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Mutually Reinforcing Design & Symbiosis: An Architectural Design Thesis

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MUTUALLY REINFORCING DESIGN & SYMBIOSIS

An Architectural Design Thesis

by

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in partial fulfillment of the

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Master of Architecture

in the Program of

Master of Architecture

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Table of Contents - Mutual Reinforcement Methods & Symbiotic Relationships in Architecture

Abstract.....	1
Introduction.....	2
Mutual Reinforcement & Symbiosis.....	4
Intermediary Zones.....	8
Urbanity & the Natural Environment.....	12
Coupling & Symbiosis.....	15
Coupling Between the Part & Whole.....	18
Symbiosis & Coupling of Functions.....	19
Mutual Reinforcement of the Past, Present & Future.....	21
Symbiosis of Building Services.....	27
Symbiosis of Technologies.....	29
Initial Design Proposals / Approach.....	32
Introduction.....	39
Mutual Reinforcement & Symbiosis.....	44
Intermediary Zones.....	47
Urbanity & the Natural Environment.....	53
Coupling	57
Symbiosis & Coupling of Functions.....	64
Mutual Symbiosis of Building Services.....	69
Human Interaction, Structure & Materiality.....	72
Conclusion.....	77
Bibliography.....	81
List of Figures.....	84

ABSTRACT

Mutual reinforcement and symbiosis can impose salutary design principles for architecture, creating more creative, interconnected, coherent and convivial cities across our planet. Symbiosis refers to the interrelationship between two or more facets of life, which are mutually beneficial or dependent on each other in a direct, indirect, visible or interpretive way. These benefits or dependencies may be metaphorical, physical in nature or philosophical interpretations of how two systems within our environment may be dependent on each other in order to exist.

INTRODUCTION

Symbiotic and mutually reinforcing relationships can be integrated into the world of architecture in a myriad of ways. The fusion and symbiosis of various opposing facets of the built environment, fosters a creative, unified and coherent architecture. Architecture has developed as a response to the human requirement of sheltering ourselves. Our world's amassment of construction has alluded to the parasitic urban sprawl our earth is covered with today. Our cities are sprawling incessantly across the landscape as our population increases, standards of living improve and our personal desire for space continues. This is also derived from our views of land as a commodity, ramifications of the industrial revolution and the invention of the automobile.

Population growth is inevitable, but this growth is something we should be able to contain within certain limits to ensure the continued life of the natural domain and mediate the threat of its destruction. Alleviation from the dualistic view of urban vs. rural can be achieved through mutually beneficial, symbiotic and mutually reinforcing relationships created between architecture, the natural landscape and urban space. Primitive forms of shelter were contrived to provide protection from the elements, a prerequisite for survival. Since these times, our built environment has accumulated into a threatening and self-benefiting system. Our humanist and rational approach to fulfilling our survival needs has led us to become self-oriented, focusing only on fulfilling our desires of lifestyle and simplicity. This approach has formed instead of incorporating the necessary mutually beneficial relationships required to protect the life of our planet and ensure urban coherence. By intensifying our cities within specific limits we can address these negative factors of sprawl, while incorporating other mutually reinforcing design principles into our architecture to ensure a harmonious urban interface. This can be achieved when architects, city planners, urban designers, engineers and the community have an understanding of the beneficial factors of symbiosis and mutual reinforcement

in design and propagate the mutually beneficial opportunities to the individuals or groups responsible for financing such projects, as well as the public. (Kurokawa, 1991)

The planet has now reached a population of 7 billion inhabitants. The demand for shelter is steadily increasing, while opportunities for symbiosis and coupling between urban development and the natural landscape are diminishing. (Worldometers, 2011) In order to ensure the implementation of symbiotic and coupled relationships into architecture, we need to design systems, principles and tools for this type of development, while providing education on the importance of this subject to our environment.

If not controlled, urban sprawl is inevitable, but our architecture of the future can consist of symbiotic and coupling networks that fuse the natural landscape with our built environment. Symbiotic design is the next step to conceiving an architecture that provides veritably sustainable and ecologically conscious design elements, providing the opportunity for mutual reinforcement and a coupling between the urban and architecture space and the natural domain. (Cocking, 2010)

MUTUAL REINFORCEMENT & SYMBIOSIS

Our perception of how elements in the urban environment interact with each other is formulated by an invisible geometrical field. The field provides a function of presenting information to an urban dweller or building occupant in different intensities and combinations. Our interaction and perception of the information we receive is expounded by urban and architectural elements. Just as opposite colours in a colour wheel may complement each other, these design elements such as form, textural surfaces, colours, patterns and details can couple and reinforce each other. Architecture should covet the maximization of this type of information to ensure urban and architectural coherence, providing benefits to both the community and environment (Salingaros, 2005).

Mutual reinforcement refers to harmonization and coherence between two opposing or contrasting elements. While symbiosis relates to mutually benefiting relationships, mutual reinforcement intensifies and reinforces aesthetic and spatial qualities of building user's perceived geometrical field. (Alexander, 2002) The harmonization between two juxtaposed and contrasting elements is the driver for their reinforcement. A walkway and a contiguous wall will couple with each other, interdependently reinforcing themselves. This means each element is stronger when juxtaposed and coupled with each other, than when they are in isolation. Together their aesthetic impression, visual impact and their perception of emotional ease is heightened. If the elements do not mutually benefit each other in this type of way there is no coupling, connection, symbiosis or reinforcement between the two juxtaposed elements. If one of the elements is removed from the other the effectiveness of that element may be lost, an action potentially inimical to the greater whole.

Coupling can create mutually benefiting, or symbiotic relationships between contrasting and complementary components fusing them into a unified whole while reinforcing each other. These relationships can take place in architecture through a variety of means. Examples of this on an

urban scale would be a walkway with a boundary wall, a parking lot traversed by a semi-enclosed pedestrian canopy, landscaping along exterior walls, curbs with bollards or arcaded entry-ways with roofs. Or on a more architectural and detailed scale, coupling can be found in the relationship between bricks and mortar, stone pavers with contrasting colours, permeable paving contrasting solid concrete with soft landscaping or glazing with mullions. A successful coupling between these elements depends on a multitude of factors and is best judged by the aesthetic and emotional perception of the urban dweller or building user. The interdependency between objects which reinforce one another formulates a symbiotic relationship between the two.

These types of relationships are also found in our natural ecologies and plant life. An example of these types of relationships would be between an epiphyte and an existing tree. An epiphyte is a plant which lacks the requirement of soil to bloom. Instead these “air plants” are able to blossom out of an existing plant, log or tree trunk, non-parasitically. The symbiotic relationships between epiphytes and their hosts are contrary to the parasitic relationship where plants such as vines, may grow while choking and killing the existing plant. Epiphytes stem from an existing plant, collecting nutrients from the atmosphere and other debris that builds up around its roots. (Hogan, 2010)

These same concepts could be applied to architecture in a number of ways. New architecture can “blossom” from an existing structure, while collecting nutrients, (rain, sun and wind, etc.) from the atmosphere and provide both ‘organisms’ with energy.



