URBAN SPINE:

A PEDESTRIAN-ORIENTED MULTI-MODAL TRANSPORTATION INFRASTRUCTURE

FOR IMPROVING HEALTH AND WELL-BEING IN THE URBAN ENVIRONMENT

HAWAIʻI AT MĀNOA

A DARCH PROJECT SUBMITTED TO THE GRADUATE DIVISION OF THE UNIVERSITY OF HAWAI'I AT MĀNOA IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF

DOCTORATE OF ARCHITECTURE

MAY 2017

By

Vincent Au

DARCH Project Committee:

Judith Stilgenbauer, Chairperson
Josh Jackson
Claudio Nigg

Keywords: Biophilia, Transportation, Walkability, Urban Environment, Pedestrian-oriented Infrastructure, multi-modal transportation

ABSTRACT

With finite land resources and ever increasing population, urbanization continues to edge natural environments off our maps. The quality of life and well-being is deteriorated with continuous exposure to the urban environment due to the heavy saturation of stress and anxiety that comes with urban living. Stress is associated with the inherent flight-or-fight reaction that humans have developed through evolution in the natural environment. The contamination of stress inducing stimuli in the urban environment has driving people into sedentary lifestyles, remain indoors within the safe confines of building. Mitigating the magnitude of stressful interactions in the urban landscape, many which are caused by automobiles, will encourage a return to the outdoor environment. The re-integration of naturalistic experiences into the environment will improve the quality of urban life. A shift of the urban landscape toward a pedestrian-orientation, through the promotion of walkability, can ameliorate the adverse impacts caused by automobile centric behavior and cultivate the streetscape as a canvas for experiencing naturalistic features and characteristics that support the health and well-being of the urban dweller – not only ensuring survival but granting the opportunity to flourish.

List of Figures

CONTENTS

1 INTRODUCTION

The experience of the urban environment, what lays outside and in-between the inhabited structures, often hosts a magnitude of detrimental side-effects. The urban environment is mostly experienced while one is in transition, moving from destination to destination, event to event, or activity to activity. The experience of what happens in-between is often neglected and unaccounted for as it happens through necessity rather than voluntarily.

The environment has only recently (in relationship to the arrival of homos-sapiens) shifted away from supporting human life. The advent of the automobile has allowed people to inhabit and interact with the environment in increasingly unsustainable means. The automobile centric lifestyle has sculpted the environment to host steel beasts. Automobiles inhabit and dominate the space in-between buildings, they are prioritized over the pedestrian, the human. The steel beasts roar through the streets, leaving death and decay in their wake, causing a constant activation of our flight-or-fight mechanism. These steel beasts have an insatiable thirst for paving over nature, driving urban dwellers further and further away from the experiences that has allowed the human species to thrive and prosper.

Experiencing nature and natural phenomena have beneficial effects on human health and well-being; inversely the experience of the urban environment and automobiles have a harmful effect. A contributing factor to the loss of these naturalistic experiences is connected the quality of walkability in the urban environment. Why would one elect to walk over driving? Who would walk and why are they walking? Where to? What are they walking for…? To some, the notion of walking is repulsive, or too strenuous and efficient, it is not an attractive or popular option but that can change.

Walking is a healthy way to experience the environment around us but what is the experience that is being offered? How can walking become more attractive than driving around in a fast car? The desire to walk or use active transportation modes maybe unappealing due to the lack of quality provisions. In many cases, there are not enough opportunities that are dedicated for it use. Pedestrian and active transportation paths are not often separated enough from the realm of the steel beasts and are seldom given the priority. Cultivating a space that prioritizes

pedestrian activity may increase its favor. A separate realm that belongs to the pedestrian, one that is impediment free, without the need for constant head checking or stifling stoplights and crosswalks that one stranded in the heat, may start to sound like an attractive option.

A pedestrian-oriented multi-modal transportation infrastructure can provide this democratic form of mobility in the urban landscape. In the form of an elevated platform, such a structure will act as a sort of refuge, an oasis in the exhausting demands of urban living. A pedestrian infrastructure can function as more than a mere transportation route, it can create opportunities for social interaction, outdoor activity, become preparatory space before arriving at an intended destination, and most importantly facilitate physical and mental restoration. Nodes or stops along the way may function as restorative checkpoints, taking advantage of the surrounding context and naturalistic features to trigger innate restorative reactions embedded from eons of evolution dwelling in naturalistic landscapes.

Experiencing naturalistic features and characteristics have been proven to have beneficial effects on human health and well-being. Integrating the concept of biophilia into the design of the urban environment will increased the attractiveness of walking and desire for interaction, providing well-being benefits from innate responses to biophilic stimuli as well as from the increased physical activity itself. These strategies for improving health and well-being in the urban environment will be explored further as a design prototype for Urban Honolulu. The tropical climate of Hawai‘i is opportune for outdoor activity and dwelling in the urban landscape. However, the rapid development and growth of Honolulu’s urban core as has transformed the tropical paradise into a concrete jungle overrun by steel beasts. The implementation of a pedestrian-oriented multi-modal transportation in urban Honolulu, along University Avenue can re-establish a symbiotic relationship between man and the natural environment.

The mauka to makai axis (mountain to ocean) produces many opportunities for visual connections with the surrounding natural landscape. At the mauka end of University Avenue is the University of Hawai‘i at MĀNOA. The commuter campus and student populate make for an ideal launching point, as well as for creating an imageable landmark that serves as recognizable entrance to the campus and infrastructure alike. There is also an opportunity to address the man-made

impediment that is the Ala Wai Canal found at the end of University Avenue. The Ala Wai Canal has the potential to become a transit hub, transforming the Ala Wai from a place often avoided into an attractive destination. Water-based transportation as well as a possible cable propelled transportation system (CPT) are possible opportunities that will be explored. The canal can be utilized as an effective transportation line rather, echoing Hawaiian tradition and culture to create a minimal impact, minimally invasive solution.

In between the university and the canal, University Avenue intersects multiple communities, each with a distinct identity. Along this axis is are also a plethora of amenities and services that may suggest high walkability; however, these communities and amenities are divided and stifled by the H1-Interstate Highway as well as multiple high volume traffic arterials that intersect them. The heavy vehicular presences and activity along University Avenue greatly reduce the appeal for walking and use of active transportation such as bicycles. A prototype pedestrian-oriented infrastructure can be utilized to ameliorate the deterring qualities of automobile prioritization to create a connective network along to diverse corridor to cultivate healthy and flourish urban environments for urban dwellers.

1.1 Overview of the impacts of the Urban Environment

The urban lifestyle is attractive, it promises efficiency, connectivity, and prosperity. Urbanization has been another step toward insuring human survival. However, on the journey for survival, it seems that humankind has lost sight on the roots of well-being. The ever-increasing rise in Urban Living is paralleled with the fall of the natural environment. The rapid pace of urbanization over the past 30 years, has been indicative of a global societal transition. Urban, as defined by Merriam-Webster, means "of, relating to, characteristic of, or constituting a city."[1] Environment, as defined by Merriam-Webster, is: "1: The circumstances, objects, or conditions by which one is surrounded. 2 a: the complex of physical, chemical, and biotic factors (as climate, soil, and living things) tat act upon an organism or an ecological community and ultimately determine its form and survival. b: the aggregate of social and cultural conditions that influence the life of an individual or community."[2] In the

[1] "Urban." Accessed December 22, 2016, https://www.merriam-webster.com/dictionary/urban
[2] "Environment." Accessed December 22, 2016, https://www.merriam-webster.com/dictionary/environment

context of this paper, the urban environment refers to a physical manifestation of space that includes land use patterns, man-made or built features, elements of nature, and transportation systems. Shifts world-wide toward an urban lifestyle and the continued densification of urban environments supports the constant concern of population growth, optimized to satisfy human survival needs but not necessarily well-being.

This shift toward an increasingly urbanized lifestyle has promised greater survival rates of the human species, often haphazardly, without consideration and understanding of the impacts imposed on the living components it encompasses and surrounds. It is also remiss of the species to which it caters, consequently increasing exposure to stress, producing detrimental side-effects on human health and well-being. Stress, as defined by Merriam-Webster is "a physical, chemical, or emotional factor that causes bodily or mental tension and may be a factor in disease causation."[3] It is the experience of involuntary physiological and psychological reactions to the perception of threats toward well-being – physical, psychological or social health and integrity. Urban living can produce stress if personal space is perceived as inadequate, safety is uncertain, or economic condition is poor. Stress can also be triggered by the anticipation of adverse situations and the fear of inadequate resources to respond to them. Through evolution, stress has served as a naturally functioning mechanism that induces the 'fight-or-flight' reaction, encouraging adaptation. As a survival tool stress is not necessarily a detrimental, however, well-being is greatly jeopardized when exposed to chronic stress without the opportunity to completely recover.[4]

The increased focus on human health with the aid of technological advancements has yielded research that has revealed the impact of the environment's ability to increase or reduce stress. The experiencing of the environment extends beyond the senses – optical, auditory, haptic, olfactory, and/or gustatory – at any given moment and effects not only mood, but significantly influences physiological functions such as the nervous, endocrine, and immune systems. The stress induced by an unpleasant

[3] "Stress." Accessed December 22, 2016. Accessed December 22, 2016, https://www.merriam-webster.com/dictionary/stress

[4] Adli, Mazda. 2011. *Urban Stress and Mental Health.* November. Accessed 11 10, 2016. https://lsecities.net/media/objects/articles/urban-stress-and-mental-health/en-gb/

environment will foster anxiety and depression which leads to elevation in blood pressure, heart rate, muscle tension, and the suppression of the immune system.[5] In contrast, an environment that is perceived to be pleasing induces the opposite effect. In a study cited in *Healing Gardens*, discovered that over two-thirds of the participates chose to retreat to a natural when stressed because nature is found to be universally pleasing.[6]

Experiencing the urban environment can be perceived to be stressful and often uncomfortable. People travel from event to event, destination to destination and the experience in-between is polluted with stress and anxiety, from the agony of traffic congestion, limitations of parking availability, sardine packed bus rides, dangerous crosshairs of circulation paths, and poor pedestrian considerations. These experiences leave one depleted upon arrival to destinations, reducing performance ability and overall well-being.

The recent approach to dwelling in the urban environment is far disconnected from the environment that has supported evolution and allowed for the human species to thrive for thousands of years.[7] There are far more experiences that trigger unpleasant responses opposed to pleasant, largely because the urban environment is built around the function of automobiles. Over-dependence of automobiles have fostered unattractive streets for pedestrians and has crippled the ability to walk, cultivating obesity and a host of other related illnesses. The lack of natural (physical) activity within the environment has driven obesity and chronic diseases that include: high cholesterol and blood pressure, type-2 diabetes, sleep apnea, asthma and liver disease.[8] Compounding on top of the detrimental side-effects on physical health, the automobile has steered the creation of inhospitable landscapes for pedestrians and active lifestyles.

---

[5] University of Minnesota. 2014. *How Does Nature Impact Our Wellbeing?* June 25. Accessed 11 10, 2016. http://www.takingcharge.csh.umn.edu/enhance-your-wellbeing/environment/nature-and-us/how-does-nature-impact-our-wellbeing

[6] Marcus and Barnes, *Healing Gardens: therapeutic benefits and design recommendations.6-9*

[7] Browning, Ryan, Clancy. *14 Patterns of Biophilic Design.* New York: Terrapin Bright Green LLC. 46

[8] "Caring for Our Common Home: the Challenge." Crowhurst Lennard. November 27, 2016. http://www.livablecities.org/articles/caring-our-common-home-challenge.

1.2 Research Methodology

This paper will analyze the human evolutionary history with the environment and how the current urban environment is counter-intuitive to evolved preferences, causing negative impacts on human health and well-being. Research by experts have quantified characteristics and qualities of the environment and its impact on health and well-being. The understanding and incorporation of evolved preferences and the human condition will make it possible to devise design strategies to adapt and optimize the urban environment to not only insure survival but the opportunity to flourish.

To cultivate a dwelling environment that emulates the preferences humankind has evolved to thrive and flourish in, this paper will draw on the wealth of studies that attempt to measure and quantify the effects the presence of nature and natural characteristics have versus the effects of urban characteristics. An understanding of urban planning best practices and concepts will help to actualize the needs of living in urban settings in support or remiss of characteristics that support and promote human health and well-being. There is an increasing amount of interventions in urban environments that begin to address this issue, serving as precedents to support the necessity for change, of the built form and lifestyles.

The results of these studies will be applied toward cultivating active lifestyles and promoting pedestrian oriented design in the urban landscape of Honolulu, Hawai‘i. A place where people once fostered a deep connection and understanding of the natural environment and systems.

2 HISTORY OF THE DWELLER

2.1 Evolution from Nature

As we continue in our journey of evolution, venturing in the built environment and further away from the natural, we become increasingly disconnected with the qualities of the habitat that we have evolved to thrive and flourish in. Fortunately, nature has compiled a manuscript throughout the course of human evolution, an intuitive guide to habitat quality through our emotions. Neurological signals induce positive emotional states of pleasure and interest toward resource rich environments, indications of increased chances of survival and well-being. While the evocation of negative emotional states serve as caution signs of threats, harm and discomfort.[9] The "savannah hypothesis", as discussed by Gordon Orians and Judith Heerwagen, suggests humans intrinsically prefer environments that emulate characteristics and qualities of the African savannah that provide the greatest survival rates and promote well-being.[10]

Ecologist Gordon Orians also draws on the habitat selection theory to argue that human physiology is adapted to prefer landscape features that exhibit the characteristic of the African savannah, the theoretical origin of evolution. Orians argues that despite the current variety of environments that humans inhabit today, the evolutionary history of being mobile hunters and gatherers of the African savannahs is still embedded in deep in the human psyche.[11] In this frame of light, what is perceived is not necessarily subjective, but is objective and quantified through evolutionary preferences. Evidence exists that supports strong universal, cross-cultural patterns that quantify and objectify the perception of human behavior and preference. These patterns originate from primitive habitat preferences that have insured survival throughout the course of evolution. Since humans evolved in the natural landscape it is reasonable for the natural environment to elude to preference patterns that can be drawn on to enhance the experience of the built environment.[12]

[9] (Orians and Heerwagen, Evolved responses to landscapes 1992, 555-579)
[10] Ibid
[11] (Orians, Habitat Selection: General Theory And Application to Human Behavior 1980, 479-493)
[12] (Browning, Ryan and Clancy 2014)

2.2 Affinity for Nature

Erich Fromm, a social psychologist, coined the term biophilia from the Greek, meaning the love for nature but it was Edward O. Wilson, an American biologist, who popularized the term in the 1980s. He sought to pioneer a new school of thought that focused on returning humankind to a connection with nature after realizing the implications of departing from the evolutionary environment. The concept of biophilia implies that humans have evolved a biological need to have a connection with nature on a physical, mental, and social level. This desire directly impacts personal well-being, productivity, and societal relationships.[13]

Ornamentation and decorative patterns have historically been symbolizations of plants and animals. Themes of nature can be observed throughout the history of human civilization such as: Göbekli Tepe, characterized by stylized animal motifs, Egyptian monuments like the sphinx, Greek's adorning of temples with acanthus leaves and their origins from Vitruvius's primitive hut, to the leafy filigree representations of the Rococo.[14] Cultures around the world have also displayed an evolutionary affinity toward nature beyond ornamental representation by integrating nature within their dwellings such as: courtyard gardens, pottery, garden compositions of natural elements, and water elements.[15]

2.3 Defining Nature

What constitutes and defines what is nature or natural greatly varies. Attempting to formalize an explicit definition or an articulation of what 'nature' is and/or consists of is required to clarify the scope it will be examined through. Connotations of what is nature are often polarized extremes. One extreme only allows for the classification if it is a living organism that has not been influenced or impacted by human intervention on the environment – a narrow, linear perspective that has virtually become extinct because nearly everything on the planet has been impacted, directly, or indirectly by human inhabitation and will continue to be. This perception of nature excludes celestial objects, pets, gardens and parks, to the human species and everything that was created by the human hand. Inversely, another extreme argues

[13] (Terrapin Bright Green 2012)
[14] (Browning, Ryan and Clancy 2014)
[15] (Ibid)

for the inclusion of human intervention and everything designed and made by humans to be considered natural or a part of nature as they are an extension of the human phenotype. This perspective therefore accepts nature or natural to be inclusive of everything from computers and textbooks, to parking lots and highways.[16] The extremity and magnitude in difference between perspectives of nature convolutes the idea of experiencing nature. It can also be argued that whatever environment or conditions one is born into can be considered as natural because it is one's native environment. This idea is remiss of human biology and evolution, it is not the natural environment of the human species, but the "natural" environment for the individual.

To frame the idea of nature and natural in the light of human inhabitation of the Earth, the built environment, nature is designed and sculpted by the human hand as humans have developed an obsession with control – a "god" complex. Nature in the modern environment is designed and constructed, intentionally to serve a function or as an aesthetic feature, for resource access or navigability, or in some cases left alone either through neglect or preservation.[17] As a medium, for the purposes of this dissertation, nature will take in consideration human health and well-being. What is considered as the natural environment for humans will encompass the conditions that promote optimal health and well-being. What is considered as nature will be the living and non-living components of an ecosystems composition – inclusive of everything ranging from celestial objects, managed forests and constructed urban gardens, to emulated and conserved habitats. Emphasizing humankind's affinity with savanna landscapes, analogues of the savanna are constantly manifested, these analogies are considered as natural in this light.

Throughout history, majority of human civilization practiced an agrarian lifestyle, a symbiotic relationship with the natural environment. It has only been recent, in the past few centuries or so, that humankind began to transform the dwelling habitat into what is known as the modern city. Dwelling in the urban environment has supplanted interactions with nature with the artificial and superficial experiences that do not resonate with the evolutionary human condition. It is generally excepted that most of the world's population will migrate to an urban lifestyle. This radical shift in

[16] Ibid
[17] Ibid

habitation makes it imperative for design interventions to not only consider but integrate natural concepts that emulate the experiences that have previously shaped evolution and allowed the human species to thrive. It is a measure to ensure continued survival in parallel with promoting well-being and allowing for the opportunity to flourish.[18]

2.4 Evolution Toward the Artificial

What is known as modern civilization is a relatively recent occurrence in the timeline of human evolution. Humankind has departed from its ancestral hunter-gatherer lifestyle and environment, one that was seamlessly integrated with the natural surroundings. As previously discussed, humans have evolved from the natural environment, therefore intuitive responses to nature were developed. Humans have an innate understanding of sensory interactions with natural elements and a familiarity with spatial organizations and compositions of natural landscapes.

The industrial revolution catalyzed the shift toward: urbanization, technology, fabrication, and isolation from nature; ushering the departure from an agrarian lifestyle and active interaction with the natural environment. This rapid shift in the environment and lifestyle has not permitted the opportunity for proper adaptation, leaving urban dwellers treading in a grey sea of unfamiliar experiences.

Frederick Law Olmsted, an American landscape architect, argued that "…the enjoyment of scenery employs the mind without fatigue and yet exercises it, tranquilizes it and yet enlivens it; and thus, through the influence of the mind over the body, gives the effect of refreshing rest and reinvigoration to the whole system."[19] In the 19th Century, the rise of urban populations was accompanied by an increasing concern for health, safety and sanitation. Large public parks were implemented in response to reducing the stress imparted by urban lifestyles as a method to promote health and increase the quality of life in the grudge of city.[20] Interaction with the natural environment is a vital component to maintaining human health and well-being. As humankind progresses through its evolutionary time-line with the dwelling environment riding shotgun alongside this journey, a connection

[18] (Browning, Ryan and Clancy 2014)
[19] (Olmsted 1993)
[20] (Browning, Ryan and Clancy 2014)

with nature remains evidently important to those who critically observe and design the relationship between nature, man, and the dwelling.

John Ruskin, English painter and art critic, along with many other influential artists and designers of the Victorian era were resistant to industrial cities, they deemed them to be dehumanizing experiences. They argued that the built form should reflect the craftsman's hand, which was to be inspired by nature.[21] On the western front, the attitude toward nature began to shift in the mid-19th century. Natural landscapes were validated as subjects of art, trips up to the mountains or down to the seashore for recreation was trending; for the wealthy, in Europe and the United States, nature also became centerpieces and attractions within their own homes. Sunlight and accessible views to nature became an influential factor in hospital design as prescribed by Dr. Thomas Kirkbride, who "…believed that the beautiful setting…restored patients to a more natural balance of sense."[22] The human experience is characterized by and is characteristic of nature, human beings are essentially a complex compound of natural components and processes. The value of nature, however, gets shifted toward increasing artificial manifestations. It begins to carry superficial value, symbolic of wealth and status. This shift in value is associated with the shift in societal values as humans continue to diminish the natural environment itself.

The ensuing Art Nouveau movement of the late 19th Century continued to exemplify nature in its works. It's style, characterized by flowers, plants, and fluid forms that were explicit representations applied to interiors as well as exteriors.[23] The Museum of Applied Arts in Budapest, Hungary by Odon Lechner and Gyula Partos, completely in 1896 iterates this concept well. Antoni Gaudi is another well-known architect that drove the 19th century schools of thought that drew inspiration from nature, such as the Arts and Crafts Movement.[24] Gaudi also studied natures engineering of structures for efficiency in constructing economic architecture.[25]

[21] (Browning, Ryan and Clancy 2014)
[22] (Sternberg 2009)
[23] (Browning, Ryan and Clancy 2014)
[24] "Works of Antoni Gaudi." Unesco. Accessed December 11,2016. http://whc.unesco.org/en/list/320
[25] Joye, J. Architectural Lessons From Environmental Psychology: The Case of Biophilic Architecture 308

Figure 1: Museum of Allied Arts in Budapest by Odon Lechner and Gyula Partos, © ilaria[26]

Louis Sullivan designed with an affinity for ornamental representations of tree characteristics which continued through to Frank Lloyd Wright, who participated in establishing The Prairie School.[27] Human contact with the natural landscape continues to diminish and vanish as man continues to devise ways of artificially representing it. The perversion of nature into a man-made element further pulls humankind away from the nature-health value it once strongly coined, the relationship is not symbiotic nor equal as man now makes nature in the form of building components. These components are static formal gestures or representations, not necessarily capturing the qualities and characteristics of its nature.

[26] "2113076216_13767e050d_o" February 27, 209. Digital Image. ©ilaria. Accessed Janurary 2, 2017 <https://farm3.staticflickr.com/2115/2113076216_13767e050d_o_d.jpg>
[27] Browning, Ryan and Clancy. 14 Patterns of Biophilic Design.6-7

Figure 2: Fallingwater by Frank Lloyd Wright[28]

Wright, like his predecessors before him continued to use conceptualize nature in his works. He utilized the raw characteristics of nature such as the grain of wood and texture of brick and stone but also infused concepts of nature into the experience of space. Wright conceived his constructed spaces to embody a natural flow, exhibiting qualities which emulated those observed in nature, especially of the African savannah. View prospects were composed together with intimate refuges to offer a natural sense of comfort through the sense of safety promised by the ability to survey the surroundings simultaneously with the opportunity to retreat to shelter. Wright's Fallingwater incorporated a more stimulating spatial experience, provoking a sense of exhilarating, featuring a balcony that cantilevers over a waterfall.[29] The experience and connection with nature starts to take steps back into the built environment as dynamic experiences opposed to static facades. The concept of Wright's Broadacre City was to restore man's contact with nature.

[28] "18205225_a30031f40f_o." June 3, 2005. Digital Image. ©Robin Williams. Accessed December 3, 2016. <https://farm1.staticflickr.com/14/18205225_a30031f40f_o_d.jpg>

[29] Browning, Ryan and Clancy. 14 Patterns of Biophilic Design.7

European Modernists like Ludwig Mies van der Rohe continued to explore the spatial relationship between the built form, man, and the natural environment. Minimalization of ornamentation emphasized a focus on the experience of interior qualities and exterior space respectively. His Barcelona Pavilion, built in 1929, emphasized such relationship through the composition of glass volumes to frame exterior characteristics, while his Farnsworth House, built in 1951, defined interior and exterior explicitly by offering the opportunity to completely server or emerge with nature visually.[30] Despite the incorporation of nature in design concepts and attempts to re-integrate its place alongside humans, the value of nature in relationship to human health and well-being is still remiss, it is more or less a design element to increase the perceived value of an artificial construct.

Enter the International Style, glass buildings everywhere. Unfortunately, the characteristics of this style, especially in the interiors of commercial buildings, further disconnected human interaction with nature. Though it may be deemed as disastrous in the sense of urban design, Le Corbusier's unbuilt vision of Cité Radiant in 1924 attempted to provide connections to nature for urban dwellers by locating the structures centrally around greenery.[31] Frank Lloyd Wright's Broadacre City concept in 1932 was a response to the increasing density of cities and restore man's connection with nature.[32]However, by this junction, nature began to be packaged as a commodity or amenity rather than a necessity. In the attempt to optimize dwelling in the urban environment and the natural landscape is further diminished.

Toward the turn of the 21st century researchers began to draw a connection between the environment and productivity, especially after financial gains were realized.[33] Productivity and performance ability of building occupants became a chief directive, predicating the design imperatives in the design of buildings today. Breakthrough discoveries from researchers such as Roger Ulrich suggested the value of nature through its potential for improving recovery rates simply by providing availability of views connecting to nature.[34] The intrinsic desire for humankind to achieve optimal well-being correlates to the desire for a connection with nature. Despite the often-

[30] Ibid, 7
[31] Ibid
[32] Krier, *Urban Space*, 12)
[33] (Ibid)
[34] (Ulrich, View through a window may influence recovery from surgery 1984, 420-422)

skewed objective and application as an associative factor for economic gain, Ulrich's findings increased awareness for natures beneficial effects on human health and well-being.

A pattern of the human relationship with nature is recorded throughout the history of human civilization. It eludes to the intrinsic value placed on nature but also to the capacity people have for its neglect. Natures participation in the dwelling environment can be elucidated through further examination of the evolution of human preferences. Human intuition and neural science reveal that the connection with nature is a vital part of well-being and the ability to flourish, especially in the urban environment where these connections are few and far between.

There has been a steady growth in the body of work intersecting neuroscience and the built environment, in both research and practice. Green building standards have even begun to incorporate biophilia, particularly as a strategy to improve the indoor environmental quality and connection to place. Biophilic design is being utilized as a complementary strategy for addressing stress in the workplace, student performance, recovery in healthcare facilities, community and personal health and overall well-being. The increasing exposure of this concept will eventually leak into the minds of the public population and challenge modern society's dependency on artificial luxuries to recourse the disconnection with nature.

It is increasing important to understand the humankind's intrinsic preference for nature as natural landscapes and environments continue to diminish. The practice and implementation of biophilic design principles can, and should be an active tool in sculpting the inhabited environment. It is even more important to understand the nature of this relationship. Haphazard application into the urban fabric may serve as pleasing aesthetics but quantification of nature's characteristics as intuitively understood by the human species is vital to unlocking its true value. Knowledge of nature's relationship with human evolutionary preferences can be actualized in a contemporary language, bridging innate responses to be to the modern dwelling to optimize well-being.

2.5 Evolution of the Dwelling Environment

Planning to Survive

Since the twilight of human existence, the shelter or dwelling was imperative to survival. The concept of planning was and is a process to ensure survival. The earliest hunter-gatherers subsisted through the understanding of a mutual relationship with the natural landscape and availability of resources. Where is water? Where is food? Where is shelter? What threats exist and are there opportunities for protection?[35] The answer to these questions provided a framework to determine the environments ability to sustain and support human inhabitation as well as elude to preferences humans have developed over millenniums of symbiotic relationship with nature.

This framework for survival has not changed but the understanding of the human relationship to the surrounding environment has.[36] Availability of resources is no longer tied to a location in the natural environment; water is siphoned from where it belongs to allow people to inhabit environments that are traditionally unsupportive. Food has become an excess and no longer depends on local land fertility or the seasons, it can be artificially cooked up with a mixture of numbers and colors. Throughout most of human evolution, locations chosen for habitation met a survival criteria: proximity to water, opportunities for agriculture and storage, safety, and ability to interact and communicate with others.

Greek and Roman cities were based on the allocation of an individual's plot of land and the planning of main street arterials in a grid pattern. Water ways and natural trade routes were considerations to resource management. Establishing permanent communities called for the leveling and straightening of the natural landscape, removing rocks and trees to sculpt the surrounding environment as desired. Vertical structures such as barricades were erected for protection against the elements and threats posed by others as well as animals.[37] Survival needed planning, planning

[35] (Duhl and Sanchez 1999)
[36] (Ibid)
[37] Ibid

meant control, it was no longer about how humans adapted to the surroundings but how humans adapted the surroundings for convenience. The development of human civilization transformed the relationship with the natural environment from symbiotic to Malthusian – Thomas Malthus's proposed theory that the current rate of population increase is greater than its means of subsistence; if left unattended by either human or natural intervention, it will inevitably result in mass poverty and degradation.

Most early civilizations were also established and organized around common spaces that contextualized the human relationship to the universe and spiritual ideologies. The church or temple and other religious institutions were planned as geographic centers and were often the dominating structure. These structures provided a location for assembly and fostered interaction and activity. The Basilica of San Petronio in Bologna, Italy, illustrates this concept, serving as the infrastructure and organizing system that promotes the realization of other extensions.[38] The roots of planning focused on spaces, structures and processes that facilitated community activity. However, the haphazard manipulation of the environment to excessively and in some manners exclusively serve human needs has unsurfaced new concerns that extend past basic survival needs. This realization has led to the development of the urban or land-use planning profession. However, what is perceived to be survival needs in the urban environment is dramatically disconnected from its nature.

Reformation of the Dwelling Environment

During the 19th century, as cities began to establish prominence, so did concerns regarding the cultivation of a healthy, beautiful environment. What quickly followed was the desire for social progress and efficiency. The Haussman model responded to health and beautician of the dwelling environment, while the functionalist model was devised to springboard social progress, personal health and efficiency though a circulation network that connected divisions of functions.[3940] These two models are important platforms for the origins of the modern urban environment; laying the

[38] (Ibid)
[39] (Hall 1996)
[40] (Mumford 1961)

foundations for land use and transportation systems, vital operations in planning to promote activity and prosperity.

The succession of ideas of Ebenezer Howard, Patrick Geddes, and Lewis Mumford were monumental to shaping the urban landscape into its modern-day form. Peter Hall, in *Cities of Tomorrow*, describes their vision of the city as, an alternative approach that focused on social aspects rather than the built form to create a society where the people themselves shaped and dictated the public realm, this approach would thus foster a stronger sense of place.[41]

Ebenezer Howard's Garden City was essentially the progenitor of sustainable development, considering public health and sociological aspects with significantly greater availability of public and private green space.[42] The Garden City modeled a relatively low density aggregation of people living in walkable environments that were networked through a rail transit system. Patrick Geddes, a biologist, furthered Howard's idea as regional planning but with greater emphasis on sustainable subsistence, understanding the need to balance ecology and resource renewal. Lewis Mumford understanding the cities impact on social life and interaction set the plan in motion around 1920 with the establishment of the Regional Planning Association of America.[43] These ideas continue to be reflected in the modern approach to urban design today, laying the foundations for cities that are designed around the walkability and connectivity as well as health and sustainability. The vitality of the urban environment requires pedestrian interaction, this continues to be a challenge in designing urban environment today as the idea of a connective network is toward the prioritization of the automobile, diminishing community life and the sense of a public commonwealth.

Urban planners continue to encourage walkability with strategies including but not exclusive to: pedestrian and active transportation infrastructures, automobile-free streets, tactical urbanism, pocket parks, and greenbelts. The primary design characteristics are focused on pedestrian orientation. Economic and social activities within a threshold of a five-minute walk, a quarter-mile, so that communities can function and operate efficiently through active or public transport systems that

[41] (Hall 1996)
[42] (Krier 1979)
[43] (Hall 1996)

connect various mixed land-uses.[44] The walkable environments cultivate self-reliant mobility that allows one to traverse the urban landscape for pleasure or necessity and fosters social interaction between neighbors and neighborhoods. The consideration of walkability in the urban environment is the promotion of well-being; people will receive positive benefits to physical, mental, and social health and enhance the overall quality of the community itself.[45] Walkable environments also allow for opportunities to re-connect with nature and natural experiences through daily operations, walking is after all the natural human mode of movement through the landscape.

[44] (Duhl and Sanchez 1999)
[45] (Moudon, et al. 2006)

3. THE URBAN DWELLING

Human life has irreversibility migrated away from dwelling in the natural landscape that it has evolved to thrive in. Though there have been many efforts to cultivate the urban landscape into an environment that promotes health and well-being on all fronts, there is still a larger effort that is required to shift the perceptions and desires of urban dwellers as each successful generation evolves and adapts to the adversities imposed by urban lifestyles. This adaptation to urbanized environments supports the need for intervention to re-sensitize urban dwellers to positive experience of nature.

