with their extraction, production, transport, assembly and demolition. Additionally, the often externalized aspect of material extraction has social, cultural and health impacts and ecological repercussions on local cultures and economies. In the Anthropocene, a paradigm shift is required where architecture is conceived through an understanding of energy. Architecture must be envisioned as a collection of energy and must treat energy as an inherent consideration its conception rather than an afterthought. This would influence architects' decision to preserve existing high-embodied energy structures and select low-embodied energy or carbon-positive building materials. In order to adopt the ecologically sensitive design strategies of adaptive reuse, waste materials, and natural materials, society must shift from formal to moral aesthetics derived from an understanding of energy. Viewing architecture and materials as a part of larger energy systems will require the reconsideration of traditional design. More urgently, it will require a change in the behaviour of designers, architects, and society, where existing structures and unorthodox materials are viewed as a valuable resource, providing unique opportunities for architects to re-imagine the aesthetics, functionality and assembly of buildings and their components. Architecture must embrace this methodology to catalyze a cultural shift towards an ecologically aware and responsible era.

CASE STUDY

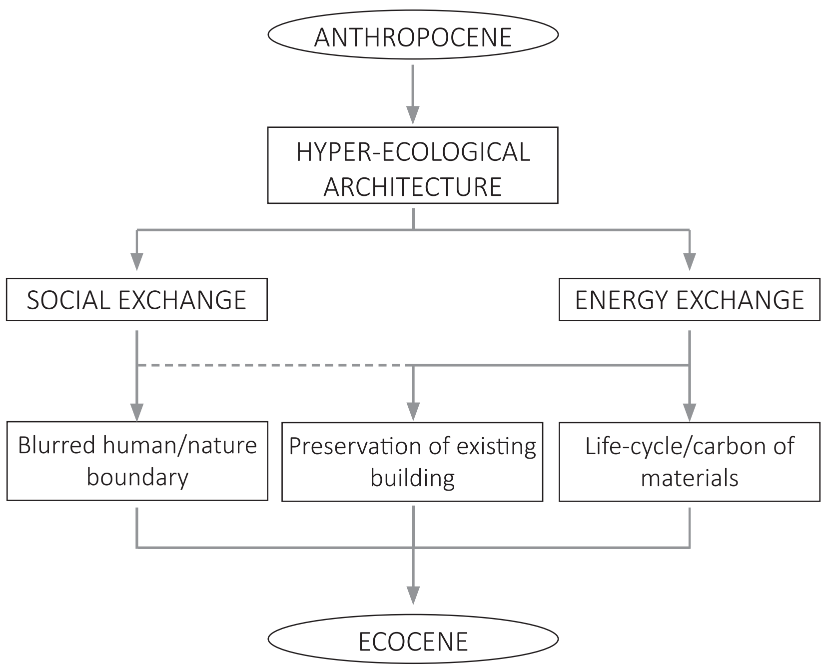


Figure 26. Investigating a methodology for a shift towards an Ecocene.

Methodology for a Hyper-Ecological Architecture

The selected architectural case studies represent the urgent reconsideration of contemporary design required to operate in an ecologically sensible manner. The following projects demonstrate a more ethical and conscientious approach to the act of building. The case studies explore the interlinked energy and social exchanges through a blurred human/nature boundary of separation, the preservation of existing built structures and consideration of the entire material life-cycle. The case study investigation informs the formation of a hyper-ecological architecture.

Urban spaces that integrate the natural environment and provide people with immersive experiences increase compassion toward the natural environment. The case studies showcasing ‘human-nature-connect’ create a social and cultural link between the public and ecology, embedding ecological topics into the urban fabric.

A holistic understanding of energy exchanges views the built infrastructure as a material artifact open to adaptation. Through layered interventions, the ‘conserve-maintain-enhance’ projects highlight the capabilities of existing structures and exemplify how minimal interventions can radically change their usability and performance.

Energy exchanges also consider the ethical sourcing of materials. Projects exploring ‘materials-carbon-unorthodox’ go beyond formal aesthetic conventions of modernism through alternative material applications to meet the standards of twenty-first century ecological design.

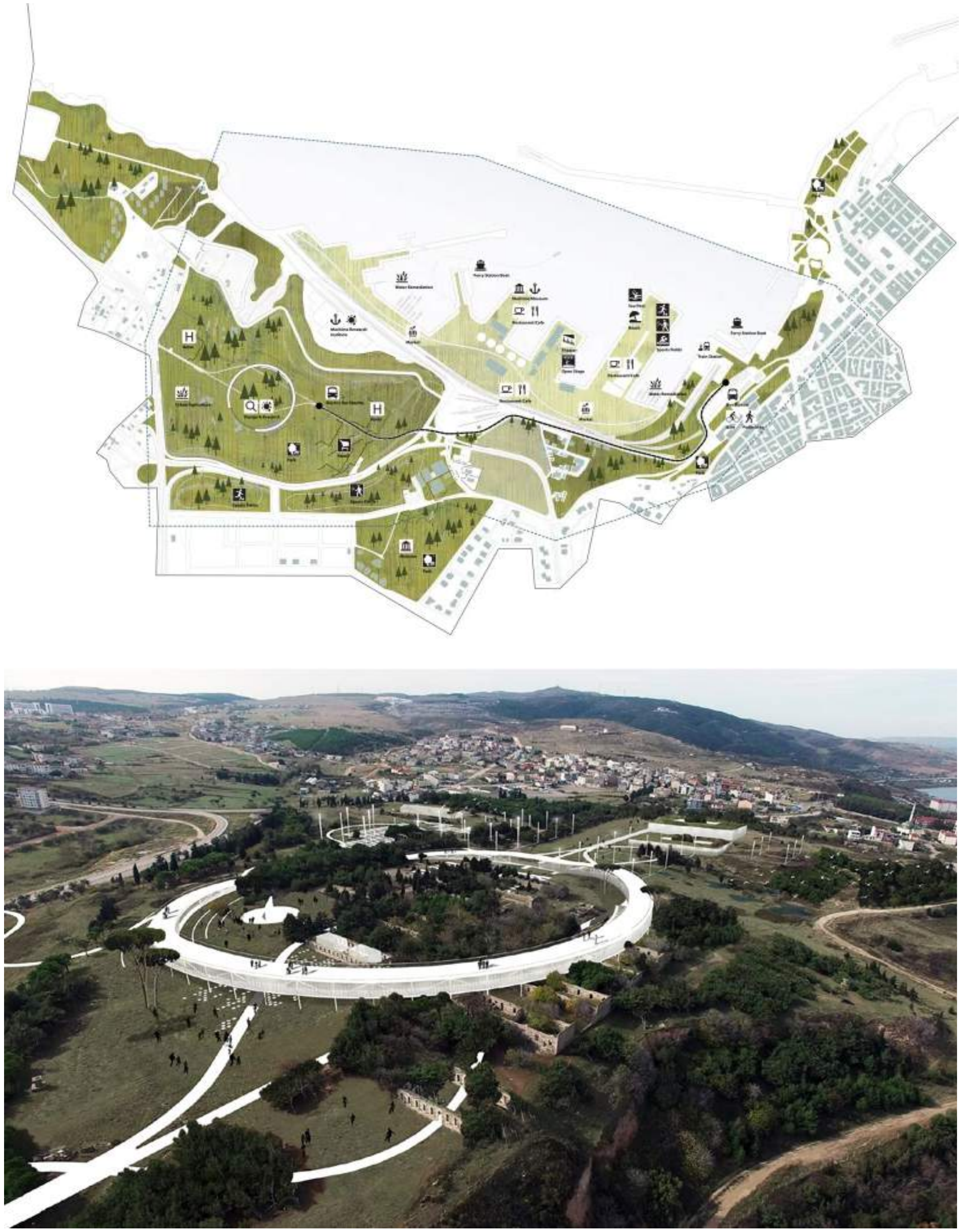


Figure 27. The Ecologically-Driven Research Park features ecological and educational programming in Bandirma, Turkey.

Human - Nature - Connect

Bandrima Park - Openact Architecture

In a period of rapid climate change, it is integral that humans view themselves as a part of nature rather than separate from it. Park design presents the opportunity to amend the perceived separation between humans and nature by providing communities with a platform for immersive and educational experiences in the natural environment. Such experiences aid in generating an awareness of the interconnectedness of our planet. Emulating ideas of urban collectivity and coexistence by authors such as Naess and Morton, Openact's Bandirma Park competition proposal acknowledges that humans are a part of a larger network that is intertwined with nature.

The project proposes the revitalization a former military and industrial brown field that preserves the site ecological character. The project intends to foster connections, allowing the park to be a network "between people, ecology and the territorial surroundings."[1] The park includes outdoor educational programming, ecology and the community to create awareness of contemporary environmental concerns. The design envisions a diverse combination of ecological, infrastructural and urban programs defined as "open, interactive, and collective for the exchange of ideas between the variety of users on the site such as public visitors and professional researchers.[2] A key design feature is the promenade that "contains, connects, links, separates, orients, articulates, access, and displays…[around the site as required]"[3] Openact's design of Bandirma park becomes an educational tool for the community, informing the public on the process of the natural environment and human interconnectedness within it.

1 "Openact Architecture · Bandirma Design Park: Winner," Divisare, accessed January 19, 2022, https://divisare.com/projects/339213-openact-architecture-bandirma-design-park-winner.

2 Osman Bari, "Openact Architecture Envisages Ecologically-Driven Research Park as Bandirma's Future Hub," ArchDaily (ArchDaily, March 11, 2017), https://www.archdaily.com/806835/openact-architecture-envisages-ecologically-driven-research-park-as-bandirmas-future-hub?ad_medium=bookmark-recommendation&ad_name=iframe-modal.

3 Ibid.

The Highline - Diller Scofidio + Renfro & James Corner Field Operations

The High Line exemplifies the reclamation of urban space by transforming an abandoned elevated railroad into a public park in Manhattan. The park addresses the preservation and adaptive reuse of existing urban infrastructures and the reclamation of public space in an urban context that becomes a platform for connecting humans to nature. The project takes inspiration from the re-naturalization process that occurred after the railroad was left to ruins - using the found architecture to create a variety of site-specific urban micro-climates.[4] Nature is encouraged to grow in an emergent manner and the public is able to explore the park in unscripted ways due to the open and flexible programming of the park.[5] This enables people and nature to coexist fluidly within the park, providing freedom of movement for both entities and encouraging engagement between the two in a dense urban context.

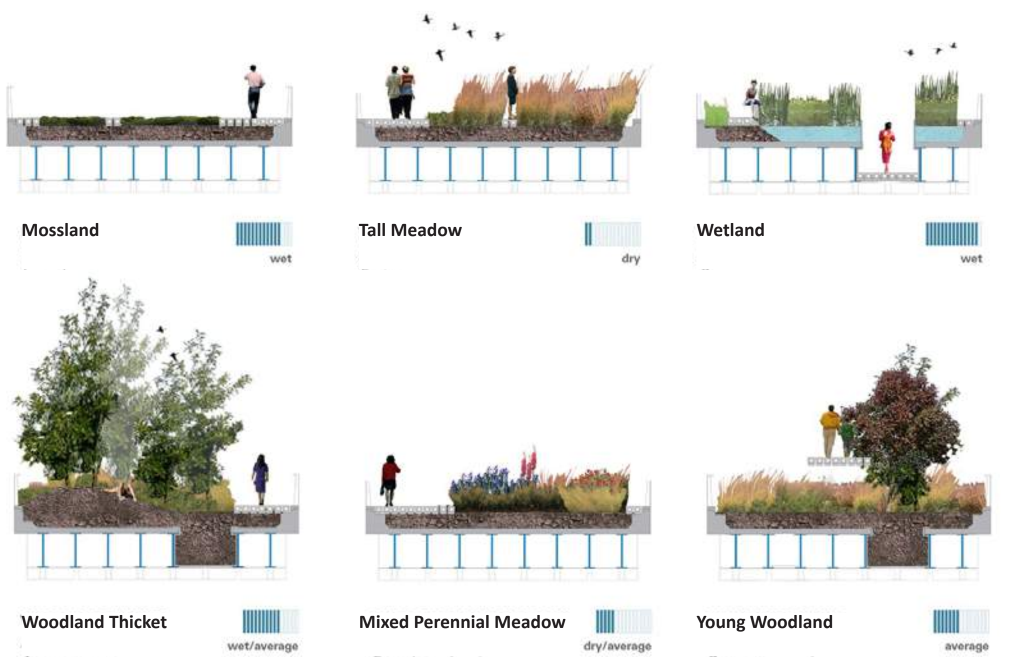


Figure 28. The Highline features site-specific ecological landscapes in New York.

4 "The High Line," DS+R (Diller Scofidio + Renfro), accessed January 18, 2022, https://dsrny.com/project/the-high-line.

5 Ibid.

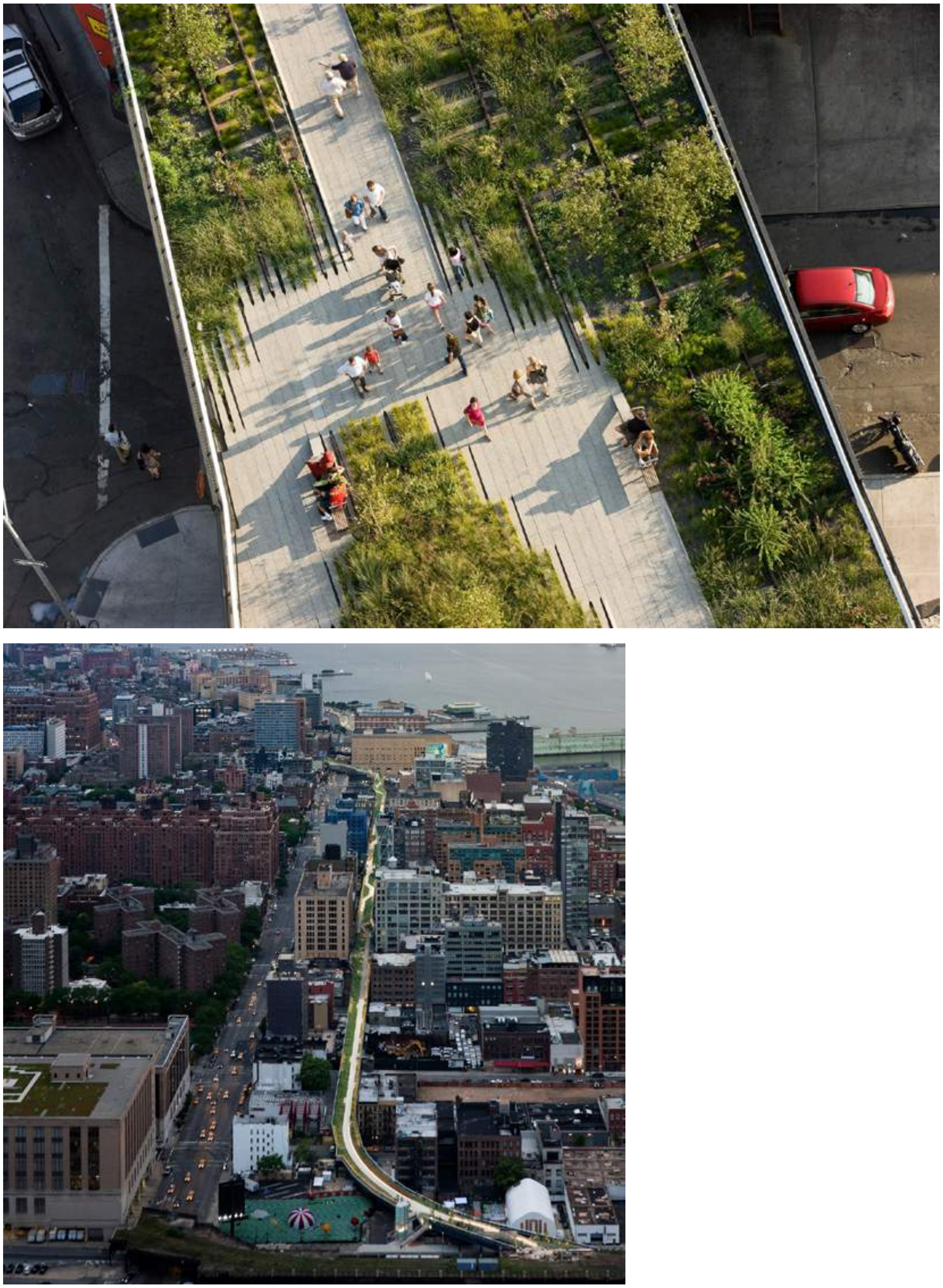


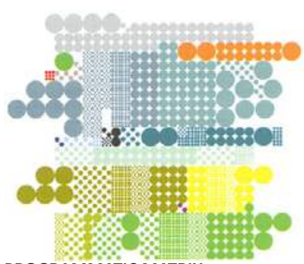
Figure 29. The Highline's ecological landscape is a product human culture.

Figure 30. OMA's Tree City proposal responds to the needs of the community.

Figure 31. OMA's Tree City proposal features flexible programming to evolve over time.

Tree City - Office of Metropolitan Architecture & Bruce Mau Design

'Tree City' was a winning Downsview Park Toronto Competition entry for an urban recreational green space on the site of a former military base. While many entries presented elaborate schemes to transform the landscape, OMA proposed a flexible conceptual strategy that would guide the evolution of the park over time.[6] The architects presented guidelines for the park design to occur over three long term phases: site and soil preparation, pathway construction, and cluster landscaping.[7] "Tree City treats the park as if it is an adult soon capable of sustaining itself rather than a child in need of eternal care."[8] For this reason, they proposed a formula of "grow the park + manufacture nature + curate culture + 1,000 pathways + destination and dispersal + sacrifice and safe = low-density metropolitan life"[9] rather than an extensive and fixed design. Their flexibility model allows for different programs to occur in the park as required by users, incorporating political, economic and vegetation changes into the planning framework. In this way, recreational and cultural demands of the site can be met as needed by the site over several years. The design features a patchwork of clusters accommodating various activities without specifying programs in addition to meadows, playing fields and gardens.[10] One of the key consideration of the design is the '1000 pathways' that were proposed to connect the clusters providing users with an multitude of experiences and access points to the site- weaving the park into its surrounding urban context.



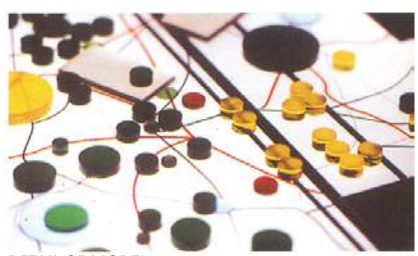


Figure 32. OMA's Tree City proposal diagrams program clusters and connections.

6 Marco Polo, "Environment as Proccess," *Canadian Architect,* October 2000, pp. 14-19.
7 "Downsview Park," OMA, accessed January 19, 2022, https://www.oma.com/projects/downsview-park.
8 Ibid.
9 Polo, "Environment as Proccess."
10 "Downsview Park," OMA.

Conserve - Maintain - Enhance

Transformation of 530 Dwellings - Lacaton and Vassal

Starting with the existing built context plays a significant role when operating within the limits of Earth's natural systems. While renovations increase resource consumption in the short term, the overall energy consumption is decreased over the lifespan of the building by increasing energy efficiency. Additionally, such projects reduce waste and the large amounts of energy associated with demolition and new construction. Architects Lacaton and Vassal advocate this architectural approach with a belief that such interventions can improve the lives of many, while responding to the climatic and ecological emergencies of our time.[11] Their 2016 transformation of 530 Dwellings in Bordeaux, France, is an influential project for its "sensitivity towards understanding existing structures, highlight[ing] how with minimal interventions, radical changes can be made to the habitability and usability of a modernist building."[12] The most notable transformation of the project was the addition of winter gardens and balconies to the facade of the building through large sliding glass doors. This resulted in more space for residents in the form of gardens and increased the natural lighting and connection to outdoors, improving the comfort and pleasure of the existing structure without resorting to its demolition.

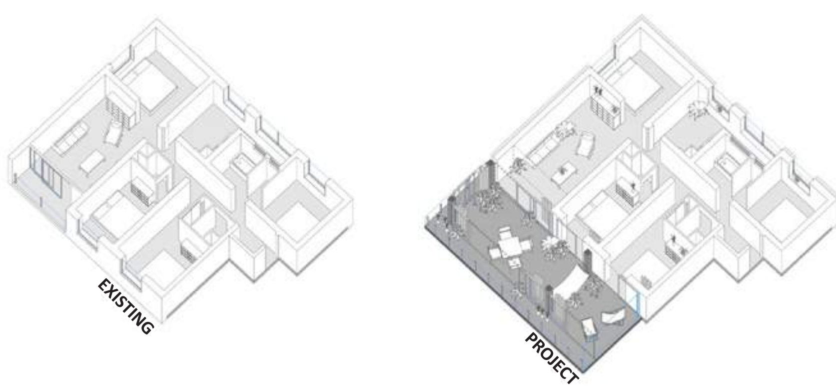


Figure 33. Lacaton and Vassal's Transformation of 530 Dwellings, in Bordeaux, France.