Figure 1 - Costa Rican sloth slowly climbing an epiphyte covered tree

Symbiosis does not just refer to a co-existence or harmony between two organisms, but a mutually beneficial or reinforcing aspect of their relationship, where their lives may be entirely dependent on each other. Examples of this type of relationship are found in a variety of natural forms. Plover birds and crocodiles are two entirely different animals that have a rather interesting symbiotic relationship with one another. Crocodiles will intentionally open their jaws inviting the Plover bird to fly in and perch themselves inside their mouths. While anyone would usually expect the wild reptile to chomp down and swallow the bird for lunch, it sits patiently, allowing the Plover to peck at residual meals caught between the croc's teeth. Since crocodiles do not have the benefit of visiting a dentist, or the ability to floss their teeth, they rely on these birds to clean their teeth and reduce the risk of infection, while the Plover is provided a meal for itself. (Web Ecoist, 2012) A similar natural symbiotic relationship is found between the Egret and Ox-peckers with hippos, horses, elephants, zebras and other mammals. These birds perch themselves on the backs on these

mammals and are provided a meal of lice, ticks and other mites which reside in the hair and skin of the animal. The birds not only relieve them of these annoyances, but are also more sensitive and aware of predators in their surroundings and give the zebras, elephants and other mammals a fair warning of potential threats. (Web Ecoist, 2012)



Figure 2 - Natural Symbiosis - Plover Bird & Crocodile

INTERMEDIARY ZONES

Interior vs. exterior space, urban vs. rural space and human vs. nature are examples of dualistic opposites that the principles of symbiosis would reject. In a world of symbiosis these opposites are no longer divided and recognized as the only options in perceiving a relationship between elements. Instead, there is an intermediate zone which overlaps opposing elements, each with shared elements of each other. Existing and coupling together, the contradicting elements live together in symbiosis to produce an undifferentiated, vague and ambiguous domain.

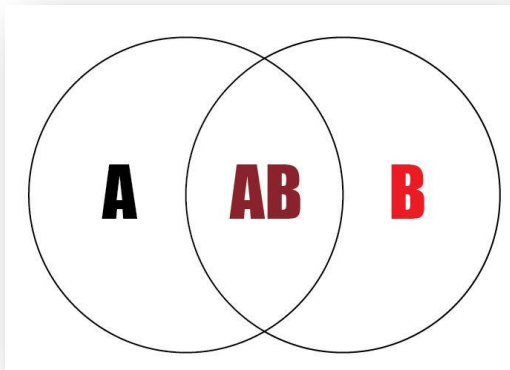


Figure 3 - Intermediate Zone AB

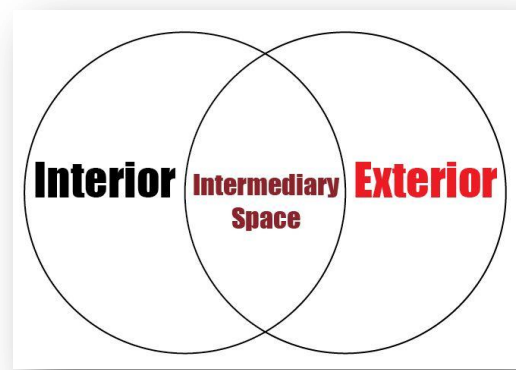
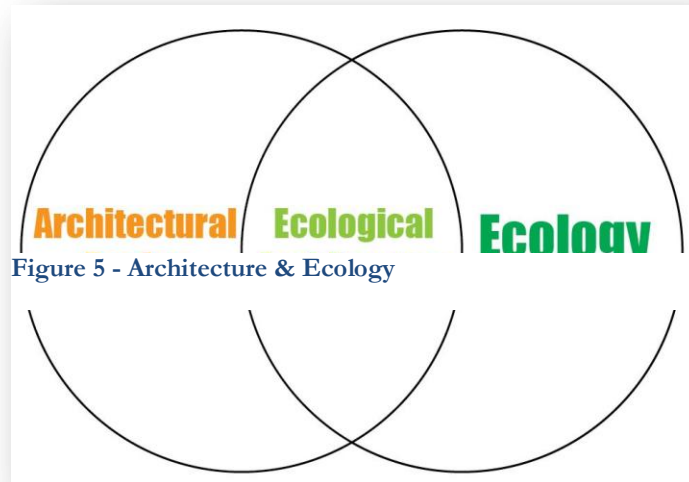


Figure 4 - Intermediate Zone Example

The symbiosis of various elements in our built environment allows for an ever changing dynamic balance between the two opposing elements, permitting sudden mutations and an architecture of life cycles and growth as it couples with the world around it. These principles outline the “Age of Life”, which dissipated from the “Age of the Machine”. (Kurokawa, 1991) This change took place as a simultaneous transformation from an industrial society to an information society. As the age of the machine strived to express function and rationality, the architecture of the age of life focuses on expressing meaning, in connection to ecology and sustainability. In contrast to the age of the machine, which promoted homogeneity and universality, the age of life honors the individuality and

uniqueness of every element of life. The architecture of the age of life is represented by our strong interest in the sustainably and preservation of our ecology and the diversity of life.



In order to create a symbiotic environment in our cities, our urban and architectural designs require elements to be coupled and reinforced by the incorporation of intermediary spaces. Here a common understanding and relationship between opposing elements is achieved, allowing for a dynamic, contingent, ambiguous and creative environment. Intermediary space acts as a catalyst for morphosis and the cycle of life, much like in nature when an egg hatches into a bird or larva transforming into a butterfly. In order for architecture to be symbiotic, a coupling between past, present and future architecture must be achieved, reinforcing and coupling with each time period. Architecture too must be able transform itself over time, blending with it architecture from the past, and allowing for coherent transformation in the future. (Foote, 1995)

Over time, many traditional elements of architecture have been lost. (Salingros, 2005) North African retractable street canopies and the stoas and porticoes of the Hellenistic and Roman times are both examples of traditional intermediary spaces which ease and fuse the connection between interior and exterior space.



Figure 6 - Remains of the Parthenon's Portico

Without these intermediary elements, the transition between each space is too sudden and the opportunity to couple and reinforce each other is eliminated. Intermediary zones, as put forth by Kisho Kurokawa, are established between two opposing elements to create a third zone which belongs to neither, enabling a mutually reinforcing and coupled relationship. Intermediary zones allow for ambiguity and irrationality, fostering human creativity and new thought processes. These zones are created when a portion of each element extends into the third intermediary space (Kurokawa, 2006). These can be physical elements or even ideas which conjure a virtual reality or perception of a space (Journal of Arts & Technology, 2009). Contrary to the Western attitude of dominating dualisms, where the stronger of the two elements transcends the weaker, here common and contrasting elements strengthen and benefit from each other forming a symbiotic co-existence without eliminating aspects of each other. In all symbiotic relationships, some aspects of both elements are shared within these zones, regardless of their differentiation or opposing ideologies. (Kurokawa, 2006)

An example of an intermediary space would be a half covered veranda, a commonly utilized and comfortable space, because it provides an enclosure while remaining open to the street. A contiguous streetscape and an un-covered porch do not have the opportunity to couple or reinforce each other as there is no contrast between the elements. (Salingaros, 2005, Pg. 88).