> *"Admittedly, human beings are so adaptable that they can survive, function, and multiply despite malnutrition, environmental pollution, excessive sensory stimulation, ugliness and boredom, high population density and its attendant regimentation. But while biological adaptation is an asset for the survival of Homo sapiens considered as a biological species, it can cause a progressive loss of the attributes that account for the peculiarities of human life" – Rene Dubos, 1969* [46]

3.1 The Urban Dweller

People have always been driven toward the city and urban life, it has often been a source of inspiration for many great minds and an engine of intellectual life. At the same time, the city can stall and inhibit the mind. The many positive aspects of urban living come with just as many negatives. This modern-day dwelling environment is, for the most part, unnatural and overwhelmingly stressful. Advancements in technology in the recent decades have drastically transformed the urban and natural landscape alike but has also allowed for the examination and quantification of how the urban environment affects human physiology, psychology and social integrity. Research and studies done by experts suggest the need for intervention before a Malthusian effect sets in. It has been found that simply being in an urban environment can have detrimental impacts on basic mental processes; it is an exhausting and busy lifestyle plagued with stress and anxiety. Despite the urban

[46] (R. Dubos 1969) ,80

environments ability to inspire creativity and innovation, it can also dull the mind and handicap the human condition.[47]

In navigating the outdoor environment one can expect to find sidewalks full of distractions. There can be hordes of pedestrians and vehicles to avoid as well as hazardous crosswalks with and intersecting blitz of traffic that require constant attention and mental exertion. Automobiles command and dictate the interactions of the outdoors. Streets have gotten wider, blocks longer, and roads are designed for higher speeds to make street intersections and crossings treacherous crosshairs. A pedestrian cannot be so quick to assume safety from signalized interactions as street corners have been designed to round off to allowing vehicles to right-turn-on-red, a prime example of optimization of automobile priority. This increases a pedestrian's exposure to danger due to impatient drivers attempting to race against time, only minding the left for oncoming traffic rather than the right for pedestrians which have the right-of-way. At the same time, left turning drivers under the presumption of exclusive turn arrows, gun the opportunity to go, often forgetting that there may pedestrians may be crossing.[48] The streetscape promotes the neglect of pedestrian activity, reducing the perceived domain for humans to the confines of indoor environments and further exacerbating the diminishing experience and interaction with nature.

The constant demand for monitoring looming threats of automotive traffic along with avoiding other pedestrians while simultaneously focusing on a destination and its upcoming activities are normal operations of the urban dweller. However, constant exposure to such seemingly minor conditions cannot be healthy maintained indefinitely without detrimental impacts. After experiencing just a few minutes on a crowded street in the city, the brain's ability to retain thought and memory begins to diminish along with the capacity for self-control. Even just a brief glimpse of natural elements holds the potential to restore brain function by providing an opportunity for a cognitive break from the complex demands of urban life.[49] The attrition of natural experiences and elements in the urban environment depraves the opportunity for recovery.

[47] (Lehrer 2009)
[48] (R. Ewing 1999)
[49] (Berman, Jonides and Kaplan 2008)

Seemingly trivial mental tasks leave a sense of depletion from over exploitation. The urban environment is overloaded with stimuli that requires a constant redirection of attention. Seemingly irrelevant interactions that take place in the urban setting, like the flashing of lights or even near-by conversations require expenditure of mental energy, in fact, the prioritization of attention is quite demanding. The human mind is much like a computer and subjecting it to too much processes will over exert its processing power and cause internal failure.[50] The fleeting availability for restorative experiences in conjunction with the ever-increasing stress and strain exerted on urban dwellers requires more than just the provisioning of street trees and tacky street interventions but also the mitigation of the negative components. Interactions with automobiles, whether directly as a user or indirectly with the experience of its presence is a key component to the atrophy of not only human health and well-being but the overall environment as well.

3.2 The Urban Beasts

The development of human civilization has always been paralleled with developments in transportation. Transportation ability has played a vital role and is significant factor of dwelling in the urban environment. Technological advancements in transportation systems and modes in the 20th century revolutionized the way people and resources could be distributed. Transportation, the physical mobility within the environment, is a fundamental part of life-sustaining activities, more so now than ever as it has become a daily operation for urban dwellers. Mobility has a direct relationship to human well-being but it is not a linear relationship. Increasing the magnitude of travel may reflect constraints on opportunities, deplete resources, and impair personal performance and well-being.[51]

The relationship of human civilization with mobility and transportation has led to the dependency of automobiles, ever increasing the human disconnection with nature. There exists a multitude of stresses that ride shotgun with the automotive paradigm, from driving on congested roadways to the strain of public transit. Commuting stress has detrimental impacts on physical and psychological health. Contemporary urban lifestyles are polluted with stressful environmental conditions, the automobile fueling

[50] (Lehrer 2009)
[51] (Novaco and Gonzalez 2009)

many of them. The reliance and desire for private modes of transportation in conjunction with constraints on affordable housing opportunities subject many people to be exposed to congested commutes and absorbing its respective stressful consequences.[52] The daily requirement for commuting implies daily exposure to stress impacts, with the current trend of population growth, it can be expected that the transportation environment gets more congested, revving up negative impacts.

However, humans are resilient, the capacity to adapt has allowed the inhabitation of a diverse range of natural environments, therefore, it could be expected that humans can adapt to the urban environment. Rene Dubo's, a microbiologist devoted to analyzing the environmental and social impacts on human well-being, observed that people have a disposition to develop tolerances to adversity, in situations and conditions alike in to function and perform in less than optimal environments. However, negative side-effects can occur when required to adapt to unhealthy conditions, these side-effects man not reap is course immediately and/or temporarily but can manifest itself as a future infliction with great penalties to health and well-being.[5354] Through habitual exposure to perceived detriments in the urban environment such as, experiencing traffic congestion, exposure to air and noise pollution caused by the daily operational need, these qualities become tolerated and eventual no longer a concern. This adaptation through tolerance imposes severe detrimental impacts on physical and/or psychological health and well-being. Adaptations to chronic exposure of stressors is not recommended.[55] The prominent use of automobiles as the popular mode of transportation also increased accident and mortality rates.

The increase of accident and mortality rates associated with automobiles led to the enforcement of policies such as speed limits, drunk driving arrests, and the infamous requirement of seat belts. It also led to the research of human causes in the role of accidents. It was found that psychological stress variables affect the operation of vehicles, as revealed by studies of driver error and decreased performance ability.[56] Fatigue has been the most popular topic in this regard. Pure physical exhaustion, is

[52] (Ibid)
[53] (R. Dubos 1965)
[54] (R. Dubos 1969)
[55] (Glass and Singer 1972)
[56] (Rothengatter and Vaya 1997)

most commonly associated with fatigue but it can be caused by many other factors. Drivers are not normally aware of the impact of their fatigue and overestimate their performative abilities. Fatigue and stress can leak from the workday and continue to the commute home.[57]

The automobile solidified its domination of transportation and commuting mode in the United States less than a century ago but has already greatly transformed the natural and urban environment. The use of private automobiles for travel purposes between home and work rocketed from 43 million in 1960 to 83 million in 1980. [58] This phenomenon prompted the desire to understand what type of trips were being taken and how. The rise in automobile ownership and availability allowed people to relocate to suburbs because of the increase ability to travel longer distances. Transportation infrastructures were not initially designed to support commuting between suburbs causing increased traffic congestion. Despite the exacerbated traffic congestion people did not forfeit their individual vessels, the cause of the problem, but sought to cope with it.[59]

Alan Pisarski, in analyzing long term commuting trends in the United States, showed that the rapid shift toward suburbanization, suburb-to-suburb commutes, automobile ownership, and private commuting continued through to the turn of the 21st century.[60] The ever-increasing population further compounds traffic congestion with each new generation. Travel times to work of two hours are normal and correlates to productivity loss and decreased quality of life.[61] This phenomenon is not exclusive to the United States; in Japan, 48.2% of workers in major cities expend two or more hours in daily commuting and 12.7% even spend three or more hours. The problem extend beyond merely private commuting as the commuter train experience is just as if not worse.[62] The strain of commuting and traffic congestion is something that is experienced world-wide.

Exposure to traffic congestion can be further understood and related as stressful experience in terms of impedance – the hindrance of movement and attainment of

[57] (Pisarski, Commuting in America: National report on commuting patterns and 1987)
[58] (Pisarski, Commuting in America: National report on commuting patterns and 1987)
[59] (Ibid)
[60] (Pisarski, Commuting in America: The third national report on commuting patterns 2006)
[61] (Jones 2002)
[62] (Novaco and Gonzalez 2009)

goals. Conceptualizing impedance as a measurement toward stress and commuting was originally used for identifying obstructive and frustrating aspects of road traffic. This impediment to desired objectives provoke negative and unpleasant emotional states, reducing efficiency, performance ability and personal satisfaction.[636465] Traffic congestion can thus be perceived as a threat to human survival and a detriment to well-being. Impedance is exacerbated from traveling long distances at a slow rate, conversely, the least impedance occurs when short distances can be traversed quickly. General result displayed a higher impedance was led to increased blood pressure, lower tolerance for frustration, negative mood, and lower personal satisfaction.[66]

Routine exposure to congested and high density traffic, commuting strain on congested roadways, and long commuting distances and durations has become associative with interacting with the urban environment. As commuting is an imperative operation for the completion of daily tasks, its experience implies grievous impacts on well-being. Transport systems shape the structure of the built environment, and the experiences associated travel beyond the commute itself. It is shown that health and performance impacts resulting from travel impedance is also inclusive of travel mode decisions, personal attitudes and performance abilities, the intersection of public and private life, well-being, and the provision of transportation facilities.[67]

The increasing inadequacy and dependency of transportation infrastructure and transportation systems, especially automotive, can only truly be remediated by reducing the demand or shifting the behavioral preferences to favor a mode of transport that supports large volumes of flow with limited disruptions and impediments. It is also important to consider the pace of travel and its deviations. Although automotive transportation modes offer a faster pace of travel, this attractive quality is often offset by extreme delay times. The speed of travel bottle necks access points as everyone reaches the same point at the same time. Vehicular

[63] (Novaco, Stokols and Campbell, et al. 1979)
[64] (Stokols, Novaco and Stokols, et al. 1978)
[65] (Stokols and Novaco, Transportation and well-being 1981)
[66] (Novaco, Stokols and Milanesi, Objective and subjective dimensions of travel impedance as determinants of commuting stress 1990)
[67] (Novaco and Gonzalez 2009)

traffic is also a constant fluctuation of acceleration and deceleration which is another factor that contributes to congestion.

Commuting occurs in the space between destinations, the impact of the stress experienced can produce side effects that negatively affect subsequent experiences. "Inter-domain transfer effects" is another useful concept for understanding the impacts of commuting stress. The psychological consequences induced by the environment in the domain of one's home, commute, work, or recreation transfers to another, either positively or negatively.[68] The stress imposition of transportation systems, its interaction and its built form further drives the disconnection of the evolved preferences that humans have evolved to experience. The experience of the environment is not only shaped by the physical structures required to support automobile transportation but also the lifestyle changes that results. The physical inactivity fostered continues to dilute the natural experiences as well as human function.

3.3 The Urban Blight

As the urban environment becomes the standard for dwelling, successive generations are born without knowing nature, they adapt to the urban condition whether positive or negative. This causes the human relationship with nature and natural experiences to further degrade and thus well-being. As new generations of people are born into this environment it becomes perceived as their natural habitat. Maintaining a human connection and relationship with nature is challenged by the phenomenon known as Environmental Generation Amnesia. This concept suggests that as the experience of the natural environment is further dislocated, the baseline for what people consider to be normal is shifted. The baseline line is further shifted with each continuing generation.[69] The urban environment, however, tends to neglect many of the preferences the human species has evolved to experience, leading to amnesia of the natural environment and a negative adaption and evolution toward a reduction of health and well-being – what is the 'natural environment' today is the city.

[68] (Novaco, Stokols and Milanesi, Objective and subjective dimensions of travel impedance as determinants of commuting stress 1990)
[69] (Browning, Ryan and Clancy 2014)

If people are made aware of what natural, healthy, habitats and conditions are, it can help to cultivate the once symbiotic relationship with the environment; a shift toward supportive interactions and experiences. The practice and integration of biophilic design has started to re-establish what these experiences are and what humans have evolved to prefer, in turn, improving the quality of the environment and human well-being.

Peter Kahn's studies attempt to demonstrate this effect by showing how people have been re-wired to perceive what nature and the experience of is. There exists a plethora of technologies that simulate, mediate, or augment the human experience of nature. Television networks and digital devices supplant the actual, physical experiences with artificial ones. In his experimental studies, Kahn, comparing the physiological and psychological effects of experiencing actual, physical forms of nature with experiences simulated through technological means, it was found in terms of physiological effect, that experiencing nature simulated in a technological window (TV screen) was the same as not experiencing it at all. There was no restorative effect exhibited after exposure to low-level stress, this was measured through heart rate recovery, whereas a view of nature through an actual window evoked restorative qualities.[70] There is however, a psychological benefit to nature simulated through technology. It has been found that people have enhanced mood states and an overall improvement in perception of quality.[71]

The results conclude that simulated nature through technology means does not fully satisfy and support the human condition, health and wellbeing, but incorporating it with actual nature itself could potentially produce significant benefits. It is unfortunate however, that people are increasingly deprived access of experiencing actual natural features and landscapes.

[70] (P. H. Kahn 2011)
[71] (P. H. Kahn 2011)

3.4 Stepping Back into Nature, Toward Well-Being

The shift toward increased stress from artificial influences caused by urban lifestyles has forced adaption toward unnatural and unsupportive environments. Although stress can be manifested in many ways, it is founded on the relationship between an individual and the environment.[72] Research on how stressors and environmental conditions affect perception, physical, and mental health is not a new phenomenon. Excessive exposure to stress effectively hinders human functionality. Automobiles and the operation of is a major contributor to the reduction of human health and well-being. In contrast, a smaller body of available research exists that has explored factors for improving transportation environment to reduce stress and ameliorate well-being.

Parsons, Tassinary, Ulrich, Hebl, and Grossman-Alexander examined whether stress recovery and/or mitigation was a variable function of the roadside environment. Participants in the study were shown different video recordings of drives that varied in natural vegetation and appeal immediately after and before mildly stressful scenarios. The stress responses were logged through several physiological measurements: skin conductance, electrocardiogram (ECG), facial electromyogram (EMG), and electrooculographic (EOG) signals. It was found that exposure to roadside environments that were dominated by artificial elements reduced the rate as well as impeded recovery from stress relative to the exposure to roadside environments that featured natural elements. Exposure to the environmental condition predominately featuring nature decreased the magnitude of the autonomic response to the introduced stress and improved the coping ability, iterated through the task performance.[73]

Cackowski and Nasar also researched and studied the potential effects of vegetation on mitigating driver anger and frustration. Following a ten-minute exposure duration to stress in the form of a time restricted task with the presence of random auditory distractions, participants were given the State-Trait Anger Expression Inventory.[74] They then proceeded to randomly viewed one of three video recordings of highway drives, which similarly featured a variety of natural vegetation and artificial

[72] (Lazarus and Folkman 1984)
[73] (Parsons, et al. 1998)
[74] (Speilberger 1996)

elements, concluded by a second stress-inducing task in the form of a time restricted anagram, some of which were unsolvable. The duration of time expended on the unsolvable anagrams served as a frustration measurement, frustration increased relatively with time expended. However, Anger dissipated substantially throughout all roadside conditions.[75] The results from the frustration tolerance revealed that the experience of the natural vegetation increased the subject's capacity to work on the task for almost a minute and a half longer than their counterparts.[76]

The potential benefits of reducing stress in the transportation environment and experience range from increased processing capacity and attention to reduced negative emotional states. Mitigation of stress inducing environmental factors may reduce negative impacts and the associated consequences. There is a relatively small and limited body of research available on stress mitigation in transportation environments and the driving commuter's ability to cope with the stress experienced, a suggested solution could be to avoid the use of automobiles all together.[77]

Modern society's ever-increasing dependence on the automobile has caused some new streets to be constructed without sidewalks or with inadequate provisions. Traffic engineers and developers have disregarded the need for sidewalks on the street level arguing that that no one will walk anyway. The engineers and developers do have a point, the sidewalk itself will not encourage walking, it requires the inclusion of other pedestrian-oriented features. Walkable environments are receiving an increasing amount of attention because of the wealth of evidence supporting the socio-physical structure of walkable communities to exhibit a significant greater relationship with physical activity – a solution for improving health and remediating transportation problems.[78]

The Return to Nature

The human body naturally responds with anxiety and illness in the absence natural geometric constructions and structural stability. Research evidence supports that humans have innate reactions to the adverse effects of the modern lifestyle.

[75] (Cackowski and Nasar 2003)
[76] (Parsons, et al. 1998)
[77] (Novaco and Gonzalez 2009)
[78] (Moudon, et al. 2006)

Physical, mental, and social decline is inherent with the deprivation of experiencing the natural environment or naturalistic features.[79] While dwelling in nature, there is a reduced need for filtering unpleasant ambient noise pollution and other mental interferences that are common characteristics of the built environment. The reduction of unpleasant stimuli allows for the relaxation of the mind and mental restoration. Being away from the routine stress exposure of the urban setting and experiencing comfortable environments is vital for maintaining healthy well-being states.[808182]

Human ecologist Stephen Boyden suggests that the prime environment for the promotion of optimal physiological, psychological, and social performance is in the natural or original evolutionary environment itself. Boyden's discussion two main concerns of well-being: first, there is a clear mismatch between the evolutionary environment of humans and that of the current settings, and second, this mismatch has detrimental impacts to human well-being because the current environment does not cover the full range of evolved survival and well-being needs. There are many factors, many of which are by the intervention of man himself, that quality of life that range from environmental toxins to the lack of community and social interaction. People dwell in settings that are drastically different from those which supported human civilizations throughout history. Boyden's argument is that environments need to satisfy the demands of survival needs and well-being needs.[83]

Survival needs directly affect human health and physiology, such as the need for clean water, breathing clean, non-toxic food, and the opportunity for rest and recovery. Well-being needs address quality of life, psychological and social health. The failure to satisfy survival needs will cause illness or death, while failure to fulfill well-being needs causes psychosocial maladjustment as well as stress-related illnesses.[84]

Animals living in a zoo can be used as a source of insight. Animals belong in the natural environment, however, they become disconnected with their evolutionary

[79] (Salingaros, Biophilia and Healing Environments: Healthy Principles For Designing the Built World 2015)
[80] (R. K. Kaplan 1989)
[81] (S. Kaplan 1995)
[82] (S. a. Kaplan 1983)
[83] (Boyden 1971)
[84] (Boyden 1971)

setting and stuck in cages, very much like the humans and the displacement to the urban environment. In the recent decades, the zoo has undergone radical transformations, cages now emulate natural habitats and zoos consider the geographic grouping of animals. In some instances, the animals are free-ranging and the spectators are enclosed in vehicles that traverse through the habitat. Animals in zoos now exist in settings that more accurately represent their natural landscapes, even inclusive of other species. As in nature, the animal is granted greater, though not complete, control over their behavior and act natural.[85] Whereas caged animals frequently showed characteristics of neurotic behaviors such as: constant pacing, aggression, withdrawal, and repetitive motions.[86]

A definitive link exists between the disconnection with natural environment and experiences, and well-being. The greater the disconnection becomes the greater the detrimental impacts are and the ability to recovery diminishes. Technology advancement aims to improve quality of life, however, in some instances it becomes a double-edged sword, such as will the automobile. The automobile, driving alongside with urban population growth and increasingly sedentary lifestyles has sped up the declination of interaction with as well as the loss of natural environments and experiences. This has caused the environment to shift from one that drives human survival and well-being to reserve, causing grievous implications to quality of life. It is important to look back and check rear-view mirror to insure we are not blind-sided by ignorance to our surroundings.

[85] (J. Heerwagen 2008)
[86] (J. Heerwagen 2008)

4. REDISCOVERING THE INTUITIVELY OBVIOUS

The Biophilia Hypothesis was put forward by one of America's greatest biologists, Edward O. Wilson, suggesting that humans needed to connect with living structures in the environment. This was not a superficial or aesthetic preference, but a physical requirement scripted into the human species that is equivocal to survival needs. A survey of what people preferred in their dwelling environment showed a preference for greenery in the immediate outdoor surroundings, indoor plants, pets, and contact with other people. [87] The instinctive desire for nature has guided the human hand to shape the environment to satisfy that need.

Aside from bringing living components into the dwelling environment, there are also aspects to the design of built form that generate an intuitive attraction and enhance well-being. By analyzing indicators of human health, it is possible to identify built forms that have the capacity to promote a sense of well-being for their users. These structures trigger a healing process within the human body, thus it is perceived to with positive emotional states, the natural response that indicates the support of survival and well-being needs.

There are two parallel theories that help to explain the effects of biophilia. One is the previously discussed "Savannah Hypothesis", deriving from the inherited memory of evolutionary preferences development from the African savannah, the origin of humankind. Physical and mental development progressed over the course of human evolution without losing sight of the savannah, it is programmed into the human DNA. The second is biological structure, the geometric logic of all biological forms. This structural composition is believed to elicit a scripted response in humans to help identify what is a living organism opposed to an inanimate object. Artificial structures created by humans resonate with basic properties common of biological forms an intrinsic expression of biophilia. Living structures either have the same mechanism, or parallel a basic compositional organization of biological systems. Biophilia, therefore, is the synthesis of geometric properties and the elements of natural landscapes with the complex structures exhibited in all living forms.[88]

[87] (Kellert, Heerwagen and Mador 2008)
[88] (Salingaros, Biophilia and Healing Environments: Healthy Principles For Designing the Built World 2015)

4.1 Quantifying the Dwellers' Experience to Evolutionary Nature

Healing and Restorative Experiences

The human body has evolved to respond to the geometric compositions of nature, characterized by scale, colors, fractals, and complex symmetries. Humans have evolved to perceive positive and negative aspects in the environment through emotions that resonate with our biophilic instincts.[89] Experiments in hospitals show much faster recovery rates and a reduced demand for pain medication in patients whose rooms had windows offered views of nature.[90] Going all the way back to ancient Greece, healing environments were set in natural settings, and part of successful medical treatment typically prescribed exposure to nature in gardens and refuge under trees.[91]

Emotional states also have an influence on the immune system. Psychoneuroimmunology is a relatively new field of science that is focused on understanding the relationship between the nervous system and its impact on the immune system and the body's innate healing capacity. Of course, medical treatment cannot be replaced with the manipulating of emotions, however, understanding human sensibilities has the potential to enhance the effectiveness of treatment by stimulating the body's natural healing mechanisms. In the case of stress-induced and autoimmune diseases, the significance of environmental factors is extremely relative.[92]

Re-connecting humankind with natural biophilic desires in the built environment requires the application of natural geometric logic to fully satisfy physical and mental appetites. Biophilia works to lower the stress the human body experience, bolstering the body's natural defense mechanism to fight illness and promote healing. For most of human history, the environment was considered as an imperative factor in health and the healing process. Unfortunately, as previously discussed, the rapid shift into urban dwelling driven by industrialization and technological advancements, the environment took a backseat and often neglected. Human health became a carousel

[89] (Salingaros, Fractal Art and Architecture Reduce Physiological Stress 2012)
[90] (Ulrich, View through a window may influence recovery from surgery 1984)
[91] (Mehaffy and Salingaros 2015)
[92] (Mehaffy and Salingaros 2015)

of chemical cocktails, drugs and surgery.[93] The ever-increasing list of pharmaceutical side-effects has encouraged many people to explore homeopathic and other natural treatments.

Healing environments can exist when experiencing the complexities of nature while one conceives their feelings and emotions. There is an increasingly demanding for mitigating the stresses associated with the urban environment and the cultivation of healthy spaces to work and dwell. The healing effect of biophilia in architecture can be quantified through precise and measurable geometric properties. [94][95][96][97]

Biophilia is sometimes misconceived for purely the "green" aspects. It is true that plants are therapeutic but the environment and built structures itself must align with healing principles so that it does not further induce stress and anxiety. Biophilic design encompasses the design of structures with a bottom-up philosophy, entrenching biophilic properties that parallel biological development and reproduction from the start design process. These processes embody healing properties because they reflect the complex order associated with natural adaption. A top-down design often results in sculptures that may impede the process of natural elements, shaking up a cocktail of living elements with stress and anxiety-inducing forms.[98]

Prolonged exposure to and living in an artificial environment causes a longing for nature. Designers attempt to make up for the lacking experience by carving the surroundings with such geometric qualities exhibited in nature.[99][100] People attempt to shape their immediate vicinity to reproduce the responses evoked by natural environments. When sufficient and immediate access to plants and animals are not available, ornamentation is used. Healing responses may occur whenever the surrounding environment follows the natures compositional logic and organized complexity. Human evolution has generated an instinctive desire to create visually

[93] (Salingaros, Biophilia and Healing Environments: Healthy Principles For Designing the Built World 2015)
[94] (C. Alexander, The Nature of Order, Books 1-4 2001-2005)
[95] (Kellert, Heerwagen and Mador 2008)
[96] (Mehaffy and Salingaros 2015)
[97] (Salingaros, Unified Architectural Theory: Form, Language, Complexity 2013)
[98] (Salingaros, Biophilia and Healing Environments: Healthy Principles For Designing the Built World 2015)
[99] (Salingaros, A Theory of Architecture 2006)
[100] (Salingaros, Unified Architectural Theory: Form, Language, Complexity 2013)

coherent ornamentation that facilities healing in the form of a building, a part of a building, the interior space, exterior space, a community.[101]

Information, as visual patterns, order, symmetry, along with other psychological organization systems are mathematical equations of nature that are coded in the human brain and strengthens the coherence of the emotions. The human survival mechanisms are programed to relax upon feeling the influence of specific patterns and characteristic of a supportive environment as well as elicit stress and anxiety in the presence of perceived threats and danger in the absence of such qualities. The human body responds viscerally to such patterns, it requires no thought.[102][103][104] People can override and develop different learned and conditioned responses but that does not dismiss the actual signals that are triggered in any way.

The knowledge and instinctual responses to patterns in the natural environment, especially those that evoke the most positive emotional states requires detailed cataloging and studying so they can be recreated in the built environment.[105] Applying such biophilic and living patterns has potential to enhance human health and well-being. A manuscript for enhancing human experience of the built environment exists within the framework of nature. The human species has an intimately relationship with the surrounding environment that is normally not consciously perceived. With the increasing loss of natural environments and experiences in the urban living, it is important to integrate patterns that elicit positive emotion states in the built environment to re-sensitize the surrounding habitat toward human preferences.

Healing quality depends on interaction, between individuals, social groups, and/or with the built environment. To induce inherited intuitive positive responses in built form specific geometrical configurations, compositions of form, spatial organizations, structures, surfaces, and connective network systems need to function as catalysts for human interaction. The urban environment thus allows people to utilize their dwelling habitat for emotional support. It provides the freedom to move and interact unimpeded by superficial and artificial detriments and foster stronger connections

[101] (Salingaros, Biophilia and Healing Environments: Healthy Principles For Designing the Built World 2015)
[102]
[103] (Lakoff and Johnson 1999)
[104] (Salingaros, A Theory of Architecture 2006)
[105] (Browning, Ryan and Clancy 2014)

with others. This concept of built space depends on high quantity and quality of visual and intuitive interactions to be experienced simultaneously.[106] These interactions can be actualized in structural components themselves and through material and spatial organization. A variety of different patterns can form physical connections to establish a cohesive and synergetic interactions between the dweller and the urban environment.

Behavior in Space

Psychological and physiological responses are evoked accordingly to different spatial organizations and patterns. The human species evolved from the savannas of Africa, therefore the human preference for expansive and high open spaces elicits a greater positive reaction as it is characteristic of savanna-like qualities.[107] Spatial organization of the surrounding environment significantly impact emotional and mental state. The design concepts characteristic of the African savannah comprises of prospect and refuge, which can be exemplified through elevated views coupled with protected spaces. As well as enticing a sense of mystery and to some extent peril, encourage exploration of the unknown, curiosity.[108]

Through evolution much of human behavior is dictated by biology which offers a key to understanding how space is interacted with. People tend to avoid being exposed prefer to tuck along edges.[109] The human brain perceives the edges with a sense of safety and helps to facilitate wayfinding and the creation of mental maps.[110] The sense of increased survivability is an instant innate reaction that dictates emotion states based on resource expenditure such as time and energy required to analyze the surroundings. Naturalistic characteristics are instantly recognizable and thus triggers positive autonomic stress responses.[111]

[106] (Salingaros, A Theory of Architecture 2006)
[107] (Kellert, Heerwagen and Mador 2008)
[108] (Browning, Ryan and Clancy 2014)
[109] (Salingaros, Principles of Urban Structure 2005)
[110] (Sussman and Hollander 2015)
[111] (Joye 2007)

Movement Patterns

Space is perceived and thought as fixed and static, while human movement and life generates constant dynamic interaction within the environment. The experience of paths can be analyzed as wayfinding, whether in the indoor or outdoor setting and depending on environmental the changing of information assessed while one moves about. Markers and signals aid navigation in a space through continuous reinforcement of the perceived flow. In contrast, such signals, designed poorly, will hinder movement ability can cause confusion.[112] Much of directional and navigational information is connected to visual patterns of a surface or the ground. Visual indications draw progression through space and indicate a path to follow. Studies performed in hospitals demonstrate visual cues such as color and pattern can direct circulation. People respond intuitively to the perceivable information patterns on floors.[113]

The built environment is often void of visual patterns that guide movement. Paths such as sidewalks are linear and offer restructure mobility and can make the navigation of space quite unattractive and disturbing. This leaves people with the adverse desire to move and can be further discouraged by impeding obstacles that denying passage which can even be in the form of buildings and structures. Every spatial portion of the environment along a path must offer the opportunity for refuge to grant the sense of safety and allow for individual negotiation of a journey. This makes the experience more comfortable as it allows more freedom and choice. At the same time, prospects offer an understanding of range that can help to establish goals or checkpoints along the journey. Breaking up the journey into incremental refuges allow for more opportunities of interaction and allow people move as and when they please. A path should encourage people to want to interact and explore and reduce resistance of movement.[114]

4.2 Nature-Health Relationships

Functional magnetic resonance imaging test (fMRI) has provided the opportunity for researchers to study the and measure neural activity responses to various media. The results of the studies support the human preference for savanna-like qualities,

[112] (Lyons Stewart 2015)
[113] (Salingaros, A Theory of Architecture 2006)
[114] (Salingaros, Biophilia and Healing Environments: Healthy Principles For Designing the Built World 2015)

showing increased pleasure responses. The measurements provide quantified data iterating the that people preferred natural environments preferred over artificial environments.[115][116]

Tests also indicate that complex and dynamic scenes of nature trigger significantly more interactions of the mu (opioid) receptors in the large rear section of the visual cortex. A view of nature is measured to be a pleasurable experience. Visual richness or the lack of, such as a blank facade or a tree-less street, induce significantly less mu receptors, triggering measurably less pleasurable reactions.[117] Experiencing movement in the natural environment, such trees and leaves in the wind, waves in the ocean, the dancing of flames, or even fish in an aquarium can capture and hold attention.

Evidence supporting the biophilic effect can be linked to research in either one or more of three branches of human function: physiological, psychological, and cognitive. They have been explored, measured and verified to varying degrees, either in the field or in the laboratory. These research results help to quantify human health and well-being in relationship to the environment.

Many beneficial physiological effects are associated with interactions with nature. The effects of walking through a forest atmospheres versus urban areas have been measured by analyzing salivary cortisol, blood pressure, and heart rate. The average results indicated that salivary cortisol lowered between 13.4-15.8%, heart rate reduced by 3.9-6.0%, and systolic blood pressure was lower in subjects who walked through the forest, compared with those who experienced a walk in an urban area. There was also an overall effect on parasympathetic activity, measurement of relaxation. The results showed a dramatic increase of 56.1%, while sympathetic activity, occurrence of stress, decreased by 19.4% in the subjects that walked through the forest.[118] These study results support Kaplan and Kaplan's Attention Restoration Theory (ART), stating that positive restoration can be stimulated through interaction and connections with nature. The application of nature and/or naturalistic characteristics in the dwelling environment can be an effective strategy to manage

[115] (Biederman and Vessel, Perceptual pleasure and the brain 2006)
[116] (Terrapin Bright Green 2012)
[117] (Biederman and Vessel, Perceptual pleasure and the brain 2006)
[118] (Park and Yoshifumi 2010)

and mitigate stress, promote health, create therapeutic conditions, and serve as counter measures to preventing disease and illness that are linked to urban lifestyles.[119]

Stress is also known to cause cardiovascular disease and mental health disorders. Per the World Health Organization, if workers have no opportunity to relieve stress in the workplace, a host of illnesses can arise such as psychiatric, stress-induced, and anxiety-related illnesses.[120] Heartbeat has also been measured in natural and urban environments, suggesting that even a video depicting natural environments evokes an involuntary relaxing effect on autonomic functions, causes positive cardiac deceleration and beneficial physiological arousal.[121]

In a review of over 375 relevant journal articles that examined human well-being benefits from natural elements, scientific evidence provided clear evidence to support that both passive and active interactions positive effects (See figures 1-6). However, the results of these studies cannot necessarily offer a solution for every situation, as each situation is unique. There needs to be a consideration for social and cultural differences, as well as climate and ecological variances.[122]

Despite the concept being simple in nature, the scientific underpinnings and impacts in the environment can be complex. As exhibited through many studies and experiments performed by researchers, the human body reacts intimately with its environment. The human body's autonomic nervous system consisting of the sympathetic and the parasympathetic system is finely in tuned with the surrounding environment. The sympathetic system stimulates the human body when requiring cognitive function while the parasympathetic system provokes relaxation of the body along with internal processes such as digestion. Homeostasis, the body's ideal state is achieved when these two systems are balanced. However, in disruptive and unpleasant environments, the sympathetic system is intensively engaged in the 'fight-or-flight' mechanism – the stress of survival is exhausting and gravely detrimental if chronically engaged. Simultaneously, the parasympathetic system falls into remission, the result, energy depletion and mental fatigue. This imbalance

[119] (Terrapin Bright Green 2012)
[120] (Terrapin Bright Green 2012)
[121] (Lauman 2003)
[122] (Choudhry 2015)

induces stress and compounded with increasing stresses imposed by societal factors and transportation, people in urban environments are entrapped in frustration, distraction and irritation. In contrast, human interaction and connection with nature induces increased parasympathetic activity resulting in better bodily function and reduced sympathetic activity, thus decreasing stress and reducing irritability, and overall ability to cognitively function.[123]

Routine interactions with restorative or healing, natural environments have the capacity to mitigate detrimental effects on human health and well-being, especially through the reduction of stress.[124] The characteristics and qualities these natural elements that elicit positive effects on human health and well-being can adapted into built forms that emulate them. There is no denying that the presence and availability of actual nature will continue to diminish at a quicker rate than can be restored. The emulation of naturalistic qualities and experiences can provide surrogate experiences in the urban environment that can potentially stitch the adaptation gap of humankinds evolved preferences. Bridging the gap will cultivate an environment that will enrich the experience of urban environments to nourish human health and well-being as well as promote natural, physical activity.