11 Tom Ravenscroft, "Anne Lacaton and Jean-Philippe Vassal Win Pritzker Architecture Prize," Dezeen, March 17, 2021, https://www.dezeen.com/2021/03/16/anne-lacaton-jean-philippe-vassal-pritzker-architecture-prize-2021/.

12 Diego Hernández, "Lacaton & Vassal's Transformation of 530 Dwellings through the Lens of Laurian Ghinitoiu," ArchDaily (ArchDaily, March 17, 2021), https://www.archdaily.com/958572/lacaton-and-vassals-transformation-of-530-dwellings-through-the-lens-of-laurian-ghinitoiu.

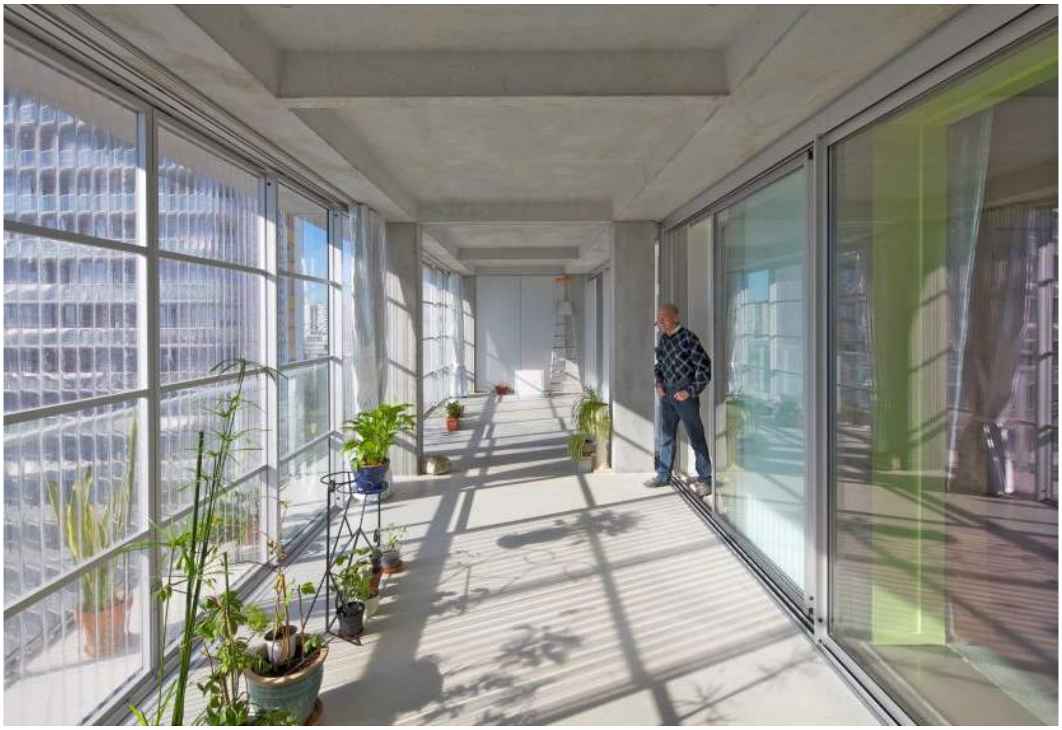


Figure 34. Lacaton and Vassal's transformation improves the livability and performance of the exiting building through minimal interventions.

National Arts Centre Rejuvenation - Diamond Schmitt Architects

Retrofit and renovations update the building to keep pace with the demands of users as well as the site. Informed by the past and looking towards a more integrated future for the building, the rejuvenation of the National Arts Center by Diamond Schmitt Architects transforms the existing fortress-like mass of the brutalist structure to accommodate the need for inclusivity, transparency, and connectivity within the community.[13] A glazed tower is designed to re-orient the building towards the city with a new entrance that caters to pedestrians rather than cars, activating the public realm around the urban site.[14] The rejuvenation provides a break in the heavy dark mass of the original building to create a "welcoming presence to the city that connects and engages the public by revealing the activity within."[15] The addition extends the overall lifespan of the building by accommodating for updated needs of the site and community through additions and transformations that preserve the existing structure.

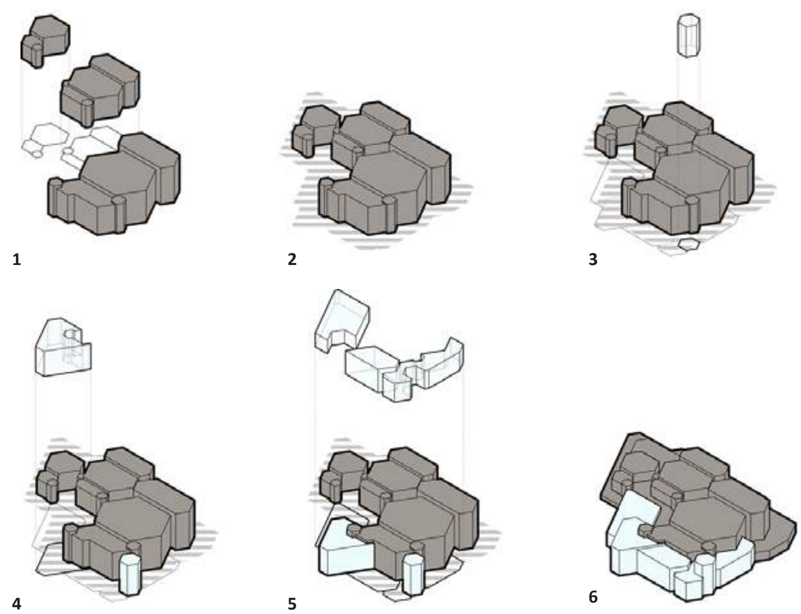


Figure 35. National Arts Centre additions in Ottawa, Ontario.

13 "National Arts Centre Rejuvenation," Diamond Schmitt, November 26, 2021, https://dsai.ca/projects/national-arts-centre-rejuvenation/.

14 Ibid.

15 Andreas Luco, "National Arts Centre Rejuvenation / Diamond Schmitt Architects," ArchDaily (ArchDaily, April 9, 2021), https://www.archdaily.com/959751/national-arts-centre-rejuvenation-diamond-schmitt-architects.

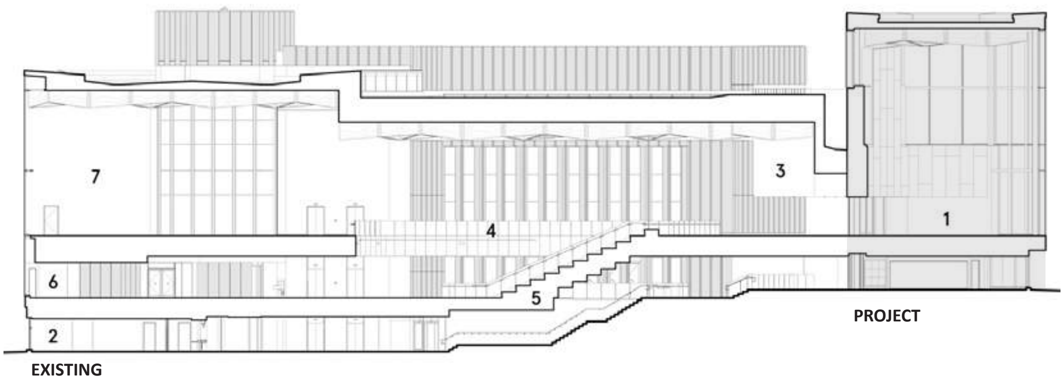


Figure 36. The National Arts Centre renovation converts the brutalist structure into a welcoming presence and orients the building to the pedestrians.

Materials - Carbon - Unorthodox

Urban Mining & Recycling Unit - Werner Sobek, Dirk E. Hebel & Felix Heise

As discussed in the previous chapter, materials play a significant role in architecture's contribution to environmental degradation through the energy associated with their extraction, production, transport, assembly and demolition. Circular economy practices present an alternative to society's current mode of operation that is based on the production, consumption and disposal of valuable energy intensive materials. The Urban Mining & Recycling Unit (UMAR) in Switzerland is designed through considerations of "Temporary removal and borrowing instead of permanent acquisition and disposal, maximal modularization and prefabrication, and the potential for all materials to be recycled, reused or repurposed]."[16] As such, materials extracted from other buildings are reused while retaining their original qualities. Also, the materials can be extracted cleanly [after useful life], separated out and sorted [to be recycled, reused or repurposed]."[17] This approach makes the most of the

Figure 37. Urban Mining & Recycling Unit features circular design principles.

16 "Urban Mining & Recycling," Empa Materials Science and Technology, accessed October 28, 2021, https://www.empa.ch/web/nest/urban-mining.

17 Ibid.

Figure 38. Urban Mining & Recycling Unit features modular design and re-purposed experimental materials.

embodied energy invested in the extraction and production of the material and reduces the energy required for new building components. Some innovative material applications employed in the project include waste-grown mushroom mycelium, re-purposed copper sheets, recycled bricks, re-purposed insulation materials, reused door levers, and reused carpeting. All joinery is designed to be reversible, and after use, the materials can be separated into their respective material cycles without leaving behind any residue or waste. For this reason, adhesive joints are not used in favour of plug-and-socket or screw joints. In this way, the project anticipates changes to occur, accommodating the deconstruction of the building components to reduce the waste creation caused by demolition practices. The building is also designed as a prefabricated modular system, which not only reduces construction time and labour and site, but also ensures that materials are precisely planned for a circular economy. The Urban Mining and Recycling Unit is envisioned as a laboratory and a public repository of information, serving as a model example and a source of inspiration for building design and construction[18]

18 Caroline O'Donnell and Dillon Pranger, *The Architecture of Waste: Design for a Circular Economy* (New York, NY: Routledge, 2021), pp. 200.

Wood Innovation Design Centre - Micheal Green Architecture

While carbon-intensive materials such as steel and concrete have dominated the construction industry for decades, the world's oldest building material wood, presents various ecological benefits in construction. As theorized by Marc-Antoine Laugier, the primitive hut highlights the opportunities of natural, local materials for the construction of new architectures in contemporary practice. Due to its carbon-sequestering properties, wood construction is brought to the forefront of climate-positive discourse. Wood is a renewable resource when managed through responsible forestry practices. Its carbon-sequestering abilities allow it to capture and stores carbon dioxide from the atmosphere throughout its life cycle. Therefore, when used in the construction of buildings, it presents a method for reducing atmospheric carbon dioxide. At the time of its completion in 2014, the eight-storey Wood Innovation Design Centre by Michael Green Architecture in British Columbia was the tallest wood building in the world, hosting researchers and design professionals for generating ideas

Figure 39. The Wood Innovation Design Centre features an innovative timber post-and-beam structure.


Figure 40. The Wood Innovation Design Centre is eight storeys tall.

on the future of wood. The centre highlights wood's aesthetic and structural capabilities and expresses the flexibility and adaptability of the material. The post and beam structure allows for the change of programming to suit future users. "The building is made exclusively of dry construction, without the addition of concrete and wet materials, allowing the wooden components to be dismantled and reused at the end of the building life.[19] And "because a timber building weighs 20% of a concrete building, the gravitational load is vastly reduced"[20] This means that the building requires minimal foundations, eliminating the need for massive amounts of carbon-intensive concrete foundations in the ground. Wood buildings' climate-positive qualities engage with the larger systems of ecology, and anticipate future change and adaptability of structures for user requirements to prevent demolition and toxic waste accumulation. Thus, wood construction presents a viable option for future architecture projects.

19 Tim Smedley, "Could Wooden Buildings Be a Solution to Climate Change?," BBC Future (BBC, July 24, 2019), https://www.bbc.com/future/article/20190717-climate-change-wooden-architecture-concrete-global-warming..

20 Ibid.

Stock Orchard Street - Sarah Wrigglesworth and Jeremy Till

The standard material practice of contemporary architecture involving steel, aluminum, and concrete is associated with significant amounts of embodied energy and carbon dioxide emissions. The contemporary paradigm requires the very nature of materials to be questioned. Architects Sarah Wigglesworth and Jeremy Till's 2004 home in London called Stock Orchard Street is a testbed for unusual materials. The project includes multiple unconventional materials such as straw, railway sleepers, and newspapers and features facades constructed of quilting, sandbags and straw bale, bringing an intriguing perspective to the role of aesthetics in architecture. In Edward Winters' book *Architectural Aesthetics*, he writes that Stock Orchard Street is an example of a work of architecture that establishes an aesthetic by instantiating a moral view.[21] He continues to add that the house "takes the political and moral strand of energy and makes a work of architecture in which we find aesthetic pleasure."[22] The materials are carefully selected due to their low embodied energy. "We wanted to make a building that was made out of things that were easy for people to learn to build with" state the architects, highlighting the didactic and informative aspect of the project.[23]

The environmental features of this project are not last-minute add-ons. Instead, the materials and their properties are an inherent consideration in the design process. The article *Is this the most influential house in a generation?* in the Architect's Journal concludes that Stock Orchard Street has instigated a debate about the use of resources and aesthetics in current architecture and set out a new architectural language that is transparent and 'absolutely legible.[24] Through the unorthodox materials and language of the house, Stock Orchard Street generates a needed discourse on building materials by questioning the role of aesthetics in future architecture.

21 Sang Lee and Glen Hill, "The Aesthetics of Architectural Consumption," in *Aesthetics of Sustainable Architecture* (Rotterdam: 010 Publishers, 2011), 26.
22 Ibid.
23 "Interview: Sarah Wigglesworth," The Architectural League of New York, accessed November 4, 2021, https://archleague.org/article/interview-sarah-wigglesworth/?printpage=true.
24 Hattie Hartman, "Is This the Most Influential House in a Generation?," The Architects' Journal, January 11, 2021, https://www.architectsjournal.co.uk/buildings/is-this-the-most-influential-house-in-a-generation.

Figure 41. Stock Orchard Street features an unconventional material aesthetic.

Figure 42. Stock Orchard Street features a sandbag wall, gabion wall and quilted wall.

THE SETTING

Figure 43. Site photos showcase brutalist architecture style with expressed concrete, and user connection to site from within building though view oriented openings, 2021.

A Vehicle for Design

A hyper-ecological intervention at the Ontario Science Centre, located within Flemingdon and Thorncliffe Park, transforms the building to fit its current social, cultural and ecological context. The project aims to maximize the potential of the existing building and site, making the project a prototype for the further densification of the growing city. The design focuses on reinforcing the natural infrastructure and conserving the existing Brutalist structure to transform it into a twenty-first century environmental centre based on energy and social exchanges.

The Ontario Science Centre's location within the Don River's floodplain is a key consideration for the intervention. The protection of at-risk natural infrastructure is facilitated through ecological awareness and participatory programming. The design project proposes the reclamation of the Centre's underutilized hardscapes for the creation of an extended public realm that supports the watershed capacity of the site. Roofs and parking lots are converted to better connect the building and community to the ecological context. The project preserves the existing high-embodied energy structure, introducing new public and private programs through superimposed layers onto the existing structure. The transformation of the Centre expands the use of the site from a specific demographic and visitor group to integrate researchers and the adjacent community members of Thorncliffe and Flemingdon Park in its planning. In doing so, the existing high-embodied energy structure is 'conserved, maintained and enhanced' to demonstrate its value and bring a new consciousness to the existing infrastructure. The additions are designed through an understanding of energy, considering the energy associated with the extraction, production and transport of materials, as well as the energy associated with the performance of uninsulated concrete buildings. In this way, the project starkly contrasts performance-energy-based architecture. The design becomes a visual and participatory methodology and expands the social and ecological role of the Ontario Science Centre within its context.

Figure 44: Map of Toronto's hidden ravine network.

Figure 45: Toronto's Don River.

Toronto Ravines

Toronto's extensive ravine network plays a key role in the ecological health of the city. The city of Toronto, with an area cover of 630 square kilometres and a population of 2.9 million (based on 2018 figures), is often labelled as "a city within a park" with an extensive ravine network.[1] In their natural state, the ravines contribute greatly to the ecological health of the city, providing carbon dioxide absorption, cooling relief from the heat island effect, as well as watershed during rainfall. Toronto cannot be examined separately from its ravines. The selected site is located along the Don River- its significance can be understood through its geologic, Indigenous, settler, and contemporary urban history. Toronto's ravine network was formed through geologic transformations that occurred when two glaciers split; they retreated to reveal a sandy ground that eroded to form deep channels with flora and fauna.[2] Several ravines emerged, the larger ones being the Humber, Don, and Rouge, which defined the contemporary landscape of Toronto. The Don River watershed became home to indigenous groups 7,000 years ago where Wendat longhouse villages developed.[3] The river was the main route connecting to Lake Ontario, while also facilitating trade, fishing and harvesting. In 1787, the problematic "Toronto Purchase" forced the Mississaugas occupying the land to surrender its rights to the British.[4] In 1795, industrialization of the land began with factories using the river to power their plants.[5] Later in the 1800s, rails for the Canadian Pacific Railway were built, along with the Brick Works. The following 200 years brought intense urbanization to Toronto, leading to the degradation of ecology of the Don River. Today, the expansion of development has led to an abundance of hard paved surfaces that instigate flooding and erosion of the river banks during weather events, which are occurring with more force and more frequently within the current period of climate change.

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1 City of Toronto, "Toronto at a Glance," City of Toronto, July 29, 2020, https://www.toronto.ca/city-government/data-research-maps/toronto-at-a-glance/.

2 Leyland Cecco, "'There's No Major City like It': Toronto's Unique Ravine System under Threat," The Guardian (Guardian News and Media, December 21, 2018), https://www.theguardian.com/cities/2018/dec/21/theres-no-major-city-like-it-toronto-unique-ravine-system-under-threat.

3 "History," The Don River Valley Park, accessed August 21, 2021, https://donrivervalleypark.ca/about-the-park/history/.

4 Ibid.

5 Ibid.

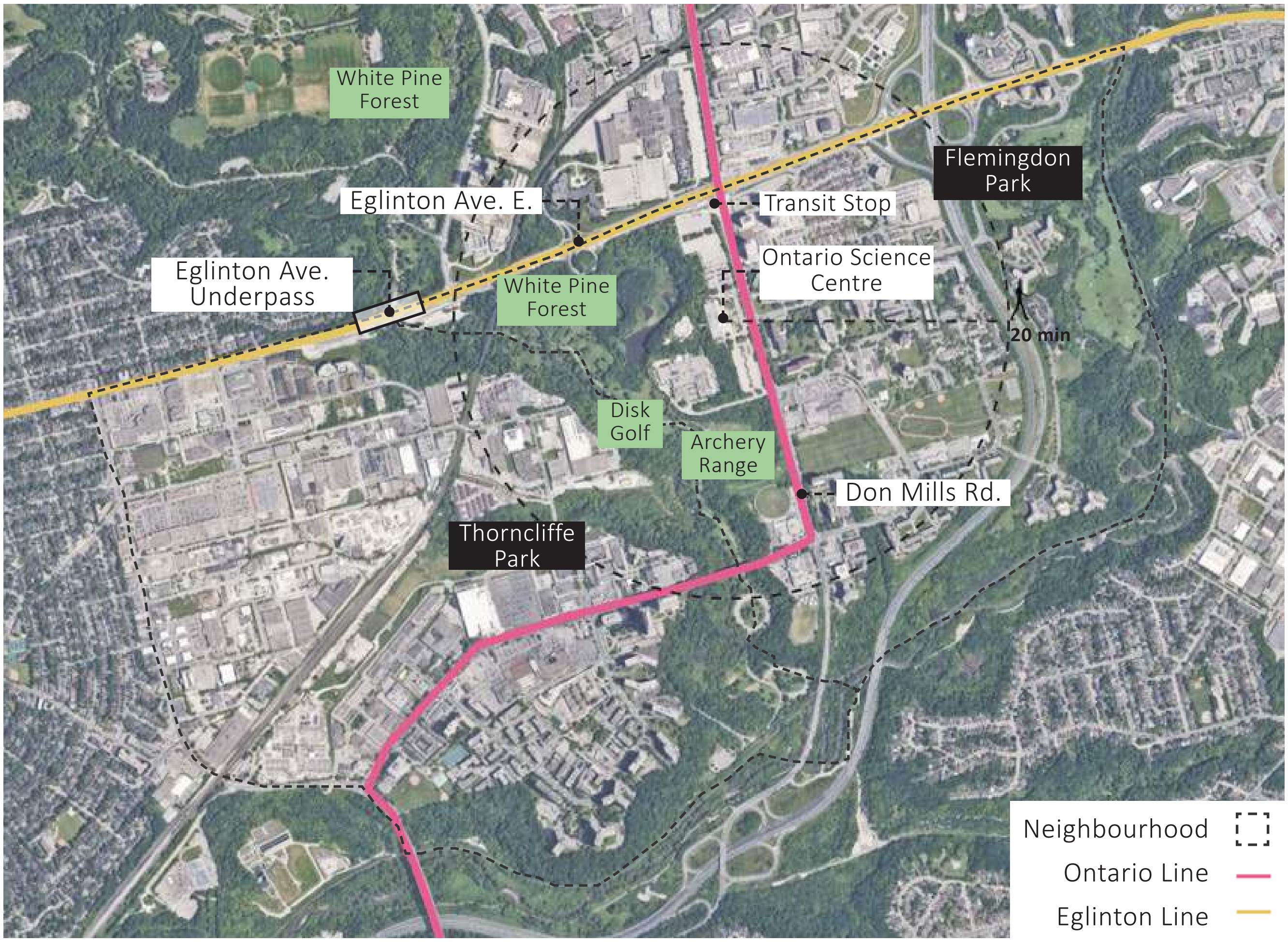


Figure 46: Context plan of ravine surrounding Don River and Thorncliffe and Flemingdon Park neighbourhoods.