Contemporary glazing walls lack the ability to couple spaces. The separation simply eliminates aural and physical connections, while sustaining a visual connection. This lack of an intermediary zone creates a vague perception of each space, neither reinforcing nor coupling with either element.

The porch space found in many contemporary suburbs is often open and unprotected from the street or entirely separated by the vacuity of a front lawn or building setback. A coupling or mutual reinforcement between each element is usually attainable through the use of a semi-enclosed intermediate region. A roofed corridor or exterior arcade space can ease the transition between each element, eliminating the abruptness between interior and exterior. (Salingaros, 2005, Pg. 99)

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URBANITY & THE NATURAL ENVIRONMENT



Figure 7 - Renaissance Garden

Cities often negate a connection to the natural landscape, ecology and forests by controlling nature in a piece meal, tamed and domesticated manner. A perfect example of such exquisitely tamed nature would be the gardens of the Baroque and Renaissance periods, where the natural elements were consciously placed and physically manicured to fit an ideal vision of nature. This is an expression of man's victory over nature, and is in opposition to the traditional Japanese gardens that depict a genuine and authentic representation of a naturally forming landscape. (Kurokawa, 1991)

Today many cities around the world lack a symbiotic connection to natural forests and landscapes. The basis for the differentiation between the western ideal of a controlled garden city and the traditional Japanese garden derives from the opposing views towards the natural environment and

urbanity. Europeans and North Americans have always had a more direct and intimate connection with the environment, as most of Japan's forests grow in the mountains where little of the population resides. People inherently feel more strongly about defending something when they have a close relationship with it. A close relationship with nature would trigger our protective instincts to contrive methods of reinforcing, conserving, integrating and cohering symbiotically with our built environment.

Human manipulations to the environment can eventually become elements of nature itself. Man-made canals, lakes, vegetation and forests ultimately grow into the existing natural domain, blurring their differences. In some ways the city, as well as technology, is becoming a part of nature itself. City dweller's perception of nature is being blurred as the city is being perceived as a part of nature. Our future generations, when asked where a frog or insect comes from, may answer the "pet shop", opposed to a forest or swamp, as our cities are becoming perceived and experienced as a kind of nature and the pavement as a kind of earth. The intermixing of natural elements such as forests, various ecologies, as well as animals, insects and birds with cities and technology is essential for a healthy, convivial and unified urban environment. (Kurokawa, 1991)

The goal to achieve when designing cities of the future is one which couples and reinforces architecture and urban space with the natural environment, fusing each into one homogenous entity. (Kurokawa, 2006). This forms a symbiotic, mutually beneficial relationship between the opposing two elements. The concomitant benefits of having vegetation integrated into the city; fresher, cooler, cleaner air, reduced urban heat island, etc., will benefit the urban dwellers.

The natural environment benefits from the community's inherent protective qualities. These are qualities acquired by their stronger ecological awareness and their closer relationship with the environment. This helps to work toward the diminution of environmental destruction and maintain its ability to sustain growth.

A way of fusing together city with ecology can be achieved by designing urban spaces with fractal interfaces. Traditional urban geometry is derived from fractal interfaces. (Batty and Longley, 1994) Any structure that shows complexity at any perceivable scale can be considered a fractal interface. A successful urban interface should depict a permeable surface that allows for a flow of interchange, or a sinuous and variegated street path with perforations for program.

There are a variety of ways to integrate this idea into architecture. The first analogy would be to imagine an open plane fenestrated with various holes throughout. This could be imagined as a colonnade or a row of houses with alley ways or a commercial shopping street with gaps to allow for pedestrian cross paths. Permeable spaces such as these allow for the physical movement of people as well as the growth of vegetation between urban elements, while separating vehicles from the pedestrian domain. Designing at a human scale is necessary for creating urban coherence and therefore the porous gaps in the fabric designed for human interaction will be most successful between the scales of one to three meters. (Salingaros, 2006) Over designing these spaces eliminates the opportunity for fractal coupling as elements of different scales fail to couple with each other. These spaces can create a complex system of connecting nodes throughout the city, enabling urban coherence.

COUPLING & SYMBIOSIS

As seen in the world of biology, for coupling to occur between connective elements there must be an element of variety. (Salingros, 2005) If we look back to the primordial molecules of life on earth, there had to have been a mixture of complex molecules that had some kind of chance reaction to create life. The chance of the first life form being created would have increased with the more variety of molecules that would be able to intermix with each other. Some molecules may have the capability to react with one or more other elements, while others may not at all have the possibility for a reaction at all. This chance reaction can be related to architecture as it can be a catalyst for various “elements”; people, program, materials etc, to interact and produce some sort of unexpected outcome or reaction. Defined intentionally or not, each “molecule” or architectural element can act as a catalyst for these reactions to occur. In architecture, our designs can create spaces to allow for free interaction between two ‘components’ (occupants, materials etc,) that have the ability to become an eventual whole. Every component would have an equal opportunity to perform as a catalyst for another components reaction, but variety is evidently needed. Any individual components may have the ability to form a specific connection between one ‘component’ but not with another. (Salingros, 2005) Although two ‘components’ may be able to have a reaction, some elements may act as an intermediate connector to catalyze an interaction between two components. Therefore, the more variety of ‘elements’ increases the chance of potential reactions that may occur. These reactions would be subjective to who or what is interacting with each other, which can in turn form symbiotic, mutually benefiting relationships. Jane Jacobs posits that urban life is formed when an essential mixture of urban elements and density has been contrived, and is lost when one of the crucial elements is eliminated, isolated or disconnected. (Jacobs, 1961) If a city has a variety of components within its urban fabric, but they are sparsely positioned, disconnected and segregated

from other elements, the interconnecting process is lost and the opportunity for symbiotic, coupled or mutually reinforcing relationships is eliminated.

There are a variety of design methods for linking architectural elements. The pairing of two elements is dependent on both their position and formal qualities. The elements may be physically connected, or paired by each other's function. A coupling can be formed between a pair of elements through visual, structural, functional and geometrical means. Two elements simply in contrast or in juxtaposition with each other do not couple. They must have some sort of affect on one and other, enabling an opportunity for a reaction between them. A simple juxtaposition has the ability to weaken or diminish the importance of another element. This is why scale is of much importance as a stronger or larger element can render the smaller element obsolete. Below are five diagrams that depict strong coupling situations. Each two dimensional module has complementary and contrasting qualities that depict potential coupling opportunities.