[123] (Terrapin Bright Green 2012)
[124] (Ibid)

SOCIOLOGICAL ASPECTS OF NATURALISTIC AND URBAN ENVIRONMENTS AND PEOPLE'S PREFERENCES.		
AUTHORS	INVESTIGATION	MEASUREMENT
Tzoulas et al. (2007) Ward Thompson (2002), Thwaites (2001), Thwaites et al. (2005), Tan (2006), Tveit et al. (2006), Alexander et al. (1977).	Significance of network of open space to ecosystem and human health and well-being. Network of linked open spaces that are woven into the fabric of urban areas. Link between ecological and social systems. Link between spatial arrangement of open space and social benefits. Values of small and loose-fit spaces in urban planning.	Accessibility and connectivity Openness Heterogeneity Naturalness Coherence Way finding
Laumann et al. (2001)	Nature scenes: forest with lakes and creeks; park with various plant species and artificial creek; sea area with coastline, grass, cows and birds; mountain with snow and ice. Restorative effect	Interview and Questionnaires
Staats et al. (2003)	Urban scene: major pedestrian street, bus/train station, rush hour. Restorative effect.	Interview and Questionnaires
Kaplan (1993)	Natural environment; dense and open forest, path, no people. Attention fatigue gave higher preference for the natural environment over the urban environment.	Self-Reports of emotional state
Staats et al. (2003)	View including natural elements. Availability of nature in the view strongly affected satisfaction and restorative ratings.	Self-Reports of emotional state
Kuo et al. (1998)	Amount of green vegetation in neighbourhood common spaces (greenness rating 0–4) Stronger social ties, higher sense of safety and adjustment.	Neighbourhood social ties test
Kuo and Sullivan (2001)	Amount of green vegetation in neighbourhood common spaces (greenness rating 0–4). Less aggressive behaviour.	Crime rate reported to police
Kuo and Sullivan (2001)	Amount of green vegetation in neighbourhood common spaces (greenness rating 0–4) Lower mental fatigue: residents with nearby nature were more likely to be able to deal with the major issues of their lives.	Mental fatigue via Interview and questionnaire

Figure 3 Adapted from Table 1: Social value of naturalistic and urban spaces[125]

[125] (Choudhry 2015)

SOCIOLOGICAL ASPECTS OF NATURALISTIC AND URBAN ENVIRONMENTS AND PEOPLE'S PREFERENCES. (CONTINUED)		
AUTHORS	INVESTIGATION	MEASUREMENT
Taylor et al. (2002)	Amount of window view of nature (0–4 scale). Improved self-discipline in inner city girls: for girls, view accounted for 20% of the variance in scores on the combined self-discipline index.	Attention tests
Stigsdotter (2004)	Workplace greenery; four levels from no view of and no access to garden to view of and access to garden at workplace	Interview and Questionnaires
Leather et al. (1998)	View or access to garden gave improved comfort, pleasure and well-being.	Self-report of emotional state
Kaplan et al. (1988, reported in Kaplan, 1993)	Percentage of the view from window with rural elements (trees, vegetation, plants, and foliage). A view of natural elements was found to buffer the negative impact of job stress.	Job satisfaction survey

Figure 4: Adaptation of Table 1: Social value of naturalistic and urban spaces.[126]

[126] (Choudhry 2015)

PSYCHOLOGICAL ASPECTS OF NATURALISTIC SPACES		
AUTHORS	INVESTIGATION	MEASUREMENT
Ryan (2005), Brown et al. (2003), Cooper-Marcus (1995), Lalli (1992), Rivlin (1987), Ahlbrandt (1984), Tyrvainen et al. (2005), Tyrvainen et al. (2007), Takano et al. (2002), Tanaka et al. (1996)	Psychological values of naturalistic spaces to urban dwellers. Personal meaning and cultural values linking to restoration and psychological well-being Residents' preferences and emotional feelings to greenery Enhance sense of community	Sense of place Place attachment Aesthetic Social imageability Comfort and being relaxed
Ulrich (1979)	Nature scenes; dominated by green vegetation including cultivated fields. Improved well-being and reduced anxiety	Anxiety levels, fear levels
Moore (1981)	View of Rolling farmland and trees. Stress reduction compared to prisoners viewing prison courtyard.	Sickness records, stress levels
Hartig et al. (2003)	Natural environment: tree views/nature reserve (1600 ha of vegetation and wildlife). Reduced stress and improved mood.	Emotional tests
Staats et al. (2003)	Natural environment; dense and open forest, path, no people. Attention fatigue gave higher preference for the natural environment over the urban environment.	Interview andQuestionnaire
Tennessen and Cimprich (1995)	Natural or mostly natural view (trees, grass, bushes and/or lakes, no evidence of human influence) Natural views gave higher scores on directed attention than built views.	Attention tests
Grahn (1997)	School playground with high degree of naturalness. Fewer sick-days, fewer attention problems, fewer concentration problems, improved motor function.	Behavioural Observation
Ulrich et al. (1991)	Nature scenes; dominated by vegetation including cultivated fields. Positive influence on psycho-physiological state.	Interview and Questionnaire
Herzog and Chernick (2000)	Natural scene: field/forest with high and low degree of openness. Higher tranquillity, lower feeling of danger.	Interview and Questionnaire

Figure 5: Adaptation of Table 2: Personal meaning of naturalistic spaces[127]

[127] (Choudhry 2015)

PSYCHOLOGICAL ASPECTS OF NATURALISTIC SPACES (CONTINUED)		
AUTHORS	INVESTIGATION	MEASUREMENT
van den Berg et al. (2010)	Park-like forest area with and without creek. Restoration; higher happiness, lower stress, anger, depression and tension. Improved mood and concentration.	Emotional test
Heerwagen and Orians (1990)	Painting of natural scene; distant mountains, sunset, clustered trees and open grassy areas, path (mystery). Stress reduction: patients felt calmer and less tense in the mural condition than in the plain waiting room.	Interview and Questionnaire
Wells (2000)	Amount of nature in window view (different rooms in the house) on a naturalness scale 1–5. Yard material; 4 naturalness categories. Higher naturalness score post-move gave better cognitive functioning.	Behavioural Observation

Figure 6: Adapted from Table 2: Personal meaning of naturalistic spaces[128]

[128] (Choudhry 2015)

PHYSIOLOGICAL EFFECTS OF INTERACTION WITH GREENERY		
AUTHORS	INVESTIGATION	MEASUREMENT
De Vries et al. (2003), Payne (1998), Hartig et al. (1991, 2003), Kaplan et al. (1998), Ulrich et al. (1991), Kuo and Sullivan (2001), Kuo and Sullivan (2001), Korpela et al. (2001), Newell (1997), Frumkin (2001), Kendle and Rohde (1994), Beck and Katcher (1996), Russell et al. (1999), Lewis (1996), Herzog (2000), Tennessen and Cimprich (1995), Weiss (1991)	Public attachment to urban parks and natural areas. Natural views restore attention fatigue and recovery from stress and increase cognitive performances, and relaxation. Favourite place often relate to natural settings.	Cognitive performances Preference Place attachment Self-regulation Comfort
Ulrich (1984)	Natural scene; trees. Shorter post-operative hospital stays, lower scores for minor post-surgical complications.	Doses of pain killers during recovery
Hartig et al. (2003)	Natural environment: tree views/nature reserve (1600 ha of vegetation and wildlife). Reduced stress and improved mood: reduced stress levels/lower blood pressure.	Blood pressure
Laumann et al. (2003)	Natural environment: waterside/coast environment with grazing cows. Restorative effect: lower heart rate than subjects who watched the urban environment.	Blood pressure
Ulrich et al. (1991)	Natural scene: vegetation and vegetation with water. Lower fear and anger, higher levels of positive affects and intake/attention, faster and more complete recovery.	Blood pressure Skin conductance
Lohr and Pearson-Mims (2006)	Urban background with trees with varying canopy form (spreading, rounded and conical). Positive emotional responses to urban with trees versus urban with inanimate object. Lower blood pressure.	Attention tests
Nakamura and Fuji (1992)	Hedge relaxing effect: the EEG data supported the conclusion that the greenery elicited relaxation. Concrete block fence watching the concrete block fence brings sensory stress.	Brain activity EEG

Figure 7:(Adapted from Table 4: Physiological effects of encountering greenery)[129]

[129] Ibid

PHYSIOLOGICAL EFFECTS OF INTERACTION WITH GREENERY (CONTINUED)		
AUTHORS	INVESTIGATION	MEASUREMENT
Ottosson and Grahn (2005)	Garden, with old fruit trees and a variety of flower species. Increased powers of concentration after resting in a garden outside the geriatric home, compared to that after resting indoors in their favourite room. The results did not show any effects on blood pressure or heart rate.	Concentration level Blood pressure
Diette et al. (2003)	Nature scene; mountain stream in spring meadow, plus nature sound. Significantly reduced pain for the participants exposed to nature scene and sound.	Pain levels
Maas et al. (2006)	Amount of green space within a radius of 1 km and 3 km from residence. Better perceived general health.	Self-rating of health perception

Figure 8 (Adapted from Table 4: Naturalistic urban studies selected for review)[130]

PHYSIOLOGICAL EFFECT OF INVOLUNTARY EXPOSURE		
AUTHORS	INVESTIGATION	MEASUREMENT
Ulrich (1984) Ulrich (1979) Moore (1982, 1981) West (1985) Rohde and Kendle (1994)	Improving recovery time from gall surgery Reduction in anxiety levels Prisoners view of nature in reducing sickness incidence	Observation Questionnaires Records of sickness seen
Rohde and Kendle (1994)	Young adults proof reading subjects mood enhancement	Mood scale questionnaires
Evans et al. (2000) Wells (2000)	Improvement of mood by replacing asphalts space with natural environment in comparison of child hood to adult experiences to nature	Physiological parameters in addition to self reports
Hartig et al. (1991) Hartig et al. (2003)	Lowered diastolic blood pressure in view of trees through windows in contrast to increased DPB without view. Difference even more significant when walking in respective environments.	Blood pressure change Questionnaires

Figure 9 (Adapted from Table 4: Naturalistic urban studies selected for review)[131]

[130] Ibid
[131] Ibid

EFFECTS OF EMULATED ENVIRONMENTS THROUGH MEDIA		
AUTHORS	INVESTIGATION	MEASUREMENT
De Lucio (1999) Dupont et al. (2014)	Visual behavior preference to natural elements	Eye tracking data analysis
Mooney and Nicell (2006) Rice and Remy (1994, 1998)	Improved mood and decreased levels of violence in Alzheimer's patients and prisoners post exposure to photos	Records of violence pre and post exposure
Bixler and Floyd (1997)	Perception of pleasant and unpleasant natural env-iornments effect on developing preferences toward indoor or outdoor activity between children of urban and rural background. Urban backgrounds tended to develop more adversion to natural enviornment.	Observation Questoionnares
Heerwagen and Orians (1990)	Enhanced psychological and cognitive function with exposure to series of surrogate landscapes.	Eye tracking Visual Behavior

Figure 10 (Adapted from Table 4: Naturalistic urban studies selected for review)[132]

[132] Ibid

PERCEIVED EFFECTS DERIVED FROM BEHAVIORAL SURVEY		
AUTHORS	INVESTIGATION	MEASUREMENT
Pate et. al (1995) U.S. Department of Health and Human Services (1996)	Value of physical activity in practicing healthy life-styles.	Telephone and postal surveys
Ball et al. (2001)	Physical and mental health benefits from walking enviornments. Increased levels of walking for exercise with aesthetic attractiveness of environment	Post walk surveys Likret scale replies
Bell et al. (2004)	Reduced stress levels from interaction with outdoor environment and visual connection to flora.	Post exposure to green flora survey
Ball et al. (2001)	Enhanced psychological and cognitive function with exposure to series of surrogate landscapes.	Eye tracking Visual Behavior
Bixler et al. (1994)	Negative reaction amongst urban background students during field trip into natural environment	Field Oberservation
Burgess (1995a,b) Burgess et al. (1988)	Negative perception of natural environment caused by preference toward urban settings	Questionnaire Focus groups
Kweon et al. (1998)	Benefits of connection and interaction with natural landscapes, specifically among elderly.	Questionnaire Focus groups
Milligan et al. (2003)	Therapeutic qualities of social encounters in outdoor settings for relieving everyday life stresses.	Interviews Focus groups
Sullivan and Kuo (1996) Hartig et al.'s (2003) Sullivan and Kuo (2001)	Lowered levels of violence in urban public housing with the presence of trees.	Records of violence
Galea et al. (2005)	Depression levels increased in indoor living environments opposed to external built environments in New York	Interviews
	Positive memories associations with nature such as the way trees offer shelter and emotional or spiritual connection with nature. Negative feelings of dense tree canopies and untidiness of nature	Interviews

Figure 11: (Adapted from Table 4: Naturalistic urban studies selected for review)[133]

[133] (Choudhry 2015)

4.3 Walking Toward Well-Being

The aim should not only be preserve the natural environment but to also reintegrate it, whether through strategies like urban forestation or through the emulation of its characteristics and qualities into the urban fabric. The urban environment is the naturally unnaturally dwelling habitat of the future so measures need to be taken to stitch the gap caused by the rapid environment transformation from evolved preferences to increasingly artificial and disconnected experiences. There exists the potential to properly adapt and re-cultivate the experience of the natural environment that humankind originally thrived in through the integration of characteristics and qualities observed in nature – that have been proven to support and promote human survival and well-being – into built forms within the urban landscape. A focus on pedestrian-oriented infrastructure with the incorporation of biophilic design strategies will foster walkability and expose people to experiences that allowed humankind to thrive, forming a bridge toward dwelling in an environment that not only ensure survival but an opportunity to flourish.

> *"In a city the street must be supreme. It is the first institution of the city. The street is a room by agreement, a community room, the walls of which belong to the donors, dedicated to the city for common use. Its ceiling is the sky. Today, streets are disinterested movements not at all belonging to the houses that front them. So you have no street. You have roads, but no streets."*
>
> *-Louis Kahn, The Street*[134]

There is no doubt that the 20th century was the century of the automobile. Mass production of the automobile catalyzed a revolution in mobility and convenience, democratization of movement. The need for speed and privacy allowed the automobile take priority over the pedestrian and thus the planning of cities to cater for it. In just about the course of a century, automobiles have invaded spaces once full of human life.

Transportation infrastructure and systems can become an impediment and causes division and segregation. Rather than improving the threshold for accessibility it thus reduces at the human and pedestrian scale. Pedestrian scale interventions turn

[134] (Mackenzie 2015)

segregators into opportunities. I can serve cross, bridge, or connection elements that are impediments or deterrents land uses.

Walking has many benefits, it produces endorphins which improves mood, counters stress and lowers cortisol levels, and reduces anxiety and depression.[135] However, physical activity is on the decline, dropping 32% over the last 44 years in the United States and 45% in only 18 years in China.[136] The decline of activity in the urban context is directly related to the automobile and other 'passive modes of transportation. Subsequently leading to poor walking infrastructure, inadequate and general lack of recreation facilities, and high-density traffic.

These modern threats and dangers to survival and well-being are far removed from the conditions that humans have evolved to adapt and respond to. These urban blights cannot continue to be combated with the resource cost of human health and well-being. Solutions of artificial blends and compounds will only further the Generational Environmental Amnesia and widen the adaptation gap to the point of no return, descending human evolution down an un-scalable depression. Fortunately, through the vigilance of those who have detected this deficit before turning terminal, a potential remedy can be extracted from nature. Thus, cultivating an environment provides the optimal opportunity for the human condition to intuitively re-align.

In response, there has been an emergence of planning efforts world-wide to reduce vehicular traffic in favor for active modes of transportation and they have begun to yield significant positive results. The increasing public desire for concepts and strategies that oriented toward developing streets that promote active modes of transportation in favor over driving in urban environments begins to point human evolution and the evolution of the dwelling environment back in the correct direction. This revelation in awareness is credited to studies correlating physical activity and well-being. Walking itself is natural experience, it is an agile, democratic mode of transport, it provides opportunities for multisensory engagement, social interaction – most attractively, especially terms of modern value, is that it is free.

[135] (Claris and Scopelliti 2016)
[136] (Nike 2012)

Shinrin-Yoku

Another emerging field of research regarding human interactions with nature is Shinrin-yoku. Concrete evidence supporting human health benefits induced by natural environments continues to pour in Japan. It is the ancient practice of walking through natural settings, particularly forests, for restorative and healing purposes. Experiments conducted over the course of six year, among 87 non-insulin-dependent diabetics, to quantify and measure the restorative qualities of this practice. The results revealed decreased blood glucose levels in the patients. Glucose levels, on average, lowered 179 milligrams to 109 milligrams after a 3-6 kilometers walk in the forest. To authenticate the lowered level to the forest environment in respects to pure physical activity of walking, measurements were also taken during indoor activities such as swimming in an indoor pool and running on an indoor treadmill. Comparatively the activity in the indoor facilities reduce blood glucose levels by 21.2% while the forest walk had a significantly greater effect, measuring a reduction of 39.7%.[137]

In the forest setting, hormonal secretion is induced while organic compounds excreted by the forest itself, known as phytoncides, are breathed in, stabilizing autonomic nervous functions. The inhalation of these organic compounds help to produce the extraordinary health benefits observed. Entrenchment in the urban environment does not allow this opportunity.

Response to daylight is another important interaction for the human body, especially for the eyes and inherent circadian rhythms. The retina of the eyes require exposure to specific wavelengths of light to balance circadian rhythm which regulates the cycle of hormonal activity daily, a function of living organisms. The fluctuation of color throughout the cycle of a day is associated with this function, making it important to have access to natural daylight. The hormonal level balance regulates serotonin production, which is associated with mood, during the day and melatonin production, associated with sleep, during the night. Disturbances to the natural sleep pattern tends to inhibit neurological and immune system functions. These wavelengths of

[137] (Ohtsuka, Noriyuki and Shigeru 1998)

light can be artificially induced but the lux value in not as great what the sun can provide.[138]

Consideration for opportunities to receive natural daylight is increasing important as people tend to spend most of their time in indoor environments, not necessarily as a preference but as society dictates. People do not always have the option or opportunity to be exposed to natural daylight, shifting toward active modes of transportation will provide many opportunity to harvest the benefits of the outdoors. The act of commuting has become imperative in modern civilization and urban lifestyles, whether-or-not people can choose the qualities of indoor environment does not necessarily correlate with choice of transport mode. Walking as a transport mode puts one in the outdoor environment, allowing for the balancing of circadian rhythm among other human health and well-being benefits provided by the sun. Not every climate will support open-air and exposure to the outdoor environment however, people inhabiting tropical climates, such as Hawai‘i, should not neglect or be deprived of this opportunity.

The understanding of the human biology and the systems that support its function are rooted in nature and the natural processes, as humans are indeed natural components of the world. Unfortunately, as the decline in interaction with nature and natural environment continues with urbanization and the trending indoor predominate lifestyle, people are increasing unaware of the negative effects that can occur from being deprived of nature.[139] The trend toward indoor and sedentary lifestyles is consistent the previously posited concept of Generational Environmental Amnesia.

Re-connecting people with nature through the integration of green space in the urban landscape will cultivate a society that is healthier, more productive and more aware of the effects the environment has on well-being.[140]

[138] (Boyce 2010)
[139] (Terrapin Bright Green 2012)
[140] (Terrapin Bright Green 2012)

5. DWELLING THE URBAN LANDSCAPE

5.1 Perception of Walkable

Awareness of health and well-being benefits of physical activity is on the rise along with the desire for walkable environments, a shift in the perception of transportation and its corresponding infrastructure must occur. Behavioral adaption is a fundamental part of transportation psychology, people will adjust accordingly to the transportation environment, needs, and functions to improve their individual experience and well-being.[141] With that concept, a decreasing the demand for automotive trips may aid in facilitating adaptation to transport means; ameliorating the detrimental impacts accrued through the evolution toward urban lifestyles and environments.

It is important to understand travel patterns and land use, they are tightly intertwined. Land use should be designed to support the human, pedestrian transport mode, opposed to the current orientation toward automobiles. As the other side of the coin, the transport mode must also support the land use, if they are too separated, the distances between too great, scale and available infrastructure supports automobile function more than people, it is a more attractive option to drive. It is a two-way street, it goes both ways. The United States is generally obsessed with driving, only 1% of trips are made on bicycles and 9% on foot. For comparison, in the Netherlands the bicycle accounts for 30% of all trips are and walking for 18%, and in England the respective figures are 8% and 12%.[142] Roughly 25% of all trips in made in the United States are of a distance shorter than one mile; which 75% are by car.[143] However, walking and bicycling trips in the United States increased 25% from 1999 to 2009, unfortunately, it still represents and uninspiring 12% of total trips taken.[144] The increase in walking and bicycle trips supports the demand for infrastructure. The account for total trips however indicate that destinations in the proximity of only one mile are not quite within reach for people to elect to use active transportation and/or the environment does not encourage it.

[141] (Novaco and Gonzalez 2009)
[142] (Pucher 1997)
[143] (Koplan and Dietz 1999)
[144] (Novaco and Gonzalez 2009)

Figure 12: Eero Saarinen's "Tech Center"[145]

Speed of travel has been another component to the dilution of our experience with the environment, the level of detail one can observe and the perception of space is influence by the speed that one passes through it. Eero Saarinen's General Motors "Tech Center" in Warren, Michigan is designed to be experienced at 30 mph; oversized buildings and spacing between structures do not interface well with the pedestrian experience. The urban environment follows a similar approach, large, simple facades and signage – it is designed for the automobile. A pedestrian-oriented environment will tend to have smaller and more elaborative features that stimulate interaction. Similarly, the use of landscaping in freeway and highway greenbelts are typically implanted as large swatches that are not distracting and are easily recognizable. In contrast, a pedestrian focused environment will have more detailed application in that may cause one to pause and provoke further exploration.[146] Designing for the environment for automobiles requires a less detail rich environment since the driver assumes much more responsibility and should not have their attention pulled away from the road, eyes forward. The environment as shaped by the automobile has a linear focus and poses limitations for positive spontaneous interactions.

[145] "AM_Eero_Saarinen_GM_Tech_Center_1_tx700" December 21, 2016. Digital Image. KPBS. Accessed Janurary 2, 2017 <https://kpbs.media.clients.ellingtoncms.com/img/photos/2016/12/21/AM_Eero_Saarinen_GM_Tech_Center_1_tx700.jpg?8e0a8887e886a6ff6e13ee030987b3616fc57cd3>
[146] (Browning, Ryan and Clancy 2014)

The inactive use of street-level land use generates fewer pedestrian trips and are avoided like the plague, leaving behind dead space. The automobile is a major component in creation of dead space in the urban environment. The reliance on automotive travel generated a demand to more parking spaces and parking lots. It is believed that 9% of land devotion to parking and vehicular services is the threshold before people perceive the environment to belong to the automobile rather than pedestrians.[147] The orientation of street and building variation toward the scale of pedestrians will help to increase the interest of walking in the urban environments by decreasing the perception of the length of the walk. With the shoe on the other foot, a walk past uninteresting structures that occupy large footprints accompanied by vast parking lots, or monotonous facades, can feel longer than it really is.

Buildings and their facades are another source of dead space such as: blank walls, windowless or reflective glass buildings, garage-dominated residential streets, and flat security walls. Though walls can define and enclose space, it is characterless without details; Surface textures, modulation of light and shade, or changes in color can capture and hold pedestrian interest by injecting life into a space.[148]

Nearby parks and other public spaces (playgrounds, plazas, gardens, squares, etc.) attract pedestrians; People are more likely to walk when there is a specific place nearby to go to. Public spaces can enhance the street environment when they occur as an extension of the street and sidewalk. If a good pedestrian street can be characterized as an outdoor room, then a good park, playground, or plaza serves as another room that is connected to the main room. In this light, public spaces punctuate the street network, break up long stretched of distance, and provide beginnings and endings to travels. They give character, which is lacking in modern street networks. There is little to be desired in many of the streets in urban areas, nothing differentiates one from another, making the street network less legible to travelers and undermining sense of place.[149]

William Whyte's study of plazas in New York shows just how important connections to the street and sidewalk can be. Well-connected plazas had the capability to generate a substantial amount of impulsive use but they must be in sight. "If people

[147] (Alexander, Neis, et al. 1987)
[148] (R. Ewing 1999)
[149] (Ellis 1986)

do not see a space, they will not use it."[150] The connectivity and contiguity of sidewalks and pedestrian pathways facilitates walkability and is critical for safety and accommodating a diverse range of people regardless of age and ability. A network and connectivity and diversity of paths and walkways also to help break up large block into more attractive walking distances.[151]

Thresholds for Walkability

The spacing of interactions and activities in relationship to the reach and range of pedestrian users has always been understood to be an important part of promoting walkability. By provisioning the network of the urban fabric with nodes or attractions/points of interests to stitch or fill the gap in-between, the perceive distance between destinations can be measured in increments through various nodes rather than a singular path. The increased opportunities for interactions can shift the perceived acceptable range/threshold for pedestrian interaction and extending reach. Research on identifying measurable attributes and thresholds of walkable neighborhoods has provided insight on walking behavior.

[150] (Whyte 2009)
[151] (R. Ewing 1999)

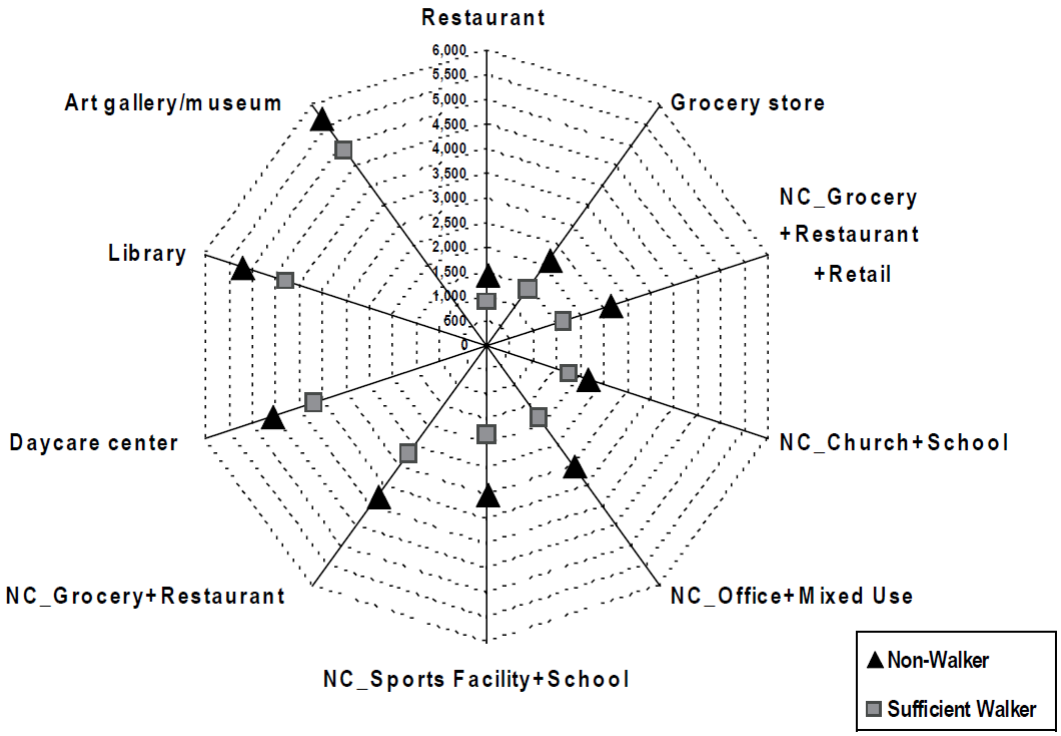


Figure 13: Perceived attractable distance thresholds, Figure 1, pp.10[152]

The threshold for attractive walking environments have been found to consist of approximately two or more collections of grocery stores, non-fast food restaurants and retail stores, but no more than four individual grocery stores within 1km. Large office parcels and schools were found to be considered "deterrent" to walking preference. Threshold parameters for environments deterring walking included office complexes larger than 9.8 acres within 3km and the presence of more than five schools within 1km. Threshold distances for eating/drinking establishments and grocery stores were found to range from 860 and 1445 feet. The threshold for transportation infrastructure to support walking adequate walking distances of health purposed was found to require more than 10 miles of sidewalks within 1km of a user.[153]

5.2 Design Qualities of Walkability

The quality of the urban environment can be significantly influenced by its perceived walkability. In attempt to quantify and measure qualities of walkability, a report was

[152] (Moudon, et al. 2006)
[153] Ibid

prepared for the Active Living Research Program of the Robert Wood Johnson Foundation in July of 2005, by Ewing, Clemente, Handy, Brownson, Winston with the help of an expert panel comprised of experts and researcher in urban design concepts or other fields of relation. Through the expert panel's rigorous studies, qualities of physical features in the urban environment where chosen to be studied further to measure and quantify characteristics exhibited to influence, directly or indirectly, the perception of walkability. The perceived quality of the urban environment can be improved through the consideration of individual sensitivities; toward perceived legibility, sense of enclosure, human scale interaction, visual transparency, linkage of space, and balanced complexity.[154] The quantification of such qualities eludes to evolved responses to the natural environment. The designing of the urban environment calls for the implementation of walkability; the suggested qualities resonate with observable characteristics of the natural environment. The cross-examination of urban design qualities to foster walkability and characteristics of nature further supports the innate human preference toward dwelling amongst nature.

Imageability & Coherence

The quality of the space that makes a place recognizable, distinct, and memorable. Imageability can be characterized by physical elements, organization, attractions, or anything that may capture one's attention and establish a relationship or perception. Imageability, as defined by Kevin Lynch, leaves a memorable impression;

> *"that quality in a physical object which gives it a high probability of evoking a strong image in any given observer. It is that shape, color, or arrangement which facilitates the making of vividly identified, powerfully structured, highly useful mental images of the environment." - Kevin Lynch (pg.9)*[155]

A sense of coherence is achieved through harmonious relationship between the elements and physical features of the built environment. The quality of coherence, as described by Allen Jacobs in *Great Streets,* is influenced by the relationship of

[154] (Ewing, et al. 2005)
[155] (Lynch 1960)

buildings to one another; buildings and structures of the urban environment should respond to each other to create a scene of unity.[156]

There are many aspects of the urban environment that shape its imageability and coherence, ranging from building details to pavement patterns. Imageability and coherence does not call for everything to be the same, scales and levels of variation are required to creating high quality dwelling environments. When structures and features seek to make individual statements, it tends to nullify its surroundings. Richard Hedman describes this effect in *Fundamentals of Urban Design,* stating that when something is too unique and doesn't respond to its surroundings it causes nervousness and confusion instead of excitement. A repetition, rhythm and pattern, of features allows creates visual cohesiveness.[157] The unity of visual features is recognizable and perceived as structured information.

The promotion of walkable, pedestrian infrastructures can increase ease of accessibility to and through the urban landscape, creating a sense of structure and organization desired in the experience of the environment. The opportunities presented by walkability allow one to experience the surroundings and discover something previously unknown and increase exposure to overlooked areas. It provides free and fluid movement in contrast to the stop and go culture of the automobile.[158] Interval distances within attractive thresholds can have landmarks or indicators of activity and life ahead, as a sort of beacon or lighthouse, informing a traveler of their destination. Creating points of interest between attractions can stitch the distance to seem closer as there is some sort of reward or intermediate element to hold or restore one's attention and expand interest. A pedestrian infrastructure has the potential to improve the quality of experiencing and interaction with the space in-between buildings. This space is often unattended to and ignored as it is perceived as mere transition space. However, this space has many effects on people that are direct and indirect, affecting behavior along with human health and well-being.