The Ontario Science Centre, a public building located along the Don River presents the opportunity to apply the concepts of the thesis and create a threshold for the public to access the ravine network. Located between Flemingdon and Thorncliffe Park the natural site within an urban context is a critical aspect of the two 'tower neighbourhoods', providing much needed space for recreation. With the anticipated densification and the growing interest of the public in green spaces post Covid-19 pandemic, the site of the Ontario Science Centre becomes an intriguing opportunity to educate the public on the natural environment and ecology of Toronto and provide an integrated social and ecological infrastructure for the two neighbourhoods, as well as the citizens of Toronto.

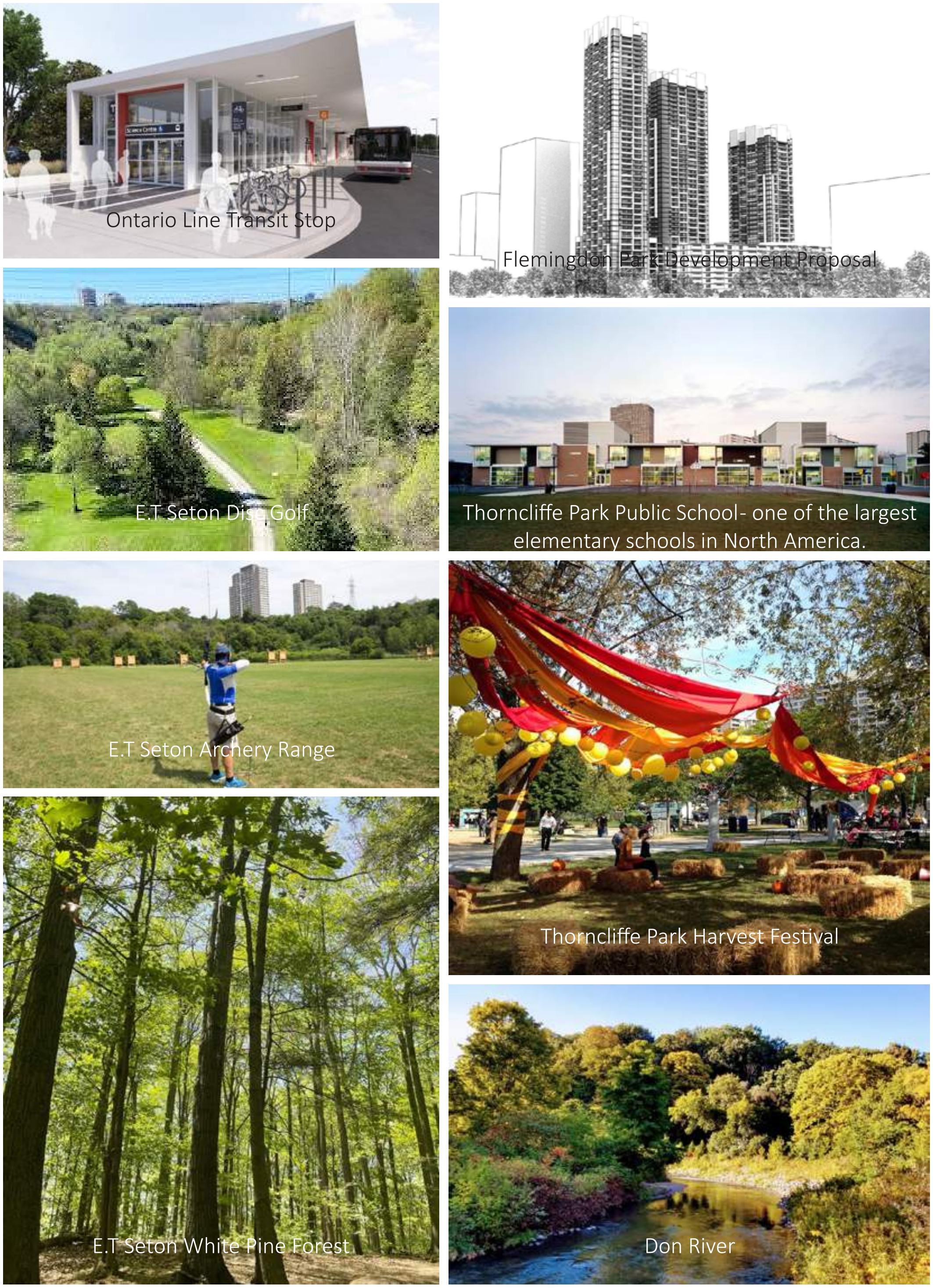


Figure 47: Context images highlight the development proposals, the recreational aspect of the ravine, the cultural profile of the neighbourhoods, and the wild ravine.

Flemingdon and Thorncliffe Park

Flemingdon Park was the first privately developed apartment complex in North America, countering suburban sprawl through the creation of a 'tower in the park' living near Toronto's first post-World War II suburb of Don Mills.[6] The ambitious development was planned with the intention of creating a 'complete community' lifestyle that included a wide range of building types to accommodate middle-class residents.[7] Adjacent to Flemingdon Park, Thorncliffe Park was developed with similar intentions.

Today, Flemingdon and Thorncliffe park have become impoverished neighbourhoods due to a lack of investment and a disconnected public realm as many of the original master plan's objectives remain unrealized.[8] The shifting preference for mixed-use and walkable neighbourhoods led to a change of residents. The two neighbourhoods now largely host low-income groups of various cultural backgrounds and are prominent areas for immigrants to settle. Immigrant populations are often unfamiliar with the Canadian wilderness, unaware of how the rich natural infrastructure can be utilized sensitively for recreational purposes.

The rapidly increasing population of Toronto suggests the neighbourhoods will face further growth and development within the next decades. The city is in the process of creating connections to the site via the Eglinton Crosstown light rail line as well as the Ontario Line Subway to aid the area's progress. As a result, Flemingdon Park has attracted various development proposals that intend to densify the area's urban form along Don Mills Road.[9]

6 "Flemingdon Park: North America's First High-Rise Newtown," Tower Renewal Partnership, January 25, 2008, http://towerrenewal.com/built-resource-guides-future-plans/.

7 Ibid.

8 "Thorncliffe Park," Tower Renewal Partnership, March 20, 2008, http://towerrenewal.com/thorncliffe-park/.

9 Téana Graziani, "Three Tower Development Proposed in Flemingdon Park Neighbourhood," Urban Toronto, accessed March 10, 2022, https://urbantoronto.ca/news/2021/12/three-tower-development-proposed-flemingdon-park-neighbourhood.

Figure 48: Photographs of Thorncliffe Park showcasing its towers in the park design, and their proximity to local light industry and highway infrastructure (1970).

Flemingdon Park

Flemingdon Park is a neighbourhood located on the East of the Ontario Science Centre, in the North York district of Toronto with a land area of 2.7km^2.[10] The neighbourhood is bordered by Eglinton Avenue on the north, and branches of Don River surround the neighbourhood from the south, east and west direction. The east and west branches of the river intersect at Flemingdon Park's southwest corner, where a park access road is located. The neighbourhood has a population of 21,933 and a population density of 9,026 people per square kilometer. The population is accommodated mostly through high-rise apartments, that host larger than average immigrant families in 'tower in a park' style living.[11] The neighbourhood residents are mainly immigrant families from South Asia, Southeast Asia, Eastern Europe and Western Europe.[12]

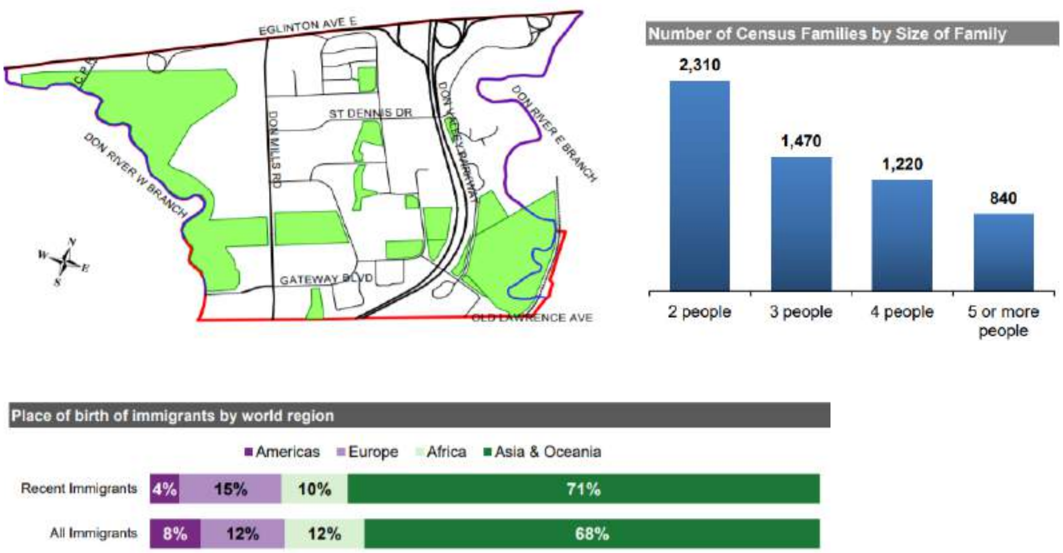


Figure 49: Flemingdon Park neighbourhood profile and demographics (2016/2017).

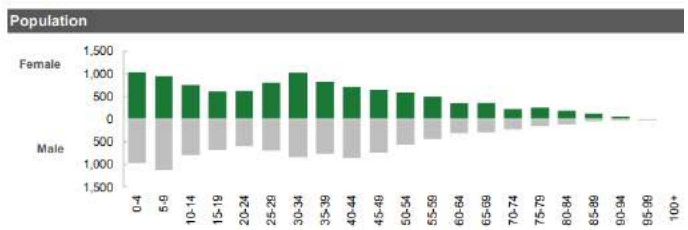
10 "2016 Neighbourhood Profile Flemingdon Park," toronto.ca (Statistics Canada, 2016 Census of Population), accessed February 8, 2021, https://www.toronto.ca/ext/sdfa/Neighbourhood%20Profiles/pdf/2016/pdf1/cpa04.pdf.

11 Ibid.

12 Ibid.

Thorncliffe Park

Thorncliffe Park, located on the west of the Ontario Science Centre shares many characteristics with Flemingdon Park. The neighbourhood has a population of 21,108, with a land area of 3.35km^2 and a population density of 6,787 people per square kilometer.[13] Similar to Flemingdon Park, Thorncliffe Park is also bounded by Eglinton Avenue on the north and a branch of the Don River in the east and south directions. The neighbourhood hosts a similar immigrant population as Flemingdon Park, with children and youth, that make up a large fraction of the demographic.[14]



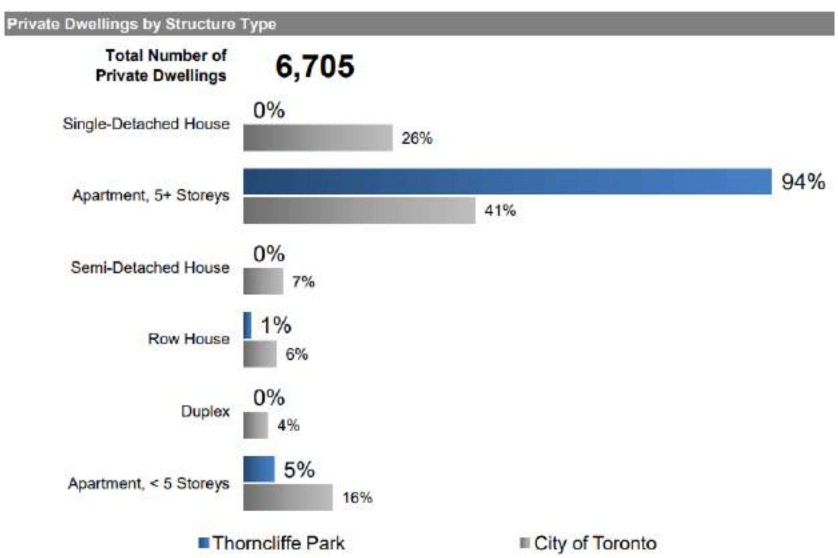


Figure 50: Thorncliffe Park neighbourhood profile and demographics (2016/2017).

13 Statistics Canada Government of Canada, "2016 Neighbourhood Profile Thorncliffe Park," 2016 Census of Population – Data products, February 8, 2021, https://www.toronto.ca/ext/sdfa/Neighbourhood%20Profiles/pdf/2016/pdf1/cpa55.pdf.

14 Ibid.

Site Context

Site investigations present visual information such as land use, future densification, circulation, and the natural variety of the place.

Figure 51: Site plan- figure-ground.

Built Form

The site is bordered by a densifying residential and employment industrial area of Thorncliffe and Flemingdon Park. As such, the natural landscape is a valuable aspect of the urban context.

Figure 52: Site plan-zoning.

Natural Infrastructure

The natural infrastructure surrounding the site is utilized by the community through a walking trail and recreational space. Apart from the wetland, the various landscapes are accessible to the public.

Figure 53: Site plan-natural landscapes.

The site's rich natural infrastructure is part of a natural heritage system protected by the TRCA regulation limit and By-law. The Ontario Science Centre is nestled into the contours of the site and built adjacent to a waterway and wetland that is identified as an environmentally significant area.

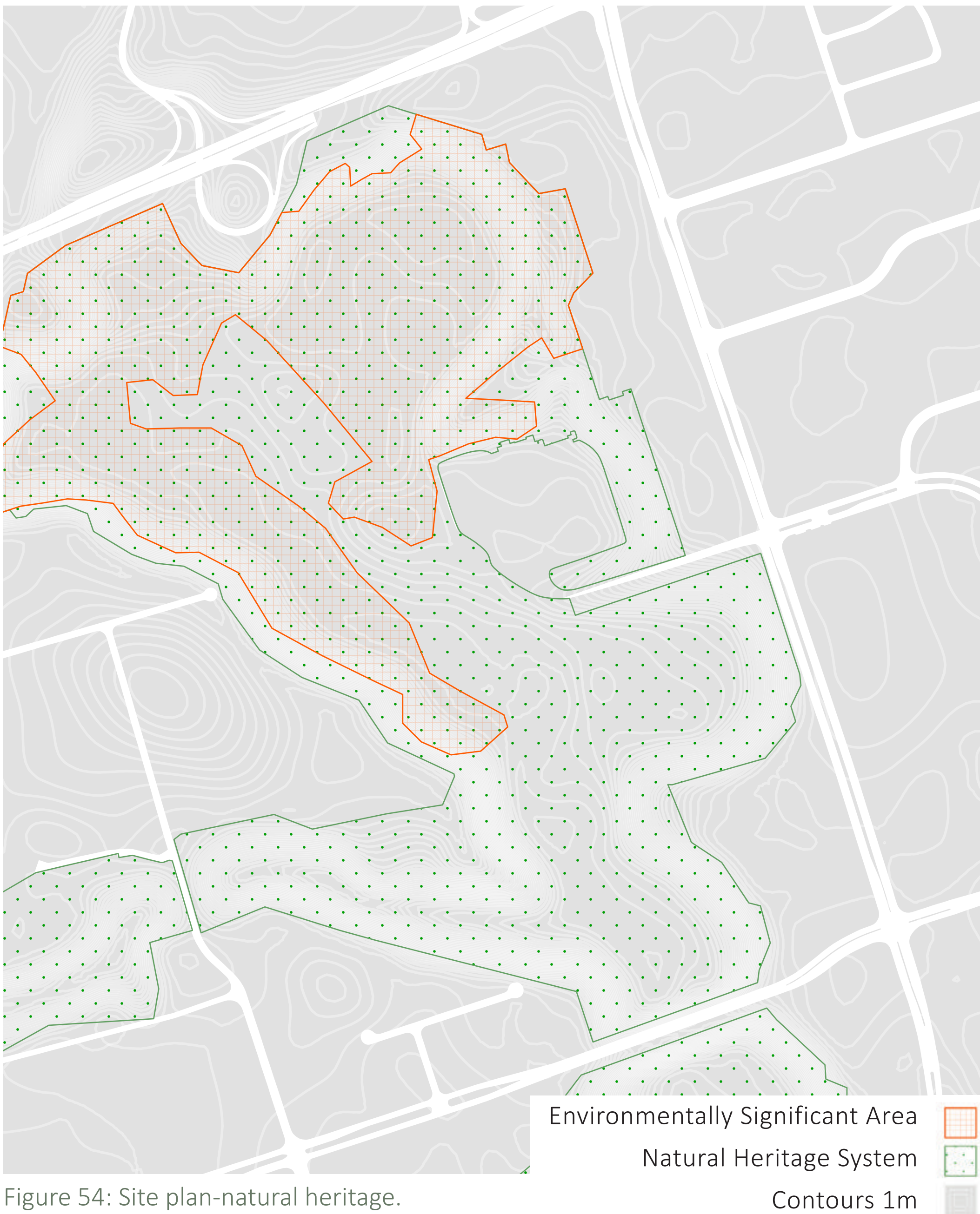


Figure 54: Site plan-natural heritage.

Urban Infrastructure

While transit connections are located on busy vehicular streets to the north and east of the Ontario Science Centre, the building is backed onto a quiet ravine landscape on the south and west.

Figure 55: Site plan-light and sound pollution.

In anticipation of the proposed residential development and transit connections, the design proposal utilizes the existing infrastructure to support the Flemingdon and Thorncliffe Park neighbourhoods through a connected public realm.

Figure 56: Site plan-future circulation and access.

Figure 57: Photograph of the original OSC entrance showcasing Brutalist design.

The Ontario Science Centre (OSC)

Brutalism

The Ontario Science was one of eight hundred buildings commissioned for Canada's Centennial Celebration in 1967 and remains one of Toronto's most iconic cultural buildings, almost half a century later.[15] The project was funded provincially along with a federal grant, and its construction cost approximately $23 million.[16] The Centre's architecture is an example of the Brutalist architecture style that emerged during the post-war period for reconstruction projects, specifically civic and institutional buildings. Brutalist architecture is characterized by its monolithic concrete appearance and unusual forms. As a successor to the Modernist movement, the style celebrates building materials and structural features, and similar to minimalist design, it rejects decorative elements. A Globe and Mail article on the Brutalist style in Canada states that "If Canada has a national style, this is it."[17] However, the movement began to decline in popularity in the 1980s for its cold and unwelcoming qualities.

15 "Ontario Science Centre," Moriyama & Teshima Architects, November 22, 2018, https://mtarch.com/projects/ontario-science-centre/#.

16 J. Tuzo Wilson, "Ontario Science Centre," The Canadian Encyclopedia, February 7, 2006, https://www.thecanadianencyclopedia.ca/en/article/ontario-science-centre.

17 Alex Bozikovic, "Will the National ARTS Centre's RENOVATION Undercut Its BRUTALIST TRUTH?," The Globe and Mail, June 23, 2017, https://www.theglobeandmail.com/arts/art-and-architecture/the-brutalist-truth-about-the-national-artscentre/article35447387/.

Educational Concept

The Ontario Science Centre intended to bridge the communication between the public and the science and technology advances that were quickly escalating during the 1960s. The Centre embraced the concept of informal learning, where education was free of constraints generated by the traditional classroom setting. It was one of the world's first interactive museums, exemplifying a museological shift from static displays to hands-on learning to engage the visitors.[18] The exhibitions encourage visitors to participate in a variety of stimulating exhibits based on individual preferences. The Ontario Science Centre's exhibits were made to convey the twentieth century idea of physics as the master of science.

Figure 58: OSC's popular museum exhibits.

18 Robert Moffatt, "MoD Toronto: Ontario Science Centre, Raymond Moriyama's Temple of Technology," Spacing Toronto, June 4, 2013, http://spacing.ca/toronto/2013/07/16/mod-toronto-ontario-science-centre-raymond-moriyamas-temple-of-technology/.