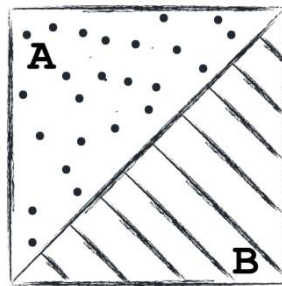


Figure A. Geometric Coupling → Contrasting Texture

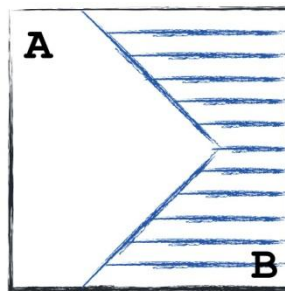


Figure B. Geometric Coupling → Contrasting Texture & Colour

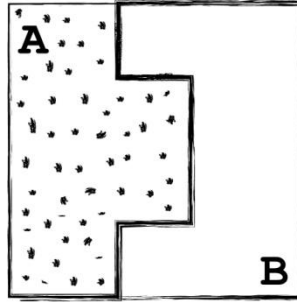


Figure C. Geometric Coupling → Interpenetration

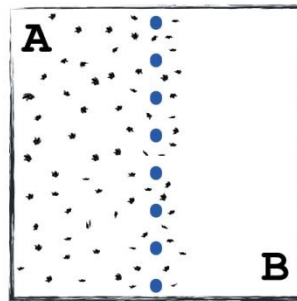


Figure D. Geometric coupling → Permeability

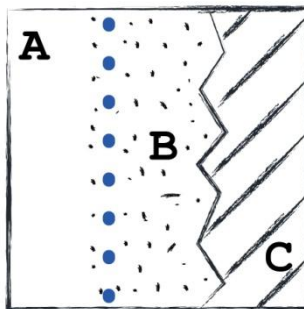


Figure E. Inductive Coupling → Common Third Element

In the first four examples, each region is somehow fixed to each other, disallowing any up and down movement or sliding apart from each other. If there is no “friction” between each pair, there is no ability to couple with one and other. Instead, this sort of friction between each allows coupling because they are together within a single module. If region A were different in shape than region B they would simply be juxtaposed, not coupling. Successful coupling must be self-contained. Each

of these elements, if in isolation, may have their own sort of internal coherence, but their effectiveness is strengthened when they are coupled together completing or reinforcing each other. The boundary of the module is what strengthens the cohesion between each element.

The boundary, drawn as a black line around the units above, can represent a variety of architectural or urban elements. Site lines, property lines, building cornices and parapets are a few examples of regulating lines which may act as a boundary when attempting to couple these types of elements. These boundaries, forming one module, work to connect modules together, so that, in an urban context, two coupled elements may be paired with another element in the city. Figures a, b and c display how elements may couple through interlocking, still remaining at the same scale of each other.

COUPLING BETWEEN THE PART & WHOLE

Symbiosis takes a holistic approach to architecture and refrains from a dualistic approach of perceiving elements as either a part or whole. Kurokawa uses the tree as an example of an element that is part of system of natural hierarchy and division between the part and whole. The tree as the primary structure represents the whole system for all other units like itself, but simultaneously it is part of a larger system, the forest. This same analogy can be applied to buildings in the city or landscape. Looking holistically at the way our cities and buildings are created can allow for a stronger relationship between the part and whole. Design traditionally takes a bottom up approach, where considerations are made on a macro scale. We begin by urban planning, designing our roads, our parks, open space, facilities, and finally our houses. When designing a home, we tend to follow the same approach, first shaping out the parts, or rooms, to form the whole, then move to smaller parts of details and such. In order to achieve a symbiosis of part and whole, equal value must be given to each element and should be considered simultaneously. (Kurokawa, 1991) This would

mean that even during the macro design process, micro design considerations such as door handles, railings or even wall textures should be under consideration. This will foster a more creative and symbiotic design.

SYMBIOSIS & COUPLING OF FUNCTIONS

Our cities have deviated from traditional highly differentiated places, to districts of mono-functionality. As a ramification of western rationalism we have segregated our cities into residential, business, commercial and industrial sectors, resulting in districts which are only occupied for certain portions of the day. The intermixing of functions fosters social interaction and random encounters between all types of people from various classes, vocations and districts of the city. A symbiotic relationship between every function of a city is required to keep it alive, as spaces of mono-functionality can be easily eliminated. If an auto-manufacturing company strictly manufactures automobiles, at a time when cars become obsolete, so will their company. If the company was diverse in nature and involved in a variety of businesses, their company would still be extant, simply losing a portion of their whole. (Kurokawa, 2006) This same concept can be applied to our cities of mono-functionality. If we subdivide, diversify, inter-mix and couple elements within our cities, we can make them flexible, adaptable and symbiotic spaces that have mutually reinforcing effects on each other strengthening their vitality.

An example of modern society's functionalism and segregation is found in the perception that since elderly people are a rather inactive demographic, they should therefore reside in quiet, secluded places among nature. In contrast, their integration into a dynamic environment, among younger generations creates an opportunity for mutually beneficial relationships to be formed. If a

retirement home was built beside or inter-mixed with a day care or school, the elderly would have a place to volunteer, supervise and play with the children as if they were their own grandchildren. In this case, the elderly are provided with activity, interaction and the opportunity to befriend people younger than themselves. Interaction with younger generations helps to re-energize the elderly and keep a fresh perspective on life. In turn they are providing the children with security, as well as their own knowledge and wisdom. (Saisan, 2010) As seen in the high density communities of Edo, Japan, where all generations and classes of people live together in symbiosis, a symbiosis of young and old generations can be achieved through the inter-mixing of city functions.

A public café is an example of a space where people of all ages, diverse vocations, level of education and various cultural and social backgrounds can intermix. In a city like Toronto, spaces such as a cafe or food courts are a dynamic common ground for all people and cultures. Business people, workers, pedestrians and residents can share this common ground while remaining in mutual opposition. This congregation of individuals opens new opportunities for unexpected interaction that has the potential to be mutually beneficial to many people. International trade is another concrete example of symbiotic human interaction, as it is mutually beneficial to both parties in exchange of goods, services, business and technology.

Kurokawa's design for Melbourne Central inter-mixes offices, retail, and multi-use entertainment facilities, while the high-rise skyscraper houses rental office space. The large glass cone preserves an old Shot Tower and provides atrium space within the shopping centre. The close relationship of the existing masonry tower and new glass cone allows for a mutual reinforcement through the juxtaposition of building conditions and materials that connected the past and present. The cut crystal shape of the tower is composed of heterogeneous materials, including stone, reflective glass, tinted glass and aluminum paneling. High-tech antennas and other equipment are visible at the top of the tower, while the base presents a more traditional design. This is to represent a mutually

reinforcing relationship between the solid city below to the light and transparent upper portion of the building as their juxtaposition accentuates the architectural features of each other.