[156] (Jacobs 1993)
[157] (Hedman 1982)
[158] (ARUP 2016)

Legibility

The quality of legibility, in and of space, is highly influenced by recognition and perception. The spatial structure and organization of the urban environment is created by its surrounding elements and components; it is necessary to consider each component's relationship to a system to create a cohesive and legible composition.[159] Increasing the ability to recognize and understand the environment can be achieved through strategies in transportation and the way one commutes. The way one moves and travels about the urban landscape is important in constructing space(s), high navigability promotes pleasurable and enjoyable spaces, reducing the stress and confusion that is created by the chaos of streets with endless, unpronounceable names. As Lynch suggests, a clear image of a city allows one to immediately and intuitively recognize the surrounding environment, evoking memories and past experiences to render a mental map or perception of place.[160]

(Figure: Streetscape_Legibility_Wayfinding Nodes & Landmarks)

The physical features and components of a place serves to orient and guide one to and from destinations. Lynch discusses the importance of the elements that mold the urban fabric and their relationship to each other as well as to the user.

> *"…paths would expose and prepare for the districts, and link together the various nodes. The nodes would joint and mark off the paths, while the edges would bound off the districts, and the landmarks would indicate their cores"[161] ." – Kevin Lynch*

> *"The designer must therefore create a city which is as richly provided with paths, edges, landmarks, nodes, and districts as possible, a city which makes use of not just one or two forms qualities, but all of them."[162] – Kevin Lynch*

Legibility facilitates wayfinding and can be achieved by manipulating or applying a change or pattern break to indicate interactive spaces, activities and functions.

[159] (Ewing, et al. 2005)
[160] (Lynch 1960)
[161] Ibid, pp. 108
[162] Ibid, pp. 155

Different strategies can be applied, with consistency, to mark specific programs or functions to further recognition of resources can be found.[163] Visual cues or attractions are effective to creating nodes or terminal points. Andres Duany and Elizabeth Plater-Zyberk suggest the use of visual terminations to punctuate a street, giving the street an understandable definition opposed to a street with no foreseeable end that vanishes into the horizon.[164] As stated by Allan Jacobs in *Great Streets,* a street has a starting and ending point and they should be clear and recognizable in order to serve as reference points and provide definition.[165] A pedestrian infrastructure can iterate many of the concepts brought forth by urban designers, it has the potential to mitigate the challenges of navigation, using the environment and its features as an intuitive GPS system. Along with the opportunity to minimize the magnitude of impediments and constraints that are common characteristics of the automobile infrastructure and its respective transportation mode, a pedestrian infrastructure is an impressionable feature that can enhance the quality of space that can promote health and well-being.

Enclosure

A sense of enclosure is created by the bounding space with other elements of the surrounding environment. These elements are often vertical in nature and works to manipulate visual focus. Buildings create boundaries in the urban environment and the negative spaces sculpted by their presence is often a secondary consideration. The space outside of the confines of buildings and houses is conceptualized by many urban designers as an "outside room."[166] Gordon Cullen argues that the shaped of the "outside room" should carry just as much weight and importance as the buildings around them.[167] Establishing a sense of an "outside room" implies a space or dwelling for people, pedestrians rather than the current occupation of automobiles. Jacobs states that fixed boundaries are perceived to be safe, comprehendible, memorable; people are likely to have positive reactions to them as they create a

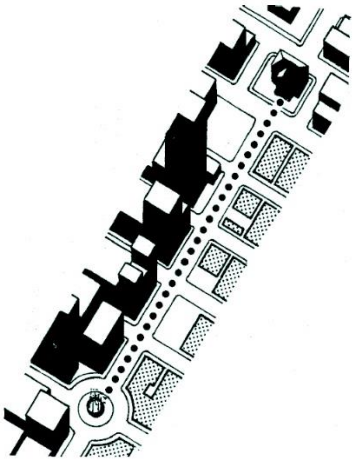
[163] (Lynch 1960)
[164] (Duany 1992)
[165] (Jacobs 1993)
[166] (Ewing, et al. 2005)
[167] (Cullen 1961)

sense of invitation and eluded to something out of the ordinary, something special.[168]

It is suggested that vertical elements that form an enclosure should have a consistent height to utilize the sky as a projected ceiling. There are different perspectives in the relationship between building heights and street widths. *A Pattern Language: Towns, Buildings, Construction* by Christopher Alexander, Sara Ishikawa, and Murray Silverstein suggests that street widths should not be greater than the surrounding building heights[169] while Jacobs suggests a ratio 1:2 for building heights to street widths.[170] There are many other suggested ratios, making it difficult to establish a universal proportion. The concept however contrasting the figures, elude to humanizing the scale of space.[171]

Termination points are also effective in creating a sense of enclosure, giving definition to the bound space. Advocates of new urbanism such as Duany, suggest that a visual termination of streets with landmarks or attractive features and architectural elements are an effective means to achieve a sense of enclosure in every direction with multiple vantage points.[172] Enclosures or the "outside room" should be crafted respectively to the human scale, offering visual buffering without diminishing view prospects and sight lines. Elements other than buildings, such as trees and vegetation, are effective strategies to partitioning space. Changing the perception of walls and divisions from artificial to natural can create a fluid transition and flow to blur or blend the realms of what is indoor and outdoor.

[168] (Jacobs 1993)
[169] (C. S.-K. Alexander 1977)
[170] (Jacobs 1993)
[171] (Ewing, et al. 2005)
[172] (Duany 1992)



Source: J.B. Goldsteen and C.D. Elliott, *Designing America: Creating Urban Identity*, Van Nostrand Reinhold, New York, 1994, p. 171.

Figure 14: Termination points to define[173]

A pedestrian infrastructure can provide the opportunity to manifest the "outside room" as a corridor or hall that punctuates points of interests in an interactive, engaging and enjoyable experience. The wayfinding experience is then punctuated with nodes or termination points that allow for fluid transitions of activity, making the operation of commuting and the idea of transportation an experience rather than a nuisance. The pedestrian infrastructure is thus stitches the urban fabric, framing a flow of human life and activity while draping the dehumanizing experience of automobiles. Transportation behavior can then shift toward a pedestrian orientation as it offers more attractive and pleasurable experiences.

Human Scale

An important consideration in the urban environment is scale. The scale at which physical components are articulated should be relative and respond to the human scale, respectively, speed of movement, size and proportions.[174] The current scale of the urban environment is prioritized for automobiles, leaving little desire and opportunity for pedestrian activity. The speed and scale of traversing the urban landscape is significantly disconnected from human interaction. Jane Holtz Kay attributes this issue to the speed of automobile transportation which has perverted the designing of environment to be experience at a fast pace and through the frame

[173] (R. Ewing 1999)
[174] Ibid

of a windshield.[175] The Distances between activities and functions should consider walkability, distance thresholds and at a human pace.

Through a pedestrian infrastructure, distances that exceed the range of walkability can have nodes or checkpoints to break and lessen the perceived distance to make

The urban environment, characteristic of expansive automotive transportation infrastructures, skyscrapers and large structures, can be stressful, intimidating, and disorienting. Street trees, as suggested by Henry Arnold, should be planted when street widths exceed 40 feet wide to create enclosures that humanize scale. Human scaled spaces can be shaped by trees with its canopies of leaves and branches.[176]

Jan Gehl, who has extensively studied the public/pedestrian realm over the decades, outlines the role of distance and human interaction. From about 1,000 feet to 1,650 feet humans can recognize and identify other objects in space as people. In the range of 330 feet to 80 feet, human features and characteristics, along with body language can be defined. A distance shortens further, levels of social interactions intensify; approaching up to 12 feet is the threshold of the public distance for individual comfort, drawing as close as 4.5 feet is the social limit, when the distance between closes further the personal bubble is breached until it becomes an intimate interaction. In addition, Gehl comments that most of the flourishing public squares and plazas found in Europe are smaller than 33,000 square feet and mostly in the range of 26,000 square feet.[177]

The distances outlined can be incorporated in the design of a pedestrian infrastructure to create a dynamic range and variety of interactions. The main flow of circulation thus be at least 12 feet in width. A variety of enclosures, nodes and spaces, can be extruded off the main path to provide opportunities to rest or engage in social activities and interactions, offering privacy as well as leaving the main flow undisturbed or disrupted. Termination points may consider and emulate the spatial characteristic of the European square.

[175] (Kay 1997)
[176] (Arnold 1980)
[177] (Gehl 1987)

Transparency

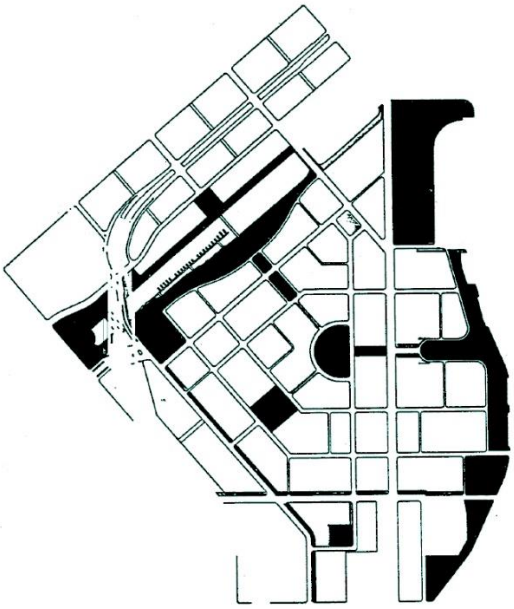
The quality of transparency should be considered alongside with enclosures. A person should be able to receive visual information or perceive what is beyond. It is important to be able to perceive life and human activity in the surrounding environment, indicating opportunities and offers of the urban landscape and influencing the perception of safety and attractiveness. This quality can be achieved through literally physical characteristics in the likes of material opacity or voids, absence of material or visual impediment. The perception of what lies beyond may not necessarily need to be visible as transparency simply elude to what exists.

Trees can be an effective means to achieve enclosure as well as transparency. High tree canopies create smaller spaces in open space but suggest that there is more beyond[178] A sense of transparency can also come from termination points that serve as public squares of plazas. As transition to and from activities, functions and services, they are precursory spaces that may elude to what is to come and a glimpse of what can be expected.

Linkage

The quality of linkage refers to the interconnectivity of features in the urban environment that create a sense of mobility and accessibility to and between spaces, freedom of movement. They can be iterated as physical connections or visual accesses such as bridges or lines of sight. Various strategies can be applied to create this quality; pavement patterns can be used to guide in smaller scales and distances, rows of trees or sequencing of features may serve to connect larger spaces, while view corridors and visual access stitch the destinations together. Strong linkage through space allow for a greater ease of movement and foster a cohesive relationship between interactions in the urban environment.[179]

[178] (Arnold 1980)
[179] (Ewing, et al. 2005)



Source: City and County of San Francisco, *Mission Bay Plan - Proposal for Adoption*, 1990.

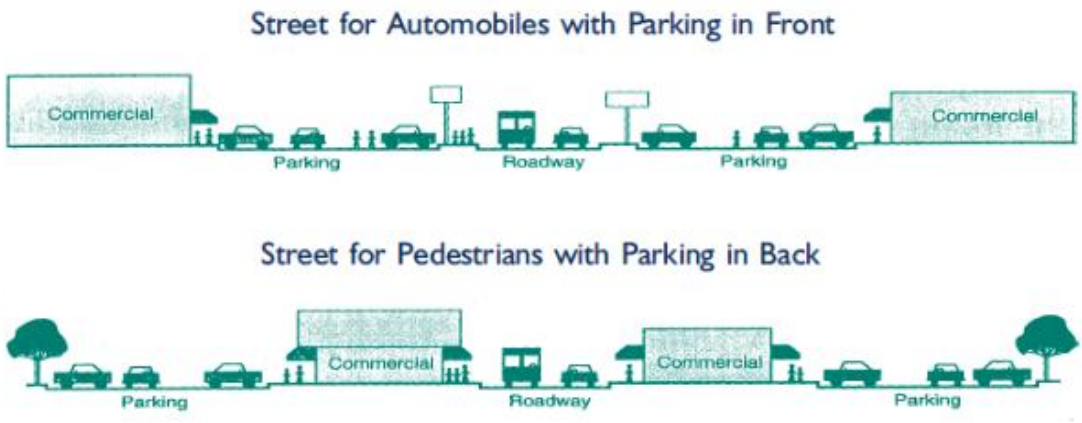
Figure 15: Linkage and short cuts through blocks increase walkability[180]

Wayfinding is an important aspect to how people orient, navigate, and understand the environment. The environment, natural and built, is full of indicators that direct human movement. The traditional approach of wayfinding in the urban setting is through visual recognition of physical features and elements such as: signs and electronic signals, landmarks, pavement material and patterns, and many more. More recently, multi-sensory approaches of wayfinding have been increasingly emerging, enhancing the experience of navigating the urban environment and encouraging pedestrian activity. The senses, through human evolution, have functioned as an innate navigational instrument. An attractive smell will lure a person over as it promises food or positive interactions.

Freedom of movement is greatly hindered by designing the environment for the function of automobiles. Transportation is an imperative operation of urban living; this is reflected in the development to prioritize the function of automobiles and land-use is respectively allocated. There currently exists more land in the urban environment dedicated to the function and activity of automobiles than there are for humans. In the United States, more than 2.67 million of roughly 4 million miles of

[180] (R. Ewing 1999)

roadways exist in the urban environment[181]. In addition to the over 2.67 million miles, there are many land-use functions dedicated to the automobile, such as: pumping stations, parking garages and lots, sales and service centers, and many more.



Source: Denver Regional Council of Governments, *Suburban Mobility Design Manual*, Denver, CO, 1993, p. 29.

Figure 16: Street experience for automobiles versus pedestrians[182]

The automobile domination of transportation has handicapped pedestrian activity and movement in many urban environments. The objective is not to entirely supplant the use of automobiles as that is impossible, but to create a harmonious transportation network that considers multiple options and modes of travel. There are many scales of interactions in the urban environment and the transportation network should be inclusive of each one, individually, as well as a part of a whole. Multi-way boulevards are an effective strategy to incorporate different scales and modes of movement, creating more attractive spaces for pedestrians, active transportation, and transit users without compromising the existing automobile transportation function. If anything, it may improve the automobile experience.

A high quality of linkage in the urban environment can promote walkability if it is designed with the human scale in mind. Urban designers, such as Jacobs and Alexander, suggest that street connections should occur about every 200 to 300 feet and advocate exclusive pedestrian crossings orthogonally through the street

[181] (The American Road & Transportation Builders Association (ARTBA) n.d.)
[182] (R. Ewing 1999)

network.[183][184] Provisioning a greater ease of movement through the urban landscape to favor pedestrian activity will aid in changing transportation behavior. People are willing to adapt and change if there are more attractive options. If the in-between space of buildings and structures were to prioritize the function and operations at the human scale, people would be more willing to shift away from an automobile dominated behavior if it is perceived to be just as or more effective and/or convenient.

Implementing an elevated structure for the exclusive use of pedestrian and active transportation users can provide the opportunity for unimpeded movement and reduce the mental exertion required to navigate the urban environment. Portions of spaces exist to serve the function of automobiles can be provisioned for such a structure. The reduction of space dedicated to automobiles will also decrease its effectiveness, promoting adaption and consideration to shift gears. Through a pedestrian oriented infrastructure people can receive a higher quality experience of the urban environment that is not achievable with the current movement and interaction behavior.

Complexity

The quality of complexity in the urban environment is influenced by the scale and magnitude of detail of its physical features. The current dwelling environment lacks the complexity and richness of that which we have evolve to positively respond to. The urban environment is, for the most part, static and its behavior in space is unnatural, lacking the details and characteristics of life.[185] The perception and interaction with physical features should be responsive to the human scale at multiple scales. The level of complexity should be appropriately applied in consideration to the rate of information one is capable of perceiving and comprehending at any given time.[186]

Complexity is a critical component in achieving human scale design in the urban environment. Rate of perception in the current urban landscape is not currently

[183] (Jacobs 1993)
[184] (C. S.-K. Alexander 1977)
[185] (Ewing, et al. 2005)
[186] (Rapoport 1990)

tuned for pedestrian interaction, it is prioritized toward the automotive operations. Pedestrian oriented complexity exhibits a higher quality of detail and richness because movement speed is dramatically slower, allowing one to digest a greater amount of information.[187] The influence of automobiles has made the experience of the urban landscape out of scale in respect to pedestrian interaction; blocks are long spans of unstimulating surfaces while crossings and intersections have an overload of information that needs to be perceived. Arnold suggests that trees are effective in creating a quality of complexity and richness to surfaces by providing peripheral stimulation. [188] Jacobs similarly believes that the use of trees provide a dynamic quality to the urban environment. Tree branches and leaves are constantly interacting with other elements, filtering light ephemerally and stochastically to create a sense of life in spaces. The fluid pattern of light and shade projected onto concrete and asphalt transforms static and unattractive surfaces into ephemeral canvases.[189]

Figure 17: Ochideorama in Medellin by Plan B Architects + JPRCR[190]

[187] (Rapoport 1990)
[188] (Arnold 1980)
[189] (Jacobs 1993)
[190] "Ochideorama." Plan B Architects + JPRCR. Accesed December 12, 2016

There are thresholds to complexity; too much complexity may leaded to sensory overload while too little leads to sensory deprivation. The processing of information expends mental energy, it becomes strenuous when there is too much and unstimulating when there is not enough. The ability to comprehend such information thus attracts or deters use of space. Easily comprehensible information and environments form positive associations, respectively, difficulty forms negative associates as spaces become disorienting, stressful, and chaotic.[191] The manifestation of space to enhance the pedestrian experience will increase the activity and interaction outside of buildings, which also adds value to complexity. In addition, the presence of people, as suggested by Jan Gehl, will attract more people and foster a desire to engage with the space. This strategy will allow the opportunity for activities and services to arise as well as introducing and exposing people to previously unknown things. Gehl also states that integrating different land uses also add to complexity. [192]

To foster a stronger sense of complexity, it is important to incorporate variety and variations in the experience of the built environment in different scales and components. Land uses, physical features, and other various urban elements should also flow together, creating a harmonious composition in the experience of the urban canvas. In creating complexity, it is also important to still consider its effect on all the users of the urban environment as the level of complexity may inadvertently have detrimental consequences such as increased automotive accidents. The separation of realms with a pedestrian infrastructure can be effective to mitigate this issue, allowing for a variation of complexity in the overall environment without having to compromising the dynamic range of operations in the urban setting.

5.3 Conditions of Urban Dwelling

Nature of The Place

Understanding site context, the natural characteristics of a place, and designing appropriately will help enhance its quality. It is important to consider the nature of a place because humans have evolved instinctively respond to the environment based

[191] (Rapoport 1990)
[192] (Gehl 1987)

on the characteristics observed in nature that support survival and well-being. In the case of human habitation, technology and population growth has driven people to dwelling in environments that are not optimized for life to thrive. The dislocation of humans from preferred habitats is inevitable and irreversible. However, the implementation and emulation of natural characteristics that humans have evolved to prefer into the urban setting can re-sensitize human nature and the relationship with the environment. Opportunities to optimize the environment for human life to flourish already exist in the urban context, it just needs to be highlighted.

Framing and visual access to nature: mountains, oceans and water features, natural or artificial landscape features, vegetation, the sky, and any other natural or naturalistic elements. Utilizing the topography of the site and its elevations can help to provide view prospects while giving a unique quality to each location. This will provide a sense of complexity, through the variation of scenes, that also relay information about one's place in space. The composition of the urban environment should respond to its natural context much like how the native Hawaiians created land division and allocated the population accordingly to maintain a symbiotic relationship between man and the natural environment. Physical features of the built environment should utilize climatic conditions as much as possible to create a dynamic quality of life and nature. Celebrating natural processes can further improve awareness to the human affinity for nature.

Urban Operations

The urban lifestyle is vastly different from that which humans have evolved to experience. The functions and activities that required to survive in and thrive in the modern world are not aligned with the human condition. The stress of resource availability is still governed by time and energy expenditure, however, the opportunity for recovery and restoration continues to diminish as modern resources do not necessarily translate to human health and well-being. The urban environment constantly challenges and strains the human condition due to ever present constraints and impediments imposed on necessary operations, particularly that of transportation and commuting.

Movement is an imperative operation of urban living, where one lives is not always relative or conveniently located by where they work or other destinations or activities performed. Commuting is a key component of the urban environment and influences the perceived quality of life. The need for constant transitioning of space is a stress inducing operation and even more stress is presented in that space between. While traversing the urban landscape, one is exposed to mainly forms and factors of stress through direct actions of individuals to the indirect effect of the surroundings. Upon arrival to destinations, opportunities to dispel or properly recover from such stresses experienced are rare and often none existent. In contrast, for many, the destination is another stress inducing operation. This prolonged and persistent stress common to urban living has been shown to be detrimental to the human functional capacity.

By shifting the imperative operation of commuting and necessity of transportation toward a means that supports the natural human condition, the detrimental effects of urbanization can be mitigated. The experience of the space in-between can have restorative functions, allowing for healthy transitions through daily activities. In space of transition there is an opportunity to recover or prepare, psychologically and physiologically, optimizing one for what is next. Provisioning a network of pedestrian infrastructures as an alternative to automobile dominated transportation behavior can have the potential to reconnect with a natural operation, walking. The cultivation of walkability has the capability to improve the quality of life in urban environments by reducing and mitigating fruitless interactions – in the light of human health and well-being. A pedestrian infrastructure also caters to human scaled interaction, the pace of walking allows for a greater amount of richness and detail one can be

exposed during the same duration of time. Attention can be directed freely while walking whereas, the operation of automobiles requires constant directional focus that can be mentally and physiologically taxing.

Successful implementation of a pedestrian oriented network may also draw people out of indoor and sedentary lifestyles. A high quality of perceived walkability will encourage human activity outside of buildings and further attract more people, reclaiming the streets from automobiles and cultivating life throughout the built environment, not just within buildings – a complete sense of urban dwelling.

Scale of Experience

The use of automobiles cannot realistically be supplanted by walking or active transportation means. The scale and means of the human habitation require extensive transportation demands of not just people but resources as well. Scales of interactions need to be analyzed and considered. A transitioning of modes is likely to occur, implementation of terminals that grant the opportunity for people to transition from long range to short range activity. The urban environment is full of diverse ranges of activities and functions. Connectivity of different land use and transportation modes is important to the urban experience. In instances where walking is not efficient or effective, alternatives should be present. Alternatives offered in the form of active transportation modes can be integrated alongside the pedestrian infrastructure network. The network can be segmented and stitched with different alternatives to provide variations and options to optimize one's experience.

This transportation network would consider different runs of lengths and distances without breaks or impediments to optimize the experience. An active transportation "highway" can run alongside the pedestrian infrastructure for more efficient and effective means to travel longer distances as well as connect to transition terminals. Different lines can accommodate and optimize the experience of different purposes; 1) external lines which occur at termination points for transitioning to other transportation modes for long distance travel and connections to different destinations or districts, 2) exterior lines with less access points commuting medium lengths of distances in a directed path such as between different communities, neighborhoods, or facilities (education, athletic, entertainment, etc.) to accommodate a faster pace of travel, and interior lines with many access points for

smaller scaled interactions within communities and neighbors. These lines consider different scales of travels and a diverse range of uses and users such as: commuting from city to city, neighborhood to neighborhood, house to house, home to work, home to school, school to work, school or work to amenities, amenities to amenities, and everything else under the sun.

Culture & Demographic

The culture and demographics of a site is an important consideration to designing not only the aesthetic features but also the functional quality. An understanding the unique culture of individual place, city, district, neighborhood, and community and those who inhabit them will promote interaction. Providing functionally spaces along the pedestrian infrastructure will encourage its dwelling. Universal needs such as gathering/meeting spaces can serve to accommodate various functions and can even host programs or cultural events to help foster a stronger sense of place. Through the encouraged interaction with spaces integrated with the pedestrian infrastructure, individual locations can exhibit the unique characteristics of those who inhabit them. Information about a place can then be extracted along the travel route.

6. ADAPTATION OF THE URBAN DWELLING FOR THE DWELLER

A network between open spaces and the natural ecosystem in the urban environment has health and well-being implications. Interaction with open space and naturalistic features or landscapes allow people to satisfy social and physical needs. The diversity of interactions and space create by a network of open/naturalistic spaces in the urban fabric provide encourages activity outdoors and fosters positive associations with naturalistic elements. The availability and accessibility to experience such spaces allow opportunities for physical and social recreation, producing beneficial effects on health (physical and mental) and overall well-being. Such experiences can be manifested in the form of parks, attractive open spaces, natural and constructed landscapes.[193]

A diversity of spaces to break the monotony of the built environment allow for organic interactions to happen, freeing people from the controlled characteristic of the typical urban infrastructure. This network of spaces can be woven into blocks and the interstitial space of built features. Frequent access to such features provides a platform for pleasant interactions to occur, in contrast to the maelstrom of interactions present in the spaces of vehicular activity. Paley Park in New York City is a prime example of providing such a refuge or oasis in the heart of one the densest and busiest urban environments. Accessibility to these naturalistic experiences provide significant improvements to health and well-being because it offers an opportunity to temporarily escape, physical and mentally, to a setting that humans have evolved to prefer.

By provisioning spaces for these experiences people will foster a stronger connection with their surrounding environment, caring for and maintaining it for they have built a positive association with it. The "inter-domain transfer effect" thus carries this mentality into the various scales of associated with urban dwelling. People will emulate the qualities they perceived as stress reducing, relaxing, and pleasurable into the aspects of their homes and work spaces, continuing to trigger positive effects on emotional states and in turn improve cognitive capacities and restoration, especially in attention.[194]

[193] (Choudhry 2015)
[194] (Choudhry 2015)

People will eventually form an attachment with such spaces and a demand for them will grow. The implementation of such as network of spatial experiences in the urban environment should occur incrementally. Rather than attempting to provision these experiences everywhere in a planned/controlled sense, the infrastructure should allow for the users to cultivate these spaces as a natural or organic process. The result would create spaces for the people by the people, aggregating the different scales of the urban environment, the individual to the community and the community to the city, to fostering a flourishing habitat for urban dwelling.

A strong network of diverse spaces and experiences achieved through a pedestrian infrastructure can reduce the favor of automobiles and its dominance of the streetscape. The reduced presences of automobile activity or even just the perception of it will allowing for a return to dwelling in the outdoors as the urban environment moves toward the human scaled and the streetscape is balanced with increased pedestrian activity.

6.1 Biophilic Design Patterns

As a response to urban design and the promotion of walkability, nature provides a manuscript, offering strategies that support and satisfy the criterion of high quality urban environments. Briefly discussed earlier, the concept of biophilia implies the human biological need to connect and interact with nature on physical, mental, and social levels. These experiences have measurable and in some instances significant effects on health and well-being, as they are also relative to performance, productivity, and social relationships. Whether interaction through a walking in a park, with other living things, or a simply window view of greenery, these experiences provide stimulation of primal instincts that allow the dwelling environment to promote optimal human function instead of deterioration.[195]

Experts have worked diligently in attempts to define aspects of nature that can be fulfilled and satisfied within the built environment, developing patterns through extensive interdisciplinary research and empirical evidence.[196] These patterns on their own serve as powerful tool in designing the built environment toward the improvement of health and well-being, integration in the urban landscape will foster

[195] (Terrapin Bright Green 2012)
[196] (Browning, Ryan and Clancy 2014)

the cultivation of an environment that provides not only the optimal opportunity to survive but to flourish.

Overview of Patterns

Below is a list of patterns and their effects based on the studies and research that have been compiled by and iterated in 14 Patterns of Biophilic Design published by Terrapin Bright Green in 2014.[197]

Source: Table 1. Biophilic design patterns and biological responses (pg.14)[198]

Nature of The Space

Prospect

- Stress reduction: Reduced stress[199]
- Cognitive performance: Reduced boredom, irritation, fatigue[200]
- Emotion, mood & preference: Improved comfort and perceived safety[201][202][203]

Refuge

- Cognitive Performance: Improved concentration, attention and perception of safety[204][205][206][207]

Mystery

- Emotion, mood & preference: Induced strong pleasure response[208][209]

Risk/peril

[197] (Ibid)
[198] (Ibid)
[199] (Grahn and Stigsdotter 2010)
[200] (Clearwater and Coss 1991)
[201] (Herzog and Bryce 2007)
[202] (Wang and Taylor 2006)
[203] (Petherick 2000)
[204] (Grahn and Stigsdotter 2010)
[205] (Wang and Taylor 2006)
[206] (Petherick 2000)
[207] (Ulrich, Biophilia, Biophobia and Natural Landscapes 1993)
[208] (Biederman and Vessel, Perceptual Pleasure & the Brain 2006)
[209] (Ikemi 2005)

- Emotion, mood & preference: Resulted in strong dopamine or pleasure response[210]

Nature in The Space

Visual Connection with Nature

- Stress reduction: Lowered blood pressure and heart rate[211][212][213]
- Cognitive performance: improved mental engagement/awareness[214]
- Emotion, mood & preference: Positively impacted attitude and overall happiness[215]

Non-Visual Connection with Nature

- Stress reduction: Reduced systolic blood pressure and stress hormone[216][217]
- Cognitive performance: Positively impact on cognitive performance[218][219]
- Emotion, mood & preference: Perceived improvements in mental health and tranquility[220]

Non-Rhythmic Sensory Stimuli

- Stress reduction: Positive impact on heart rate, systolic blood pressure and sympathetic nervous system activity [221]
- Cognitive performance: Observed and quantified behavioral measures of attention and exploration[222]

Thermal & Airflow Variability

- Stress reduction: Positive impact on comfort, well-being and productivity[223]

[210] (Kohno, et al. 2013)
[211] (Brown, Barton and Gladwell 2013)
[212] (van den Berg, Hartig and Staats 2007)
[213] (Tsunetsugu and Miyazaki 2005)
[214] (Biederman and Vessel, Perceptual Pleasure & the Brain 2006)
[215] (Barton and Pretty 2010)
[216] (Park, et al. 2009)
[217] (Hartig, Evans, et al. 2003)
[218] (Mehta, Zhu and Cheema 2012)
[219] (Ljungberg and Neely 2007)
[220] (Q. M.-N. Li 2012)
[221] (P. Kahn 2008)
[222] (Windhager, et al. 2011)
[223] (J. Heerwagen, Investing in People: The Social Benefits of Sustainable Design 2006)

- Cognitive performance: Positive impact on concentration[224][225][226]
- Emotion, mood & preference: Improved perception of temporal and spatial pleasure (alliesthesia)[227]

Presence of Water

- Stress reduction: Reduced stress, increased feelings of tranquility, lower heart rate and blood pressure[228]
- Cognitive performance: Improved concentration[229] and memory restoration[230]
- Emotion, mood & preference: Observed preferences and positive emotional responses[231][232][233][234]

Dynamic & Diffused Light

- Stress reduction: Positively impacted circadian system functioning[235] & increased visual comfort[236]

Connection with Natural Systems

- Emotion, mood & preference: Enhanced positive health responses; shifted perception of environment[237]

Natural Analogues

Biomorphic Form & Patterns

- Emotion, mood & preference: Observed view preference[238]

Material Connection with Nature

[224] (Hartig, Evans, et al. 2003)
[225] (Hartig, Mang and Evans, Restorative Effects of Natural Environment Experience 1991)
[226] (R. K. Kaplan 1989)
[227] (Parkinson, de Dear and Candido 2012)
[228] (Biederman and Vessel, Perceptual Pleasure & the Brain 2006)
[229] (Biederman and Vessel, Perceptual Pleasure & the Brain 2006)
[230] (Alvarsson, Wien and Milsson 2010)
[231] (Windhager, et al. 2011)
[232] (Barton and Pretty 2010)
[233] (Biederman and Vessel, Perceptual Pleasure & the Brain 2006)
[234] (Ulrich, Biophilia, Biophobia and Natural Landscapes 1993)
[235] (Figueiro, et al. 2011)
[236] (Elzeyadi 2011)
[237] (Kellert, Heerwagen and Mador 2008)
[238] (Joye 2007)

- Cognitive performance: Decreased diastolic blood pressure[239] & Improved creative performance[240]
- Emotion, mood & preference: Improved comfort[241]

Complexity & Order

- Stress reduction: Positively impacted perceptual and physiological stress responses[242][243]
- Emotion, mood & preference: Observed view preference[244]

6.2 Adaptation Toward the Urban Environment

In studying the patterns above that have been examined and compiled by experts, this section will attempt to adapt and synthesize them into strategies to re-sculpt the urban landscape with the qualities and characteristics of nature that have been proven to provide positive responses and experiences to the human condition. These qualities and characteristics of nature satisfy the criteria that urban designers use to measure walkability and quality of place.

The Nature of Space

An understanding of space crafted through the countless process of refinement of natural elements and components will be a valuable tool in adapting the urban environment to emulate the conditions that have allowed for life to thrive and prosper. The qualities of the environment that has supported human evolution and life is rapidly being forgotten and it comes with grave consequences. Adaption of the spatial compositions that nature provided to the earliest humans into the urban environment has the potential to reverse the self-inflicted urban blight that has been spreading at a terminal rate.