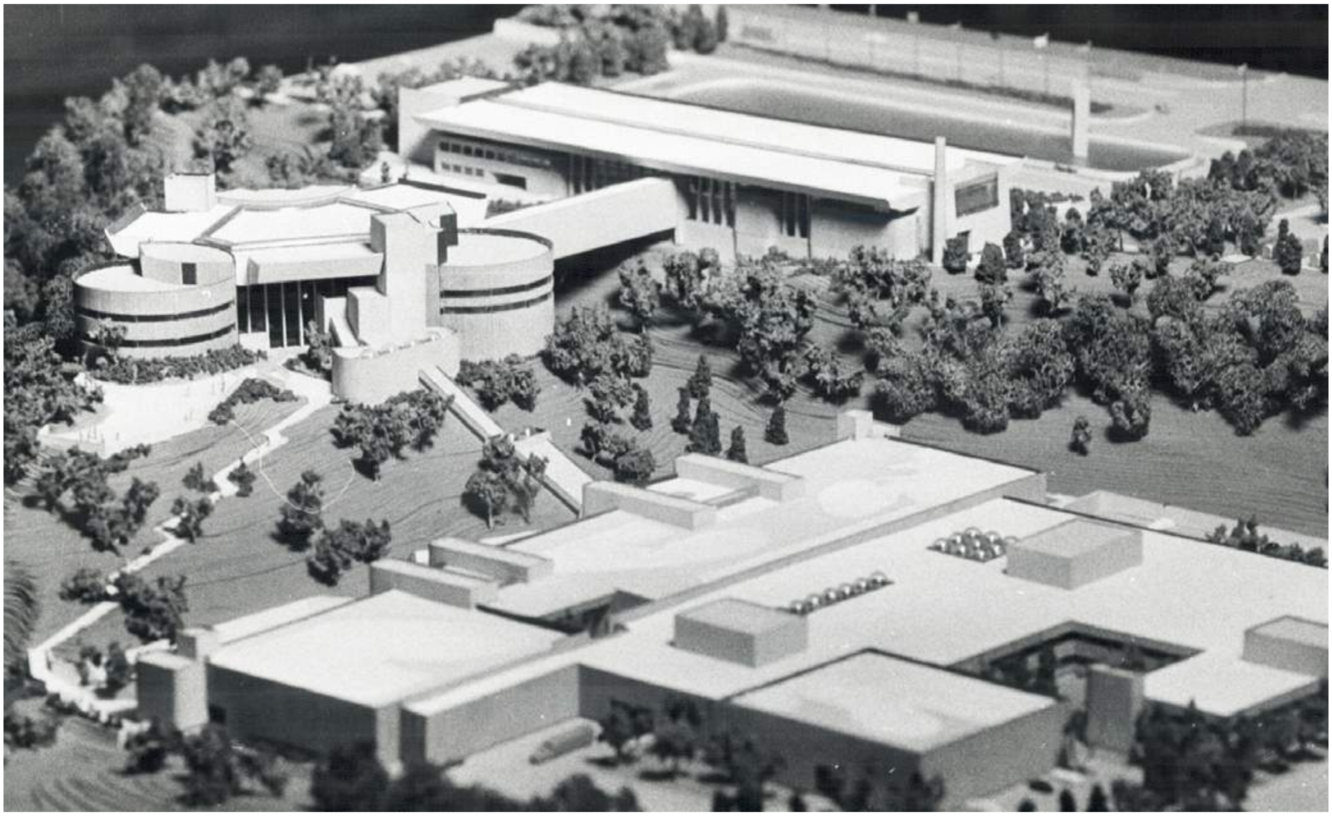


Figure 59: Photograph of the OSC's model captures an aerial view of the building and site.

Figure 60: Photograph of OSC's trillium-inspired Brutalist tower design.

Design Concept

The architecture of the Ontario Science Centre designed by Canadian architect Raymond Moriyama reflects the twentieth century idea of physics as the master of science. To house its innovative program, the building was conceived as three interconnected raw Brutalist concrete structures that sit within the natural site of the Don River. The connecting escalator between the symbolic three petal trillium flower massing and the warehouse massing allows the project to step into the ravine, which was a significant idea when the building was first conceived.

The experience of the building begins at a massive paved parking lot as visitors were expected to travel to the then remote site by car. Here, visitors are greeted by the first of three buildings-the entrance building. The entrance building is a low massing that greets visitors before they step into the museum's exhibit spaces. While it originally featured a cave-like entry with a stairway, the entrance facade was renovated in 1996 by Zeidler Roberts Partnership.[19] The renovation opened up the Brutalist entrance with a two-storey lobby enclosed by a glazed facade. It also introduced the OMNIMAX theatre, which was the first of its kind in all of Ontario. Accessed by an enclosed bridge, the entrance building leads visitors to the tower building that is located directly behind it, overlooking the ravine. The tower's cylindrical form was inspired by the shape of the Ontario trillium. The tower building is fairly enclosed and also expressive of Brutalist ideologies. The massing opens into a central great hall where an escalator guides visitors to the lower level warehouse building where the majority of the exhibits are located. The sizable massing lies low and was conceived as a flexible black box space to hold an array of exhibits and allow for their variation. The exhibitions currently displayed at the Centre target the learning of a younger demographic, therefore, the visitors of the building are mostly families with children.

19 Robert Moffatt, "MoD Toronto: Ontario Science Centre, Raymond Moriyama's Temple of Technology," Spacing Toronto, June 4, 2013, http://spacing.ca/toronto/2013/07/16/mod-toronto-ontario-science-centre-raymond-moriyamas-temple-of-technology/.

Challenges

The Ontario Science Centre is gradually attracting fewer visitors each year, highlighting a significant concern for the future of its operation.[20] A key factor leading to this decline is that the building and its interactive exhibits remain products of the time period in which they were conceived. Another challenge for the Centre is the large amounts of energy required for its operation due to the concrete masses of Brutalist structures that are typically uninsulated. This makes the building highly unsustainable for the future due to the financial and ecological implications of heating and cooling. When the number of visitors to the Centre is on a decline, the operational costs become a burden, requiring a reconsideration of the building.

There have been recent conversations within the government on moving the Ontario Science Centre to the site of Ontario Place and demolishing the existing building. Martin Regg Cohn, a writer for the Toronto Star states that the building is "'an inefficient use of valuable provincially owned real estate,' which should be opened up for residential development."[21] However, the concrete structure's demolition and reconstruction is an inappropriate measure, as it would disregard a valuable, untapped resource in the carbon-intensive expenditure. The building should also be preserved for its heritage significance as an architectural icon by celebrated Japanese Canadian architect Raymond Moriyama. Additionally, with the anticipating densification of the adjacent neighbourhoods, and proposed transit networks to connect the site, the building's role within its neighbourhood and city context should be continued and expanded. Since the Centre has accumulated a significant need for its maintenance and revitalization in the last few decades, it requires a refresh of its mandate within the municipal, provincial, and immediate neighbourhood context to address the current challenges and requirements of the site.

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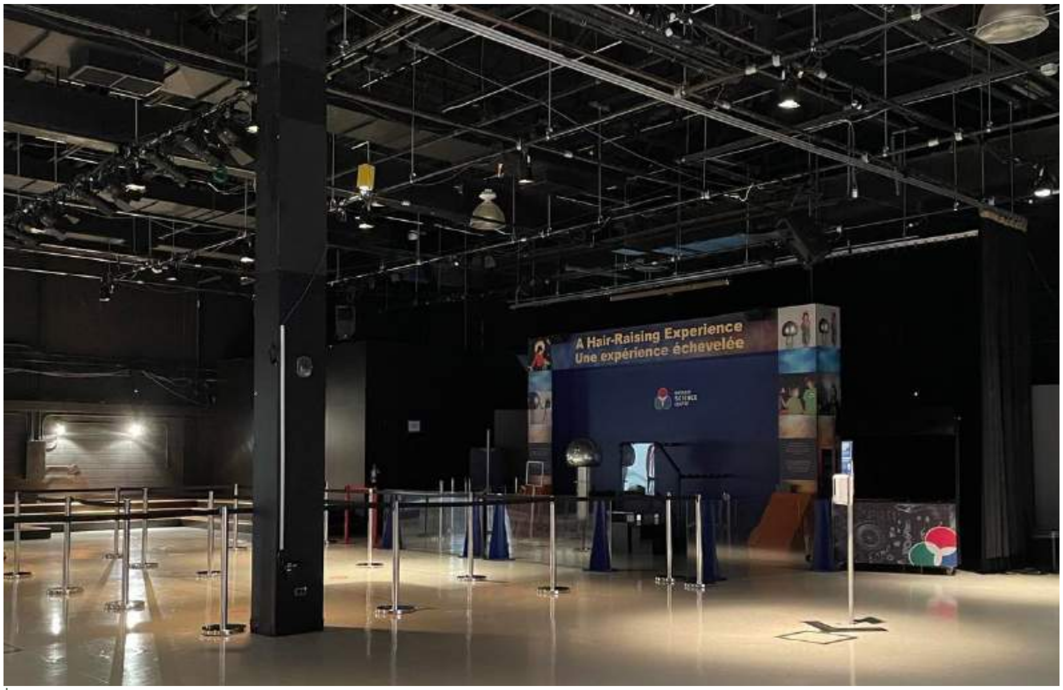
20 "2020–2021 Business Plan - Ontario Science Centre," accessed November 17, 2021, https://www.ontariosciencecentre.ca/media/1879/2020-21businessplan.pdf.

21 "Moving the Ontario Science Centre to Ontario Place Has Fans and Foes," Toronto Star, February 10, 2019, https://www.thestar.com/opinion/letters_to_the_editors/2019/02/08/moving-the-ontario-science-centre-to-ontario-place-has-fans-and-foes.html.



b.

b.

c.

Figure 61: Site photos showcase a. the open warehouse building layout, b. enclosed outdoor spaces, and d. hard-scaping around the building entrances.

THE DESIGN PROJECT

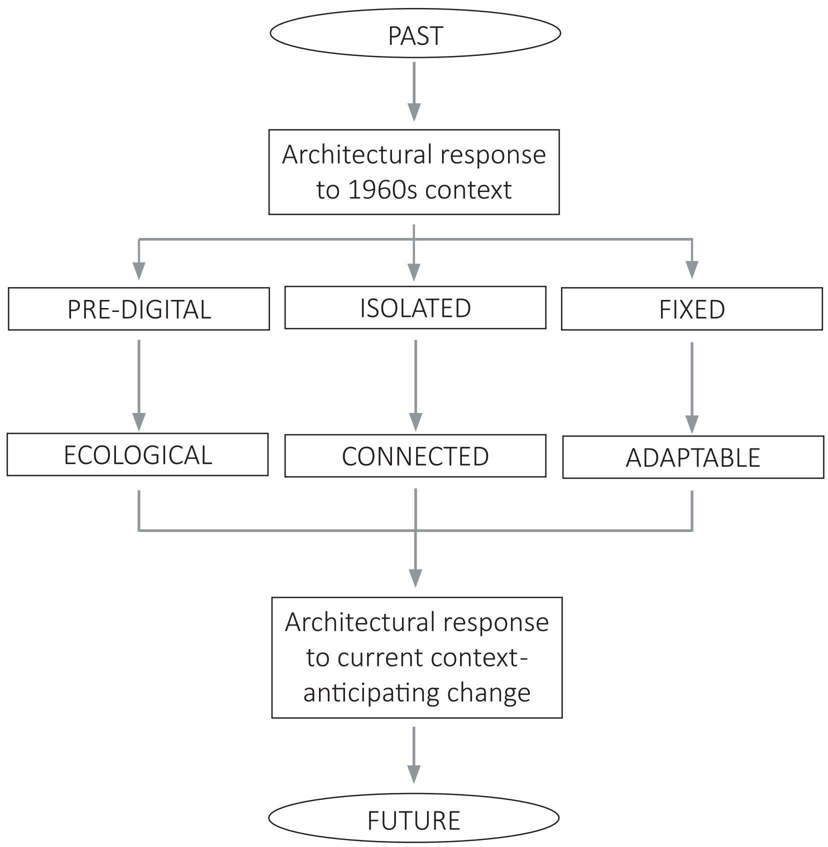


Figure 62: Key transformations for converting the OSC into a 21st century environmental education centre.

Key Transformations

It is evident that society, including the selected locale, has experienced significant changes since the conception of the Ontario Science Centre in 1969. The thesis project utilizes the existing infrastructure to transform the site into a nexus that responds to the changes that the site and society have endured over the past decades. The three fundamental changes identified are the evolved human relationship with science, technology, and nature, the shift of Thorncliffe and Flemingdon Park from high-end vehicle-accessed neighbourhoods to lower-income immigrant areas with proposed transit connections, and lastly, the change in perception of buildings as fixed formal icons to evolving entities that are to be adapted as required. The transformation of the Ontario Science Centre building and site presents an opportunity to reflect on these cultural changes and refresh its perspective, converting it from a centre for science and technology to a centre for twenty-first century environmental education. The hyper-ecological conversion transforms the Ontario Science Centre from its *pre-digital, isolated, and fixed condition to an ecological, connected, and adaptable state.* In this way, by embracing the uniqueness of the site context, the project maximizes the potential of the site. It becomes a didactic testing ground for the present, while learning from the past and anticipating the future.

Pre-Digital to Ecological

Each historical epoch had a dominant scientific discipline that professor and author Thomas Homer-Dixon defines as the prototypical science of the time.[1] He states that the master science of each period was the discipline that people first thought of when they mentioned science, as it was likely to have generated spectacular discoveries and technologies.[2] "A master science generates and orders the concepts through which society understands itself and its relation to its surroundings."[3] It is evident in the design and conception of the Ontario Science Centre that the master science of the twentieth century was physics, with a focus on emerging digital technologies. The Centre represents thinking

1 Thomas Homer-Dixon, "The Newest Science: Replacing Physics, Ecology Will Be the Master Science of the 21st Century," Thomas Homer-Dixon, September 21, 2017, https://homerdixon.com/the-newest-science-replacing-physics-ecology-will-be-the-master-science-of-the-21st-century/.

2 Ibid.

3 Ibid.

from a pre-digital period, as exemplified by its concrete structure that sits in contrast to the site. Its Brutalist form and materiality represent the human domination over nature rather than the contemporary concept of coexistence.

With ongoing environmental crises and a greater awareness of the subject, ecology is considered the master science of the twenty-first century.[4] The building must first transform its pre-digital perspective of physics and technology as the master science to an ecological focus by fostering connections and blurring boundaries of separation between the local ecology, the building, and the public. The project formulates a cultural link between the public and ecology by converting the large parking lot into park space and integrating immersive programming through the creation of an interactive greenspace. The building is also transformed from inward-facing to outward-looking through strategic openings and access to provide visitors with light, views and access to the surrounding context.

Isolated to Connected

The science centre was initially conceived as a tourist destination to attract visitors from across the city and country rather than the local public residing in adjacent neighbourhoods. Reflecting this user group, the Centre features a single entry point through a large paved parking area. Since its conception in the 1970s, the local context of the Ontario Science Centre has evolved significantly. The periphery neighbourhoods of Thorncliffe and Flemingdon Park were once directed at higher-income residents, with cars envisioned as to be the primary method of accessing the area. Decades later, the adjacent neighbourhoods currently host a lower-income immigrant population. In support of their growth and development, new proposed transit systems are to connect the site. The transit connections allow a larger population to access the Ontario Science Centre and encourage a shift away from personal vehicles.

4 Thomas Homer-Dixon, "The Newest Science: Replacing Physics, Ecology Will Be the Master Science of the 21st Century," Thomas Homer-Dixon, September 21, 2017, https://homerdixon.com/the-newest-science-replacing-physics-ecology-will-be-the-master-science-of-the-21st-century/.

The project proposes an extended pedestrian-oriented public realm accessible to all of Toronto. As a threshold to the ravine network, the revitalization strengthens the natural landscape and becomes a demonstration tool, educating the public on Toronto's ravine network and ecological system. The transformation integrates the building into its social and ecological infrastructure, enhancing the Centre's role within its context.

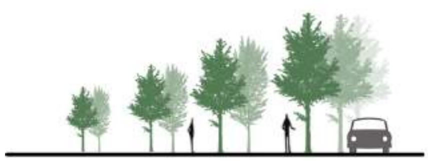
Fixed to Adaptable

The Ontario Science Centre was designed as an architectural icon celebrating Canada's centennial with its Brutalist design and representational forms that celebrate the Canadian heritage. Since its conception, the architecture has gained significant praise and admiration. However, the last few decades have accumulated new demands for the site and building.

The Ontario Science Centre is adapted to a twenty-first century environmental centre by refreshing its original perspective. The revitalization of the valuable site views architecture as constantly adaptable rather than in a fixed state. In this way, the buildings can meet the evolving demands of their users by adapting to the changing requirements. Furthermore, the addition of public participatory programming is envisioned as adaptable and open to change to avoid the structure's obsolescence in upcoming years of operation. As society and the community experience change in demands for the site in the future, the project is to be re-interpreted with possible design modifications reflecting the change.

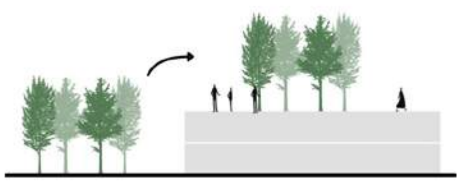
Design Strategy

The key transformations are achieved by applying the following design strategies to revitalize the Ontario Science Centre site and building. Each strategy promotes social exchanges on ecological thinking and considers the energy exchanges that are inherent to the building. As such, the strategies increase the value of the existing building, enrich the community and prevent the demolition of the valuable built infrastructure.



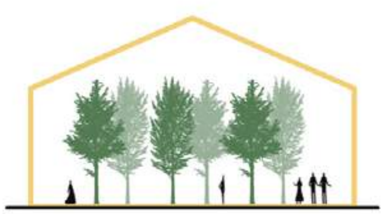
Re-Planting

Supports local ecosystem & biodiversity.
Improves storm water management in urban setting.
Provides shade and cooling effect.



Green Rooftop

Replaces lost green areas at grade.
Connection to nature and site.
Insulates building from heat loss.

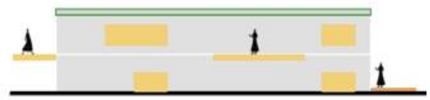


Greenhouse Addition

Urban farming strategy.
Space for community to engage in ecological topics.

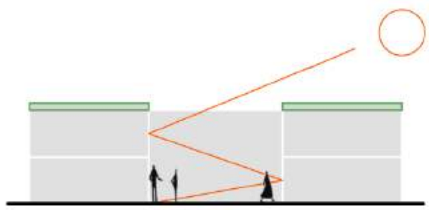
Rooftop Farm

Urban farming strategy.
Space for public to engage in ecological topics.
Insulates existing building from heat loss.



Openings and Access

Increase light, views and access to nature.

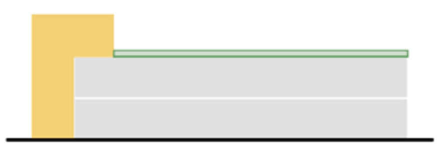


Courtyards and Terraces

Increase light, views and access to nature.
Generates micro-climate to allow for extended thermal comfort outdoors.

Re-Clad Facade

Insulates existing building from heat loss.
Contributes to increased energy performance of existing building.



Wrapped Glass Addition

Insulates existing building from heat loss.
Increases light, views and access to nature.
Contributes to increased energy performance of existing building. Eliminates need for concrete foundations.

Stacked Addition

Adding functions to increase building use and facilities for community.
Densification strategy utilizes existing infrastructure and saves space at grade in city with high land costs.
Insulates existing building from heat loss.
Eliminate need for concrete foundations.

Figure 63: Diagrams of design strategies for converting the OSC into a 21st century environmental education centre.