Figure 8 - Melbourne Central



Figure 9 - Section through Melbourne Central

MUTUAL REINFORCEMENT OF THE PAST, PRESENT & FUTURE

Kurokawa puts forth ways to inherit architecture from the past into contemporary work, creating a symbiosis between the past, present and future. Contemporary design can dissect and select successful forms and various techniques from historical design and recombine them to create an entirely new meaning and significance. This is contrary to the method of simply recreating a work of architecture from the past. The aesthetics, lifestyles, concealed ideas and historical aura behind the architecture being referenced can be expressed in the combining of these elements and allowing them to reinforce each other. These elements may be physical references or metaphorical manipulations. Choosing between which elements are appropriate for a symbiosis of contemporary design and historicism, would vary depending on each project's specific context. (Kurokawa, 1991)

Mark Alan Hewitt suggests palimpsest maps as a method of mapping the history of a specific site and context in his text, *Architecture for a Contingent Environment*. This technique of overlapping traces of history can enable a symbiosis and coupling between the historical aspects of a site and the new intervention. This overlapping can influence design decisions, but should not be the only consideration when attempting to fuse the past and present symbiotically. (Hewitt, 1984) This is to say that the architecture of the past can in some way benefit, or reinforce the architecture of the future and vice versa. Designs should not formulate themselves simply because of an existing path leading to the site or an adjacent historical building has a certain setback, they should consider the existing landscape and context, while simultaneously making design decisions based on a multitude of other factors. Potential views, exposure to light, protection from the sun, its proximity and effect on any nearby natural water supply and ecologies are a few to mention. Of course it should formulate its circulation based off existing pedestrian paths and ease of access, but it should also anticipate potential future paths and provide flexibility over time to ensure coupling and a mutual reinforcement between the past, present and the future. An existing layer of history has the ability to elicit ominous geometries which may not be apt for the design of the new building. If rational planning is not undertaken simultaneously while using palimpsest maps there is potential for serious issues regarding functionality, circulation, and sustainability.

The continuation of building cornices, parapet lines and floor heights is an important aspect of creating and maintaining a mutual reinforcement or coupling between the old and the new. This can ensure the preservation of the existing order of streets, an urban coherence, appearing proportionate and harmonic in composition. Disregard for continuity with a haphazard alignment of such elements would result in abject proportions, creating chaos along the streets elevation, negating the opportunity for harmony or coupling between elements.

This coupling and harmony between old and new is alluded to with the comparison between historically significant buildings as artifacts and the way museum curators tend to their collections. Hewitt posits that their conservation process is 'object-orientated' and that often buildings are contrived as a single object, autonomous and averting to the elements in their context. Whether designing a new building or an intervention to an existing structure, this can obviously present problematic conditions. Architectural character is the sum of the parts and features which give the building their own uniqueness and authenticity. Identifying the character defining elements of the building will help to solve the design problem with an aesthetically symbiotic and reinforcing design. (Stanley, 2009) Disregard for these elements will eliminate the opportunity to preserve, conserve and embrace the inherent historical and cultural identity of the neighbourhood or urban interface. The classic city has been replaced by the generic city, a city which does not renew itself, but abandons whatever parts become un-functional. Rem Koolhaas states, "Urban identity is a thing of the past. All cities look like one another - in particular because population growth has made the past 'too small to live in'." (Vreedenburgh, 2005)

A symbiotic and mutually reinforcing design which considers the existing architectural form and materials can foster a symbiotic morphosis of the past and continue the true expression of the city, a building, landscape or a monument's own time period. (Hewitt, 1984)

The Kunsthalle Bremen in Germany has undergone a second expansion this year allowing for an excellent example of a mutually reinforcing addition coupling with a historical building of the 1800's. A mutually beneficial relationship between the old and new was formed during the construction of the new extension.



Figure 10 - Kunsthalle Bremen, Germany



Figure 11 - Kunsthalle Bremen, Building Section

The openings created to connect the new addition allowed for an ease of access while upgrading the existing building's services, security, technology and HVAC systems. The new addition benefits the existing building by providing the required additional space and technologies, while being the least intrusive as possible. A previous extension of the building had been added in the past and is now removed due to its bold contrast of red brick with the historical sandstone and its other functional problems. This extension had created a sloped area surrounding the existing building, but was out of scale and could not couple with the existing. A symbiosis of past and present was enabled by Gildemeister as he responded to and respected this existing condition, creating a continuity of geometric aesthetics, reinforcing and benefiting both elements.

The new extension provides a continuity of building symmetry and proportions by extending the floor heights, building lines and cornices of the existing building through to the new extension. This formulates a symbiotic representation of the new “part” becoming part of a “unified whole” through mutual reinforcement of opposing elements. The parapet of the extension, which is lined with the historical cornices, allows for the display of information. A symbiotic relationship is

formed by the new extension, as it benefits the existing by being a catalyst for new interest and attraction. The existing building's proportions and form are mutually beneficial as they contrive the form of the addition, coupling and reinforcing it.

The BLC Headquarters in Beirut is an example of a roof-top project, where the goal was to design and construct an iconic tower to extend the program of the existing building without destroying it, allowing both to function interdependently, mutually benefiting each other. The new building rests upon and cantilevers over the existing structure where they both share the corner of the street. Here, the varying formal and tectonic expressions of the old building with the new structure complement and mutually reinforce each other. During construction of the new tower, measures would be taken to upgrade certain aspects of the existing building which are currently dysfunctional or insufficient in today's world. The BLC Headquarters infused the architecture of the street into communal spaces within the two towers coupling the street with the covered exterior space between each building. This communal space, or intermediary space, is inviting and accessible to the public, easing the transition between the street and the tower lobbies. The transparent canopy and the openness of each side imbues coupling of interior and exterior space, while simultaneously coupling both public and private space. This is a step away from the traditional way of designing large headquarters of this civil sort. Here, instead of a hermetic and private approach to design, a welcoming and convivial space is provided for both business people and the public to ensconce and interact in. This design simultaneously shows an understanding for the civil culture of the employees and clients as well as the pedestrian users.



Figure 13 - BLC Headquarters, Beirut



Figure 12- BLC Intermediary Space

Today we see an increasing demand for the preservation, conservation and renovation to existing buildings. In the past, existing buildings have proven to be excellent sites for retrofits and adaptive reuse projects and can even often support additional infrastructures on their rooftops. New buildings or extensions of existing program can be fused with an existing building, creating opportunity for a symbiont relationship. (Vreedenburgh, 2005) Much like the way an epiphyte may grow off an existing tree trunk, the new program can blossom from the existing structure, creating opportunity for mutual reinforcement of materiality, as well as symbiotic relationships between the two. (Hogan, 2010) Symbiosis and mutual reinforcement between the old and new building can be achieved through a multiplicity of design tactics.

A symbiosis of past and present, as discussed earlier can take place, simultaneously creating mutually beneficial and reinforcing relationships between existing cultures, context, neighbourhoods and the city. A new addition to an existing building, block or neighbourhood, provides the immediate context with a new density, demographic and program, enabling opportunity for social

and economic symbiosis. Adding density to an area that has sufficient transportation and service infrastructures can enable an economic symbiosis between the users of the city and existing businesses of the area. A mutually beneficial relationship is formed as businesses are provided with new customers to increase their financial profits and the new customers are provided the services they need. As previously discussed, this inter-mixing of functions also strengthens the symbiotic relationship between the social and economic elements of the city. (Vreedenburgh, 2005)

SYMBIOSIS OF BUILDING SERVICES

A physical and technological symbiosis can also be achieved through a variety of sustainable techniques from our contemporary world. An addition or extension to an existing building can provide new sustainable energy acquired from available natural energy sources in its specific contextual setting. In the case of a roof-top project, the existing building's services can often be extended to utilize the existing system, functioning symbiotically with the new services and the environment. This will save embodied energy in the demolition, manufacture, mobilization and construction of a new structure, creating a symbiosis between built form and the natural environment. These types of projects create opportunity for symbiosis, but also have a variety of restrictions associated with them, as a building that is constructed above another building is classified as a 'new building' and must comply with new building regulations. (Stanley, 2009)