[239] (Tsunetsugu and Sato 2007)
[240] (Lichtenfeld, et al. 2012)
[241] (Tsunetsugu and Sato 2007)
[242] (Salingaros, Fractal Art and Architecture Reduce Physiological Stress 2012)
[243] (Joye 2007)
[244] (Salingaros, Fractal Art and Architecture Reduce Physiological Stress 2012)

Visual Accessibility

The human evolutionary preference for "Prospect" derives from the savanna hypothesis referring to the ability of one to have unimpeded views. These views allow for the surveying of the environment around so one can make informed decisions of destination, opportunities, activities, as well as threats and dangers. By allowing good view prospects, a person is given the opportunity map and survey their soundings; the understanding of ones surrounding context in the urban landscape can provide a sense of control and safety, especially when one finds themselves in a new or unfamiliar environment.[245] In the urban environment, pedestrians are often lost in the rush of vehicular movement, thus they tend to forfeit their individual, personal mobility to be shepherded by the navigation of transportation services. The modern perception of the freedom of movement is represented by the ability to catch a lift, pun intended.

The Effect: Opportunities for view prospects have been measured to be more effectively utilized in greater distances. The ability to survey distances of 100 feet or greater provide one with a greater sense of place, making one more aware of what the surrounding context consists of and enhancing the perceived comfort of the environment.[246] The improved comfort reduces stress responses that are triggered in the urban environment, especially when one is in unfamiliar territory or alone.[247] The urban landscape can be better framed for human scale interaction for pedestrian rather than automobile centric interactions and services.

Urban Adaptation: The application and consideration of "Prospect" can perform a vital function for the cultivation of walkability. Considering pedestrian routes and their visual connections may help people to better understand the surrounding context, clearing the fog of automobile centric behavior and highlighting attractive paths that can reach destinations with travel times that are comparable to that which makes automobile use the predominant option. Since not all urban dwellers are conveniently located in the proximity of most frequented destinations, it can serve as an effective strategy to utilize the inevitable transition from driver to pedestrian.

[245] (Browning, Ryan and Clancy 2014)
[246] (Herzog and Bryce 2007)
[247] (Petherick 2000)

The act of commuting is a constant transition of modes, a switching from and back to pedestrian. In places that have the characteristics that support walkability, in terms of threshold distances between amenities, services, destinations, functions to pedestrian launch terminals, the ability and opportunity for "Prospect" can help to partially switch a person's transportation mode decisions. These transition spaces revert one to the pedestrian mode and create the opportunity to launch one into a pedestrian realm. Once a person reaches a destination, negligible of initial transportation mode, they revert to pedestrian mode. If the surrounding environment thus iterated favorable opportunities for pedestrian activity it would be more effective for one to continue this mode versus continuously shifting.

A visual connection linking platforms or opportunities for "Prospect" can further enhance pedestrian experience and promote walkability, promising more options within a perceivably attractive distance away. People will then be encouraged to explore further and not have to compromise, granting a sense of control in obtaining the best experience.

Nodes & Restorative Checkpoints

The human evolutionary preference for "Refuge" derives from the savanna hypothesis referring to the ability for the opportunity to rest and retreat from their surroundings. The refuge is in a sense a shelter in its most primitive state, offering protection from others that dwell in the environment and the environment itself. This allows people to have a sense of control and safety over their journeys or travel and can be points of reference, a checkpoint.[248] In combination with "Prospect" the pedestrian experience can be further enhanced by allowing greater freedom in negotiating one's interactions.

The Effect: The opportunity to seek refuge creates restorative experiences. Retreating and resting obviously promotes recovery, it can be measured physiologically through the reduction of heart rates and lowering of blood pressure. There is also the potential for improving mood by reducing feelings of irritation and

[248] (Browning, Ryan and Clancy 2014)

vulnerability, performance improvements by reducing fatigue, improving concentration and attention abilities.[249][250][251][252]

Urban Adaptation:

These "Refuges" can serve as checkpoints, points of reference for people to navigate and understand and digest the surrounding context. Refuges can be established as nodes that serve as breaks along a path; these nodes can also be look outs that incorporate characteristics of "Prospect", providing vantage points to survey what is upcoming and serve as gauges to measure travel distance. They should be just off the path of the main pedestrian circulation and activity stream, allowing one to disengage and reengage as desired. "Refuge" nodes or checkpoints can further enhance wayfinding and inform people of where there are opportunities in the urban fabric for interaction. These checkpoint nodes can also be precursory spaces that serve as preparation zones that buffers or optimize the transition back to the main stream or activities.

Aside from the more social aspects of the "Refuge", it can also be utilized as opportunities to seek shelter from environmental conditions such as, shade from the relentless heat of the sun or a screen from the wind while rifling through belongings. In contrast, it can be manifested through more subtle and delicate means such as sunspots along a shaded or covered area to receive the warm embrace of sunlight. The concept of "refuge" can be iterated as a simply canopy or a shift in spatial experience.

The crafting of "refuge" nodes or checkpoints should take consideration of the surrounding environment, the ambient characteristics such as visual or audio cues. The ever-present noise population of automobiles can be manipulated to trigger a therapeutic effect if the visual connection with automobiles is severed and replaced with water or a representation of.[253]

[249] (Grahn and Stigsdotter 2010)
[250] (Wang and Taylor 2006)
[251] (Petherick 2000)
[252] (Ulrich, Biophilia, Biophobia and Natural Landscapes 1993)
[253] (M. S. Hunter 2010)

The human evolutionary preference for "Mystery" derives from a sense of curiosity and the desire for more. This quality encourages exploration and interaction, promising continued or further pleasure and enjoyment or information. One anticipates and craves continued stimulation along a path, hide and reveal, teasing one along with a promised reward or prize at the end.[254] The aspect of "Mystery" should reflect the desires and needs that are more basic and universal as to initially engage with its audience, it can then further provide opportunities for enriched interactions.

The preference for "Mystery" is also connected with "Risk/Peril" because it provoked curiosity and fuels the intrigue to explore or test the waters. The difference between evoking fear and negative responses versus pleasurable and positive responses is the perception of control.[255] As almost everything in the modern environment is controlled to an intent, as an extension of safety, these two preference will be assimilated together with the headstone of "Mystery".

The Effect: The opportunity for "Mystery" is related to anticipation, eliciting pleasurable responses to visual and perceived stimuli. This quality has a similar pleasure response experienced when listening to music; one anticipates a positive or pleasurable pattern. The "Mystery" enhances the perceived attractiveness of a space, cultivating interaction and exploration in the absence of a visual marker or destination.[256] The crafting of "Mystery" should consider view distances as to not accidentally provoke a surprising response, which is associated with fear. Distances in the range of 20 feet or greater will allow for a more anticipated reaction versus a jarring effect that can be experience from sudden, unexpected stimuli.[257] The effect should be somewhat stochastic, being predictable but not precisely predictable.

A controlled sense of the unfamiliar or perceived risks coupled with the promise of safety produces strong dopamine and pleasure responses. Short doses of dopamine for adults can be motivational, improve cognitive functions and promote creativity.[258]

[254] (Browning, Ryan and Clancy 2014)
[255] (Rapee 1997)
[256] (Browning, Ryan and Clancy 2014)
[257] (Herzog and Bryce 2007)
[258] (Browning, Ryan and Clancy 2014)

Proactive shapes of the modern world intuitively elicit a sense of fascinating and excitement. The amygdala, the portion of the brain that processes fear, has been shown to activate in response to sharp angles and objects.[259] However, with the engendered perception of safety in the modern dwelling environment, these shapes and forms are no longer perceived as actual threats, thus creating a positive experience.

Figure 18: "Levitated Mass" by Michael Heizer at the LACMA

Urban Adaptation:

The sense of "Mystery" can be utilized by drawing people in with the preset knowledge of available amenities that are provided through convenience stores,

[259] (Moshe and Neta 2007)

grocery markets, coffee shops, food establishments or other recognizable functions or activities. The initial attraction may allow one to anticipate similar or a pattern of such occurrences throughout the path and encourage continuation. The encouragement of positive or pleasurable experiences promote exploration of the surrounding context, a flourishing opportunity for the community and establishments that go unnoticed at the scale of automobiles.

The quality of "Mystery" may be diminished with routine interaction because expectation succeeds anticipation. To mitigate this dilution of effect, a space for temporary or "pop-up" venues or attractions can be integrated along the journey or organized within the land-use functions.[260] Aside from the land-use implications, this quality can take on more formalistic manifestations such as elevated structures, overhangs, or overhead elements.

[260] (Browning, Ryan and Clancy 2014)

In the Space of Nature

The interaction with nature or naturalistic characteristics in the urban environment has the potential to mitigate the urban blight and generational environmental amnesia. Incorporating concepts of nature and evolved natural preferences not only serve to improve health and well-being but to also re-sensitize the era of urban dwellers to the qualities and characteristics of the nature and the environment that has supported the thriving of the human species. Adaption of the urban environment will cultivate an awareness for well-being and potentially drive future development back toward the human-scale and begin to wash away the skid marks of inhuman inhabitation.

Sensory Stimuli

The preference for a "Visual Connection with Nature" derives from research and studies that have correlated visual accessibility to nature and natural elements to the promotion of human health and well-being. Humans have an innate preference for nature and therefore prefer visuals of natural over artificial elements.[261][262] Visual connections with nature allows for shifts in focus, this can have a stimulating or relaxing effect, and foster a more intimate connection with one's surroundings – exhibiting the quality and characteristics of life and activity in an otherwise static, machined environment.[263]

In the absence or in cases of limited visual accessibility a "Non-Visual Connection with Nature" preference is derived from research and studies that has shown positive health and well-being results from secondary sensory interactions. The auditory, olfactory, haptic, and gustatory senses are termed secondary senses because human perception and interactions are dominated by the ocular and visual aspects. The human body responds and understands the surrounding environment through all the senses, in the modern culture, many interactions are predominantly optical. Positive sensory reactions, aside from the optical, provide subtle but beneficial effects because they are, much like visual perceptions, functions to indicate the qualities of the surroundings. The innate human desire for nature is correlative to the sensory

[261] (R. K. Kaplan 1989)
[262] (Ulrich, View through a window may influence recovery from surgery 1984)
[263] (Browning, Ryan and Clancy 2014)

responses, beyond purely visual, to evolutionary environmental characteristics that provide a perception of comfort, support, and familiarity such as: the tranquil sound of water, herbal aromas, non-abrasive textures, and familiar if not enjoyable tastes.[264] Gustatory stimulation can be engaged through the interaction and aggregation of the other senses to create richer experiences.

The effect: Visual access to nature and naturalistic elements have been shown to have positive effects on human health and well-being such as: reducing stress, enhancing concentration ability and recovery, and improving emotional and mood states. These benefits have been quantified by: decreased heart rate, lowered blood pressure[265][266][267], reduction of attention fatigue, improvements in attentiveness and engagement, decreased emotional distress, depression and aggression[268], improved attitude and overall perception of satisfaction and happiness.[269] A visual experience of nature can elicit positive effects on mood and emotional states after just 5 minutes.[270] A preemptive, 10-minute experience of nature prior to experiencing stressful activities stimulates parasympathetic activity (relaxation) and heart rate variability.[271] Post-stress experiences with nature, particularly forests, for durations of 20 minutes have been shown to promote physiological responses to regulate and return to a resting and relaxed state.[272]

Exposure to sounds representative of nature induce physiological and psychological restoration from stress.[273] It is also found to be motivational and provide cognitive stimulation while reducing mental fatigue.[274]

Olfactory exposure to herbal aromas and essential oils extracted from trees (phytoncides) have been shown to have calming and stimulating effects.[275] These effects further translates to recovery and restoration by stabilizing autonomic

[264] (Browning, Ryan and Clancy 2014)
[265] (Brown, Barton and Gladwell 2013)
[266] (van den Berg, Hartig and Staats 2007)
[267] (Tsunetsugu and Miyazaki 2005)
[268] (Biederman and Vessel, Perceptual Pleasure & the Brain 2006)
[269] (Barton and Pretty 2010)
[270] (Barton and Pretty 2010)
[271] (Brown, Barton and Gladwell 2013)
[272] (Tsunetsugu and Miyazaki 2005)
[273] (Alvarsson, Wien and Milsson 2010)
[274] (Jahncke 2011)
[275] (Q. M.-N. Li 2012)

nervous functions[276] and increasing natural killer (NK) cells and intracellular anti-cancer proteins that combat and prevent the generation and development of cancer cells.[277]

The feeling, touching and interacting with natural elements and textures have been shown and suggested to reduce fatigue and perception of pain, maintain physical condition, and stimulate relaxation by the modulation if cerebral blow flow.[278][279] Artificial materials and textures were exhibited to have a stress inducing response in contrast to the calming and soothing psychological and physiological effect of the natural. The innate internal responses were also shown to be negligible of whether the object was perceived to be pleasant or unpleasant.[280] The addition of visual stimulation, such as interacting with flowering plants is also shown to bolster positive mood and emotional states.[281]

An effective stimulation of the other senses, such as, a sweet aroma in a colorful setting may possibly evoke memories, past experiences or evolutionarily prescribed, to leave a sensation of taste. Similarly, crunch of stepping on a bed of white gravel stimulates the haptic, auditory, and optical senses simultaneously and may produce the sensation of a salty taste.

Urban Adaptation:

The availability of natural environments and landscapes in the urban environment are limited. Street trees and parks may make up most of an urban dwellers visual connection with nature. The biggest challenge to providing adequate visual access to nature comes mainly from sedentary and indoor lifestyles that are characteristic of urban environments. An effective strategy to provide visual access can be found in the transportation and commuting efforts that are requisite of the modern world. The ability to utilize an imperative and routine operation can serve as a powerful broadcasting platform. Whether transportation behavior or modes shift toward walkable environments or not, the application of naturalistic elements or nature itself

[276] (Park and Yoshifumi 2010)
[277] (Q. Li 2010)
[278] (Yamane and M. Kawashima 2004)
[279] (Koga and Iwasaki 2013)
[280] (Koga and Iwasaki 2013)
[281] (Yamane and M. Kawashima 2004)

in transportation infrastructures can allow urban dwellers to reap benefits on many scales.

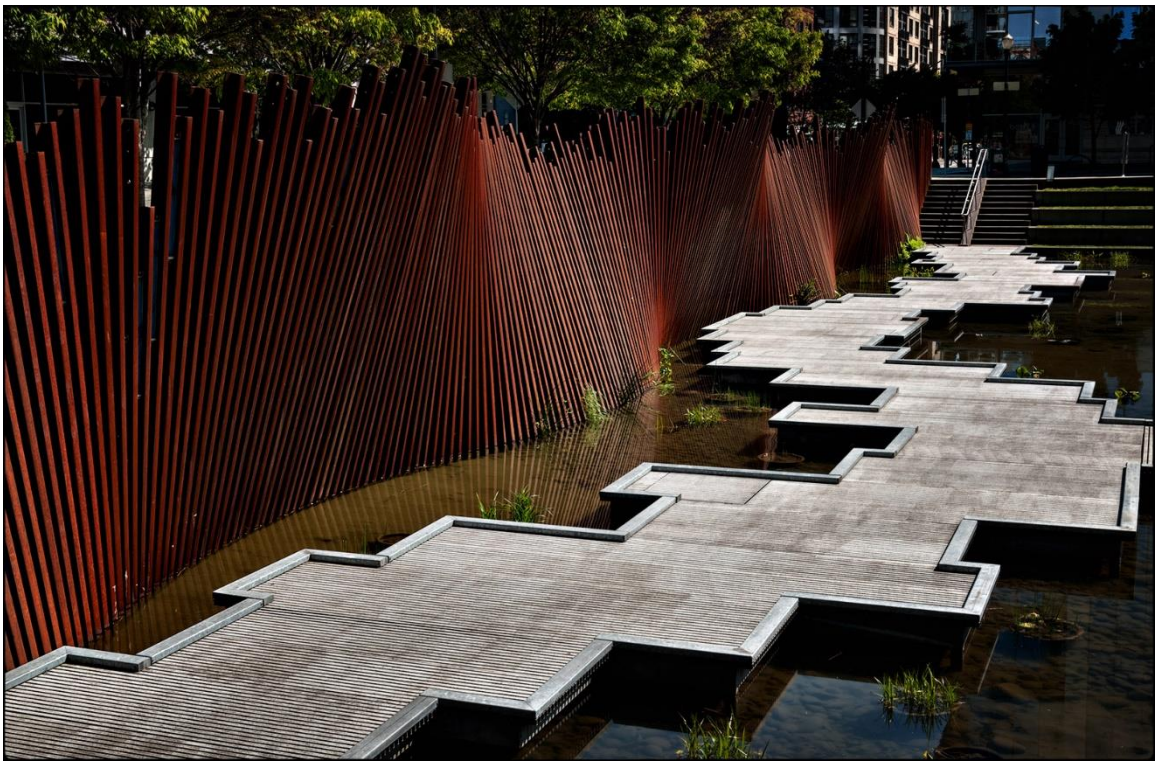


Figure 19: Tanner Spring wall sensory stimuli with form expression, © Victor von Salza[282]

Material and expression of form together with sensory stimuli can also create biophilic illusions. A study conducted by Hunter, Eickhoff, Pheasant, Douglas, Watts, Farrow, Hyland, Kang, Wilkinson, Horoshenkov, and Woodruff, found that there is a strong connection between the auditory cortex and the human experience and perception. Through functional magnetic resonance imaging, it was observed that the auditory roar of waves crashing and vehicles moving a freeway produced a similar sound. The data suggests that visual context can influence modulate the auditory perceptions.[283] Auditory stimulation in the form of vehicular movement with a visual representation of water, can produce a similar effect to that of being in the actual presence of water. This biophilic illusion can help to mitigate the stressors associated with automotive noise pollution and utilize it to elicit a positive effect instead.

[282] "17064693248_8b2c36f9f3_o." July 9, 2019. Digital image. © Victor von Salza. April 18, 2015 <https://farm8.staticflickr.com/7707/17064693248_8b2c36f9f3_o_d.jpg>
[283] (Hunter and S.B Eickhoff 2010)

The use of aromatic vegetation can help to mitigate the detrimental health impacts of the urban environment. Pedestrian corridors or active transportation infrastructures can utilize plants themselves or oil extracts where limitations to vegetation exist, along a path to emulate a forest or nature environment to create and allow for restorative health effects.

Applying naturalistic textures in interactive environments such as transportation systems, more specifically pedestrian or active transportation, will produce involuntary positive effects. The texture and characteristics of surfaces such as: paths, walls, and railings can be designed to emulate natural elements to make commuting/walking a relaxing and calming activity instead of an annoying and arduous one.

The incorporation of multi-sensory experiences in the urban environment has the potential to aid in the recollection of memory as the body processes multiple forms of understanding. This can be understood similarly to superior memory retention when one reads, writes, and says something. A multi-sensory experience will not only produce positive benefits to health and well-being but can also improve one's sense of place.

Naturally (Un)Controlled Experiences

The preference for "Non-Rhythmic Sensory Stimuli" derives from the ephemeral and stochastic characteristic of being in a natural environment. In nature, experiences are not exactly replicable, the surrounding elements are dynamic and are not precisely predictable.[284] For example, a boulder may retain the same physical composition but they are surrounding elements that interact with it may change, such as, the pattern of light and shadow casted on it, which then is also effected by variability in wind speed that may influence the penetration of light along with a rustling sound of the leaves of a nearby tree. The interaction of natural elements and components engage the human senses to further provide indications of the surrounding environment, a cool breeze can carry the crashing sound of waves and smell of salt, informing of the nearby ocean.

[284] (Browning, Ryan and Clancy 2014)

A variation in temperature and airflow also provides a haptic sensation that is reminiscent of the natural environment, providing a sense of comfort and pleasure. These fleeting, temporal moments create momentary distractions that shifts one's attention ever so slightly to provide stimulation or relaxation.[285] The innate understanding of these elements and their qualities are embedded in the human psyche and the perception of them triggers the human body to respond appropriately. Predictable patterns and rhythms register in the preference databanks of human evolution while variability and stochastic qualities grants a sense of unique individuality to an otherwise communal experience.

The Effect: The ephemeral and stochastic behavior of surrounding elements and components in nature has been shown to influence visual behavior, relaxation of the eyes, activity of the sympathetic nervous system, heart rate, systolic blood pressure, as well as attention and explorative behavior.[286] The human senses work harmoniously when exposed to temporal and variable naturalistic qualities. While visually locked and focused on something in a short range for an extended duration of time, 20 minutes or greater, such as one's beloved smartphone, eye strain and physical discomfort occurs from the contraction of the eye muscles. A momentary sensory, such as, a shift in light value, an intriguing sound, an appealing scent, or tickling breeze can serve as a distraction that shifts one's focus. Such distraction that can shift the focal range further away, 20 feet or greater, for a brief duration, 20 seconds or greater, allows the muscles to briefly relax and restore physiological functions. [287]

Alliesthesia refers to the thermal comfort and the stress responses that occur from the inability to control or adapt to temperatures, affecting well-being and in turn productivity. Environments, that provide sensory variability similarly to that of nature, such as, in light, temperature and sound are preferred over environments that lack sensory stimulation and variation as the latter fosters boredom and inactivity.[288] Temporary but large shifts in temperature over small portions of the

[285] (Browning, Ryan and Clancy 2014)
[286] (Choudhry 2015)
[287] (Browning, Ryan and Clancy 2014)
[288] (J. Heerwagen, Investing in People: The Social Benefits of Sustainable Design 2006)

body, rather than the entire body, is perceived to induce a sense of comfort.[289] It has also been shown that the interaction with natural light and its fluctuation supports homeostasis, regulating the body's circadian system and promoting health physiological functions.[290]

Urban Adaptation:

The natural environment hosts a plethora of sensory stimuli that can provide positive distractions as its surroundings are not mechanically controlled. In contrast, the urban environment lacks subtle, dynamic variability and supplants the surroundings with control switches and often unpleasant and even dangerous distractions. Many urban dwellers are also unfortunately glued to digital windows, constantly broadcasting information at a short range. One may not have the opportunity for such distractions due to the demands of urban society. However, an opportunity exists in the operation of commuting and transportation. The modern obsession with technology and smartphones have created hordes of head down zombies that are reluctant to look up and interaction with the surrounding environment, rushing from building to building as if the outdoors is a war zone with mines in the pavement and streams of bullets flying through the streets.

The outdoor realm, however, is full of unpleasant and undesirable qualities, therefore it is vital to rescript its perception and encourage interaction. A pedestrian infrastructure can shield and mitigate some of these dangers and unattractive attributes. It has the potential to transform negative distractions of the urban environment to positive ones. Utilization of the existing urban conditions to create positive sensory stimuli as previously discussed provides a platform for variation. An understanding of the natural elements can serve as an effective strategy for interaction with nature and allowing for natural, stochastic experiences. For example, a perforated canopy or vertical barrier, whether a natural component or an emulation of, can take advantage of natural light and wind to create dynamic and ephemeral effects. Trees and vegetation may also attract the likes of aviary creatures that can further create pleasant ephemeral visual and/or auditory distractions. Perhaps there is a rhythmic break to create non-rhythmic experiences or vice versa.

[289] (Edward 2006)
[290] (Kandel, et al. 2013)

Stretches of canopies and shading can be broken with pockets of natural light at varying times of the day to allow momentary kisses of warmth on the skin or encourage a pit-stop to bask in the sun. Sun-spots or partially shaded paths can allow can grant a sense of thermal control and variability, providing the opportunity to move in the light of choice. A variation or shift in light value may also serve as an indicator for transition or a shift in program or function, creating implied thresholds and boundaries. Incorporation of natural elements that provide multi-sensory experiences, such as water, with its ability to be seen, heard, and touched simultaneously, as well as interact dynamically with other elements, such as light and wind, can be an extremely effective strategy. The interaction of water and light reflect dancing patterns on blank or mundane surfaces, bringing them to life, fittingly so as these are life supporting elements.

Figure 20: Sensory stimuli from element filtering of vegetation, © Philip Moore [291]

[291] "3710834270_3db364800d_o." July 9, 2019. Digital image. © Philip Moore. March 16, 2017 <https://farm3.staticflickr.com/2509/3710834270_3db364800d_o_d.jpg>

Logic of Nature

A blueprint exists in nature that provides the script for the growth and composition of all natural components – living and non-living, sentient or not. As humans, have unleashed the urban blight, artificial components have edged out and rejected the order of natural logic – creating a world of non-sense. By understanding of how humans have evolved to engage and interact with the environment through the sense of senses, the urban environment can be adapted to incorporate the qualities and characteristics that make sense for human inhabitation. A further understanding of nature by means of the intuitive evolutionary growth blueprint embedded in all organic components can be a potential tool for routing the urban dwelling to become optimal environments for human inhabitation.

Growth Pattern

The preference for biomorphic forms & patterns derives from the natural evolution of most organic and living things. A visual preference found for patterns and numerical arrangements that occur in natural processes eluded to stress reduction through an instinctive recognition of natural components and life supporting characteristics. The color, green is characteristic of life supporting environments and is the most recognizable color to humans. Pattern that are observed in nature such as phyllotaxy, the organizational structure of plants from the arrangement of flower pedals to the organization of leaves and branches. The Fibonacci series scribes a numerical sequence of this concept most iterated in the growth process of plants and the Golden Means ratio exhibited in nature from the growth of shells to the organization of seeds. People have shown an affinity for naturalistic forms and patterns throughout history. Growth and the formation of new components in nature are informed by existing elements and conditions, promoting a balanced, sustainable evolution and progress.[292]

The Effect: The interaction with emulated, artificial and or constructed natural elements have been shown to reduce stress levels and produce restorative effects. The recognition of naturalistic qualities extends to the perceived details such as color and texture. A sense of comfort can be induced by perception of nature to elicit

[292] (Browning, Ryan and Clancy 2014)

different responses, the perception of the amount of naturalistic material one is exposed to can decrease diastolic blood pressure and increase pulse rate as well as decrease brain activity. A balance is necessarily to produce effective results. For example, high quantity exposure of wood in a room, in the range of 90% coverage, has been shown to promote healing and restorative responses while decelerating cognitive function as one registers a sense of increased safety and comfort. In a balanced setting, in the range of 45% coverage, diastolic blood pressure decreases and pulse rate accelerates.[293]

Fractal geometries in iterations of factors of three have been shown to create a degree of complexity to pique arousal and intrigue, thus, reducing stress levels and responses.[294] These fractal patterns are intuitive recognized as a formal expression that is independent to other sensory stimuli and indicators, supporting the human preference for nature.[295]

Urban Adaptation:

The understanding of the holistic approach of balance exhibited in the logic of nature can be applied to the development of the urban environment. The approach to urbanization should incorporate the blueprint of natural processes in the human/pedestrian scale. Recognition of scale and form can increase navigability and understanding of one's surroundings. The progression of the urban environment should follow the patterns and process of nature, a balanced relation between old and new, past and future – one does not simply pave over the other, they must exist symbolically as everything is one system. Mathematical transformations such as: randomness, translational geometries, reflectional symmetries, nested rotational symmetries, and glide symmetries are patterns that can be utilized.[296] The pedestrian infrastructure should respond to the existing conditions and weave through the urban fabric as a growth process rather than a renewal. It will sprout from underutilized or negative space to extend reach and accessibility to promote

[293] (Tsunetsugu and Sato 2007)
[294] (Salingaros, Fractal Art and Architecture Reduce Physiological Stress 2012)
[295] (Joye 2007)
[296] (Joye 2007)

growth and mobility. Following the logic of nature provides a script for the balancing of growth and progress in a healthy, sustainable path.

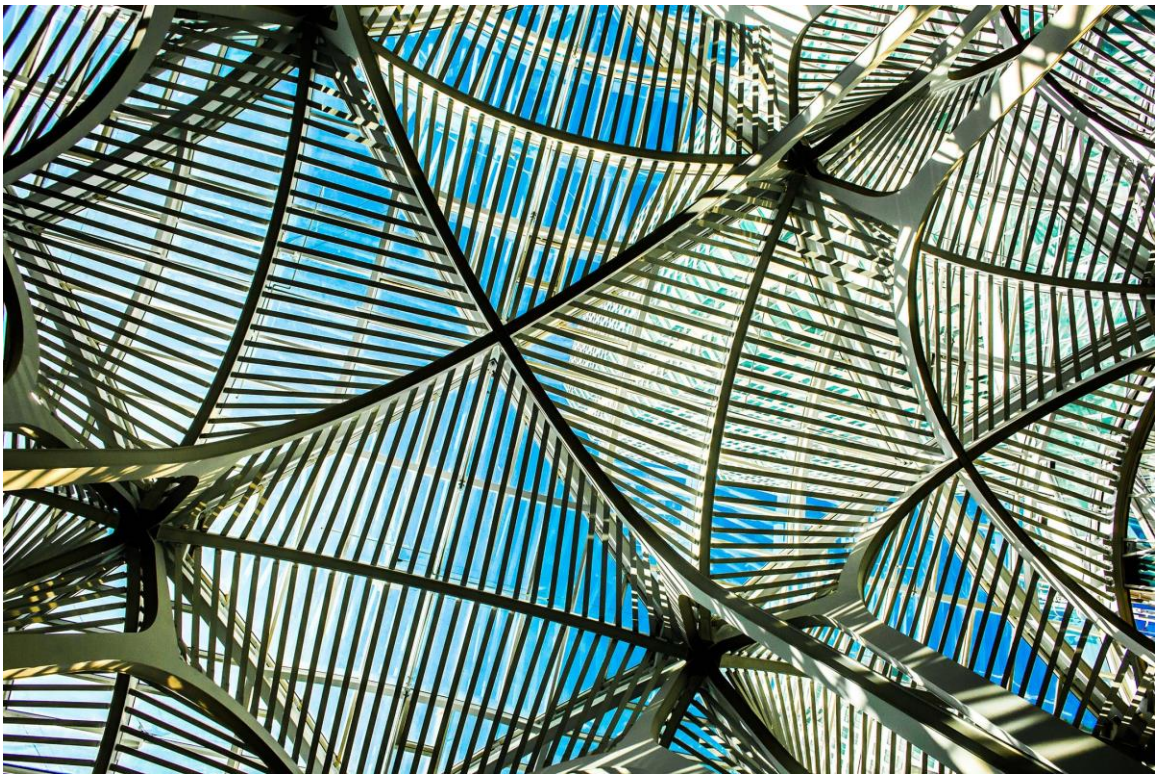


Figure 21: Ceiling structure at Brookfield Place by Santiago Calatrava, © Ossip van Duivenbode

6.3 Experiencing Natural Preferences in Urban Dwelling

Naturalistic Experiences: Naturalistic experiences in the urban environment can be achieve through active or passive interactions. Implementation of naturalistic features can be provisioned into the most fundamental and imperative operation of urban living, commuting and transportation. These experiences can be accessed frequently in relative durations if they are presented also highly trafficked routes. In this strategy, naturalistic features provide passive benefits as people are exposed to it in a periphery and indirect means. It is not the destination or intended activity, such as going to a park or for a hike, it is achieved through the necessity to travel from one place to another. Walking is a free and extremely mobile form of transportation. Scientific studies have provided unmistakable evidence that walking

amongst natural landscapes or naturalistic features promotes social interaction and has restorative effects on physical and mental health.[297][298][299]

With the emphasis on walking and walkability as the foundation for improving health and well-being in the urban environment, it becomes the first leg of experiencing the pedestrian infrastructure. The walking experience is complimented with naturalistic features that function to buffered from the stress and anxiety inducing presences of vehicular interaction as well as induce the positive effects associated with its interaction. Elevating the pedestrian path is primarily strategy as it provided opportunities to engage a multitude of evolved preferences (prospect, risk/peril, refuge). Being elevated above the street allows for views of different scales, it also improves visual access to natural landscapes where they are available.

The material and composition of its form and details can enrich the experience with a variation of opening and enclosures (Sensory and Non-Rhythmic Stimuli) that can allow for the penetration of natural elements (sun, wind, and water) or protection from them. A canopy or multiple canopies can form a sheltered travel route along only a portion of the path, allowing for variability in the interaction with the elements but provide a safe passage if when conditions are less than ideal. Utilizing the natural elements is an effect strategy for crafting richer experiences. In the event of rain, the canopy and catch and flow water off and open edge to provide a pleasant feature that emulates a waterfall to dispel the typical negative emotional state associated with inclement weather conditions. The runoff can then be channeled off into planters or the drainage system. Where the path is not elevated, it shall utilize existing or new plantings of trees for shade and shelter along with dynamic sensory and non-rhythmic stimuli created by the canopies. The street edge will be provisioned with planters that function to capture and filter street runoff as well as physically and visually buffer the presence of vehicular traffic.

The approach to the site: It is important to respond to the existing context of the site. The presences of trees or the lack of, is an important consideration. Scientific studies have shown that the presence of trees not only provides positive sensory and non-rhythmic stimulation but also improve psychological health and promote positive

[297] (Ulrich, Biophilia, Biophobia and Natural Landscapes 1993)
[298] (R. K. Kaplan 1989)
[299] (Grahn and Stigsdotter 2010)

emotion states. The experience along the path will utilize visual and experiential access of available trees and supplement the lack of with features that emulate the quality of trees or with planters and/or new plantings

"The Nature Pyramid"

As humans continue to move toward an urban lifestyle the dose and duration of experiences with nature and evolved preferences continues to diminish. The concept of the food pyramid is a measurement for humans to achieve the balanced diet necessary to ensure health by maintaining proper nutritional intake values. This concept can be re-imagined helping humans to achieve healthy servings and amounts of 'nature-nutrients'. In the food pyramid, foods that are less healthy if eaten in large quantities sit at the top, toward the middle are foods that should be consumed more frequently and in greater quantities, and serving as the foundation at the bottom are foods that should be consumed daily.[300] Adaption of this concept was first posited by Tanya Denckla-Cobb as the "Nature Pyramid" and revised by Tim Beastley, a Professor of Sustainable Communities, In the Department of Urban and Environment Planning, at the University of Virginia. The "Nature Pyramid" calls for the need to incorporate interactions with nature at different intensities to ensure a proper balance of experiences required for health and well-being. This concept will be adapted further to focus on the experience of nature or naturalistic characteristics within the urban environment. It will also consider values of experience and the operations of urban lifestyles.