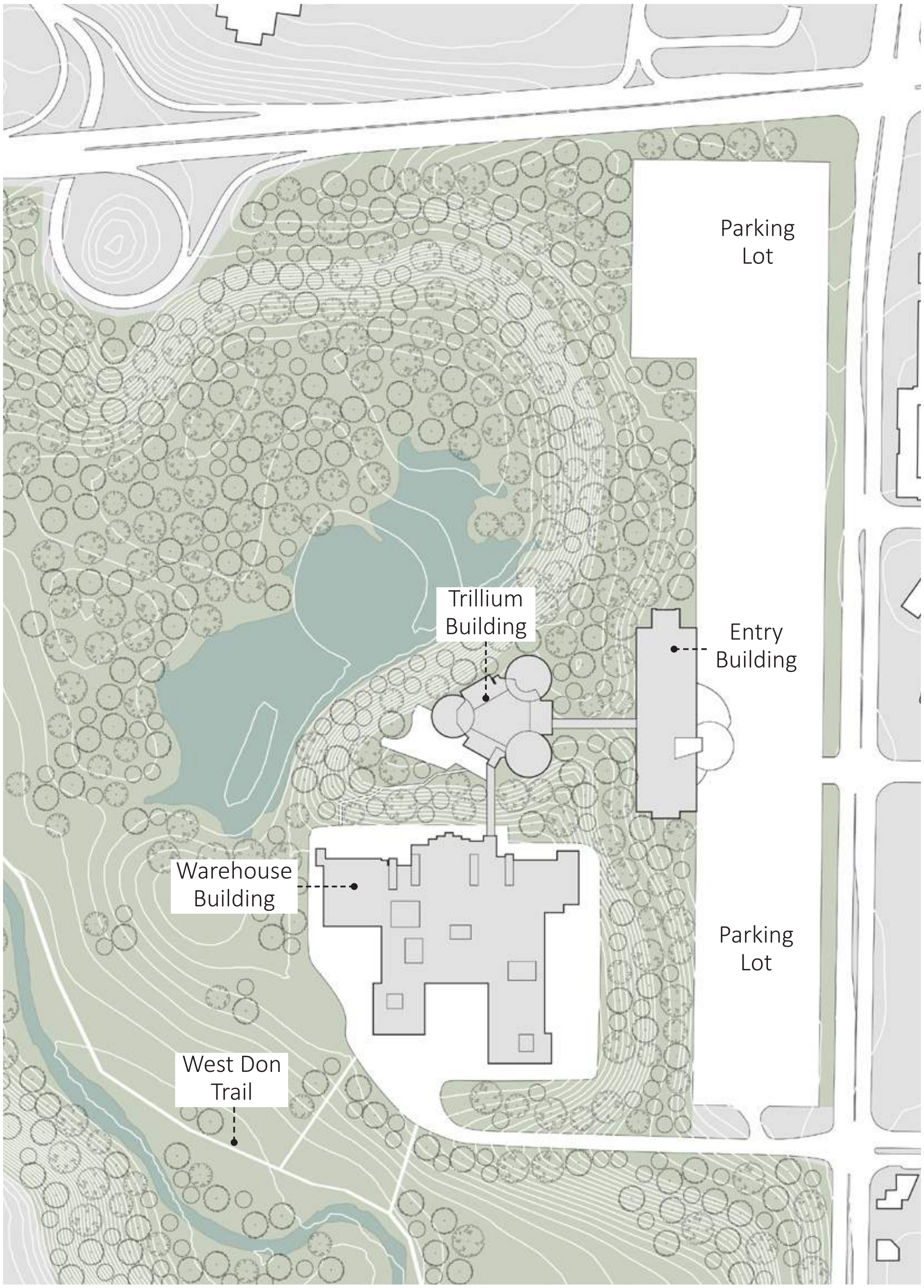


Figure 64: Site plan-existing.

Vision for the Site

The Ontario Science Centre is revitalized to meet the evolved needs of the site as a twenty-first century environmental centre. The design proposes a hyper-ecological intervention through a pre-digital to ecological, separate to community and fixed to adaptable conversion of the existing building and site. The design reconsiders the following areas: the paved parking, building facades, vacant rooftops, and the building program.

The master plan envisions the site as a community hub and a ‘living laboratory’ hosting research, education, and social functions that strengthen the existing natural infrastructure of the site and maximize the use of the existing built infrastructure.

The transformation takes advantage of the existing underutilized site and infrastructure to provide additional functions in a densifying neighbourhood context. A continuous public circulation path is proposed to connect Flemingdon Park east and Thorncliffe Park on the west to support the community context. The path prioritizes the pedestrian experience and operates independently of the ticketed functions within the Centre. With the public park scape, community-oriented participatory programming, and office areas, a mixed-use, dynamic, and active environment is created in the ‘tower in the park’ residential neighbourhoods by extending the public realm.

Accessible to all of Toronto through the proposed transit networks, the project provides environmental, educational and communal benefits to the entire city. It creates a vibrant and didactic hyper-ecological architecture intervention, connecting the two neighbourhoods of Flemingdon and Thorncliffe park through an integrated social infrastructure.

While specific programmatic changes are proposed in the project, they are not intended to be fixed or permanent transformations. Instead, the master plan illustrates how the existing infrastructure can be maximized to provide spaces for the community and meet the site’s evolved demands.

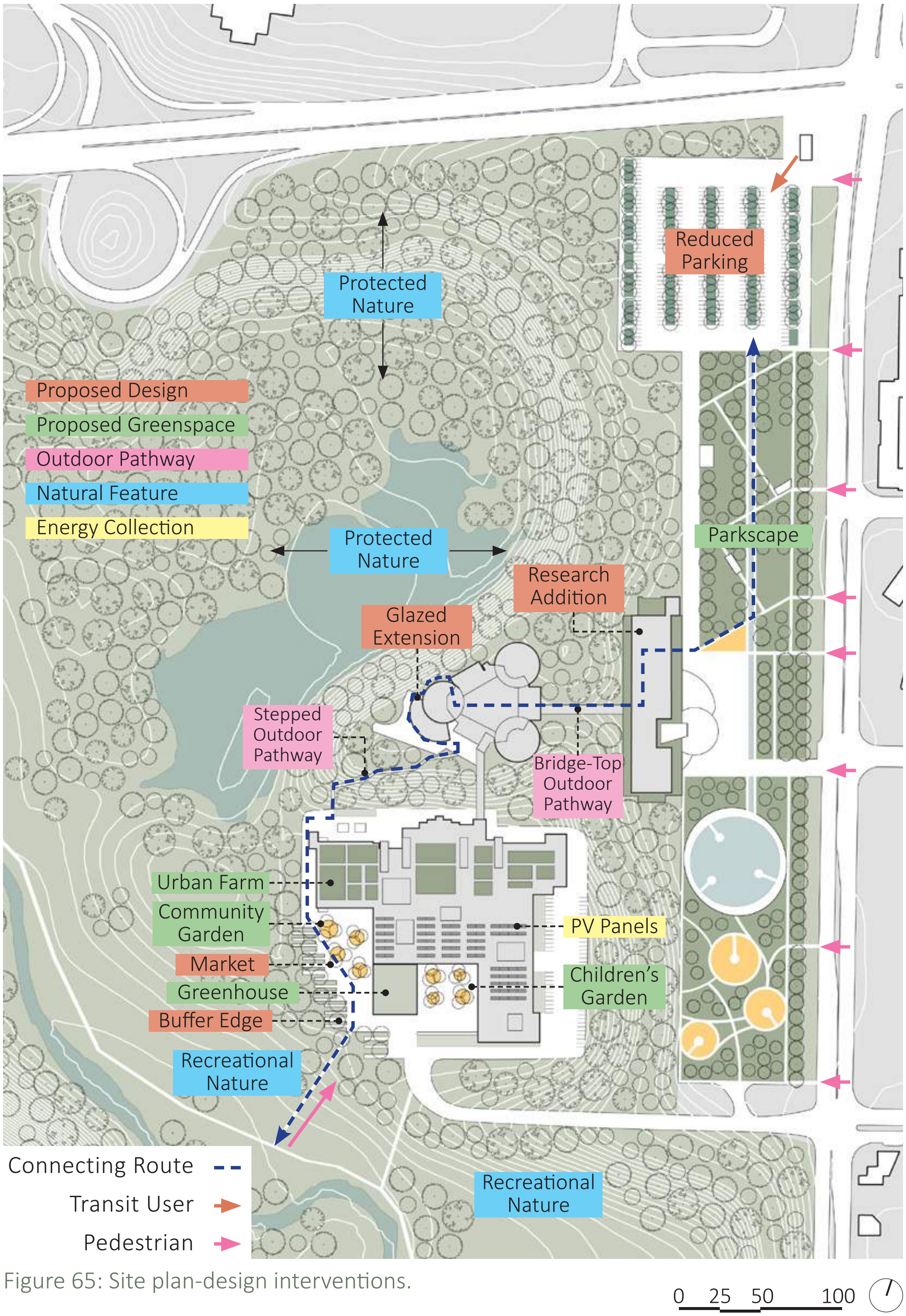


Figure 65: Site plan-design interventions.

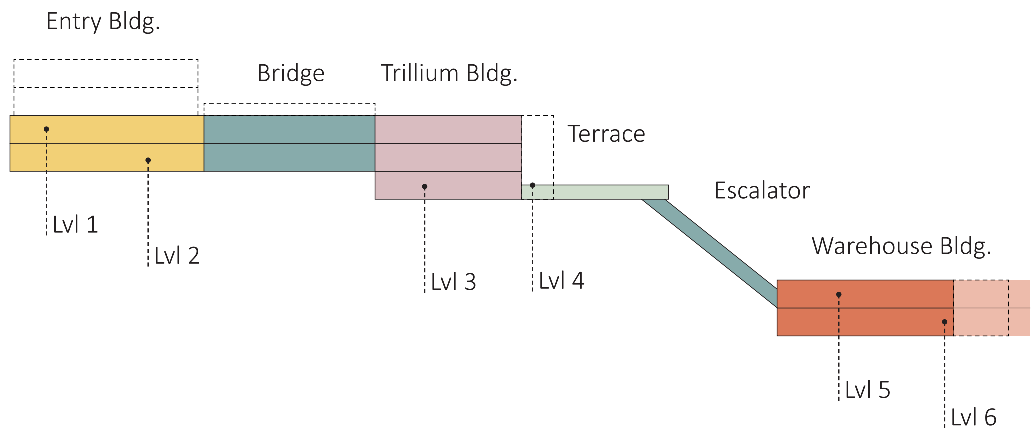


Figure 66: Section diagramming OSC building massings.

21st Century Environmental Centre

The holistic revitalization of the building and site highlights the potential of the locale through modifications considering the energy and social exchanges inherent to the act of building.

Existing Building Transformation

The following plans of the existing building identify the updated interior programs. The converted Ontario Science Centre is to continue its ticketed operation with new displays exhibiting ecological topics such as climate change, regeneration and sustainable construction materials and methods. The changes aid in transforming the Ontario Science Center's perspective from pre-digital to ecological for its transformed role as a twenty-first century environmental centre.

The following plans of the existing buildings are organized based on the experience of the site. Since the project is built into a ravine, the highest level begins at one, and the levels increase as the building steps into the slope of the ravine.

Existing Building Transformation- Level 1

In the entry building, level one is a mezzanine floor consisting of a sizeable back-of-house area for the employees and an open space with a gift shop. Visitors can take the two-storey bridge to the trillium building from level one. An education wing is proposed in place of the previous administration wing to allow for community spaces with views of the site on the west.

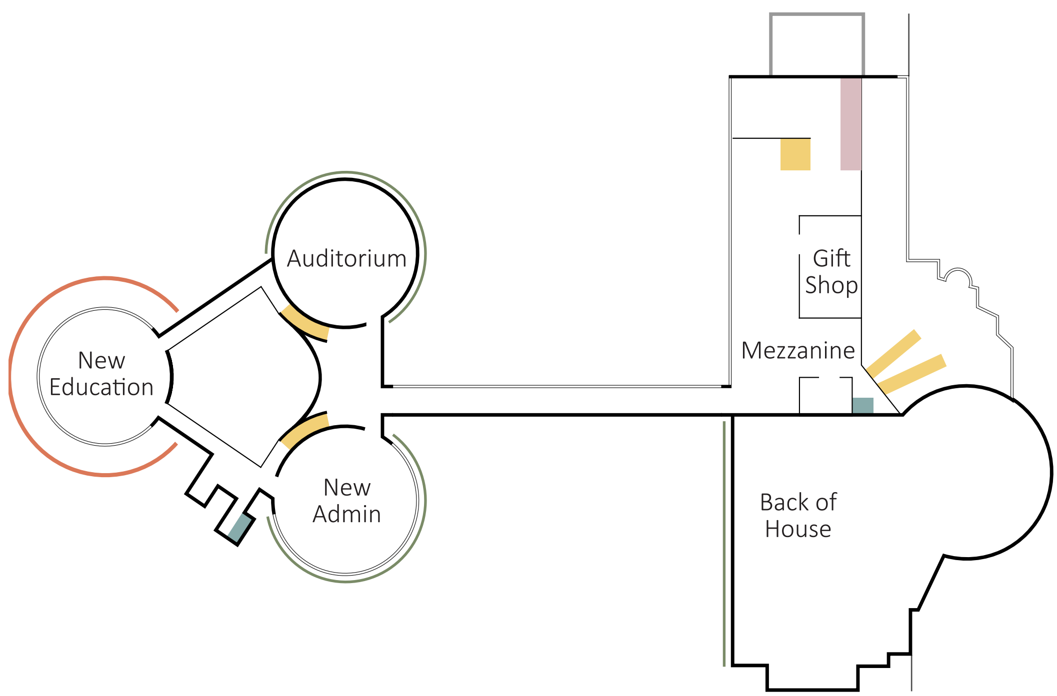


Figure 67: Level 1 transformation.

Existing Building Transformation - Level 2

The visitor experience begins at the parking lot that connects to level 2 of the entry building. Here, visitors enter the building into a lobby that leads to the suspended bridge. A proposed atrium extends the new education wing, taking advantage of the unobstructed south-west orientation to introduce a nature-connected area accessible from level two of the trillium building.

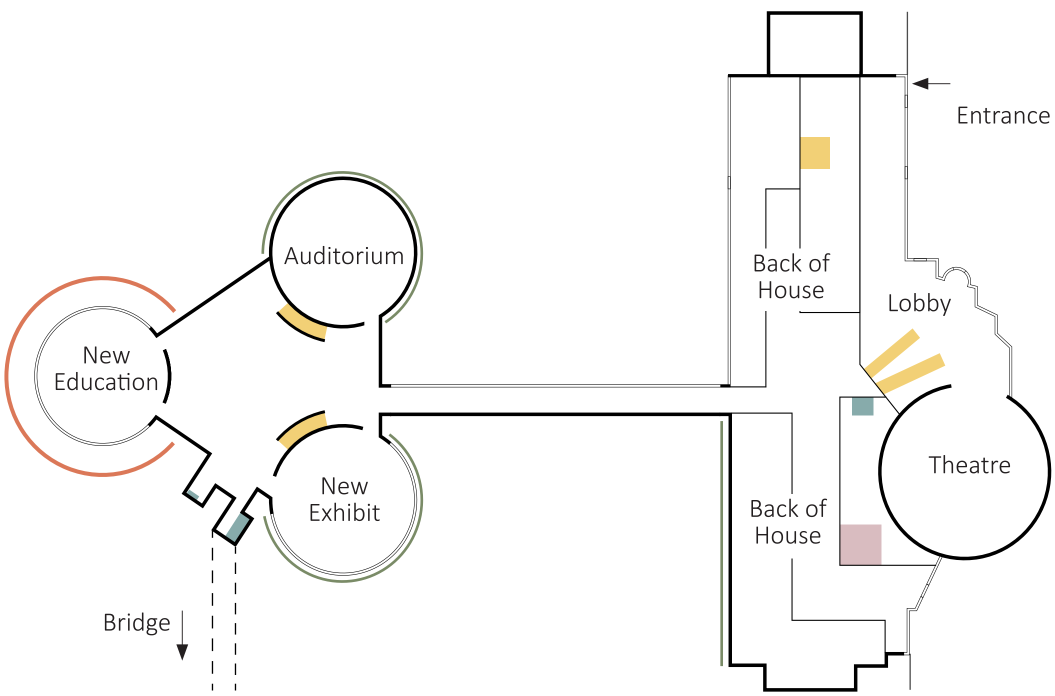
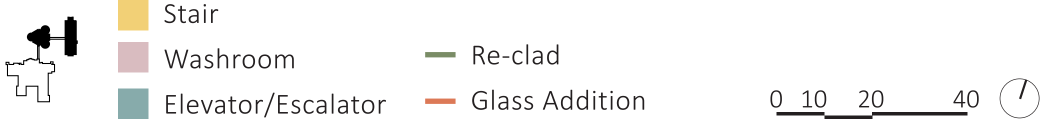


Figure 68: Level 2 transformation.



Existing Building Transformation - Level 3

Level three is the trillium building's terrace overlooking the Don River waterway. An outdoor stepped path from the terrace leads visitors to the warehouse building's paved area.

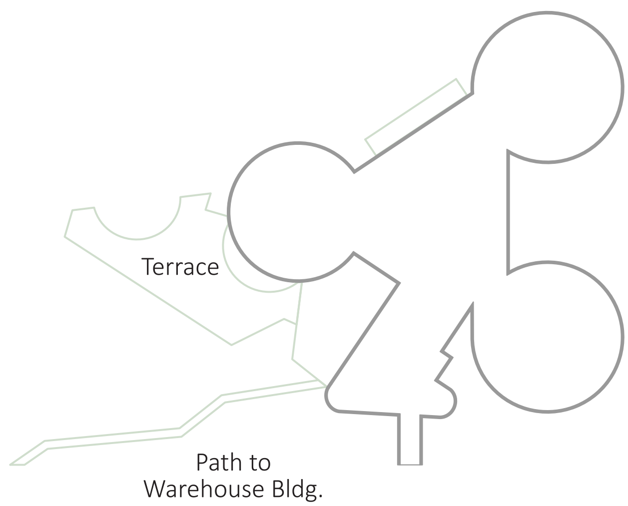
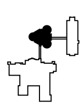


Figure 69: Level 3 transformation.



Stair
Washroom
Elevator/Escalator
Re-clad
Glass Addition

Existing Building Transformation - Level 4

The previous kid's spark and space hall displays are replaced with new ecological science exhibits on level four. From the trillium building, a descending escalator leads visitors to the lowest level of the warehouse building.

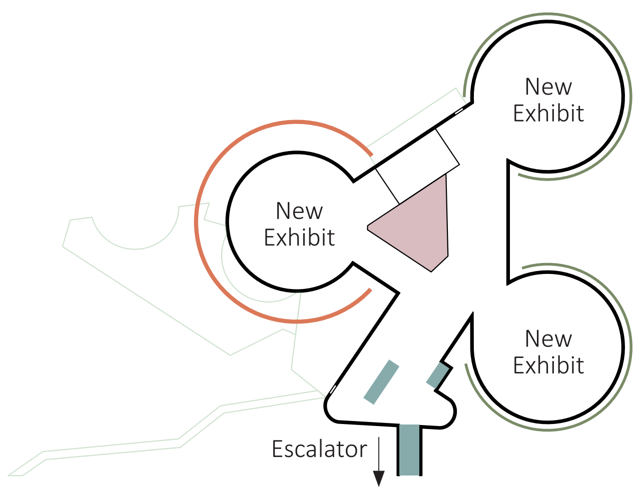


Figure 70: Level 4 transformation.

Existing Building Transformation - Level 5

Level five is the second storey of the warehouse building consisting of large back-of-house areas. The previous educational spaces for high school students are replaced with research and development support spaces for the urban farming program located on the building's rooftop. The support space will primarily consist of offices for researchers and seminar rooms.

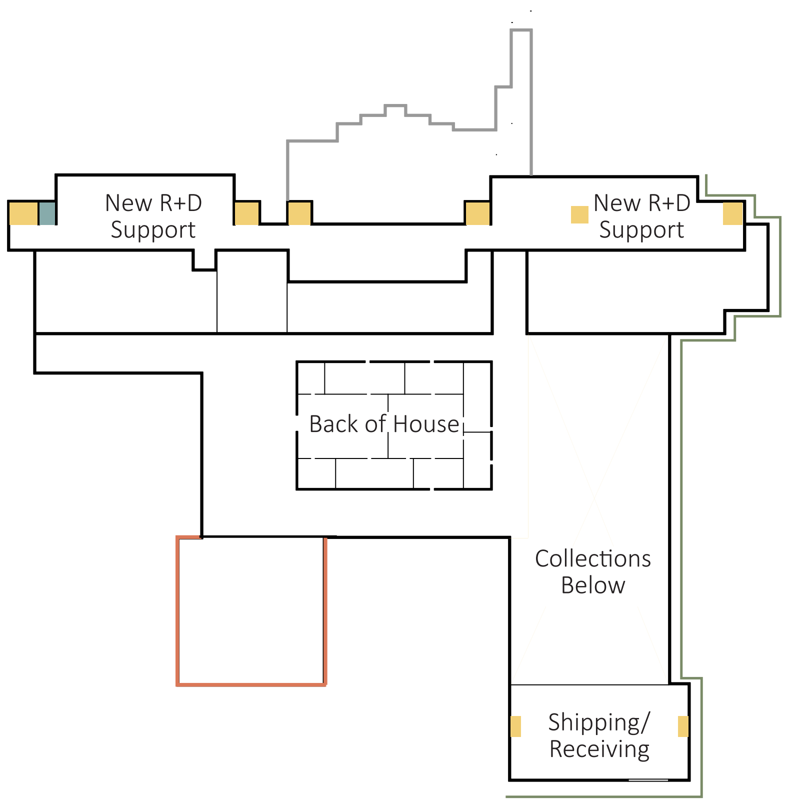


Figure 71: Level 5 transformation.