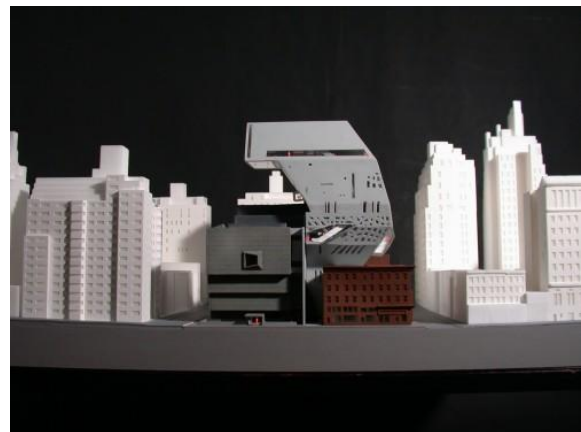


Figure 14 - Rem Koolhaas Design for the Whitney Museum, NYC

A rooftop building in most cases must be a light weight structure with the ability of being constructed quickly. This usually points toward wood and steel construction. For designs of extreme stacking, additional structural support and integrity may require reinforced concrete to provide these requirements. The rooftop surface is more adaptable to change than most people may assume. All discharge at the top of the building, from the flue, the pipes and HVAC ducts may all be diverted to allow for a new rooftop building and a symbiotic relationship between the two. This can be quite a feasible method as all of the existing duct works and pipes remain on their natural course but are simply extended. To conceive a project of this nature, calculations must be completed beforehand to determine whether the size of the pipes and ducts are large enough to withstand the additional gas, water or air. (Vreedenburgh, 2005)

Just as the existing HVAC services can be utilized to create a physical symbiotic relationship, other services such as plumbing and electrical may suffice for a new addition. Structures built after the Civil War and up until the 1980's had pipes and fittings that supplied gas from a central utility. When the supply of electricity became a commodity in the late 1800's, these buildings would have been retrofitted with electric wires. The electrical wires installed during this time period would be insufficient for use now and replacement would be necessary in an adaptive reuse and rooftop intensification project. Utilization of the existing conduit can be an easy way to upgrade the electrical system if the size and locations are acceptable for the building's new use or roof top building, enabling another symbiotic relationship between building services and the environment. (Stanley, 2009) To design a building today there are plumbing and washroom codes which must be complied with in order to occupy an existing building' with a new use. These codes have increased the size requirements of bathrooms from the past and would require expansion. Existing plumbing

fixtures may be suitable for simple extensions to supply the new rooftop program, but would be contingent on the existing building's age, as well as the size of the new program. (Simone, 2010)

The structural integrity will determine how many additional floors an existing building could support while still meeting the safety standards of new buildings. This would determine the potential revenue that could be generated by rent prices. New program above or beside an existing program not only creates a symbiotic relationship with the economy and businesses in the area through increased social and economic exchange, but can drive real estate values in areas that would otherwise go undeveloped. Rooftop intensification is an example of a technological symbiosis between existing and contemporary, and has potential of becoming a nascent paradigm for Toronto and cities around the world. (Stanley, 2009)

SYMBIOIS IN TECHNOLOGY

Culture and tradition play an important role in the evolution of an economy and its technologies. Outside coercion from developed countries onto developing nations to adapt and accept western culture and technology in their society will inevitably destroy distinct local cultural identities. Regardless of a specific nation's stage of development or cultural difference, implementing western technologies around the world was thought to be a positive step toward unifying and homogenizing the world. This may not have been the best assumption. If everyone in third world countries suddenly had the annual income of a North American and could afford to own and drive their own automobile, does that mean their countries should become automobile reliant societies? The answer would be probably not, as we understand the concomitant environmental issues with automobiles today. (Kurokawa, 1991) In relation to architecture, one technology, passive design strategy, vernacular building technique or material may be functional in one context and climate, but it does

not mean that it can simply be picked up and placed in another environment. We have seen these types of failures with the international style and modernism. (Foote, 1995) Just as a building style must adapt to its regional context, whether by utilizing the local building materials, (wood in Canada, adobe masonry in the desert or snow in the arctic) or by implementing the climatic passive design strategies of the region, etc., technologies too can adapt to a region's unique circumstances or customs.

A symbiotic approach can be contrived to incorporate the benefits of a developed world's technology with developing countries existing technology, retaining the cultural value of the place. This can allow for each cultural sphere to develop their own unique technological systems while creating and encouraging more variegated, creative, and distinctive lifestyles. We are currently following the globalization approach of having the developed countries provide economic assistance to developing countries and imposing our western technologies and cultural traditions on their current lifestyles. Instead, we must discover ways for our technologies to work in symbiosis with the historical and traditional technologies of that region. In India, the cow is not only a sacred animal, but its dried dung is also the most common method of supplying energy for cooking fires. (Branan, 2012) In an age of symbiosis, we need to find a way to incorporate a multitude of technologies together to find the most efficient combinations. Instead of simply replacing the use of cow dung, which is considered a part of Indian culture and life, with nuclear fusion reactors as their new power source, we should look for ways to somehow combine its principles with all of our current energy sources to develop something new and better. This would be a representation of intercultural architecture and symbiosis between technologies.

There are a multitude of new technologies and building materials related to sustainability that can create symbiotic relationships between built form and the environment anywhere in the world

including here in Toronto. The Symbiont Green Wall project by Koocho Jung and Jayeon Kelly Choi is an example which fuses the traditional with contemporary technologies. This project inter-mixes traditional hoarding techniques used all over the world with contemporary technologies for harvesting rainwater accumulated on construction sites.



Figure 15 - Symbiont Green Wall

Excess water on site is often pumped onto the streets into catch basins and diverted to water treatment plants. The double layered wall is designed to harvest this water through a natural process by distributing water to grasses growing within the wall.

The diversion of the water can lower costs for sewage water treatment, provides life for the plants embedded into the wall and can be used on-site at a later time. (dust control, etc.) The extrusions elevated from the ground plain also provide homes for birds, creating a symbiosis between technology and nature. The wall and its plants contribute further by absorbing noise, dust and heat, while the extrusions in the façade also provide seating for site workers and pedestrians. This design displays a symbiosis between workers and pedestrians, the construction site and the environment as well as between traditional and contemporary hoarding design. (Jolly, 2009)