Nature in The Urban Pyramid:
Nourishing Well-Being in The Urban Environment

A pyramid, as an analogy to the experiencing of naturalistic features and evolved preference, can be paralleled to the richness and quality of the respective experiences. The operations of the urban environment are an important consideration in the application of the experience of naturalistic features to ensure adequate servings and serving sizes. Exposure to small scale experiences of lower intensity should be experienced daily and often. These experiences are found in high quantities and brief durations or in lower quantities for longer durations if they were

[300] (Beatley 2014)

populated along a commuter's path. This allows the experience(s) to occur passively in as one travels from destination to destination to daily activities. These experiences and interactions with naturalistic features are a daily necessity for nourishing human health and well-being, and can be optimally utilized if implemented along heavily used circulation routes, representing the foundation of the pyramid. The need to commute is an imperative and daily operation for many urban dwellers, thus it is there that the potential for the provisioning of small scale levels of naturalistic experiences can be maximized. This can be further contextualized through natural functions; walking is the basic and fundamental natural human function of traveling through the environment; much like fish need to swim and birds need to fly, people need to walk.

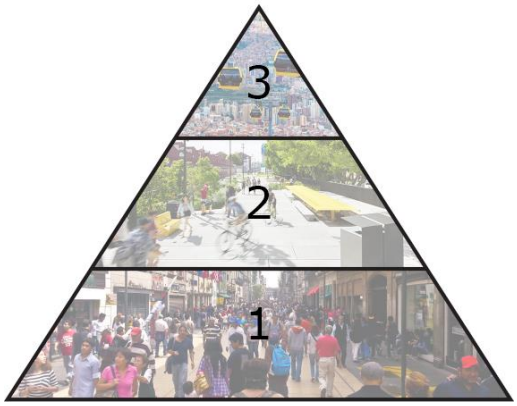


Figure 22: Scales of Experience

Walking should be a daily activity that humans perform, it is the natural human mode of transportation. However, this has been supplanted by non-active transportation methods, most notably the automobile. A pedestrian infrastructure is an effective way to operationalize natural experiences back into the urban dwellers lifestyles and routines. This daily serving of natural experiences, the activity of walking as well as the naturalistic features integrated along the way, serve to satisfy the most basic but also the most important part of human health and well-being. It provides a physical and psychological restoration and stimulation. The experience of naturalistic features can be manifested as literal, natural organic components or a constructed form that emulates naturalistic characteristics and qualities. As the pyramid's foundation, the daily and routine interaction allows for the greatest amount of exposure and duration, therefore, these experiences need not be overly rich and can be discreetly iterated.

In the pedestrian infrastructure one is privy to this fundamental experience, a high quantity of passive, subtle interactions perform a highly important function to restore and optimize human functions. These experiences of transition can found as passing textures and temporal experiences. They are not requisite of literal space but the experiences of these naturalistic features have the capability of creating a space itself. It does not require direct interaction as it is not a destination or place, but can engrain and enhance the sense of place. These experiences can be manifested through planters along the path or a row of trees, those who travel the path may discover unique uses for these elements and in time and use may cultivate into a space of its own.

Further up the pyramid, are experiences that increase in richness. These experiences build on top of the foundation, they are more direct and encourage interaction. The experience can be manifested as spaces for use, refuges or nodes along the pedestrian infrastructure that may functions as gathering spaces for activities or simply allow one to rest along the path. Naturalistic features are presented a larger scale to more explicitly define space to be interacted with to create experiences of higher intensity can encompass an entire space to have a more direct impact on the user. This next level may also accommodate active transportation modes such as bicycling. The features will be less subtle, larger in scale to be easily recognizable and perceivable as it will accommodate a quicker pace of movement for traversing longer distances.

The peak of the pyramid, the pinnacle of experiences, will be manifested as direct and intentional use. These experiences are landmarks, termination points, and destinations of the path. It is not necessarily an imperative operation and therefore may not be a routinely accessed experience. This experience accommodates the largest scale of travel for the urban dweller and its function serves more recreationally than imperatively. This mode will cover a larger distance that not typically favorable to be covered by foot or other active modes. This experience will be achieved through a gondola system that takes users on a scenic journey to specific destinations such as: a park, built facilities, recreational activities, event spaces, amenities, or another district. Though this mode of transportation is not active, restrictive and controlled, it offers the most pleasurable and stimulating experience to move across the urban landscape. It also allows for a greater opportunity to link various existing and proposed transportation modes to create a

stronger network of movement through the urban fabric. The experience is of the ride itself and its subsequent destinations which can be perceived as landmarks. The experience of a cable propelled transit (CPT) gondola is not hindered by obstacles of the urban and natural environment providing an unimpeded journey to desired destinations. For example, in the case of urban Honolulu, a CPT system can be a solution for the impasse of the Ala Wai Canal. The canal's reputation as dividing scar and impediment can be a thing of the past.

The opportunity for interactions with natural and evolved preference experiences has the potential to replenishes and fuel human physiologically, psychologically, and socially health – well-being. These experiences nourish and satisfy the appetite of the primal human condition. The integration of biophilic design patterns, extracted from evolved human preferences for naturalistic features, into the streetscape will provide humans the opportunity to healthily and optimally adapt to the urban environment. As a consideration to modern transportation behavior, automobile use, it is also important to be conscious increasing the overload of stimuli as it can be distracting for drivers and consequently lead to an increase in accidents and fatalities. The invention and provisioning of these experiences are focused on the outdoor environment and the realm of transportation, therefore, such experiences can be effective as temporal and peripheral stimuli. A high quantity of physical features not necessarily, the importance is in the perception and experience of space and place.

Nutrition from Naturalistic Experience

Different type of biophilic design patterns and strategies produce different type of effects. To increase the richness and intensity we can break down and categorize the different strategies by the effects they produce – if they elicit physiological, psychological, or social effects. For example, there is heavy evidence for the use of greenery or trees for increasing one's emotion and mood state, in turn provoking and improving the body's healing process. The initial effect is an effect that happens in the mental processes such as opioid receptors, it is then the increases in pleasure and improved mood state that induces the positive physiological process. In such instances, the strategy will thus be psycho-physio as to not get not get caught up in semantics.

It will be important to sequence the use of patterns or strategies coherently with one another and not haphazardly as it may end up creating a sense of confusion, discomfort, or disorientation. The implementation of strategies will require more research to discover the optimal combination and quantity that can a person should be exposed. It may be insightful to note how this may happen in the natural environment and savanna-like settings. How many patterns can be recognized or perceived at any given moment? Understanding of how the nature organically combines and compose these characteristics may be an effective strategy for incorporating them into the urban environment.

It would be ideal to be constantly exposed to nature or naturalistic characteristics or qualities, but realistically, in the urban environment, that is no possible. Research and experiments show empirical evidence for health and well-being benefits from 5 to 20 minutes of interaction with nature.[301][302][303] Given the limitations posed by the urban environment it can be a useful strategy to have increased amounts and higher frequency of shorter duration exposures integrated within the transportation operations. Transportation and commuting is after-all movement, therefore, within this realm one can receive high frequency of naturalistic interactions and experiences while in transition. Along the travel route there may be nodes that encourage people to stop, rest, and survey their surroundings, these nodes achieve greater durations of exposure as it is a pause in the journey. Terminal points have the opportunity for richer immersion and greater durations of exposure as they are the destinations or activity spaces. Duration and frequency thus have an inverse relationship, this seesaw relationship can be an effective strategy in assuring and maintain a balance between natural experiences and the modern lifestyle, allowing for a graduate adaptation.

6.4 Dwelling in The Outside Room

Adapting our experience from a recently, in the evolutionary sense, sedentary and indoor lifestyle back into one of outdoor activity can be catalyzed by the implementation of strategies for promoting walkability. The promotion of walkability coincides with the evolutionary experiences that support and improve human well-being, not only ensuring survival in the new (urban) environment but also providing opportunities to flourish. To be able to dwell in the outside realm of the urban environment it is imperative to address and mitigate the residual conditions of the infamous urban beast, the automobile. The concepts and strategies for implementing walkability and urban planning beckon to follow nature's blueprints. Emulating natural characteristics is quintessentially what urban design demands. Opportunities exist to transform automotive transportation infrastructure for pedestrian interaction to enhance the experience of urban spaces and create flourishing environments.

[301] (Brown, Barton and Gladwell 2013)
[302] (Barton and Pretty 2010)
[303] (Tsunetsugu and Miyazaki 2005)

The Goods Line: Sydney, Australia

Located in Sydney, Australia, The Goods Line, by ASPECT studios, is a reinterpretation of a transportation infrastructure to circulate pedestrians. The former rail line, once a channel for trade, now flows with pedestrians, promoting an exchange of culture, creativity, ideas and social interaction. The pedestrian pipeline creates a connective network for tertiary students, locals and tourists to many of the attractions of Sydney's Darling Harbor.[304]

Figure 23 The Good Line aerial photo, © Florian Groehn 305

The elevated rail structure has transformed into a corridor that hosts a variety of activities, becoming a platform for public entertainment, festivals, recreation and academic life. Further down the line it will connect with the arts, education and cultural institutions of Sydney's Cultural Ribbon.[306] The Goods Line serves as a precedent for cultivating dwelling in the outside room of an urban environment by creating a destination that enhances the quality and experience of public space

[304] (ASPECT Studios n.d.)
[305] "ArchiTravel_The-Goods-Line_2."7 October 2010. Digital image. © Florian Groehn. March 16, 2017 <http://www.architravel.com/architravel/building/the-goods-line/architravel_the-goods-line_2/>
[306] (ASPECT Studios n.d.)

through the transformation of previously isolated spaces in the urban environment. The adaptation of the rail line created a new civic spine in the heart of a densely populated urban area.

Operating as a primary circulation artery for pedestrian connection, The Goods Line creates a rich spatial experience with its tracks of various interactions and sequence of 'event platforms' that conduct exercise, play areas, lounging furniture and pods for retreat or studying for those in academia. Sun spots in beds of turf that are tucked in along the main pathway offer not only refuge but the opportunity for gathering and entertainment. A kick rail defines the edge of the main path is defined to create a threshold between the interactive space and the pedestrian flow. A narrow garden strip further buffers and bounds the activity spaces, further emphasizing the 'outside room'.[307]

The incorporation of the workbench creates a communal table that provides an outdoor gathering and work space. Interaction with the workbench can be used by people spontaneously or for organized meetings; it can also be of service to programs and functions of the surrounding context, externalizing the activity and life of the outlying buildings.[308]

The elevated infrastructure offers opportunities for view prospects, allowing people to survey and understand their surroundings – establishing a sense of place – it also forms visual and physical connections with the city and the thriving neighborhood of Ultimo. The Ultimo Bridge establishes a public north-south gateway to The Goods Line, punctuating a termination or beginning point with a recognizable landmark, thus contextualizing orientation in the city and improve understanding and awareness to the surrounding context.[309]

Elevated from the street below, The Goods Line physically separates the pedestrian zone from the vehicular domain. It provides a more attractive experience that may elicit active transportation in favor over driving. The design intervention on of the rail line also improves the quality of experience at the street level, constructing physically and visually cohesive interaction with the built context. The design also

[307] (ASPECT Studios n.d.)
[308] (Ibid)
[309] (Ibid)

increases the level of complexity of the surroundings that piques interest at a magnitude of scales.

Figure 24: The Goods Line main© Florian Groehn [310]

Takeaways:

- Stitching the space in between the acceptable thresholds to create checkpoints
- Ability to survey and locate. Provide overview/sequence/path of travel
- Wayfinding and landmarking
- Connectivity: Social and physical
- Improving pedestrian safety and promote active transportation
- Separation of the vehicular and pedestrian zones and circulation flows
- Improving overall well-being by mitigating urban environmental stressors

[310] "ArchiTravel_The-Goods-Line_2." February 9, 2017 . Digital image. © Florian Groehn. March 16, 2017 <http://www.architravel.com/architravel_wp/wp-content/uploads/2017/02/ArchiTravel_The-Goods-Line_main>

Paley Park: New York City, USA

Paley Park, designed by Zion Breen Richardson Associates, in New York City is an effective manifestation of a refuge amidst the urban landscape. The park is 4,200 sq. ft. space tucked in-between the buildings of one of the busiest parts of New York City. Paley Park is defined by its water feature of a 20ft. tall waterfall that creates a restorative experience, an oasis, within the maelstrom of the busy city.[311]

Figure 25: Tree canopy enclosure framing the water feature, ©Sampo Sikio [312]

The park incorporates many of the characteristics that humans have evolved to prefer. It offers a temporal escape from the sensory overload of the city by providing experiences oriented for human scaled interaction. Honey locust trees canopies form an overhead enclosure with a sense of life by creating a dynamic stage for light to dance. The towering heights of the surrounding buildings are buffered by the tree

[311] (Project For Public Spaces n.d.)
[312] "060716paleypark1." July 16, 2006. Digital image. ©Sampo Sikio via Flickr. Accessed March 20, 2017 <https://farm1.staticflickr.com/73/203024733_7360075dc4_o_d.jpg>

canopies along with a low brick wall that hosts a dense swatch of green ivy to draw a human scaled naturalistic space in the urban fabric. Paley Park's iconic waterfall functions to mitigate the sound of the streets and cars outside; in drowning out the noise pollution of the urban environment, the park submerges one in a multi-sensory experience that produces positive benefits to human health and wellbeing.

Takeaways:

- Refuge space set back from street
- Threshold of elevated steps as a symbolic transition
- Trees create visual connection to draw people into the space tuck in-between buildings
- Sense of enclosure appropriated to the human scale with trees amidst tall buildings

Luchtsingel Pedestrian Bridge / Rotterdam, Netherlands

The Luchtsingel Pedestrian Bridge is a crowd-funded pedestrian bridge designed by Zones Urbaines Sensibles (ZUS) that connects three districts (Pompenburg, Hofbogen, and Delftse Poort) that were previously disconnected by post war, development and transportation infrastructure (six lanes of traffic and two tram routes). The bridge is elevated approximately 5 to 6 meters off the ground and spans approximately 1,150 foot to provide an unimpeded and uninterrupted pedestrian route which was previously impassable by foot. It features at its center, a circular platform with integrated seating to promote use beyond a mere travel path. As a wayfinding and concept for cultivating a visually cohesive urban landscape, the yellow painted pattern applied on the path of the bridge continues onto the street surface as an extension and designation of the pedestrian path. A variety of public spaces were constructed and as a part of the project, making it a connective network and a catalyst for growth. The wooden bridge also features staircases of different widths unique to their respective destinations: the entrance to a public building, a bus stop, and a playground.[313][314]

[313] (Frearson 2015)
[314] (Platform 2016)

Figure 26: Luchtsingel Bridge continuous pavement pattern © Ossip van Duivenbode [315]

Takeaways:

- Visual linkage and coherence using surface pavement pattern to extend route beyond the bridge itself.
- Wooden structure spanning over transportation infrastructure
- Legible and recognizable route and function with individually unique access points

[315] "10 Luchtsingel Schieblock Day ZUS © Ossip van Duivenbode." July 22, 2015. Digital Image. ArchDaily. Accessed March 14, 2017 <http://www.archdaily.com/770488/the-luchtsingel-zus/55ac1ed6e58ece12db0001f2-the-luchtsingel-zus-photo>

6.5 Traversing the Urban Landscape

Multiple strategies can be applied to the pedestrian infrastructure to redefine the pedestrian route in the urban landscape. The path can be a flow from multi-way boulevard to elevated structure with a supplemental alternative transportation system (gondola) was well as linking existing/proposed transportation modes (Bus and Rail).

Multi-Way Boulevard: Octavia Boulevard, San Francisco, CA

Multi-way boulevards separate the travel paths from access lanes to create a more comfortable pedestrian realm in the street space. The separation of access or dwelling space and movement, pedestrian and automotive traffic, allows for a comfortable dwelling environment in the "outside room." This will provide different (three) scales of experience in the urban landscape: A slow walking pace, a medium active transportation pace, and the fast pace of automobiles.

Takeaways:

- Separates high flows of through traffic from local access
- Creates calmer traffic movement and more pedestrian space
- Side lanes

Cable Propelled Transit (CPT)

The experience provided by a CPT system offers a sense of risk and peril to simulate the users. The commute experience of a CPT slows the perceived pace of the urban environment, being at an elevated height scales the chaos of vehicular movement to a subtle periphery stimulus, focusing on the vast prospect of the environment at the aerial vantage point.

It is not "the" remedy for transportation issues but an opportunity to supplement and fill the gaps between the existing transportation network. It is useful to implement more than one way to commute and move about the urban environment. A CPT system utilizes gravity as an energy source, requires much less energy and produces significantly less emission that traditional terrestrial base transit systems. The Metrocable system in Medellin is estimated to have reduced up to 121,000 tons of CO2 since it began operations in 2004.[316]

Cables have been used as a form of transportation throughout history. Two types of CPTs, top and bottom propelled systems. CPTs debuted in the urban setting in the late 19th century in San Francisco in the form of the Iconic San Francisco Cable car. The top propelled systems were utilized mainly in recreation and the rise of winter sport activities. It was reintroduced into the urban context in the late 20th century when transportation engineers found it to be an inexpensive and cost-efficient alternative to urban transportation. New York's Roosevelt Island Tram, in 1976, is a precedent for the urbanization of the cable system.[317]

Statistics in Switzerland, the largest per capita cable car user in the world, reveals that CPT gondolas are the safest mode of transportation in comparison with other systems such as: trams, buses, rails, cars. CPT users are three times less likely to be injured than in a bus, train, or trams and fifty times less likely to be injured than in a car. Similarly, in the United States, there have only been six recorded fatalities; this statistic includes the use of chairlifts and none of the fatalities recorded are

[316] (Dale, Imhauser and Chu 2013)
[317] Ibid

associated with an enclosed gondola cabin systems. CPT related fatalities are 1:900,000,000 versus the 1: 31,000,000 of other transit systems.[318]

The 21st century is the dawn of alternative transportation and the cable system. Before the turn of the century, there were only eight CPT lines operating worldwide: Roosevelt Island Tram, Singapore Cable Car, Jialing Cable Car, Yangtze Cable Car, Macka-Taskisla Cable Car, Telepherique de Notre-Dame d'Afrique, Telepherique du Memorial, and Telepherique du palais de la Culture. Only one in the United States, the Roosevelt Island Tram. There are now over two dozen CPT lines operating worldwide, a more than 300% increase in a little over a decade and the implementation of CPT systems continue to generate more attention.[319] The rapidly growing and popularization of such a system can help to ameliorate the growing urban environments and supplement, not replace, the current transportation network.

[318] Dale, Imhauser,and Chu, Cable Car Confidential
[319] Ibid

7. INTRODUCTION TO SITE

Hawai'i and Hawaiian culture has it's roots intimately cultivated with the interaction and experience of nature. It is believed that people are related to all things of nature. The Hawaiian origin story is of man being the same as that of the island itself, along with the animals and plants. The traditions of Hawai'i are founded on a profound understanding of a symbiotic relationship with the 'aina – the land. The Hawaiian creation chant places man as the last life form to appear on the land. It is also believed that Hawaiian genealogy stems from kalo – the taro plant. Hawaiian cultural beliefs foster an intimate relationship between man and all the plants and animals of the lands, the land itself, and all celestial objects.[320]

Ancient Hawaiians strongly advocated the practice of healthy lifestyles, balancing nutrition, physical activity, and personal hygiene. Well-being a direct translation to one's lifestyle. If one fell ill, it was attributed to an imbalance of physiological, psychological, social, or spiritual means. Hawaiian Culture is based on universal mutual respect, and a constant strive for balance, structure, and unity. The Hawaiian inhabited their respective islands with a profound understand of the lands and its available resources. Habitation density was determined by resource abundance and its subsistence. Hawaiian tradition also carries a deep appreciation for voyaging as it was the main means for transportation.[321]

The development of Hawai'i's natural landscape into an urban environment occurred at an even greater and haphazard pace than most traditional cities. Hawai'i's quickly improvised infrastructure system is well represented in the lacking qualities of existing transportation and street conditions. Movement through the urban landscape can be disorienting and wayfinding can be challenging. Tradition urban planning practices are well iterated and high population density paired with poor transportation infrastructure and systems can be quite frustrating considering the great travel times require for relatively short distance trips. The urban core can at times, especially during traffic congestion, less than desirable and often avoided. One would believe that you would find yourself engulfed in greenery, but it is quite the opposite. This imposes challenges to walkability as the experience can be quite

[320] Ancient Hawaii. Info Grafik Inc. Acccessed December 11, 2016. http://www.hawaiihistory.org/index.cfm?fuseaction=ig.page&CategoryID=305
[321] Ibid

unpleasant. The tropical climate and year sunny conditions makes Hawaiʻi an optimal for location for implementing walkability. However, the combination of heavily vehicular presence on roads, poor sidewalk characteristics and conditions, the prioritization of automotive transportation and systems with exhaustive exposure to the sun, exacerbated by the urban heat island effect, makes walking an unattractive option for many.

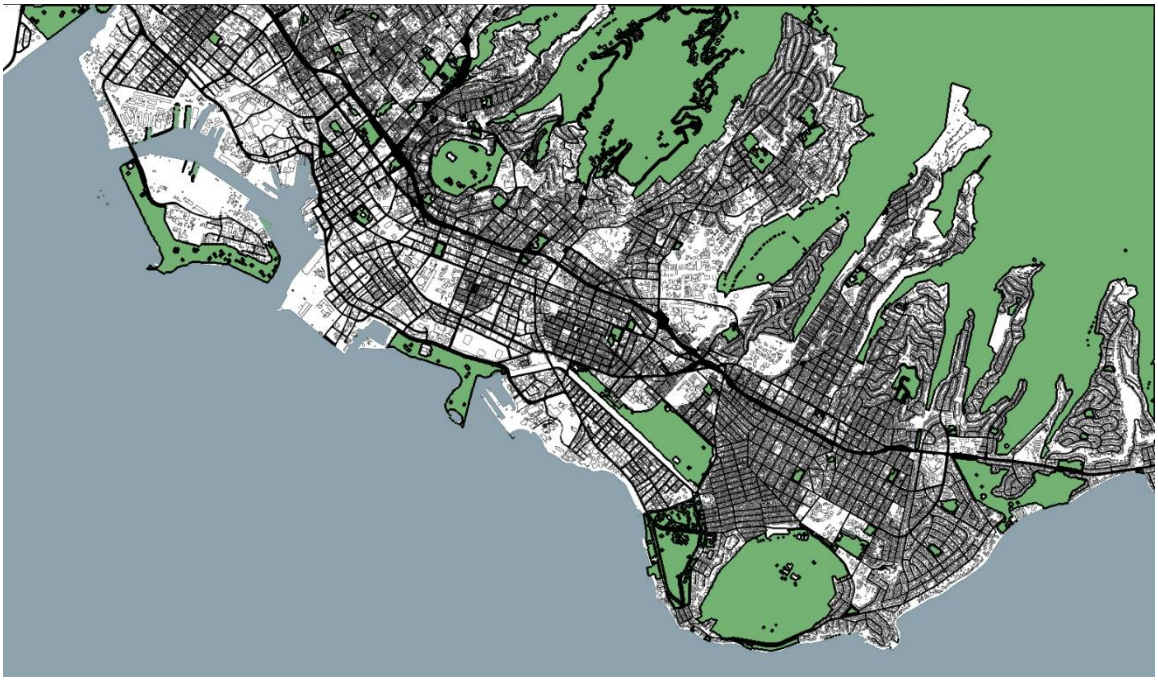


Figure 27: Oahu Overview

7.1 Site Analysis

Transportation has played a leading role in human civilization and the inhabitation of the environment. It has been a vital component to the evolution and flourishing of the human species. Habitation and transportation react and respond to one another and is embedded into the very essence of human civilization. Both operations have been drastically transformed by technology, particularly the advent and popularization of the automobile. In only a couple of centuries (a relatively small fragment of time in the timeline of human existence), the rise of the automobile has radically mutated the environment (dwelling and natural) and the interactions with those who dwell within. Transportation, of goods and people, has allowed humans to inhabit environments that are not inherently supportive of the human condition. As innovative technologies continue to rapidly emerge, so follows the decline of the natural environment, furthering the disconnect between mankind's evolved preferences and the dwelling habitat.

Hawai'i, especially the urban core of Honolulu, has seen this effect happen at a rapid pace. In just a single century, the landscape of Oahu and its south shore has had its natural landscape cut and filled with concrete and asphalt. The important axis of mauka to makai has been severed by the automobile transportation infrastructure, impeding on natural processes. The prioritization of the automobile and its transportation network severs the connection with green space and natural landscapes. The development and habitation of urban Honolulu is reflective of the transportation infrastructure, this is largely due to the topography of the island, moving laterally or east-west. This horizontal division is physically evident with the large interstate highway, major roads and the stream of automobiles that accompany it, along with the man-made feature of the Ala Wai Canal.

Figure 28: Development of the Urban Core

Justification of Site

University Ave. will serve as a prototype for a pedestrian oriented transportation infrastructure that runs in the muaka to makai axis to create a linked network to stitch together the fragments made by the existing transportation system. This new spine will improve health and well-being in the urban environment by promoting walkability along with providing opportunities to experience naturalistic features and the natural landscape.

The site of University Ave. connects three diverse communities and unique locations: University of Hawaiʻi at MĀNOA, the mixed uses of Puck's Alley at the upper mauka region of Moʻiliili, the residential neighborhoods of the makai region of Moʻiliili, the tourist market of Waikiki and bordering impasse of the Ala Wai Canal. The corridor of University Ave. has the potential for walkability and pedestrian activity, however, there are major deterrents along this mauka to makai path created by the automobile transportation demand. The H1 interstate highway situates itself in-between the University of Hawaiʻi and Moʻiliili, creating a visual disruption of the path. Furthermore, the pedestrian path is frequently intersected by vehicular access points, most notable, the two H1 on and two H1 off ramps that further rupture the connection between the two locations it straddles.

The width of University Ave. challenges pedestrians to uncomfortable situations; the pedestrian crossing time is roughly 25-28 seconds to traverse streets of 70 to 100 feet with not intermediate islands or refuges. Generally, the preferred walking pace is about 4.5 ft./s so these crossing times are supportive of a comfortable walking pace, however, it is the wait time in-between that is uncomfortable. People are often left stranding in the uncomfortable heat and the chaotic rush of vehicular traffic. Left turn only lights at these intersections going in both axis makes for a longer wait, all the while the lifeless character of the building frontages and the lack of trees and vegetation in the surroundings further exacerbates its unattractive quality.

The topography of the site is may affect its attractiveness. From the mauka to makai end of University Ave. there is an elevation change of roughly 150 feet in the span of a little over a mile and a half. However, the elevation change is not evenly distributed, roughly 130 feet of the elevation change occurs in the under one mile stretch from the mauka end of the avenue to H1 overpass that serves as a threshold

into Moʻiliili. Between the University of Hawaiʻi and the Ala Wai Canal there is also a long stretch of dismal streetscape, void of life, aside from that of the automobiles. Another two major arterials, King St. and Kapiolani Blvd., intersect the avenue makai of the H1 to further rupturing the pedestrian path.

Figure 28: Communities Divided: Mānoa, Moʻiliili, Waikiki

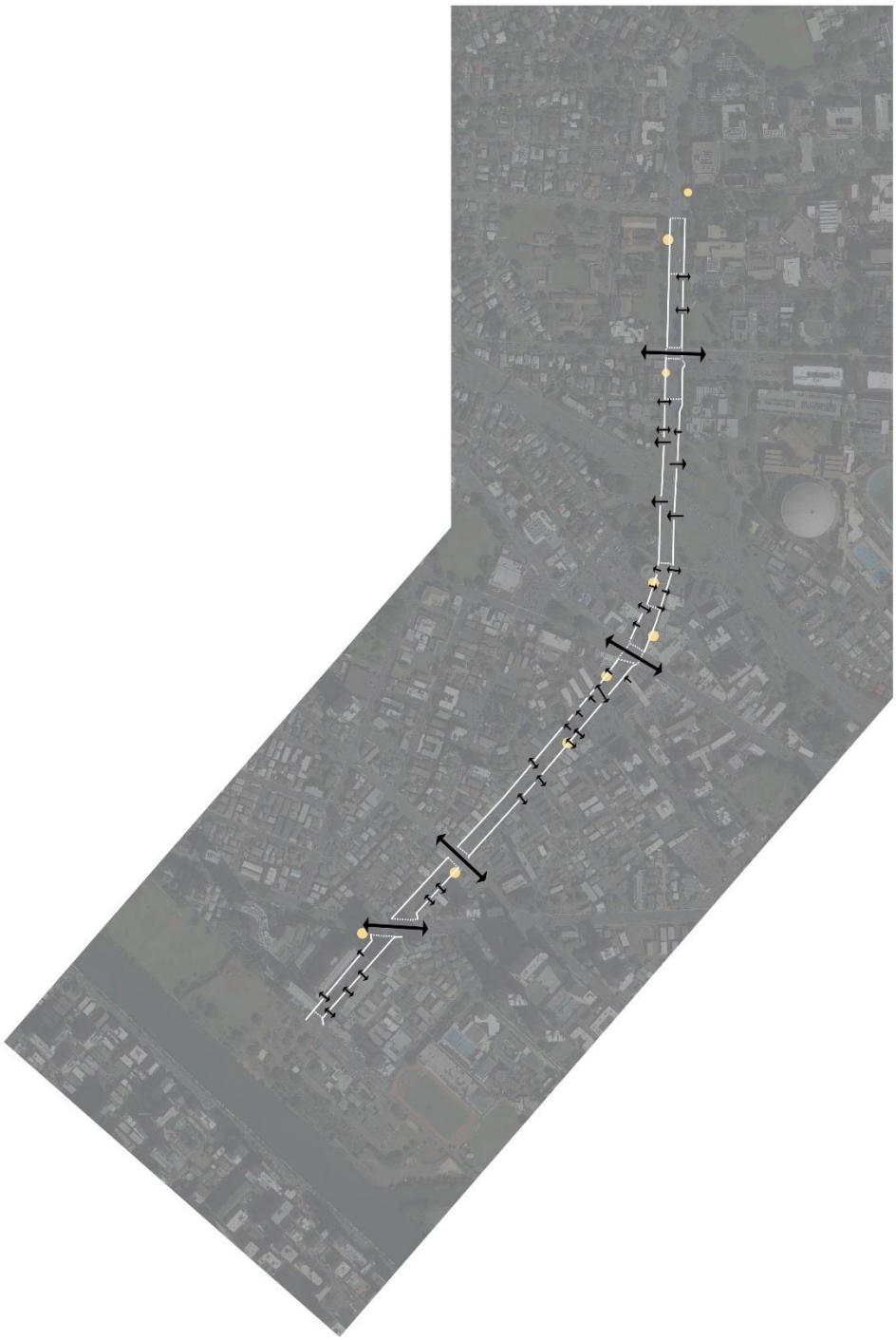


Figure: 29 Vehicular intersections of pedestrian path & Bus Stops

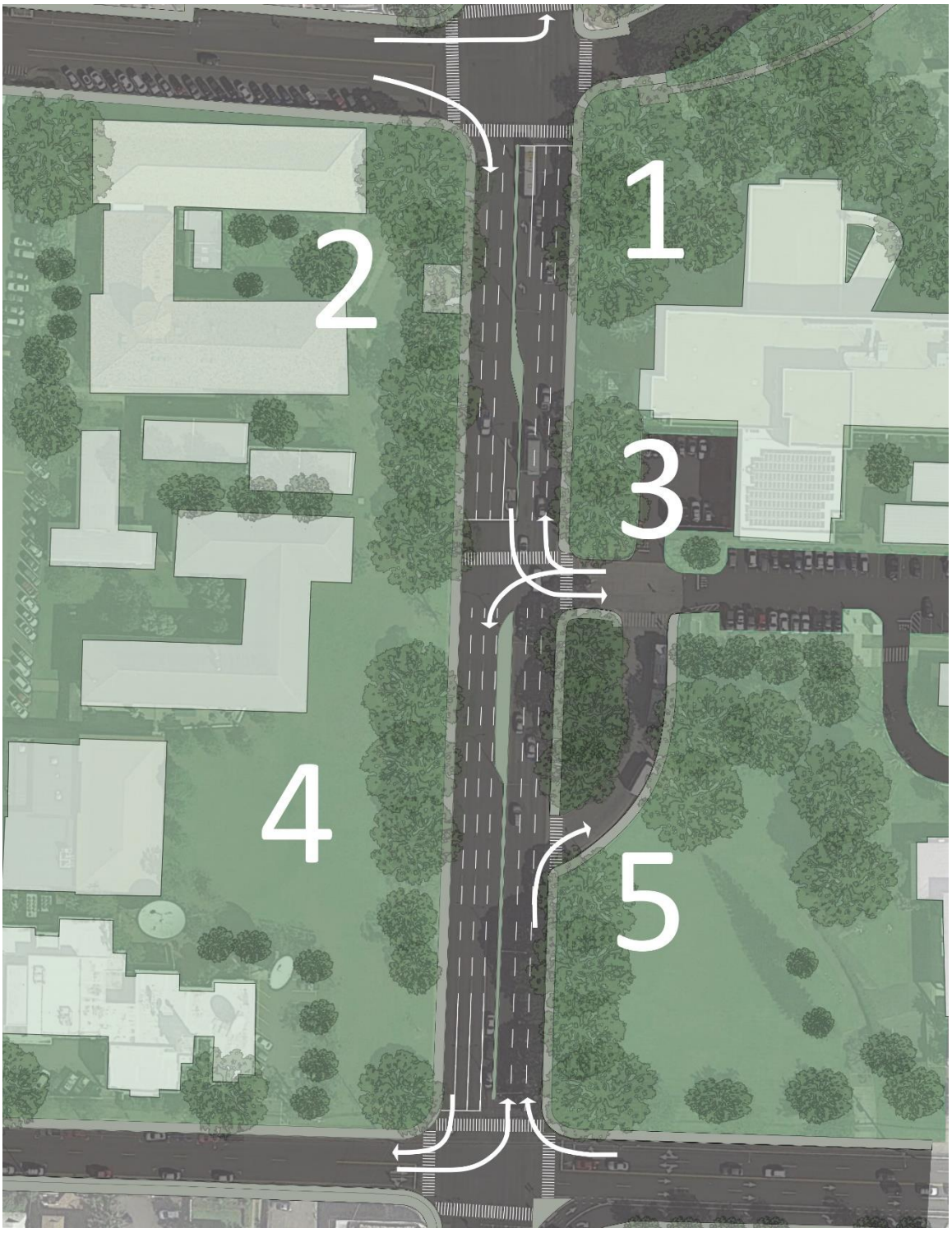


Figure 30: University Site Observations

1. Building frontage with large trees create shade along the pedestrian path. However, the enclosure of shade and building facade shifts focus toward the lit-up street and the onslaught of vehicular traffic.
2. Bus stops are shaded and heavily used (support with bus data). Provides a human scaled experience. The waiting queue juxtaposes the constant flow of traffic.
3. Pedestrian path and crossings are intersected by frantic vehicular interactions: right turn off Metcalf and Dole, left and right turns into Sinclair circle, and the rush against time, for parking and school classes.
4. Open lawns can either: attract people if it is populated with other people, attract people with activities or pop-up venues, be stimulating with lack of use.
5. Offers view prospects at different ranges and scenes: 100, 200, and 300 feet.