Existing Building Transformation - Level 6

Level six hosts the majority of the Centre's exhibits which are to be updated to display the ecological challenges and opportunities of the twenty-first century. Some exhibit spaces are converted into a public market that supports the urban farm program. In addition, a greenhouse is proposed to wrap around the south-west corner of the building for tempered growing functions.

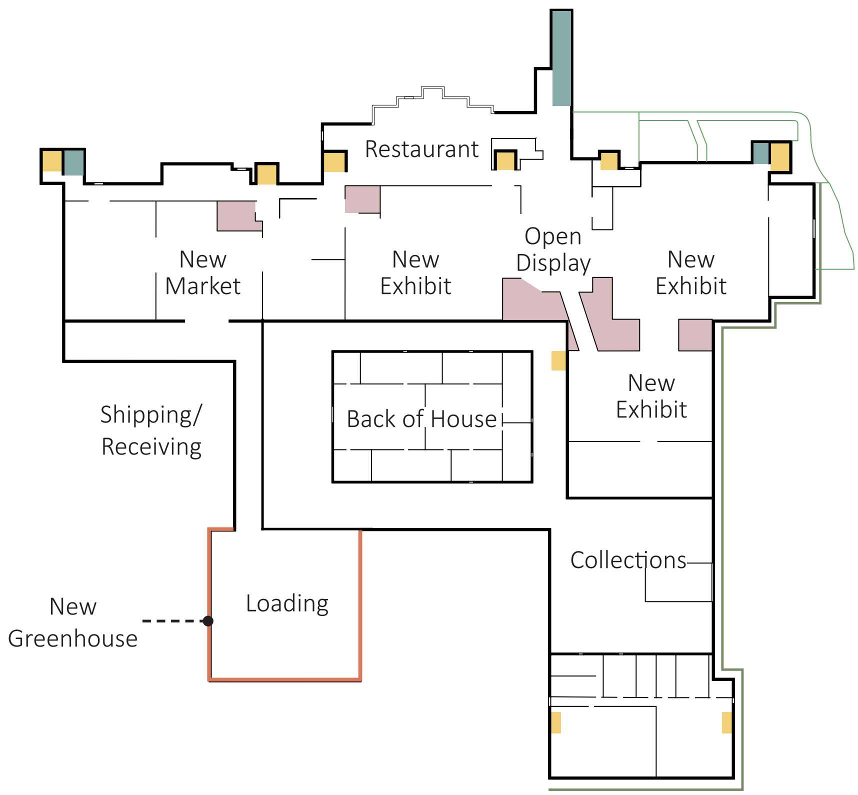


Figure 72: Level 6 transformation.

Parking Lot - Parkscape

Where the pre-digital period required extensive paved parking areas, an ecological approach reconsiders the valuable land. The project transforms the parking lot into a parkscape to aid the watershed capacity of the site and reduce the degradation of the Don River.

The parkscape reclaims underutilized public infrastructure to connect the site to its context. Its design introduces community-focused ecological programming and social infrastructure to generate social exchanges. The parkscape provides a setting for leading-edge environmental practices that bring together ecological systems, the public and environmental professionals in a shared space, strengthening the public's relationship with the natural environment- that they may not be familiar with.

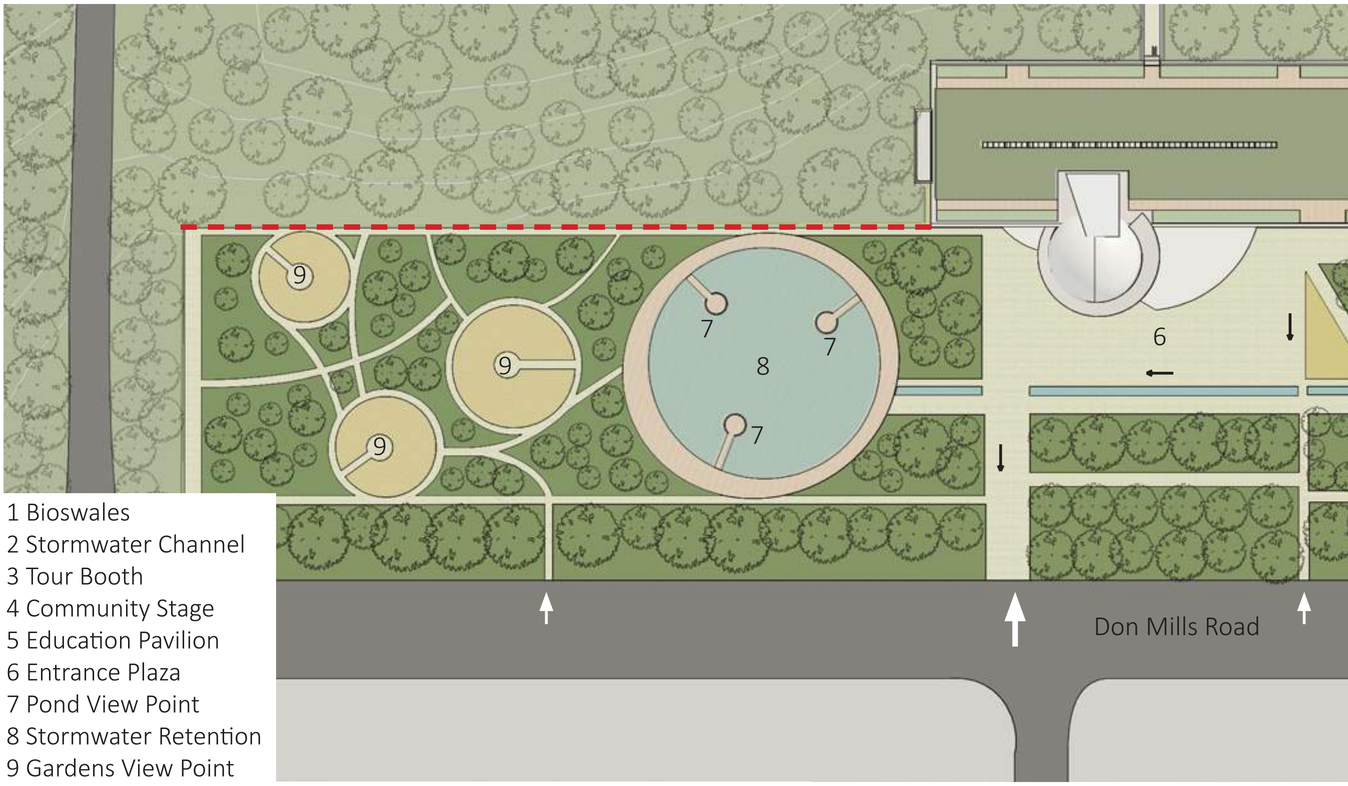
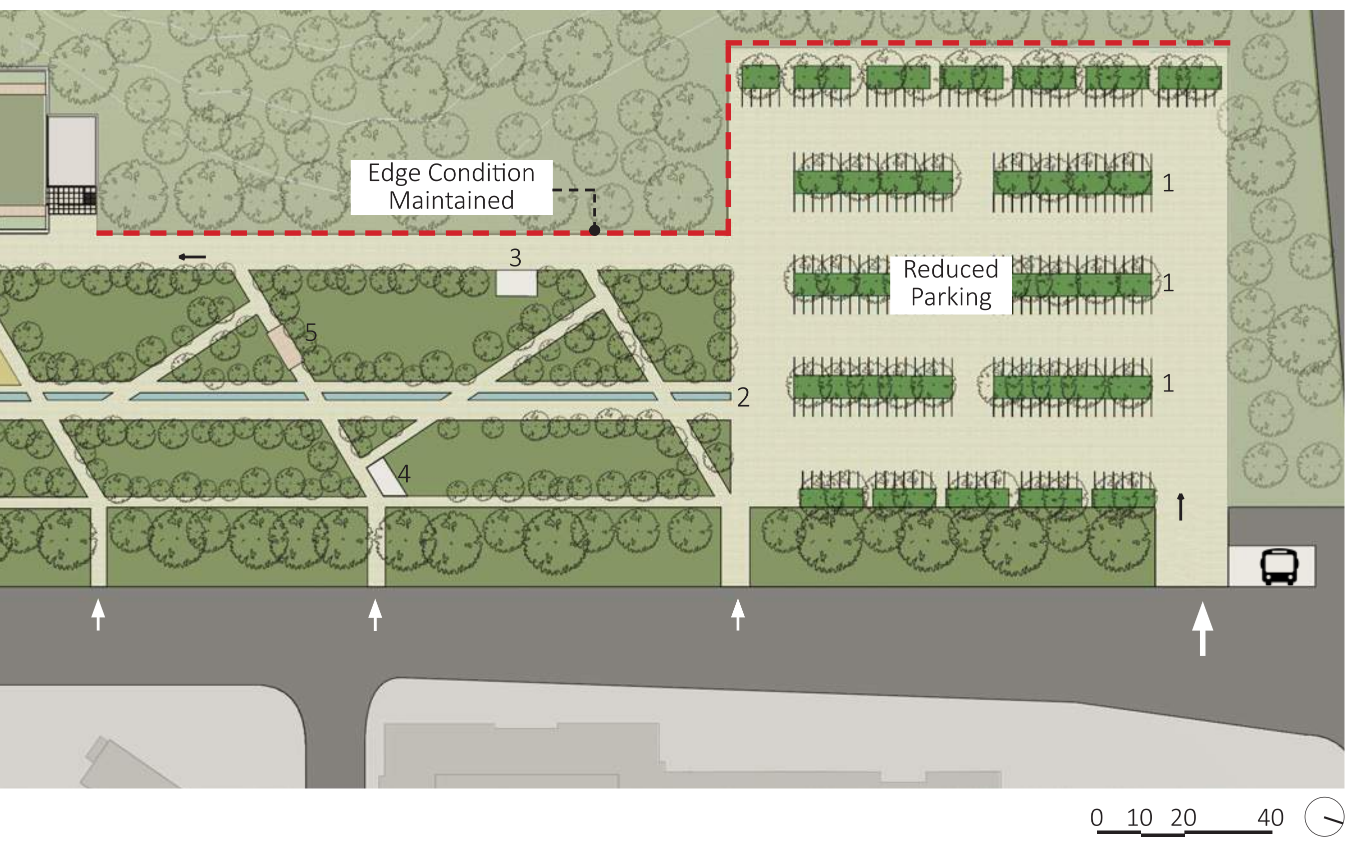
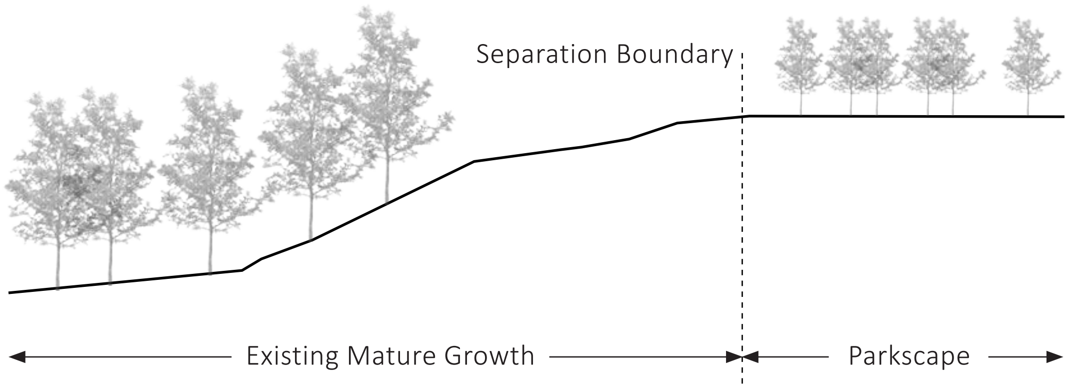


Figure 73: Parkscape plan.

The parkscape's design is to be developed alongside specialists in ecology and adjacent community members. This ensures that the design operates with the site's natural systems and meets the demands of the local demographic.

Elements of the parkscape are to be introduced to the site in phases, allowing the site to respond to the changing context. In this way, the park accepts that it will be in a constant state of evolution, absorbing and accommodating the natural systems as well as the needs of the community. The design features ample open programmed spaces and loosely programmed landscaping in anticipation of future changes.





74.Existing site and parkscape boundary.

The transformation of the flat, paved-over parking lot into a public parkscape acknowledges that it is reconstructed nature and not a return to an idealized pre-development ecology. It is instead a human creation and a product of culture. Therefore, the existing fenced boundary is to be maintained-separating the at-risk existing landscape from the parkscape designed for community engagement.

The experience for transit and car users begins at the reduced parking lot located on the north end of the site, where intensive use is anticipated as it is a major entry point for the Flemingdon Park neighbourhood. As visitors continue their journey south towards the building entrance, the parkscape features increasingly sensitive natural landscapes.

The vehicular street edge of Don Mills Road is planted row of woodlands to a buffer zone between the street and the parkscape and visually indicate the ecological transformation of the site to the passerby.

Additionally, social infrastructure is scattered throughout the parkscape to encourage pauses in the journey and educate visitors on the sensitivity of ecological systems in their local context. A shaded education pavilion, a community stage, and several viewpoints are proposed.

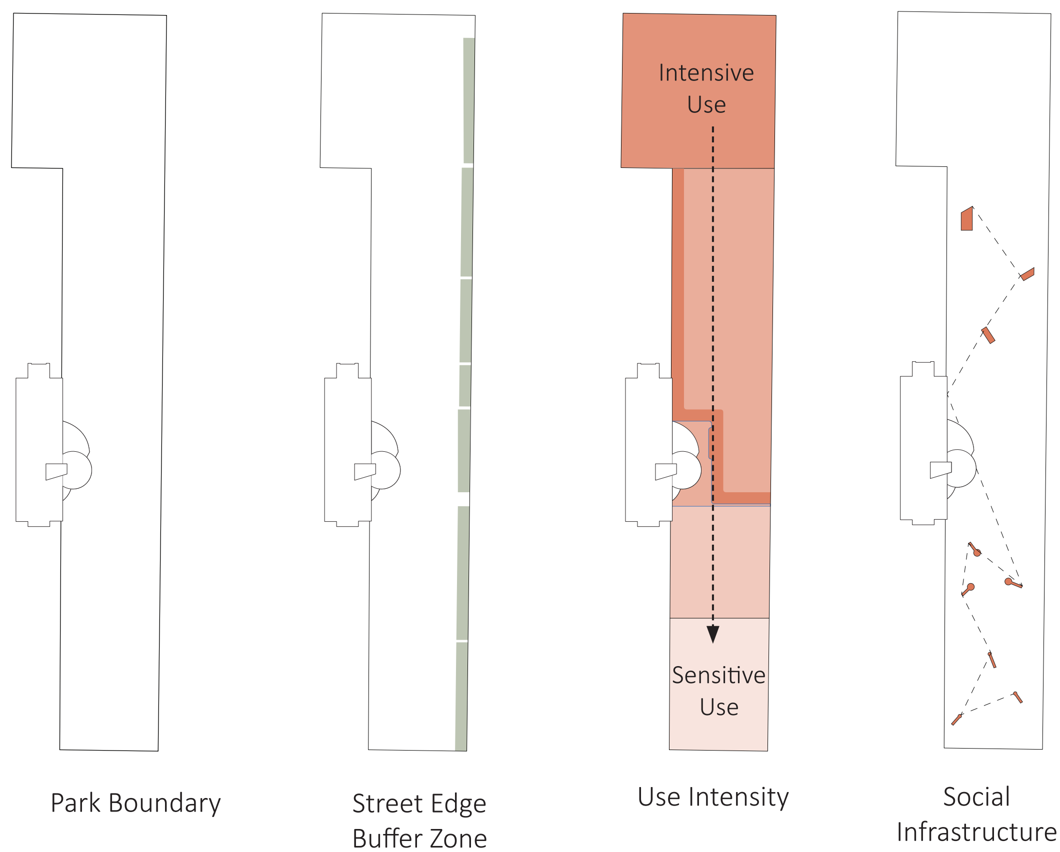


Figure: 75a: Parkscape design drivers.

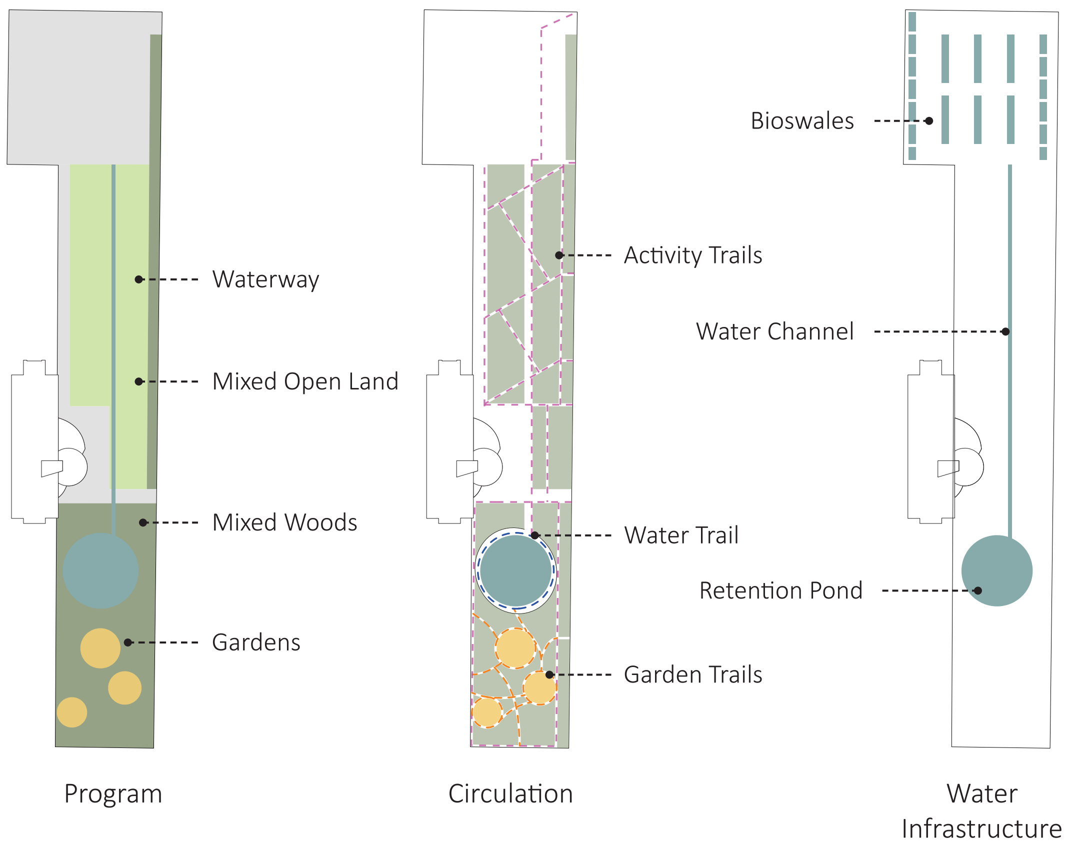
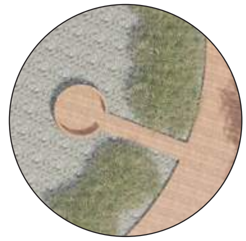


Figure: 75b: Parkscape design drivers.



Social Infrastructure Water Infrastructure Viewing Deck Butterfly Garden

Figure: 76: Parkscape areas of interest.

The parkscape introduces landscapes native to the site to strengthen the adjacent Don River's natural infrastructure. Landscapes native to the area include open land, mixed woods, meadow and waterway. Programmed and un-programmed activities within the parkscape expand the public realm with new recreational space in nature for the Thorncliffe and Flemingdon Park community. To work with the site's natural systems, landscape architects, landscape engineers, ecologists, and various other consultants are to be consulted as a part of the design process.

Circulation paths are integrated into the parkscape to convert the site from a separate to community-oriented pedestrian space. The parkscape design allows residents to enter the site from numerous points located along the east boundary. In addition, experiential trails, such as the activity trail along the park's perimeter, the water trail and the garden trails, provide program-specific experiences.

Water infrastructure within the parkscape increases the watershed capacity of the site and alleviates the erosion of the adjacent Don River. Bioswales in the parking area and a water channel lead rainwater to a retention pond located south of the site. The pond filters the collected water with plants through the process of pytho-remediation.

Figure: 77: Parking lot before parkscape intervention.

Figure 78: Performance Area.

Figure 79: Water retention pond.

Various recreational activity spaces, landscapes and social infrastructure are proposed within the parkscape to encourage activity and facilitate social exchanges. The open programming of the design allows for varied activities such as picnics, watching outdoor performances, or celebrating festivals. The design proposal imagines the water retention pond as a space where visitors can become aware of the water management strategy and celebrate the connection with the Don River and the city's open spaces. Environmental protective and restorative strategies utilized within the parkscape provide educational opportunities for visitors of the site.