INITIAL DESIGN PROPOSALS / APPROACH

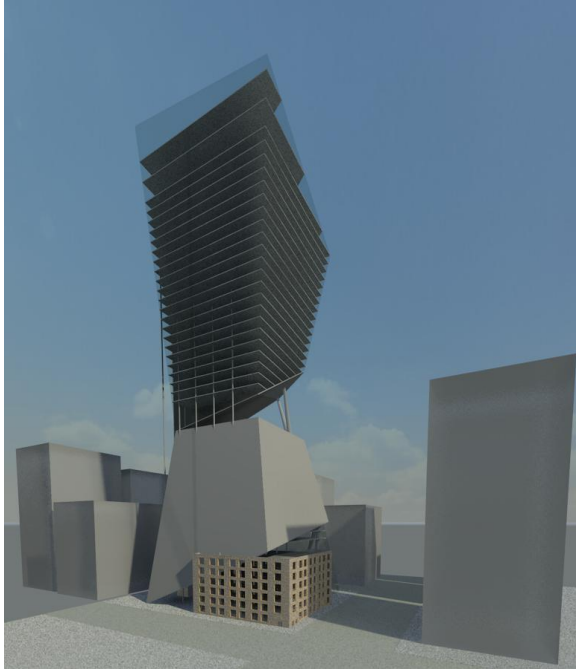


Figure 17 - Mixed Use Tower Section

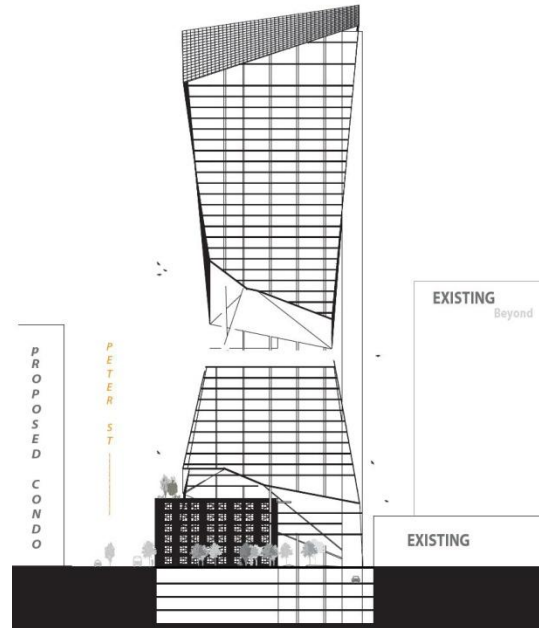


Figure 16 - Mixed use Tower

MIXED USE TOWER – Hotel, Office, Residence, Retail, Entertainment, Green House

The first approach taken was to design a building that grows out of the Westing House Building at Peter and King Street in Toronto. This approach failed to couple and be truly symbiotic in a number of ways. The scale of the tower is so grand that it over powers the existing structure rendering it obsolete and disallows a coupling relationship between the old and new. Symbiosis takes place between two opposing organisms. This tower has a multitude of programs within it so a one on one symbiosis between the two buildings is not possible. From here it was realized that in order for there to be a symbiotic relationship between two buildings, their proportions should be close to the same.

ELEVATED DWELLING



Figure 18 - Suspended Rooftop Dwelling – Migrating Landscapes



Figure 19 - Suspend Dwellings

SYMBIOSIS

Initial Design Proposal

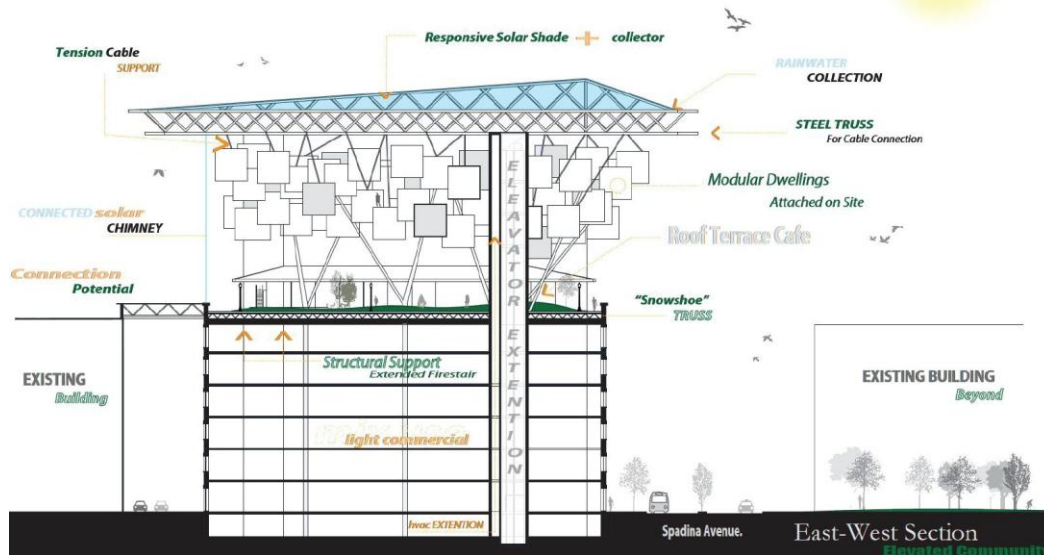


Figure 20 - Initial Design - Suspended Dwelling

The second proposal extended the existing fire stairs and elevator core of a historical building on Spadina St. in Toronto. These extensions were to provide structural support for the new residence above. A triangular truss spans to each extension and supports the suspended modular housing units. The relationship between the residence and the office workers was not strong enough to be truly symbiotic or mutually beneficial in anyway. Additionally, the proportions and randomness of the units make it hard for the existing and proposed to couple and reinforce each other.



Figure 21 - Preliminary Design Proposal – Catalyst Center

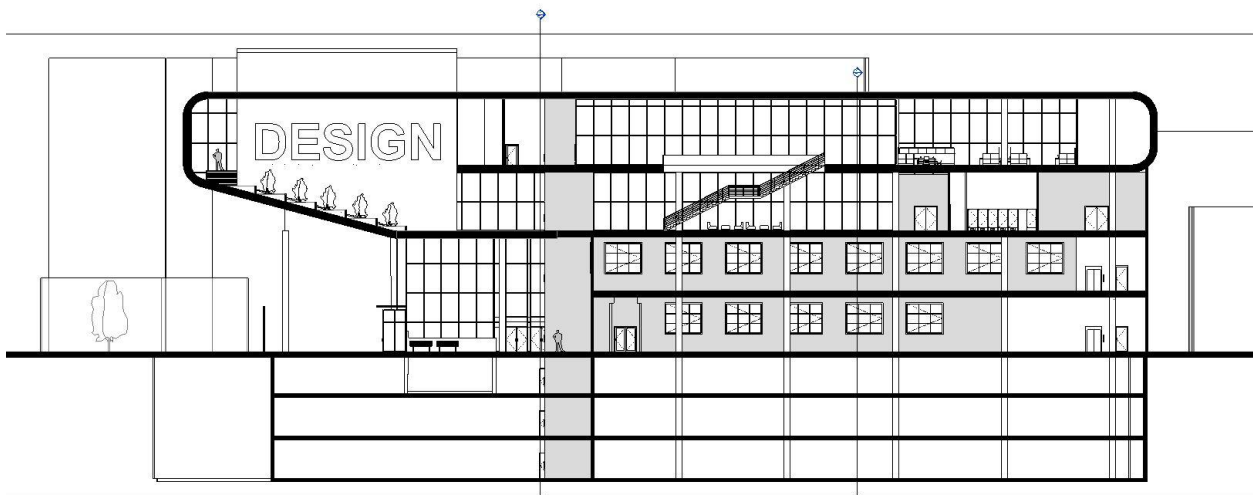


Figure 22 - Third Design Proposal Section

This was the first form of the Catalyst Center which was more organic than the existing and was to represent a white canvas for “design”. The new structure carries a continuation of the brick from below fusing one building into the other. This diminished the juxtaposition of each entity and makes reinforcement for difficult.