7.2 Opportunities

University Avenue hosts many potential opportunities for improving the quality of living in the urban environment. Its path can cultivate a connective network between currently disparate communities. An emphasis on active transportation as the primary commuting mode along with enhancements to the physical characteristics of the urban environment such as re-integrating naturalistic features and experiences will provide the opportunity to flourish – improving health and well-being for the dweller as well as growth and vibrancy to the dwelling.

Connective Network

Communities and functions around University Ave. are currently automobile centric. The multitudes of intersections that occur along University Ave. is a prime opportunity for a multi-nodal transportation. There already exists a wealth of bus stops and bus lines along University Ave, feeding into the areas of Puck's Alley and the University. The bus system would foster a symbiotic relationship with the proposed spine, The Bus System will feed the spine while the spine works to stitch together the mauka to makai gaps between bus stops and routes, creating a more attractive travel experience.

Reducing the reliance on automobiles will allow life and pedestrian activity to populate the streetscape. A focus on pedestrian orient and active transportation will also work to remediate traffic congestion during peak times, improving accessibility

and mobility, especially to events such as the athletic events of University of Hawai‘i at MĀNOA – the improved network has the potential to increase support for UHM athletics, bolstering University pride and spirit. There is also the opportunity for connectivity of existing naturalistic landscapes and features through a Cable Propelled Transportation (CPT) system anchored by Lyon Arboretum (currently hidden away deep in MĀNOA Valley) and the mountains at one end and the Ala Wai Canal, as well as the Pacific Ocean at the other.

Monocable Detachable Gondola (MDG), a detachable grip system is proposed. MDGs utilize a single cable for propulsion and support that circulates continuously around two terminals. It typically supports cabins that seat eight passengers but have can range from four to fifteen. Highly reliable, relatively low cost, quick implementation with modest passenger make it a popular option in the urban setting. They are the most common system for tourist oriented use.

The speed of the system can be responsive to peak and off peak use. The system can slow down at off peak times to conserve energy and reflect the natural procession of the day. The system is also more efficient than vehicular systems as its travel speeds are directly related to its use; vehicles are speed capacities that are never actualized in its use. Automobiles speeds vary from roughly 25mph to 60mph.

CPTs are also designed to operate in extreme conditions such as heavy snowfall and high winds; it should be expected to perform reliably in urban conditions. Hawai‘i, especially the corridor of University Ave. perfectly reflects the native design application for CPTs and juxtaposes it with the urban environment, mountains to city with significant elevation change. Evolution of the system is can be easily done by incorporating new towers and loops. Modules that can be implemented and added as the urban environment evolves. They can also be expanded vertically, lines can be stacked.

The pedestrian oriented spine will also provision a much-needed bypass of the man-made impediment of the Ala Wai canal. There alternative opportunities available to crossing the canal beyond the existing extent of vehicular use. Water ways have been a tradition method of transportation, throughout history and in Hawaiian culture. The Ala Wai canal, more of an impediment than a transportation route, can be utilized as a travel path for the a CPT system. With the introduction of a CPT

system, the canal can be crossed with gondolas in the air and water. Utilizing the canal itself will also provide an alternative routes and access to other surround areas such as the Ala Moana Shopping Center. The experience of both gondola modes will provide relief from the scale and pace of the street with intimate connections to naturalistic features.

Improving the experience of the streetscape through the pedestrian oriented intervention grants greater opportunities to activate the outdoor urban environment for pedestrian activity. The pedestrian infrastructure itself will provide a platform for interaction, serving as space and street furniture. Food services such as restaurants, food trucks, or even just beverage stands or snacks utilizes these spaces and forms to further encourage and attract pedestrian activity. The integration of food services also creates sensory stimuli through the sense of smell, providing stimulation through the promise of delicious morsels, these areas become restorative checkpoints that can occur in-between destinations. From there, communities can direct further strategies to cater to their specific demographic such as organizing block parties, street fairs/markets or other social functions and activities.

Figure 31: Reconnecting green spaces

8. DESIGN

The Urban Spine, a prototype pedestrian oriented, multi-modal transportation infrastructure for improving health and well-being in the urban environment. The design engages multiple scales of interactions that take place along University Avenue and considers diverse range of users and uses. The proposed pedestrian oriented infrastructure will allow urban dwellers the opportunity to interact with naturalistic features and experiences while traversing through the urban environment, encouraging activity in the redefined streetscape.

8.1 Design Objective

The disconnection with evolutionary experiences and interactions in the urban environment, driven by technological developments, primarily the automobile, has dehumanized dwelling and life outside of buildings and homes. This had led to a decline in physical, mental, and social health – human well-being. Activation of the Urban Spine will refine the streetscape to reintroduce naturalistic concepts in the experience of the urban environment to ameliorate the woes of the urban blight.

The urban spine provides increased opportunities for pedestrian mobility in the urban environment promotes the use of outdoor spaces. The current condition limits people to a linear path of sidewalks that only serves simple as a transition. The provisioning of the planters at the street level and the elevated path creates space(s) increases the amount of available space in the streetscape for people rather than for automobiles to dwell in. The cultivation of human space(s) shifts the perception of streets and the outdoors of urban environments always from mere passages from A to B into a beneficial and positive experience.

- Reclaim the streetscape as a pedestrian realm to promote walkability.
- Establish inter-connectivity and a network of multi-modal transportation in the urban fabric scaled toward human/pedestrian interaction.
- Improve health and well-being by providing the experience of evolved preference and naturalistic features. The greatest benefit will be received through the most basic naturalistic experience, walking. experiences in our built environment by emulating characteristics observed in nature that support and promote well-being.

Figure 32: Overview of Urban Spine

8.2 Design Project (Macros)

The Design macro of the Urban Spine is focused on the experience of moving through the landscape of the urban environment. The pedestrian oriented infrastructure will be composed of the spine, nodes, nodes, physical features that echo naturalistic characteristics that humans have evolved to prefer and experienced. The organization and composition of the components are arranged to cultivate walkability and encourage activity in the streetscape.

The Components

The Spine (elevated path) – pedestrian oriented street space that stitches the urban fabric, fills the gap between existing transportation network with an attractive experience, a wayfinding path to amenities and attractions, and creates an "outside room" for dwelling in the urban landscape. The elevation of the pedestrian route mitigates impediments along the travel path such as the intersection of vehicular access points, unappealing traffic light experiences, and unattractive sidewalks. The width of the elevated path is 12 feet for most of the run function as a shared path walking and active transportation.

Vertical Elements/Enclosures – reduces and mitigates unattractive and/or enhances attractive characteristics of the surround context through vertical elements and performative planters. Vertical and enclosing elements will vary throughout the path, increasing in transparency to providing information of the surrounding context while increasing in density detract from unappealing qualities to draw focus down the path. The composition of the vertical elements emulates the naturalistic characteristics and qualities that produce positive and restorative effects on human health and well-being.

Nodes – featured along the pedestrian path, the nodes are spaces that are unprogrammed and are defined by the fluid nature of users and uses. The nodes also function as refuges that are offset from the main path, providing space for interaction as well as view prospects. Nodes allow the opportunity for surveying the surrounding landscape and its offerings, granting the ability to negotiate the journey or simply stop to rest and enjoy the view. The nodes also serve as access points; additional access points and nodes can be attached as the spine grows and evolves,

cultivating a safe and enjoyable experience through the urban landscape. Stores and services can integrate program and utilize the node spaces to enhance the program experiences such as space for outdoor seating for cafes or restaurants.

Terminals (CPT Stations) and CPT Towers – the CPT stations serve as termination points of the path to mark destinations. These terminals also function as transfer stations for the CPT stations and transition from different modes of transportation. The terminals are landmarks that help with orientation and enhance the sense of place of their locations. The CPT towers provide the support for the gondola as well as the pedestrian spine. The formal composition of the CPT towers are integrated with the pedestrian path to also support shading elements. The location of the CPT structures follow existing building elevations to complement or imitate the existing site lines. The spatial composition of the cable lines can create a sense of boundary and enclosure of locations, they serve as transition thresholds that indicate a change of boundaries. Locating turns with intermediate stations reduces the infrastructure. It could also be tie into existing structures and utilize the pre-made routes. Locations and site elevations – to reduce the visual impact, the stations and towers can be blended with the existing built features. Utilizing mauka to makai axis will minimize disrupting scenic views of the mountains and ocean.

Scales of Experience

The design considers the multitude of scales and the diversity of interactions that happen along University Avenue. There are the scales of commute, this considers travel distance, duration, and pace. The scales of commute then dictate the scales of details, the physical characteristics and features of and along the path. The scales of commute and detail thus creates the scales of experiences.

The scales of experience correlate with the level of intensity which the user is exposed to naturalistic experiences. Analogous to a pyramid, scale one, the foundation, is grounded on the pedestrian experience of walking. At this scale, the pedestrian is commonly traveling the shortest distances at the slowest pace. Though for only short distances, the casual pace increases the amount of information that can be perceived and thus the quantity of exposure to naturalistic experiences. The increased perceivability rate and exposure allows for experiences to be subtle in scale with a focus on the richness in its details such as in the texture and patterns

along the path and surfaces. The quantity of access points is the greatest at this scale to accommodate fluid and unimpeded movement through across the urban fabric.

Next, up the pyramid is scale two, the elevated space. This tier is oriented toward users traveling medium range distances and can accommodate a walking pedestrian as well as an active transportation user, such as bicyclists. Traversing this distance calls for an uptick of pace. The increased pace reduces the level of perceivable detail and duration of exposure; therefore, the experiences are found in the physical features and spatial constructs. These experiences manifested through the characteristics of the space and place such as through the undulating vertical and horizontal elements as well as refuge nodes and view prospects. Access points are decreased at this scale as to limit interruptions and streamline the stitching of destinations and communities along the path.

At the top is scale three, the pinnacle. This scale serves for transporting medium and long distances as well as through physical impasses by utilizing a Cable Propelled Transportation (CPT) system and water-based transportation modes. The mode of transportation at this scale is non-active, negating the benefits received through active transportation modes but offer the richest experience and interaction with naturalistic features. The users of this scale will be completely removed from the urban context of the street to an experience of gliding in the sky for breathtaking views of natural features as well as the inspiring skyline, or floating through the water for scenic views and entries. The urban environment is already flooded with noise pollution; CPT gondolas and water based gondolas have no onboard motors, allowing for a relatively quiet experience and improving comfort. Access points are limited at this scale as it is intended for transportation to destinations and terminal points. However, the water-based gondolas have the potential to increase accessibility through the extent of its respective terminal.

Figure 34: Scales Plan overview

8.3 Design Project (Micro)

The design micro focuses on the details and experience of naturalistic features iterated in the Urban Spine, the human scale of the macro scales – macro micros. The elevated pedestrian oriented infrastructure also engages with the street level to promote greater walkability in the urban environment and extend its beneficial effects beyond its users. On the street level, portions of on-street parking will be reclaimed as space for human interaction and expand the pedestrian zone on the street level. The elevated path reduces the perceived width of the street to create a sense of human scaled space and enclosure for pedestrians as an "outside room." Planters and vertical elements are also used to enhance the human scaled enclosure as well as mitigate the visual presence of the street and vehicles. Features of the elevated path utilize the surrounding context for enhanced experiences and effects.

The Features

The vertical structure that supports the elevate path functions divide the width of the street to create the perception of the "outside room" and draw the perceived boundaries closer to a human scale. The path itself and the street level planters also aid in the manifestation of the human scaled enclosure. The physical characteristics of the vertical support structure emulates that of a tree branches, emulating street trees in their absence for a continuous run of "street trees" to line the pedestrian path.

The planters overtake portions of the street, where the number of lanes expand, planters claim a lane. The planters enhance the streetscape and provides naturalistic peripheral stimulation as the vegetation is rich in detail and texture, enhancing the available shade coverage and dynamic lighting effects of the existing tree canopies. The vegetation will attract critters such as birds, increasing the biodiversity and positive periphery sensory stimulation. The planters provide environmental and social benefits as well. As an addition layer to mitigating the visual presence and detrimental impacts of automobiles, the screens of vegetation will help to absorb CO2 while also having the ability to capture and filter street run-off before the water returns to the aquifer and ocean. The expanded pedestrian zone and added buffer to the street edge offers a space for people to rest or gather.

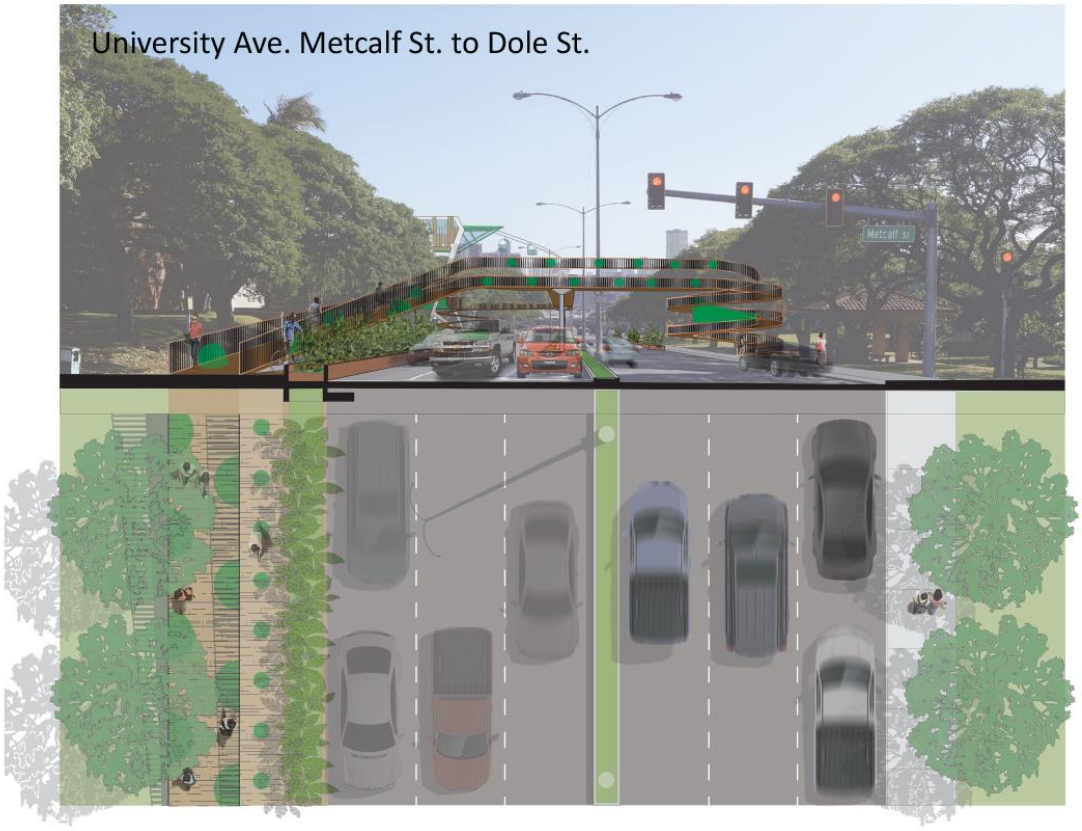


Figure 34: Plan and section perspective

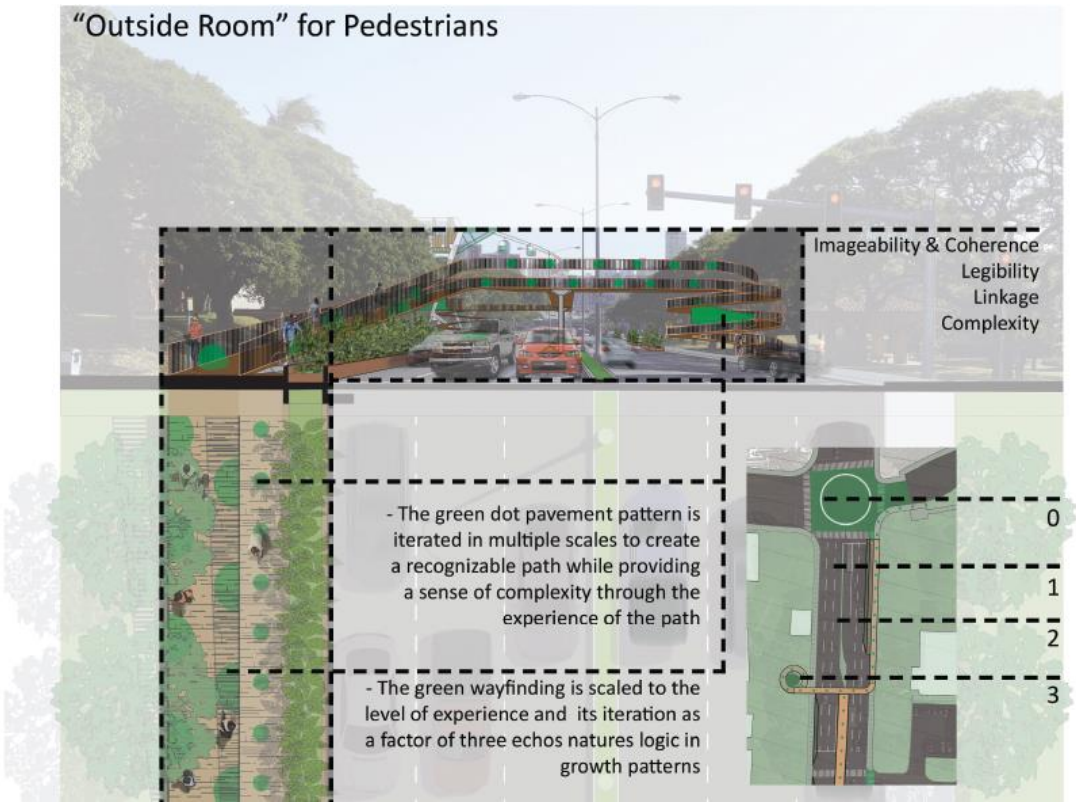


Figure 35: the outside room

Pedestrian paths and street intersections will feature a green dotted pavement pattern that designates the pedestrian oriented zone, facilitates wayfinding, and creating visual connectivity through coherent and recognizable imagery. A running but non-linear portion of the entire path will be covered to provide continuous shelter from the elements when needed while create a meandering path with pockets of sunlight. Vertical and horizontal elements of the elevated path undulate in scale and density to echo the oscillation and movement of water. Being elevated and physically removed from the scene of the street below allows the visual representation of water of the vertical elements, together with the sound of vehicular movement, to create a biophilic illusion. The illusion of the presence of water thus triggers positive and restorative effects. The vertical elements of the path also open to highlight view prospects and natural features.

Offset from the pedestrian path are access and refuge nodes that provide spaces to accommodate a variety of uses as determined by the users. They can function as gathering spaces, work spaces, a space to rest, a lookout to survey the surrounding features, or to just simply enjoy the view of available natural and urban features. The composition of the access nodes and flow to and from of the elevated path follow the spiral of the golden mean to emulate the naturally occurring pattern of growth and composition of organic components.

Scale 1

The experience of the Urban Spine at this scale emphasizes a slower pace of movement and pedestrian interaction. Its features encourage interaction in the intersections of paths. A variation of surface textures sculpts out spaces for dwelling.

The University Terminal

The University Terminal site utilizes the University of Hawaiʻi at MĀNOA recognizable landmark increase exposure and accessibility. The Urban Spine prototype establish an a imageable entry point to both the university campus as well as the pedestrian-oriented infrastructure. Large street trees provide good shade coverage over much of the pedestrian path, however, the set back of the university buildings with the trees occupying the frontage zone, together with the wide (74 feet) street with the limited context of the streetlights in the medium stretches the vast streetscape away from the human scale. The street trees height and position between the sidewalk and context instead of between the sidewalk and street draws attention to the street and flurry traffic.

The design approach to the University Terminal site will focus on rescaling the street level experience to a human scale to utilize the large trees and their respective canopies to create dynamic experiences of rippling light and shadows. The unutilized median will host the vertical structural elements for the elevated path. Application of an easily perceivable and recognizable green pavement pattern creates the threshold for the entry of the campus and pedestrian path. Surfaces of the designated pedestrian route feature green dots to clearly announce the path and create a visual link between the street level and the elevated pedestrian zone. The University Terminal site is enhanced by the connectivity of other feeder transportation systems and modes such as The Bus stops and the university parking structures. A CPT station integrated into Sinclair Circle to interface with The Bus. The integration to existing transportation modes will increase accessibility and use, serving as a transition to the pedestrian mode.

The Experience:

The scale of experience of the Urban Spine at the University Terminal focuses on interaction with the existing naturalistic features of the site. The mauka segment of University Avenue has a healthy population of large trees with vast canopies that extend its reaches to the street. On the street level, the elevated path reduces the perceived width of the street to create a sense of human scaled space and enclosure for pedestrians as an "outside room." The pavement is patterned with green dots, drawing periphery attention to the path's surface which acts as a canvas for experiencing the dancing pattern of light filtering through the tree canopy and bounding planter vegetation.

The planters function to reinforce the human scaled enclosure as well as mitigate the visual presence of the street and vehicles. Visual connection of scale and complexity are experienced with the large open lawns, small scale vegetation within and around the path, the larger scale of the trees and canopies, and an intermediate scale of the planter elements to enrich the rhythmic pattern of street trees.

The planters overtake portions of the street, where the number of lanes expand, planters claim a lane, keeping the number of lanes at six. The fluid rolling form of the planters create pockets of spaces for interaction. The fluid planter form along with the auditory stimuli of visually mitigate vehicles work together to turn the planter pockets into tranquil refuges. University students can utilize these pockets as a restorative retreat. In addition to the visual representation, the planters are designed to capture and filter street run-off before it returns to aquifer and ocean.

The experience of the elevated path at The University Terminal is created by surrounding tree canopies. Being elevated up closer to the tree canopies allows for a greater peripheral stimulation create by the restless swaying of the tree branches and rustling leaves. The elevated path features an extensive range of view prospects with an emphasis on Diamond Head. The width of the elevated path is 12 feet at its most narrow point to function as a shared path.

The elevated gondola experience offers greater views of the surroundings. For the student demographic, especially those who are residents of Oahu, the experience serves to help survey the lay of the land, improve the ability to orient and navigate around the foreign land. The experience of the gondola ride from the elevation of the

University terminal point will give views of the mountain range and valleys, the UHM campus, Diamond Head, the city skyline, and the ocean; a scenic and pleasurable experience in contrast to the maelstrom of the streets.

Design Overview

1. Pavement indication of pedestrian oriented zone. The mauka boundary of the "outside room." Street edge is expanded, reclaimed from the on-street parking. Planters line the edge to buffer vehicular presence. A ramp leads to the elevated path and possible gondola station.
2. Elevated path provides mobility with limited impediments and vehicular disruption. Spiral like ramp serves as an access point that allows for minimal displacement from the points of interest such as the bus stop. Nodes/refuges are offset from along the vertical path, providing spaces for people to rest, wait, gather, or negotiate their journeys.
3. Elevated pedestrian path leads to a gondola station that takes users down to Moʻiliili and the Ala Wai canal with a pleasant, scenic route over the urban core, floating over the frantic rush of traffic.
4. A row of planters provided spatial definition to the lawn and draws focus away from the street and encourage use or activity in the space.
5. Offers view prospects at different ranges and scenes:
   100' - bus stop and scene of "life"
   200' - an "outside room" (open lawn enclosure by trees)
   300' - iconic Bachman hall
   The row of trees fronting Dole St. Provides a quality of transparency allowing pedestrians to survey what is around the corner.

Figure 35: The University Terminal

The Puck's Alley Terminal

The Pucks Alley Site is dominated by vehicular activity. Vehicular space owns majority of the surface are of this site, together with the low-rise structures render the site flat and unappealing. The provisioned bike lane at this site is also narrow and frequently intersected by vehicular traffic. The Puck's Alley Terminal Site is designed to populate the fronting vehicular programs with vegetable pedestrian spaces. These spaces can be utilized by their neighboring facilities to enhance and promote their establishment. Provision these spaces for interaction with the surrounding built structures will provide a much-needed sense of transparency and life to this dead space of this site reclaims portions of parking lots and on-street parking for pedestrian activity. The site is also lacking features to make the street level experience attractive and enjoyable.

The design of the Puck's Alley Terminal will also be physically integrating into the surrounding context, featuring a CPT station features on top of the Puck's Alley building structure. The elevated path also functions as a canopy and create shade for the street level. Water features will also be incorporated to further mask the heavy vehicular presence. Planters are utilized for the Puck's Ally Terminal in a similar fashion to the University Terminal. The implementation of the planters along the edge of the University Building parking as along the H1 overpass will also improve the sites view prospects. Further opportunities to integrate with built structures such as a connection to the student housing development project that is being erected across from the Puck's Alley building on King street. The direct integration into residential buildings will also strengthen the connective network of the Urban Spine to reduce need for automobiles use and encourage walking and active transportation behavior – further increasing naturalistic experiences and receiving health and well-being.

The Experience:

The experience of the street level scale of design allows the pedestrian to find a refuge tucked between the relentless rush of vehicle traffic in the surrounding context. The elevated path above with the vertical supports structure along the street edge draw human scaled enclosure. The space reclaimed from the parking lot of the University building allow one to escape into an enclosure of naturalistic features, granting a moment to dispel from the stress and anxiety of the urban context. The experiencing of the water features in presented mitigate stimuli of the vehicular traffic to promote relaxation and restoration. A variety of scales in the spaces allow one to negotiate for the desired level of interaction. The view prospects iterated in the reclaimed spaces create visual connections to the elevated path and naturalistic features while hiding the slight lines to vehicular structures.

Figure 37: The Puck's Alley Terminal

Scale 2

Land use and built features shift to residential, low rise, small structure. The pedestrian infrastructure utilizes the median to prevent disrupting the residential neighborhood by taking the main travel path off the residential frontage zone. The increased presence of street trees in the median create a greater sense of human scaled enclosure (inside out) in contrast to the mauka leg (outside in), strengthening the definition of the street space.

The Experience: The Urban Spine at this scale is focused a faster face of movement and providing an unimpeded and efficient travel path between the terminals. The vertical and horizontal enclosure elements are undulating to stimulate a visual representation of water, together with the auditory stimuli of the surrounding context of vehicular traffic, the user experiences a biophilic illusion of being in the presences of water. This illusion works to produce a sense of tranquility and calm to ease the stress and anxiety of commuting. Openings in the enclosing elements function as a spotlight to highlight view prospects and points of interest in the surrounding context.

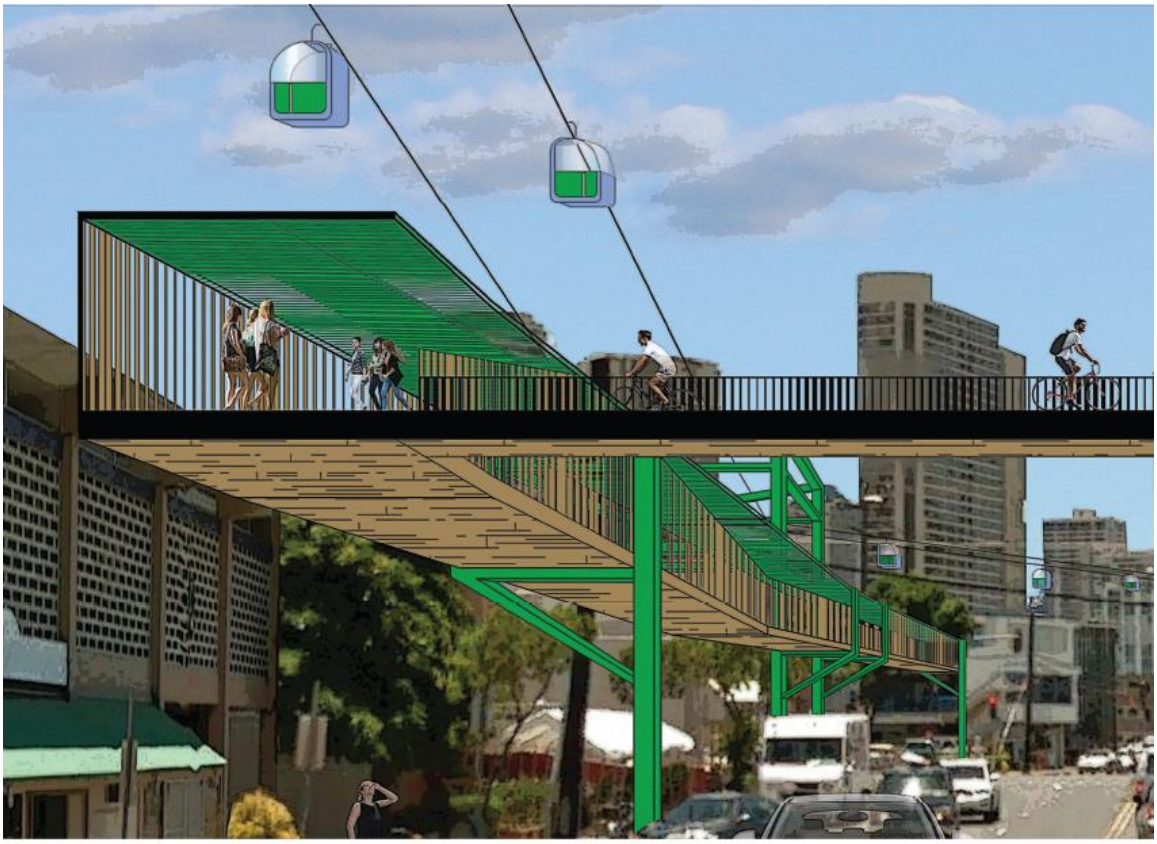


Figure 38: The elevated experience

Scale 3

At this scale, a completely unimpeded and interrupted experience with high quality views is offered. The user is isolated from the nearly all external and/or undesired stimuli and distractions of the urban context below allowing attention to be focused freely. The experience of this refuge space with great prospects create a momentary escape for a restorative effect.

The experience of the Ala Wai terminal provides a high quality naturalistic experience. The terminal itself is designed to encourage interaction with a variety of spatial scales. The experience of the water-based gondola grants a tranquil and scenic experience so one can be restored from the stresses impacted throughout the day or prepare for an upcoming event. Utilizing the Ala Wai canal as a transportation route allows each experience and route to be catered to the traveler intended destination. There is also the opportunity for the transportation routes to extend past the canal and along the south shore to Ala Moana and Kakaʻako – it may even offer an alternative entry experience into Waikiki, as if returning from the ocean.

The CPT gondola experience in its first phase will carry users over the canal. CPT stations can be integrated into the buildings such as hotels, offering tourist a scenic experience and break taking views. Connection into Waikiki also strengthens the connective network of the Urban Spine as the demographic tend to elect to use alternative modes of transportation because of the limit and unreasonably expensive parking fares.