Entry Building Stacked Addition

A two-storey stacked addition is superimposed on the existing concrete massing at the entry building. The addition uses the strength of a found architecture to add complementary functions and visually presents an ecological perspective through a display of experimental materials and design choices. Its structure, vertical circulation, skylight and glass floor reference the original architecture of the entry building below.

The addition creates a platform for leading-edge building practices by combining research and community functions. Using experimental materials and building practices, the addition acknowledges the energy exchanges inherent to the act of building. Such materials also support the local economy. The didactic methodology facilitates social exchanges and creates a 'living laboratory' for ecologically responsible building practices. The addition features an open plan structural grid to allow for flexibility of uses. In this way, the new structure is able to adapt to the evolving needs of its users and the community, and the building's function within the integrated social infrastructure can be adjusted according to future requirements.

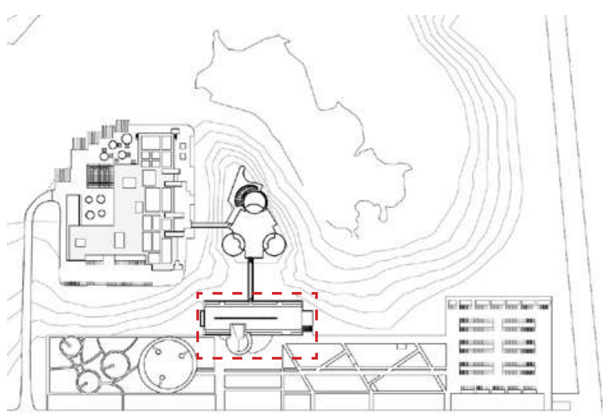


Figure 80: Entry building addition.

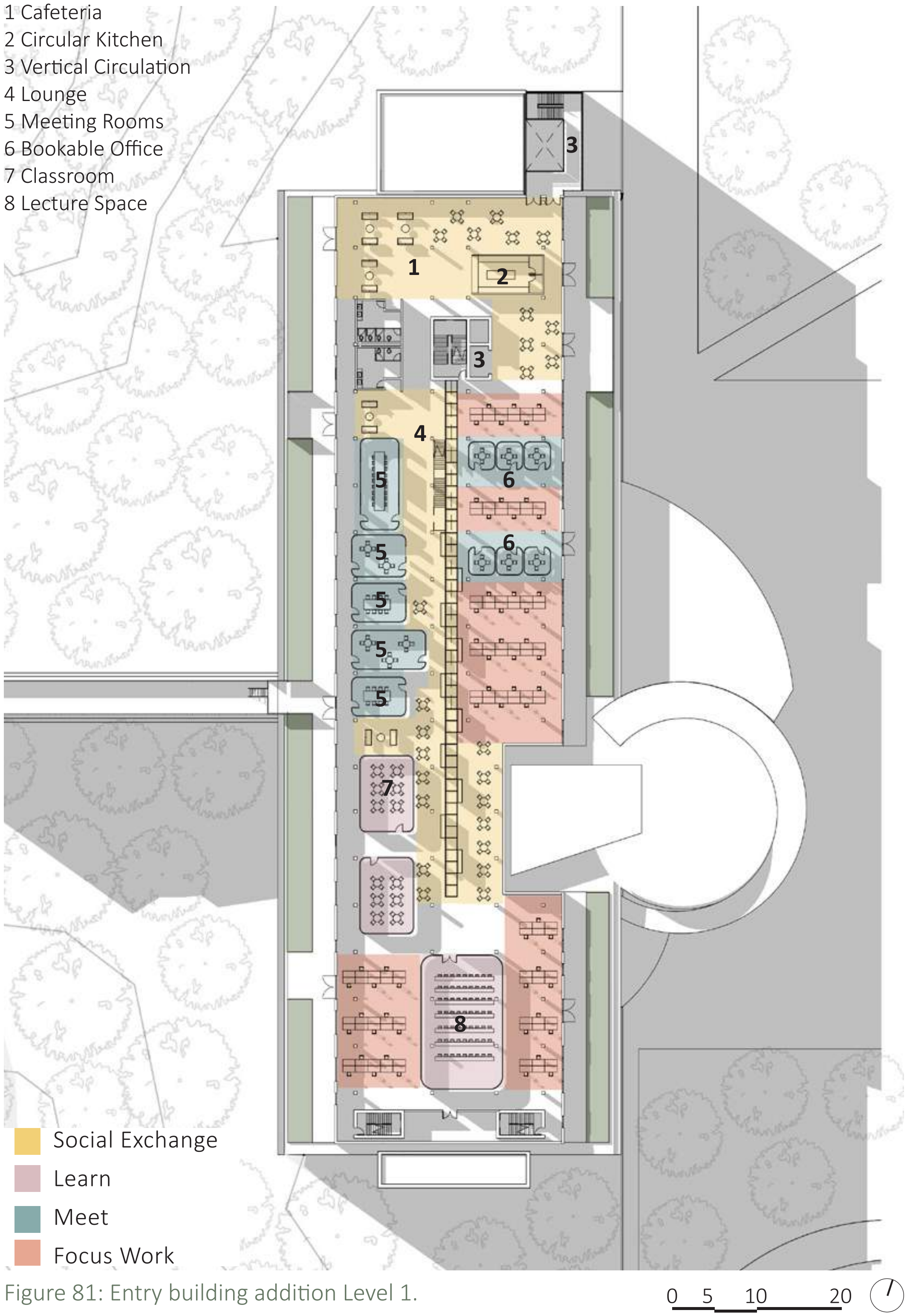


Figure 81: Entry building addition Level 1.

Figure 82: Entry building addition atrium.

The entry building uses the existing structure's strength, taking design clues from its concrete piers' three meter spacing to create a lighter timber column structure above. The carbon-sequestering addition features a six meter by nine meter grid at its largest span, allowing for a variety of functions within the building.

The Ontario Science Centre's current program is expanded to include a larger fraction of the learning community, such as university students, scientists, researchers, and community members, in addition to the children-focused programming, to maximize the variety of users on the site. The proposed functions of research, education, collaboration and socialization open the building up to the community and create public and private spaces, encouraging social exchanges amongst a mixed group of users.

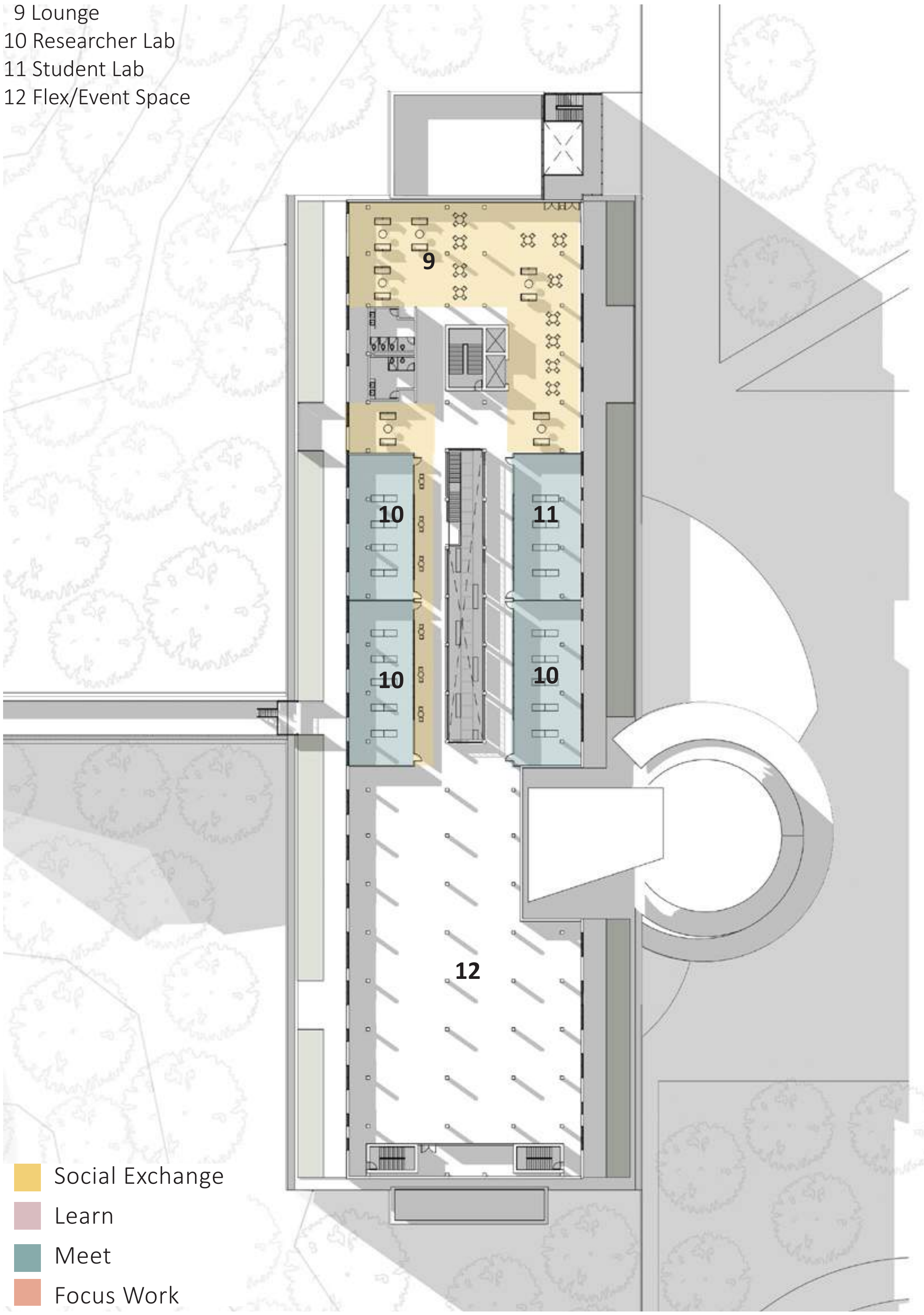


Figure 83: Entry building addition Level 2.

Figure 84: Entry building addition workspace.

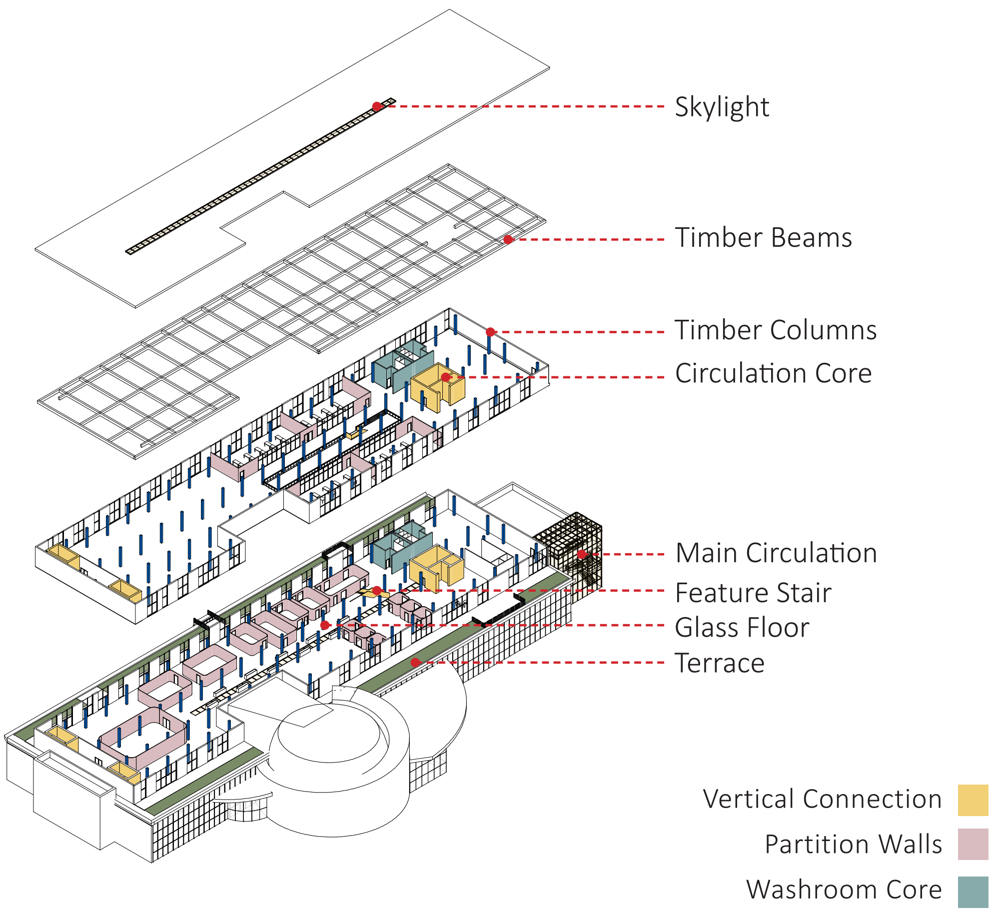


Figure 85: Entry building addition axonometric.


Figure 86: Entry building addition terrace.

Through an understanding of energy associated with the act of building, the addition integrates local, repurposed, and bio-materials to minimize the embodied carbon of the building additions. The addition's facades feature materials explored in recent experimental projects to demonstrate the potential of carbon emissions reduction. With the patchwork of materials expressed, the facade becomes a didactic and tactile celebration of materials, contrasting the renovated glazed entrance below. A roof terrace surrounds the addition to provide an intermediate zone for visitors to experience the experimental materials' application up-close. The roof terrace also features planting to support the watershed capacity of the site.

The terrace connects to the site's public circulation path leading visitors to the trillium building rooftop through an outdoor bridge pathway. A stair from the trillium building rooftop leads the public to its terrace. The public pathway provides unique views of the surrounding context while allowing the public to circulate through the site without entering the ticketed buildings.

Figure 87: Public bridge to trillium building.

Trillium Building Glazed Extension

The glazed extension of the trillium building expresses an ecological perspective, enhancing the performance of a found architecture through an understanding of energy exchanges. The concrete facade of the trillium building is extended in the southwest direction with glazing, utilizing heat gains to moderate the temperature of the building. As a result, the building performs more efficiently by reducing the energy consumed for its operation. The extension also converts the inward-looking space of the trillium building into a light-filled atrium that connects to the surrounding ecological context. During the summer months, operable glazing and vegetated facade screens reduce undesirable solar heat gains. The glazed extension incorporates community uses to allow the residents to experience their ecological context and facilitate social exchanges. The extension utilizes Canadian timber as the primary structural material to reflect the formal character of the existing building and to highlight the capacities of the bio-material.

The atrium is connected to the public circulation route, providing a break in the visitors' journey through the site with a programmed cafe and seating space. The space is flexible in its design and can be converted to serve additional functions such as an event space or gallery.

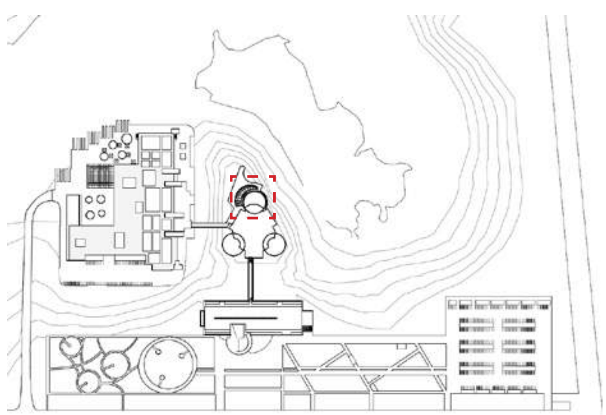


Figure 88: Trillium building extension atrium.

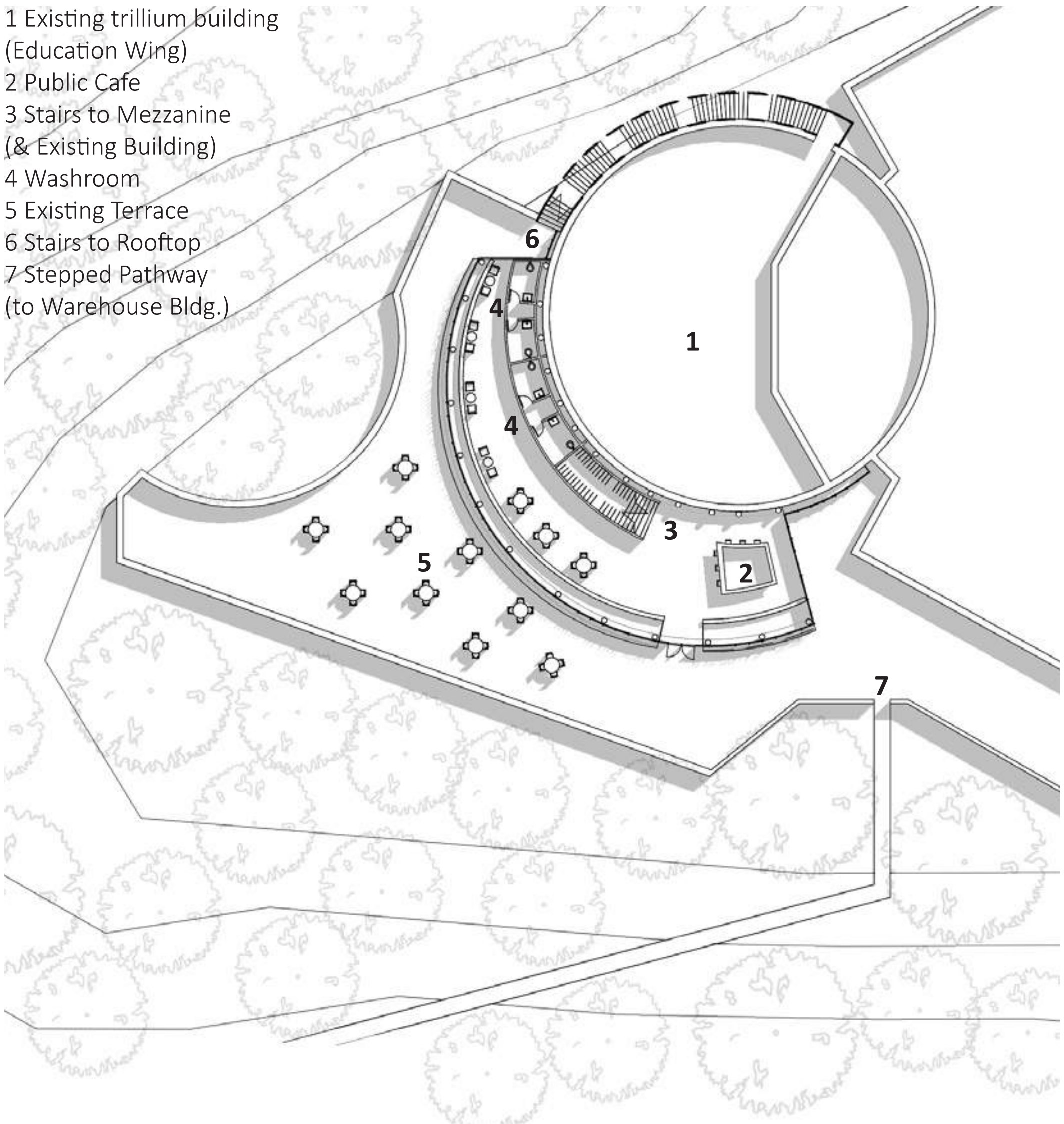


Figure 89: Trillium building extension plan.

Figure 90: Trillium building terrace before glazed extension intervention.

Figure 91: Trillium building extension with hops vines growing on cable elements.

The glazed space draws visitors' attention to the surrounding ecological context through ample daylighting and views. The space generates unique sight lines to the adjacent wetland and ravine from the second storey mezzanine. The unique and compelling space creates a feeling of interconnectedness within an open, collaborative and social atmosphere. From this roof terrace, a stepped outdoor pathway circulates visitors to the warehouse building.

Warehouse Building Urban Farming

The warehouse building's vacant rooftop is converted into a productive landscape of an urban farm. The conversion insulates the concrete structure below from heat loss and increases the site's stormwater retention and carbon absorption capacities. In addition, solar panels are introduced on parts of the roof to generate renewable energy on-site for the future operation of the Centre. Urban farming further reduces the city's contribution to greenhouse gases by eliminating the transportation energy required to move food from rural areas to urban contexts. It also benefits the natural environment through increased biodiversity and lowered heat island effect.

Furthering the thinking of energy flows, a 'zero' pollution growing system can become an educational experience where visitors learn about waste reuse and reducing energy and water use through circular practices. In addition, urban farming cultivates neighbourhood development through gathering and community engagement. The participatory programming increases the public's understanding of the urban natural environment and natural resource consumption reduction, creating a valuable opportunity for social exchanges.

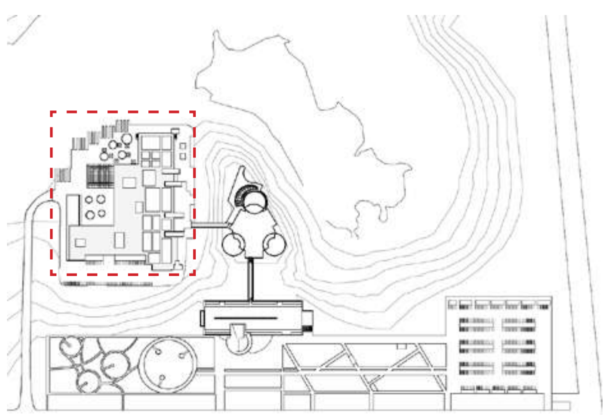


Figure 92: Warehouse building rooftop urban farm and buffer edge.

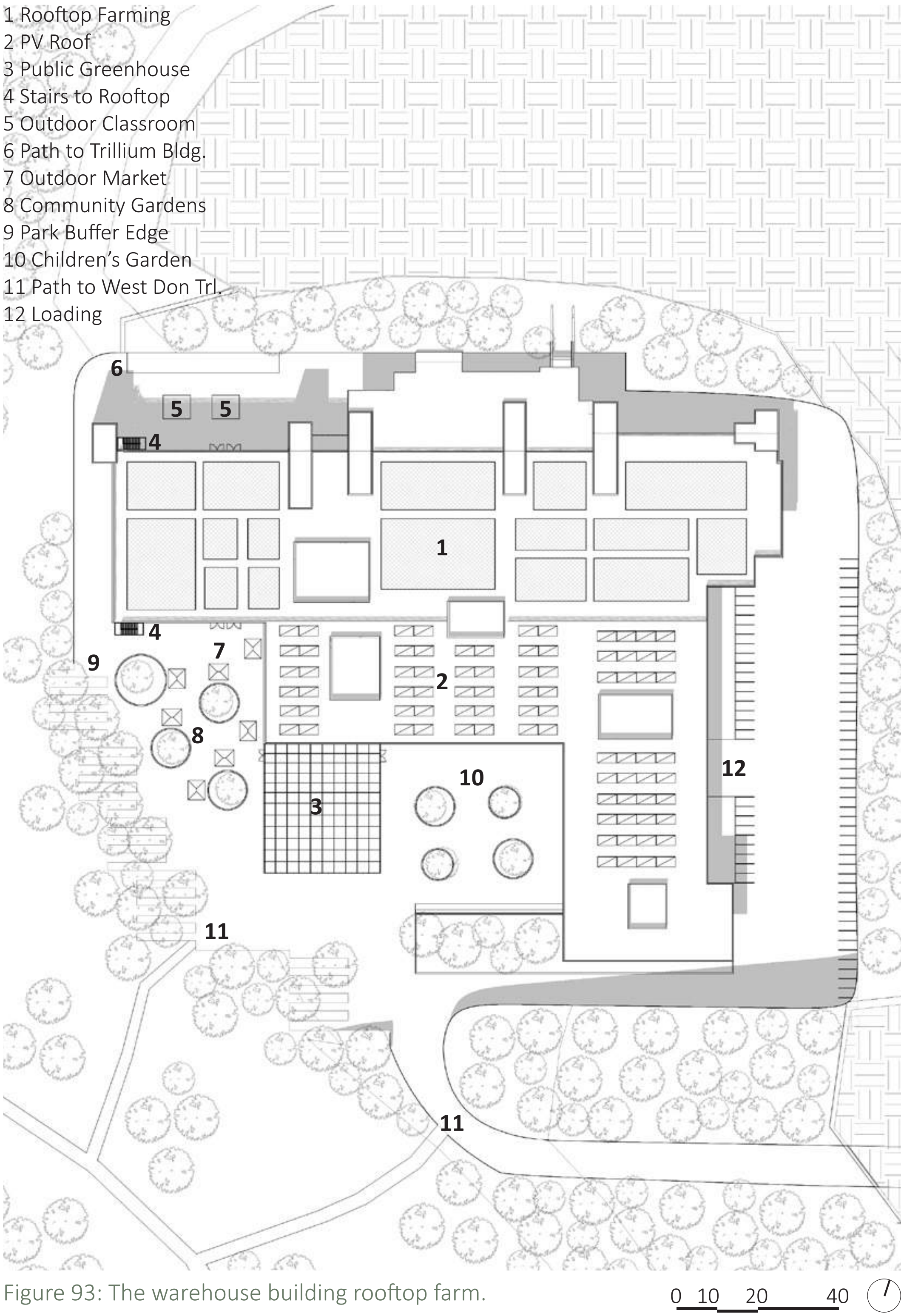


Figure 93: The warehouse building rooftop farm.

Figure 94: Warehouse lot
before intervention.

Figure 95: Warehouse building outdoor farmer's market.

The paved space around the warehouse building is transformed into temporary public markets in the summer months. The market allows community members to purchase locally grown produce cultivated on site. The rooftop farm and greenhouse also support the indoor market space proposed in the warehouse building, the existing restaurant in the warehouse building, and the cafeteria proposed for the entry building addition. The urban farm and its market areas activate the space and open up the Centre to the community.

Figure 96: Aerial view of OSC transformation.

TOWARDS AN ECOCENE

Reflections

Throughout the course of this thesis, I have attempted to define a method for architecture to operate within the planetary ecological limits. 'What is hyper-ecological architecture?' was a question that was consistently asked, and its answer was refined each time. Rather than trying to solve the climate crisis through a new construct of a 'hyper-ecological architecture,' the thesis views the existing built and natural infrastructure through the unique lens of conserving the existing energy, social, and natural infrastructure to extract their hidden potential. The final chapter's title, "Towards an Ecocene," suggests that there is no one specific solution to counter the rapid degradation of ecological systems. Rather, an interdependent collection of forward-thinking ideas can empower the shifting paradigm.

Until recently, contemporary sustainable practice has been predominantly focused on performance energy expenditures associated with buildings. This thesis investigates the potential of architecture to reconsider and re-deploy the embodied energy of the building and site in all its forms. It argues for the conservation of the existing built infrastructure, including the preservation of the Brutalist Ontario Science Centre landmark in the proposed revitalization project. The design utilizes the opportunity for the Brutalist heritage building to serve as a cultural resource within the community and maintain the architectural icon that is unique to the ravine context.

The proposal creates a platform where elements of nature, people and materials are brought together in one communal space, choreographing social exchanges. The twenty-first century ecological focus is translated into the design, emphasizing the societal changes that have taken place since the Centre's conception in the twentieth century. The intervention engages the site through a pedestrian-oriented focus, upgrading the building and site's performance, use and access through layered programs and circulation to enhance the Ontario Science Centre's role within its social and ecological context. The program includes a variety of mixed users and uses in the form of recreational and gathering spaces for the public, along with workspaces for students and researchers. The site-specific program considers the identity of the adjacent neighbourhoods, illustrating how existing built infrastructure can be integrated into the social fabric of a place to support communities, activate the site, and catalyze future growth. Through ecological building strategies, the transformation of the underutilized landscape becomes a didactic demonstration of how architectural interventions can maximize the potential of the site.

The Ontario Science Centre building and site revitalization provides a prototype and exemplar for the Ecocene due to its scalability in regards to its Brutalist structure and ravine context that exists across Toronto. Primarily designed during the centennial, Ontario’s numerous Brutalist structures contain untapped latent structural and thermal capacities that present opportunities for retrofit to improve their function and performance. Additionally, the project becomes a prototype for ecological reinforcement, which can be applied to the many sites within Toronto’s ravine network.

As the pressures on the built and natural environments increase, it becomes crucial that architecture operates within the planet’s ecological limits. In future practice, the existing built and natural infrastructures must be preserved, and architects must attempt to cultivate deeper connections between people and the environments that surround them. Through such architectural ventures, humans can become open to the interconnected state of the planet. This thesis presents the potential of urban transformations to accommodate the needs of the community and ecology in hopes that it can inspire architects, planners and policymakers to advocate for collective thinking that shifts the planet towards an Ecocene.

GLOSSARY

Anthropocene

The current geologic epoch where human activity is significantly changing the planet's climate and ecosystems. This thesis critiques the anthropocentric world view that is resulting in the rapid degradation of the natural environment. Instead, the thesis aims to shift towards an Ecocene.

Ecocene

The subsequent geologic epoch where a contemporary understanding of ecology transforms human culture (in this case architecture) towards creative design solutions and practices that operate within the limits of Earth's natural systems. The Ecocene redefines our current relationship with nature in order to survive the Anthropocene.

Ecology

The study of interrelationships between organisms and their physical environment in the natural world.

Embodied energy/carbon

The energy used in the process of producing a material or component, resulting in carbon dioxide emissions.

Human culture

Human culture encompasses all of human made creations and social beliefs.

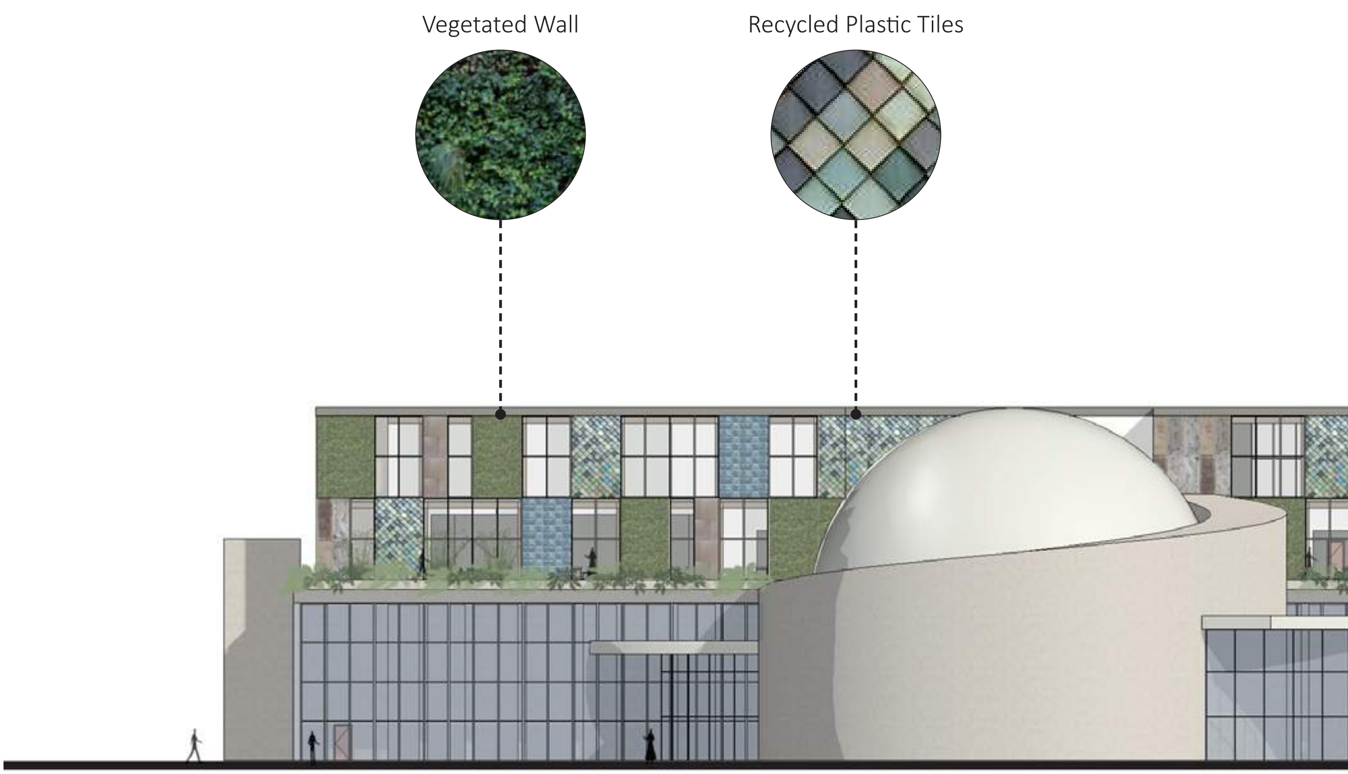
Hyper-ecological architecture

Hyper-ecological architecture embodies a sensitive method of inhabiting the planet by viewing the building as expanding beyond its physical boundaries to inform an ecologically and socially integrated approach to design.

Nature

The phenomena of the physical world collectively, including plants, animals, the landscape, and other features and products of the earth.

APPENDIX



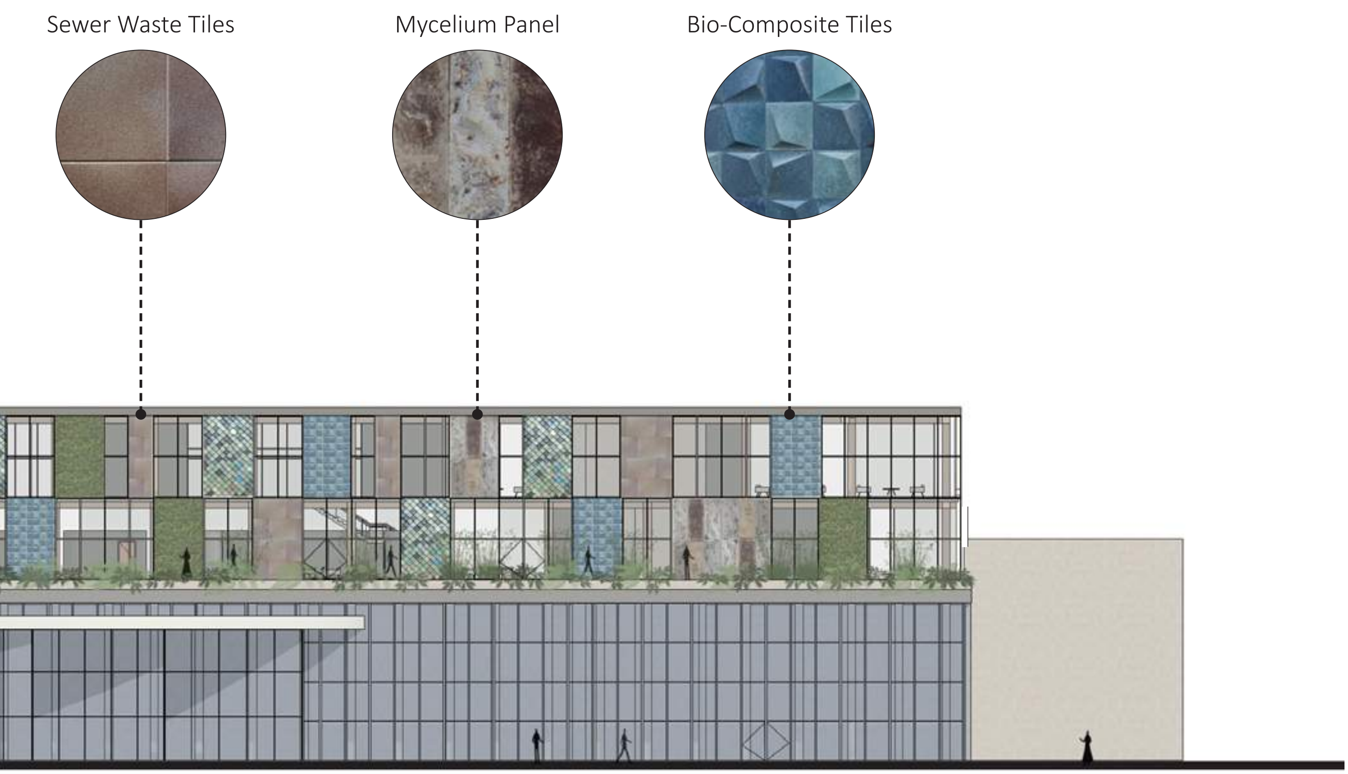
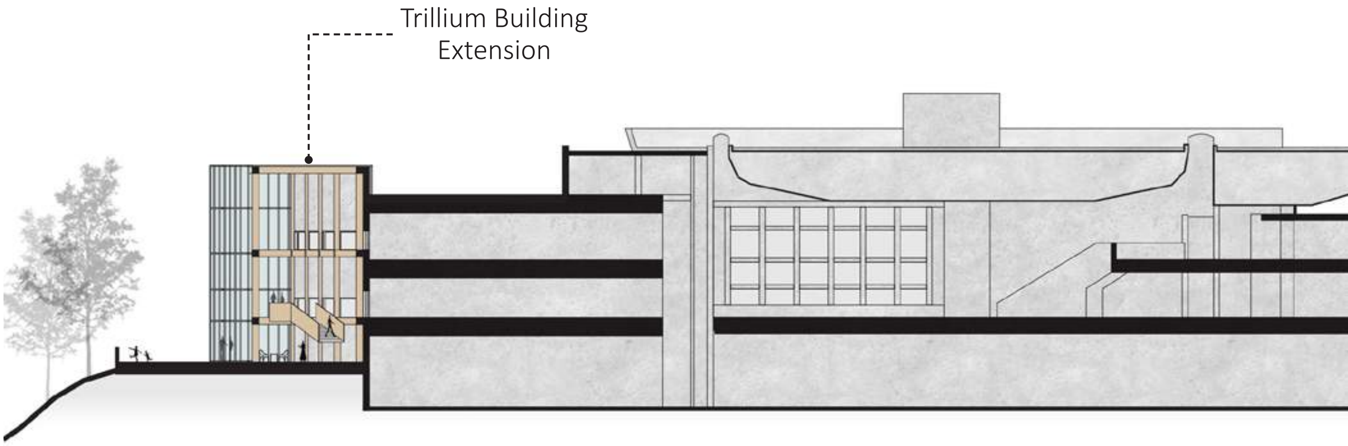


Figure 97: Entry building addition facade.


Trillium Building
Extension

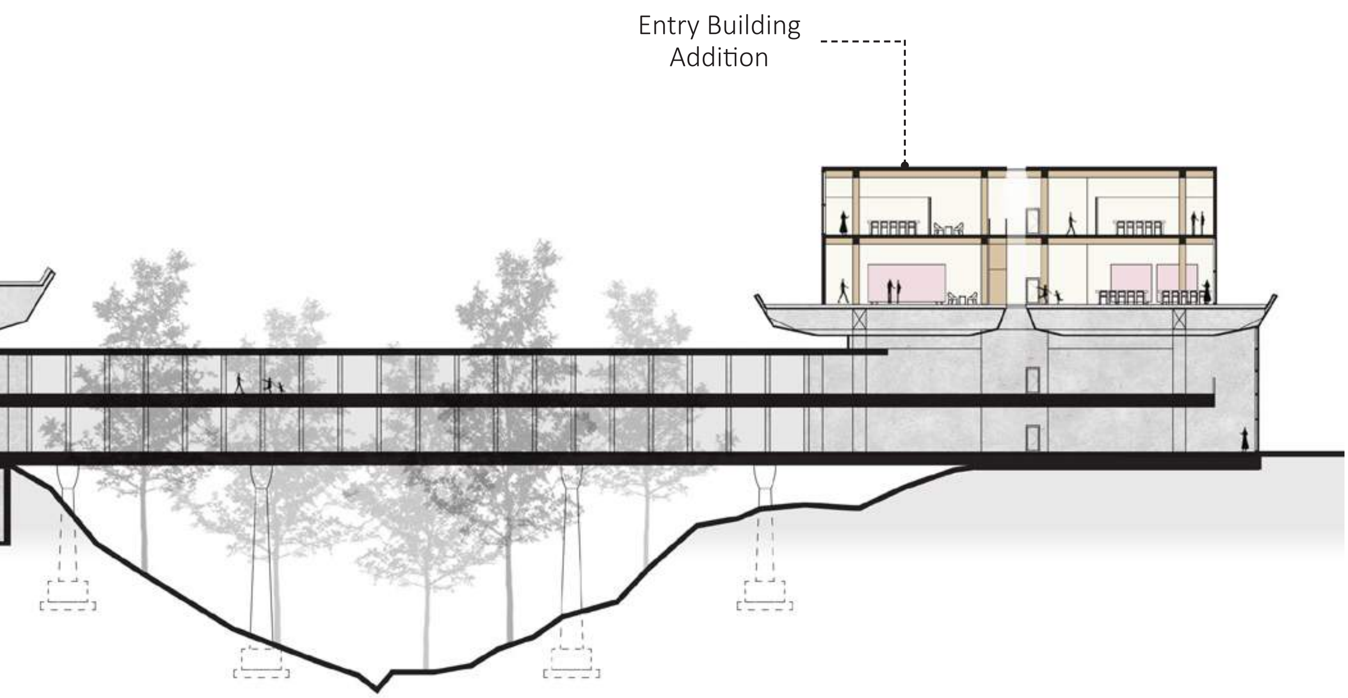


Figure 98: Section of the addition in relation to the existing massing.

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