The alternative transportation modes across the Ala Wai canal are effective and minimally invasive. They also offer the opportunity for growth and expansion because they are not permanently fixed paths. The greatest value however is in the immersive experiences of natural features.

Figure 39: The Ala Wai Terminal

8.4 Evolution

The Urban Spine, a multi-modal transportation infrastructure, is a prototype for the corridor of University Avenue but can be implemented along other mauka to makai axis to create a network of connectivity throughout the urban fabric. The growth of the network can begin with the expansion of the CPT line. Toward the Ewa side, it will start by connecting with Ala Moana to enhance the future light rail transit route as well as cultivating greater walkability another heavily traffic mauka to makai artery, Keʻeamoku Street. In the Diamond direction, stations will be provisions on Kapahulu Avenue and Kapiolani Community College to further strengthen the network. As the reach and threshold of the University spine is grows outward, new spines will form from its roots.

Figure 8.2b Gondola Route expansion to Kapahulu, KCC, and UHM lower campus on the Diamond head side. Expansion to Hawaiʻi Convention Center, Ala Moana Shopping Center, and Makiki Park toward the Ewa side.

Figure 40: Gondola Expansion

The Urban Spine(s) also have the capacity to respond to future scenarios such as the impending threat of sea level rise. Street infrastructure can be retrofitted into the spine itself as it is already elevated. As sea level rises the spine can also be expand to in the Ewa and Diamond Head directions as roads become flood and no longer suitable for use. Majority of Waikiki will be flooded with a three-foot rise in sea level. With a six-foot rise in sea level, Moʻiliili begin to be flooded, along with many other areas that are located makai of the H1. and Future development may even be integrated as attachments of the spine, redefining the streetscape as an elevated pedestrian-oriented platform. As the elevated movement progresses, the spine can begin to grow vertically (such is the building trend) and accommodate programs and services or increased transportation lines. The adaptability of the Urban Spine(s) will allow the dweller to flourish in the urban environment.

9. CONCLUSION

An elevated pedestrian-oriented infrastructure provides the opportunity for urban dwellers to experience the environment and lifestyle that optimally supported the human species throughout history. The Urban Spine, a multi-nodal transportation infrastructure, not only emulates the physical characteristics of human evolved preferences but also encourages activity and interaction in the outdoor environment; which is vital for optimizing human health and well-being. Cultivating the spine network can thus begin to remediate automobile-centric behavior as a step toward reclaiming the environment for human dwelling.

The experiences provided by the Urban Spine are integrated with daily operation of urban living. Being a part of the daily experience, the naturalistic features and characteristics emulated in the design can produce beneficial effects peripherally. As a direct effect, urban dwellers will experience increased physical activity because of the environments improved walkability. Stochastic and ephemeral qualities (while walking one is moving at a slower pace, the urban environment is designed around automobile function, a pace that is dramatically different than that which humans have evolved to experience. While walking a rich amount of detail can be perceived at any given moment, in contrast, while operating an automobile too much detail creates unnecessary and undesired distractions.

The beneficial effects provided by the experience of naturalistic characteristics and evolved preferences in the urban landscape will directly transfer through to intended destinations; optimizing human performance, improving social behaviors, bolster mood states, encourage positive emotions, and support overall health and well-being at multiple scales. The integration of the Urban Spine into built structures of the urban environment can cultivate a strong connective network of mix-used buildings and pedestrian oriented multi-modal transportation networks. Such a network can encourage the increased use of pedestrian and active-transportation modes, reducing automobile centric behavior, and improving the health and well-being of both the urban landscape and the urban dweller.

A pedestrian-oriented multi-modal transportation infrastructure can provide this democratic form of mobility in the urban landscape. In the form of an elevated platform, such a structure will act as a sort of refuge, an oasis in the exhausting

demands of urban living. A pedestrian infrastructure can function as more than a mere transportation route, it can create opportunities for social interaction, outdoor activity, become preparatory space before arriving at an intended destination, and most importantly facilitate physical and mental restoration.

The reclamation of the urban landscape from automobiles through pedestrian-oriented multi-modal transportation infrastructure such as the Urban Spine Prototype can connect fragmented communities and support the health and well-being or urban dwellers. The elevated infrastructure designed to emulate naturalistic characteristics and features will provide the opportunity for optimizing the pedestrian experience of the urban landscape and improve overall quality of life. Provisioning alternative transportation modes such as water-based transportation and CPT lines will potentially alleviate some of the stress and anxiety commonly associated with commuting in urban settings with high volumes of vehicular traffic. The exchange of stressful scenarios for experiences of naturalistic features, either emulated in a physical form or through sensory stimulation, will evoke positive reactions and responses intuitively. The cultivation of positive associations with the experience of the infrastructure will increases the desire to interact and utilize it; potentially shifting the dynamic the urban landscape is traversed and experienced. Automobiles will remain in park and urban dwellers will walk toward well-being.

10. BIBLIOGRAPHY

Adli, Mazda. 2011. *Urban Stress and Mental Health.* November. Accessed 11 10, 2016. https://lsecities.net/media/objects/articles/urban-stress-and-mental-health/en-gb/.

Alcock, I., M.P. White, B.W., Fleming, L.E. Wheeler, and M.H. Depledge. 2014. "Longitudinal Effects on Mental Health of Moving to Greener and Less Green Urban Areas." *Environmental Science & Technology, 48* 1247-1255.

Alexander, C. 2001-2005. *The Nature of Order, Books 1-4.* Berkeley, CA: Center for Environmental Structure.

Alexander, C., H. Neis, A. Anninou, and I.F. King. 1987. *A New theory of urban design.* New York: Oxford University Press.

Alexander, Christopher, Sara Ishikawa, Murray Silverstein, Max Jacobson, Ingrid Fiksdahl-King, and Shlomo Angel. 1977. *A Pattern Language: Towns, Buildings, Construction.* New York: Oxford University Press.

Alvarsson, J., S. Wien, and M. Milsson. 2010. "Stress Recovery during Exposure to Nature Sound and Environmental Noise." *International Journal of Environmental Research and Public Health, 7* 1036-1046.

An Encyclopaedia Britannica Company. n.d. *Merriam-Webster.* Accessed December 7, 2016. https://www.merriam-webster.com/dictionary/stress.

—. n.d. *Merriam-Webster.* Accessed December 11, 2016. https://www.merriam-webster.com/dictionary/environment.

An Encyclopeaedia Britannica Company. n.d. *Merriam-Webster.* Accessed December 11, 2016. https://www.merriam-webster.com/dictionary/urban.

Arnold, Henry F. 1980. *Trees in Urban Design.* New York: Van Nostrand Reinhold Company.

ARUP. 2016. *Cities Alive: Towards a walking world.* London: ARUP, June.

ASPECT Studios. n.d. *The Goods Line.* Accessed December 5, 2016. http://thegoodsline.aspect.net.au/.

Barton, J., and J. Pretty. 2010. "What Is the Best Dose of Nature and Green Exercise for Improving Mental Health." *Environmental Science & Technology, 44,* 3947-3955.

Beatley, Tim. 2014. *TNOC Encore: Exploring the Nature Pyramid.* Auguest 2. Accessed December 12, 2016. http://www.thenatureofcities.com/2014/08/02/tnoc-encore-exploring-the-nature-pyramid/.

Berman, Marc G, John Jonides, and Stephen Kaplan. 2008. "The Cognitive Benefits of Interacting With Nature." *Psychological Science vol. 19 no. 12 1207-1212.*

Biederman, I., and E. Vessel. 2006. "Perceptual Pleasure & the Brain." *American Scientist, 94* 249-255.

Biederman, I., and E.A. Vessel. 2006. "Perceptual pleasure and the brain." *Am Sci, 94* 249-255.

Boyce, P.R. 2010. "Review: The Impact of Light in Buildings on Human Health." *Indoor and Built Environment, vol. 19 no. 1* 8-20.

Boyden, S. 1971. "Biological Determinants of Optimal Health." *The Human Biology of Environmental Change.* Blantyre Malawi: London: International Biology Program.

Brown, D.K., J.L. Barton, and V.F. Gladwell. 2013. "Viewing Nature Scenes Positively Affects Recovery of Autonomic Function Following Acute-Mental Stress." *Environmental Science & Technology, 47* 5562-5569.

Browning, W.D., C.O. Ryan, and J.O. Clancy. 2014. *14 Patterns of Biophilic Design.* New York: Terrapin Bright Green LLC.

Cackowski, J. M., and J. L. Nasar. 2003. "The restorative effects of roadside vegetation: Implications for automobile driver anger and frustration." *Environment and Behavior, 35* 736-751.

Choudhry, Kahizar Z., Richard Coles, Salman Qureshi, Robert Ashford, Salim Kahn, and Rabia R. Mir. 2015. "A review of methodologies used in studies investigating human behaviour as determinant of outcome for exposure to 'naturalistic and urban environments'." *Urban Forestry & Urban Greening* 14: 527-537.

Claris, S., and D. Scopelliti. 2016. *Cities Alive: Towards a walking world.* London: ARUP.

Clearwater, Y.A., and R.G. Coss. 1991. "Functional Esthetics to Enhance Wellbeing." In *From Antarctica to Outer Space*, by Clearwater, McKay Harrison, 410. New York: Springer-Verlag.

Crowhurst Lennard, S.H. n.d. "Caring for Our Common Home: the Challenge." *International Making CIties Livable LLC Web Site.* Accessed November 27, 2016. http://www.livablecities.org/articles/caring-our-common-home-challenge.

Cullen, Gordon. 1961. *The Conside Townscape.* London: Reed Educational and Professional Publishing.

Dale, Steven, Tim Imhauser, and Nicholas Chu. 2013. *Cable Car Confidential.* Canada: Creative Urban Projects Inc.

Duany, Andres and Elizabeth Plater-Zyberk. 1992. "The Second Coming of the American Small Town." *Wilson Quarterly* 16: 19-48.

Dubos, R. 1965. *Man adapting.* New Haven, CT: Yale University Press.

Dubos, Rene. 1969. "The human environment." *Science Journal, October* 75-80.

Duhl, L.J., and A.K. Sanchez. 1999. *Healthy cities and the city planning process : a background document on links between health and urban planning.* Copenhagen: WHO Regional Office for Europe.

Edward, Arens, Hui Zhang, and Charlie Huizenga. 2006. "Partial- and whole-body thermal sensation and comfort—Part II: Non-uniform environmental conditions." *Journal of Thermal Biology* 31: 60-66.

Ellis, W.C. 1986. "The Spatial Structure of Streets." In *On Streets*, by S. Anderson, 115-131. Cambridge: MIT Press.

Elzeyadi, I. 2011. "Daylighting-Bias and Biophilia: Quantifying the Impacts of Daylight on Occupants Health." *Thought and Leadership in Green Buildings Research.* Washington, DC: USGBC Press.

Ewing, R., O. Clemente, S. Handy, R.C. Brownson, and E. Winston. 2005. *Measuring Urban Design Qualities Related to Walkability.* FInal Report, Robert Wood Johnson Foundation - Active Living Research Program.

Ewing, Reid. 1999. *Pedestrian- and Transit-Friendly Design: A Primer for Smart Growth.* The Smart Growth Network.

Figueiro, M.G., J.A. Brons, B. Plitnick, B. Donlan, R.P. Leslie, and M.S. Rea. 2011. "Measuring circadian light and its impact on adolescents." *Light Res Technol, 43* 201-215.

Frearson, Amy. 2015. *Crowdfunded Luchtsingel pedestrian bridge opens in Rotterdam.* 07 16. Accessed 02 19, 2016. https://www.dezeen.com/2015/07/16/luchtsingel-elevated-pathways-bridges-rotterdam-cityscape-zus-architects/.

Gehl, Jan. 1987. *Life Between Buildings: Using Public Space.* New York: Van Nostand Reinhold.

Glass, D. C., and J. E. Singer. 1972. *Urban stress: Experiments on noise and social stressors.* New York: Academic Press.

Grahn, P., and U.K. Stigsdotter. 2010. "The relation between perceived sensory dimensions of urban green space and stress restoration." *Elsevier Science Ltd., Journal of Landscape and Urban Planning* 264-275.

Hall, Peter. 1996. *Cities of tomorrow.* Malden: Blackwell Publishers.

Hartig, T., G.W. Evans, L.D. Jamner, D.S. Davis, and T. Garling. 2003. "Tracking Restoration in Natural and Urban Field Settings." *Journal of Environmental Psychology, 23* 109-123.

Hartig, T., M. Mang, and G.W. Evans. 1991. "Restorative Effects of Natural Environment Experience." *Environment and Behavior, 23* 3-26.

Hedman, Richard. 1982. *Fundamentals of Urban Design.* Chicago: American Planning Association.

Heerwagen, J.H. 2006. "Investing in People: The Social Benefits of Sustainable Design." *Rethinking Sustainable Construction.* Sarasota, FL.

Heerwagen, J.H., and B. Hase. 2001. "Building Biophilia: Connecting People to Nature in Building Design." *U.S. Green Building Council.* March 8. Accessed November 27, 2016. http://www.usgbc.org/Docs/Archive/External/Docs8543.pdf.

Heerwagen, Judith. 2008. *Psychosocial Value of Space.* May 23. Accessed November 13, 2016. https://www.wbdg.org/resources/psychspace_value.php.

Herzog, T.R., and A.G. Bryce. 2007. "Mystery and Preference in Within-Forest Settings." *Environment and Behavior, 39* 779-796.

Heschong Mahone Group. 1999. *Daylighting in Schools: An Investigation into the Relationship Between Daylighting and Human Performance.* Pacific Gas and Electric Company: California Board for Energy Efficiency Third Party Program.

Heschong, L. 1999. *Daylighting in Schools: An Investigation into the Relationship Between Daylighting and Human Performance.* Fair Oaks, CA: California Energy Commission: Pacific Gas and Electric Company.

Heschong, L. 2003. *Windows and Offices: A Study of Office Worker Performance and the Indoor Environment.* Fair Oaks, CA: California Energy Commission: Pacific Gas and Electric Company.

Howard, E. 1965. *Garden Cities of To-Morrow.* Cambridge: MIT Press.

Hunter, M.D., and R.J. Pheasant, M.J. Douglas, G.R. Watts, T.F.D. Farrow, D. Hyland, J. Kang, I.D. Wilkinson, K.V. Horoshenkov, P.W.R. Woodruff S.B Eickhoff. 2010. "The state of tranquility: Subjective perception is shaped by contextual modulation of auditory connectivity." *NeuroImage* 53: 611-618.

Hunter, M.D., S.B. Eickhoff, R.J. Pheasant, M.J. Douglas, G.R. Watts, T.F.D. Farrow, D. Hyland, J. Kang, I.D. Wilkinson, K.V. Horoshenkow, P.W.R. Woodruff. 2010. "The

state of tranquility: Subjective perception is shaped by contextual modulation of auditory connectivity." *NeuroImage* 53: 611-618.

Ikemi, M. 2005. "The Effects of Mystery on Preference for Residential Facades." *Journal of Environmental Psychology, 25* 167-173.

Info Grafik Inc. n.d. *Ancient Hawaii.* Accessed 12 11, 2016. http://www.hawaiihistory.org/index.cfm?fuseaction=ig.page&CategoryID=305.

Institute at the Golden Gate. 2010. *Parks Prescriptions: Profiles and Resources for Good Health from the Great Outdoors.* Full Report, San Francisco, CA: Institute at the Golden Gate.

Jacobs, Allan. 1993. *Great Streets.* Cambridge, MA: MIT Press.

Jahncke, Helena, Niklas Halin, Anne Marie Green, Kenth Dimberg. 2011. "Open-Plan Office Noise: Cognitive Performance and Restoration." *Journal of Environmental Psychology* 31: 373-382.

Jones, G. W. 2002. "Southeast Asian urbanization and the growth of mega-urban regions." *Journal of Population Research, 19* 119-136.

Joye, Yannick. 2007. "Architectural Lessons From Environmental Psychology: The Case of Biophilic Architecture." *Review of General Psychology* 11: 305-328.

Kahn, P.H. 2008. "A plasma display window?—The shifting baseline problem in a technologically mediated natural world." *Elsevier Science Ltd., Journal of Environmental Psychology, 28* 192-199.

Kahn, Peter H. 2011. *Technological Nature: Adaptation and the Future of Human Life.* Cambridge: MIT Press.

Kandel, E.R., J.H. Schwartz, T.M. Jessell, S.A. Siegelbaum, and A.J. Hudspeth. 2013. *Principles of Neural Science, Fifth Edition.* New York: McGraw Hill.

Kaplan, R., Kaplan, S. 1989. *The Experience of Nature: A Psychological Perspective.* New York: Cambride University Press.

Kaplan, S. 1995. "The restorative benefits of nature: Toward an integrative framework." *Journal of Environmental Psychology, 15* 169-182.

Kaplan, S., and Kaplan, R. 1983. *Cognition and Environment: Functioning in an Uncertain World.* Ann Arbor, MI: Ulrich's.

Kats, G. 2006. *Greening American's Schools - Cost and Benefits.* Capital E Report, The US Green Building Council.

Kay, Jane H. 1997. *Asphalt Nation: How the Automobile Took over America, and How We Can Take It Back.* Berkeley: University of California Press.

Kellert, S.R., J. Heerwagen, and M. Mador. 2008. *Biophilic Design: The Theory, Science and Practice of Bringing Buildings to Life.* New York: John Wiley and Son.

Koga, Kazuko, and Yukata Iwasaki. 2013. "Psychological and physiological effect in humans of touching plant foliage - using the semantic differential method and cerebral activity as indicators." *Journal of Physiological Anthropology* 32: 7.

Kohno, M., D.G. Ghahremani, A.M. Morales, C.L.. Robertson, K. Ishibashi, A.T. Morgan, M.A. Mandelkern, and E.D. London. 2013. "Risk-Taking Behavior: Dopamine D2/D 3Receptors, Feedback, and Frontolimbic Activity." *Cerebral Cortex, bht219.*

Koplan, J.P., and W.H. Dietz. 1999. "Caloric imbalance and public health policy." *JAMA, 282* 1579-1581.

Kou, F.E., and W.C. Sullivan. 2001a. "Aggression and Violence in the Inner City: Effects of Environment via Mental Fatigue." *Environment and Behavior, Vol. 33* 543-571.

Kou, F.E., and W.C. Sullivan. 2001b. "Environment and Crime in the Inner City: Does Vegetation Reduce Crime?" *Environment and Behavior, Vol. 33* 343-367.

Krier, Rob. 1979. *Urban Space.* New York: Rizzoli International Publication Inc.

Lakoff, G., and M. Johnson. 1999. *Philosophy in the Flesh: The Embodied Mind and Its Challenge to Western Thought.* New York: Basic Books.

Lauman, K. 2003. "Selective attention and heart rate responses to natural and urban environments." *Journal of Environmental Psychology 23* 125-134.

Lazarus, R. S., and S Folkman. 1984. *Stress, appraisal, and coping.* New York: Springer .

Lehrer, Jonah. 2009. "How the city hurts your brain - And what you can do about it." *Boston Globe.* January 2. Accessed 11 13, 2016. http://archive.boston.com/bostonglobe/ideas/articles/2009/01/04/how_the_city_hurts_your_brain/.

Li, Q., M. Kobayashi, Hirofumi Inagaki, Y. Wakayama, M. Katsumata, Y. Hirata, Y. Li, K. Hirata. T. Shimizu, Ari Itoh-Nakadai, T. Kawada. 2012. "Effect of Phytoncides from Forest Environments on Immune Function." In *Forest Medicine*, by Q. Li, 157-167. ebook: Nova Science Publishers.

Li, Qing. 2010. "Effects of forest bathing trips on human immune function." *Environmental Hleath and Preventative Medicine* 15: 9-17.

Lichtenfeld, S., A.J. Elliot, M.A. Maier, and R. Pekrun. 2012. "Fertile Green: Green Facilitates Creative Performance." *Personality and Social Psychology Bulletin, 38* 784-797.

Ljungberg, J.K., and G Neely. 2007. "Stress, Subjective Experience and Cognitive Performance During Exposure to Noise and Vibration." *Journal of Environmental Psychology, 27* 44-54.

Lynch, Kevin. 1960. *The Image of the City.* Cambridge: MIT Press.

Lyons Stewart, B. 2015. *Flooring Psych.* San Anselmo, CA: Architectural Design Psychology Press.

Maas, J. 2011. "Take a hike! How attention restoration theory shows that nature sharpens the mind." *Ode for Intelligent Optimists, Vol. 8, Issue 4.*

Mackenzie, Annah. 2015. *Project For Public SPaces.* March 3. Accessed 12 10, 2016. http://www.pps.org/reference/reimagining-our-streets-as-places-from-transit-routes-to-community-roots/.

Marcus, C.C., and M. Barnes. 1999. *Healing Gardens: therapeutic benefits and design recommendations.* New York: Wiley.

Matthews, G., A. Tsuda, G. Xin, and Y. Ozeki. 1999. "Individual differences in driver stress vulnerability in a Japanese sample." *Ergonomics, 42* 401-415.

Mehaffy, M.W., and N.A. Salingaros. 2015. *Design for a Living Planet: Settlement, Science, and the Human Future.* Portland, OR: Sustasis Press.

Mehta, R., R. Zhu, and A. Cheema. 2012. "Is Noise Always Bad? Exploring the Effets of Ambient Noise on Creative Cognition." *Journal of Consumer Research, 39* 784-799.

Moshe, Bar, and Maital Neta. 2007. "Visual elements of subjective preference modulate amygdala activation." *Neuropsychologia* 45: 2191-2200.

Moudon, A.V., C. Lee, A.D. Cheadle, C. Garvin, D. Johnson, T.L. Schmid, R.D. Weathers, and L. Lin. 2006. "Operational Definitions of Walkable Neighboorhood: Theoretical and Empirical." *Journal of Physical Activity and Health, 3, Suppl 1* 99-117.

Mumford, Lewis. 1961. *The City in History: Its Origins, Its Transformations, and Its Prospects.* New York: Brace and World Inc.

Nike. 2012. *Designed to Move.* A Physical Activity Action Agenda, Nike.

Niklas, M.H., and G.B. Bailey. 1996. *Student Performance in Daylit Schools.* Raleigh, NC: Innovative Design.

Novaco, R. W., D. Stokols, and L. Milanesi. 1990. "Objective and subjective dimensions of travel impedance as determinants of commuting stress." *American Journal of Community Psychology, 18* 231-257.

Novaco, R. W., D. Stokols, J. Campbell, and J. Stokols. 1979. "Transportation, stress, and community psychology." *American Journal of Community Psychology, 7* 361-380.

Novaco, R. W., W. Kliewer, and A. Broquet. 1991. "Home environment consequences of commute travel impedance." *American Journal of Community Psychology, 19* 881-909.

Novaco, R.W., and O.I. Gonzalez. 2009. "Commuting and Well-being." In *Technology and Well-Being*, by Yair Amaichai-Hamburger, 174-205. New York: Cambridge University Press.

Ohtsuka, Y., Y. Noriyuki, and T. Shigeru. 1998. "Shinrin-yoku (forest-air bathing and walking) effectively decreases blood glucose levels in diabetic patients." *International Journal of Biometeorolgy, 41* 125-127.

Olmsted, F.L. 1993. *Introduction to Yosemite and the Mariposa Grove: A Preliminary Report, 1865.* Yosemite Association.

Orians, G.H. 1980. "Habitat Selection: General Theory And Application to Human Behavior." In *The Evolution of HUman Social Behavior*, by J.S. (Ed.) Lockard. Chicago, IL: Elsevier.

Orians, G.H., and J.H. Heerwagen. 1992. "Evolved responses to landscapes." In *The adapted mind: Evolutionary psychology and the generation of culture*, by J.H. Barkow, L. Cosmudes and J. Tooby, 555-579. New York: Oxford University Press.

Park, B.J., Y. Tsunetsugu, T., Morikawa, T. Kasetani, T. Kagawa, and Y. Miyazaki. 2009. "Physiological Effects of Forest Recreation in a Young Conifer Forest in Hinokage Town, Japan." *Silva Fennica, 43* 291-301.

Park, B.J., Yuko, T., Tamami, K., Takahide, K., and M. Yoshifumi. 2010. "The physiological effects of Shinrin-yoku (taking in the forest atmosphere or forest bathing): evidence from field experiments in 24 forests." *Environmental Health and Preventative Medicine, 15* 18-26.

Parkinson, T., R. de Dear, and C. Candido. 2012. "Perception of Transient Thermal Environments: Pleasure and Alliesthesia." *In Proceedings of 7th Windsor Conference.* Windsor, UK.

Parsons, R., L. G. Tassinary, R. S. Ulrich, M. R. Hebl, and M. Grossman-Alexander. 1998. "The View from the Road: Implications for Stress Recovery and Immunization." *Journal of Environmental Psychology, 18* 113-140.

Perry, C. 1929. *Neighborhood and Community Planning Comprising Three Monographs: The Neighborhood Unit.* New York: Regional Plan of New York and Its Environs.

Petherick, N. 2000. "Environmental Design and Fear: The Prospect-Refuge Model and the University College of the Cariboo Campus." *Western Geography, 10* 89-112.

Pisarski, A. E. 1987. *Commuting in America: National report on commuting patterns and.* Westport, CT: ENO Foundation for Transportation.

—. 2006. *Commuting in America: The third national report on commuting patterns.* Washington, DC: Transportation Research Board.

Platform. 2016. *Projects: Projects: The golden bridge. The Luchtsingel by ZUS.* 03 08. Accessed 02 20, 2017. http://www.platform-ad.com/the-golden-bridge-the-luchtsingel-by-zus/.

Project For Public Spaces. n.d. *Great Public Spaces: Paley Park.* Accessed 12 10, 2016. http://placemaking.pps.org/great_public_spaces/one?public_place_id=69.

Pucher, J. 1997. "Bicycling boom in Germany: a revival engineered by public policy." *Transportation Q, 57* 31-46.

Rapee, Ronald M. 1997. "Perceived threat and perceived control as predictors of the degree of fear in physical and social situations." *Journal of Anxiety Disorders* 11: 455-461.

Rapoport, Amos. 1990. *History and Precedent in Environmental Design.* New York: Kluwer Academic Publishers.

Rothengatter, T., and E. C. Vaya. 1997. *Traffic and transport psychology: Theory and application.* New York: Pergamon.

Salingaros, N.A. 2006. *A Theory of Architecture.* Portland, OR: Sustasis.

—. 2015. *Biophilia and Healing Environments: Healthy Principles For Designing the Built World.* New York: Terrapin Bright Green LLC.

Salingaros, N.A. 2012. "Fractal Art and Architecture Reduce Physiological Stress." *Journal of Biourbanism, 2* 11-28.

—. 2005. *Principles of Urban Structure.* Amsterdam, Holland: Techne Press.

—. 2013. *Unified Architectural Theory: Form, Language, Complexity.* Portland, OR: Sustasis.

Speilberger, C. D. 1996. *State-Trait Anger Expression Inventory: STAXI professional manual.* Tampa, FL: Psychological Assessment Resources.

Steg, L. 2007. "Environmental Psychology: History, Scope & Methods." In *Environmental Psychology: An Introduction*, by L. Steg, A.E. van den Berg and J.I.M. de Groot, 1-11. Chichester: WIley-Blackwell.

Sternberg, E.M. 2009. *Healing Spaces.* Cambridge: Bleknap Harvard University Press.

Stokols, D., and R. W. Novaco. 1981. "Transportation and well-being." In *Transportation and behavior*, by I. Altman, Wohlwill J.F. and Everett P.B., 85-130. New York: Plenum.

Stokols, D., R. W. Novaco, J. Stokols, and J. Campbell. 1978. "Traffic congestion, type-A behavior, and stress." *Journal of Applied Psychology, 63* 467-480.

Sussman, A., and J.B. Hollander. 2015. *Cognitive Architecture.* Routledge: New York.

Taylor, A., F.E. Kou, and Sullivan W.C. 2001. "Views of Nature and Self-Discipline: Evidence from Inner City Children." *Journal of Environmental Psychology, Vol. 22, no. 1-2* 49-63.

Terrapin Bright Green. 2012. *The Economics of Biphilia.* New York: Terrapin Bright Green LLC.

The American Road & Transportation Builders Association (ARTBA). n.d. *Frequently Asked Question.* Accessed February 3, 2017. 2017.

Tsunetsugu, Y., and Y. Miyazaki. 2005. "Measurement of Absolute Hemoglobin Concentrations of Prefrontal Region by Near-Infrared Time-Resolved Spectroscopy: Examples of Experiments and Prospects." *Journal of Physiological Anthropology and Applied Human Science, 24* 469-472.

Tsunetsugu, Y., Miyazaki, Y., and H. Sato. 2007. "Physiological Effects in Humans Induced by the Visual Stimulation of Room Interiors with Different Wood Quantities." *Journal of Wood Science, 53* 11-16.

Ulrich, R.S. 1993. "Biophilia, Biophobia and Natural Landscapes." In *The Biophilia Hypothesis*, by S.R. Kellert and R.S. WIlson, 73-137. Washington: Island Press.

Ulrich, R.S. 1984. "View through a window may influence recovery from surgery." *Science, Vol. 224* 420-422.

UNESCO. n.d. *Works of Antoni Gaudi.* Accessed December 11, 2016. http://whc.unesco.org/en/list/320.

University of Minnesota. 2014. *How Does Nature Impact Our Wellbeing?* June 25. Accessed 11 10, 2016. http://www.takingcharge.csh.umn.edu/enhance-your-wellbeing/environment/nature-and-us/how-does-nature-impact-our-wellbeing.

van den Berg, A.E., T. Hartig, and H. Staats. 2007. "Preference for Nature in Urbanized Societies: Stress, Restoration, and the Pursuit of Sustainability." *Journal of Social Issues, 63* 79-96.

Wang, K., and R.B. Taylor. 2006. "SImulated Walks through Dangerous Alleys: Impacts of Features and Progress on Fear." *Journal of Environmental Psychology, 26* 269-283.

Whyte, W.H. 2009. *City: Rediscovering the Center.* Philadelphia: University of Pennsylvania Press.

Windhager, S., K. Atzwangera, F.L. Booksteina, and K. Schaefera. 2011. "Fish in a Mall Aquarium-An Ethological Investigation of Biophilia." *Landscape and Urban Planning, 99* 23-30.

Wolf, K.L., and K. Flora. 2010. 2016. *Mental Health and Function - A Literature Review. In: Green Cities: Good Health .* June 15. Accessed 11 13, 2016. https://depts.washington.edu/hhwb/Thm_Mental.html.

Yamane, K., and N. Fujishige, M. Yoshida M. Kawashima. 2004. "Effects of Interior Horticultural Activities with Potted Plants on Human Physiological and Emotional Status." *Acta Hortic* 639: 37-43.

"060716paleypark1." July 16, 2006. Digital image. Flickr. Accessed March 20, 2017 <https://farm1.staticflickr.com/73/203024733_7360075dc4_o_d.jpg>

"10 Luchtsingel Schieblock Day ZUS © Ossip van Duivenbode." July 22, 2015. Digital Image. ArchDaily. Accessed March 14, 2017 <http://www.archdaily.com/770488/the-luchtsingel-zus/55ac1ed6e58ece12db0001f2-the-luchtsingel-zus-photo>

"ArchiTravel_The-Goods-Line_2." February 9, 2017. Digital image. © Florian Groehn. Accessed March 16, 2017 http://www.architravel.com/architravel/building/the-goods-line/architravel_the-goods-line_2/

"ArchiTravel_The-Goods-Line_2." February 9, 2017. Digital image. © Florian Groehn. March 16, 2017 <http://www.architravel.com/architravel_wp/wp-content/uploads/2017/02/ArchiTravel_The-Goods-Line_main>

"3710834270_3db364800d_o." July 9, 2019. Digital image. © Philip Moore. Accessed March 16, 2017 <https://farm3.staticflickr.com/2509/3710834270_3db364800d_o_d.jpg>

"17064693248_8b2c36f9f3_o." April 18, 2015. Digital image. © Victor von Salza. Accessed March 16, 2017 <https://farm8.staticflickr.com/7707/17064693248_8b2c36f9f3_o_d.jpg>

"AM_Eero_Saarinen_GM_Tech_Center_1_tx700" December 21, 2016. Digital Image. KPBS. Accessed January 2, 2017 <https://kpbs.media.clients.ellingtoncms.com/img/photos/2016/12/21/AM_Eero_Saarinen_GM_Tech_Center_1_tx700.jpg?8e0a8887e886a6ff6e13ee030987b3616fc57cd3>

"2113076216_13767e050d_o" February 27, 209. Digital Image. ©ilaria. Accessed January 2, 2017 <https://farm3.staticflickr.com/2115/2113076216_13767e050d_o_d.jpg>

"18205225_a30031f40f_o." June 3, 2005. Digital Image. ©Robin Williams. Accessed December 3, 2016. <https://farm1.staticflickr.com/14/18205225_a30031f40f_o_d.jpg>

"stringio." May 17,2008. ArchDaily. Digital Image. Accesed December 12, 2016 http://www.archdaily.com/832/orquideorama-plan-b-architects-jprcr-architects/500ec0f828ba0d0cc700025c-orquideorama-plan-b-architects-jprcr-architects-image