Figure 23 - Floor Four Studios & Circulation Space / Birds Eye View & North East Corner



Figure 24 - Cafe Interior

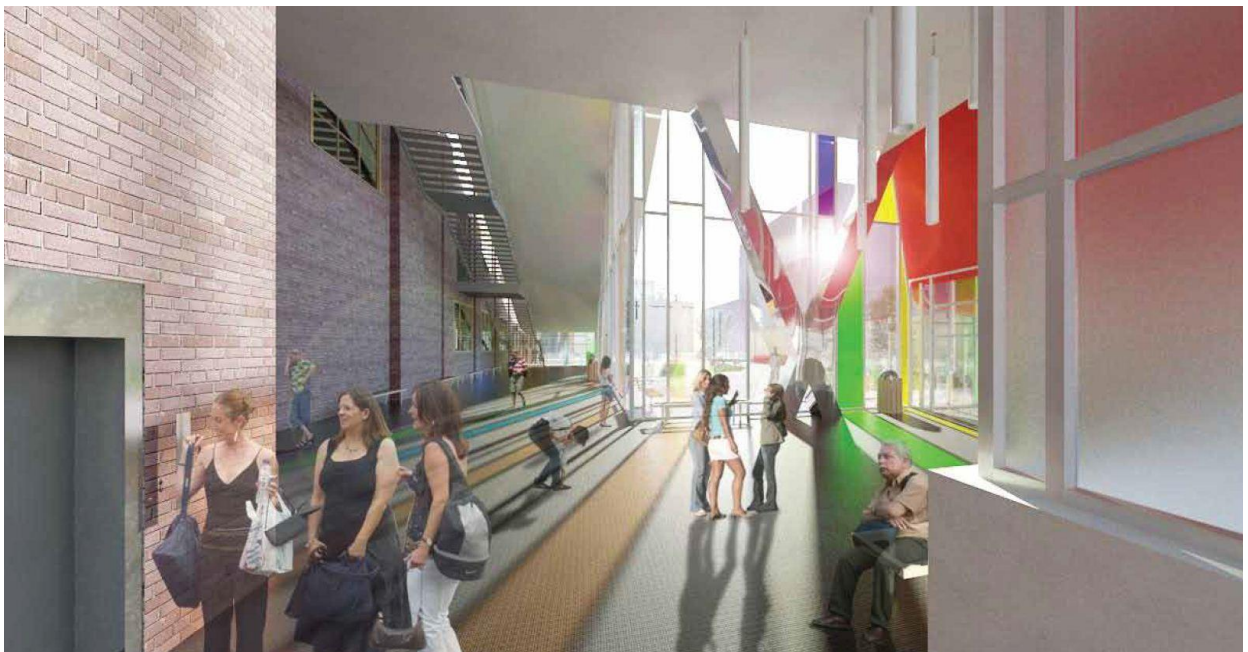


Figure 25 - Ground Floor Lobby



Figure 26 – Under Theater – Northwest Corner



Figure 27 - North-west Corner

FINAL PROPOSAL – THE CATALYST CENTER

INTRODUCTION

The final design proposal of The Catalyst Center was placed on top of existing George Brown School of Design, located in the Queen-Richmond East district, at 230 Richmond Street East in Toronto, Ontario. The existing school resides in a two-story masonry and beam building, constructed in 1909 and recently renovated in 2000. The 73,767 square foot building is located one half block east of George Street and between Britain Street on the north, and Richmond Street East on the south. (Allied, 2003) By choosing a site with an existing building from the early 1900's, there is opportunity for rooftop intensification and a symbiosis or coupling between historical and contemporary architecture. The site is situated north of Richmond Street, south of Britain Street and half a block west of George Street. The site is approximately 60 meters north and south and approximately 70 meters along Richmond and Britain Street with a site of approximately 4200 m².



Figure 28 - Site Map - www.google.com

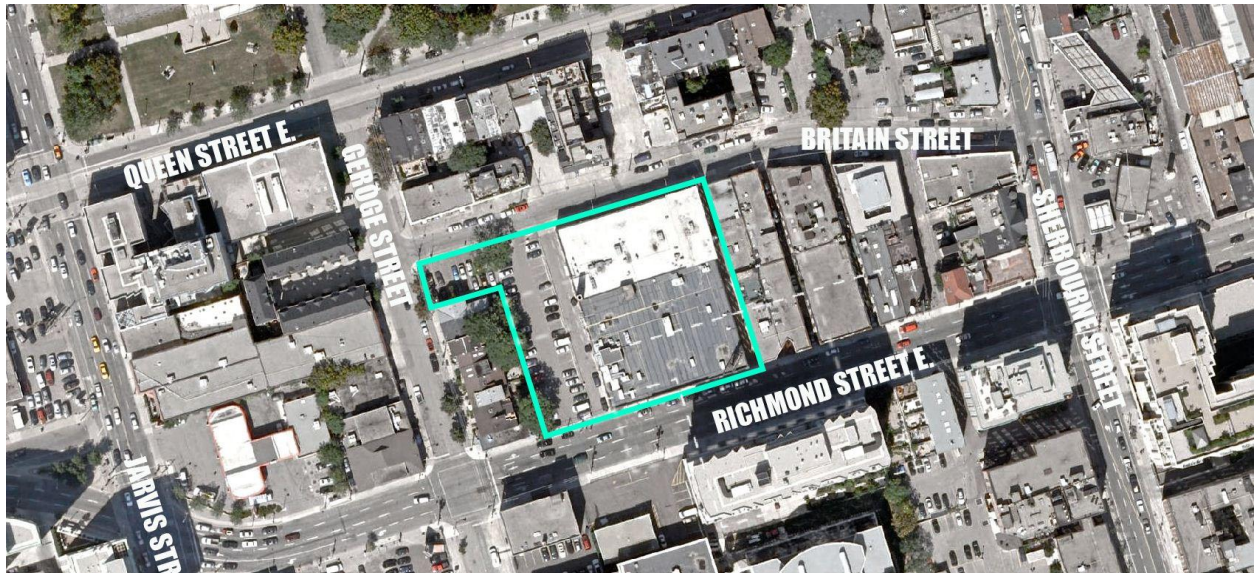


Figure 29 - Site Map

My proposal strives to incorporate principles of symbiosis, coupling and mutual reinforcement into a new design “incubator” space for design startup companies in Toronto. The users of the building would be post-grad students from universities and colleges all over the world, increasing the neighbourhood’s study/work density and contributing to the vitality of the Queen-Richmond East area. The Design School addition incorporates ideas of intermediary spaces, coupling between architecture and natural ecologies, a symbiosis and mutual reinforcement between the past and present, technology, materiality, program and function as well as public and private space.



Figure 30 - Birds Eye View Looking North

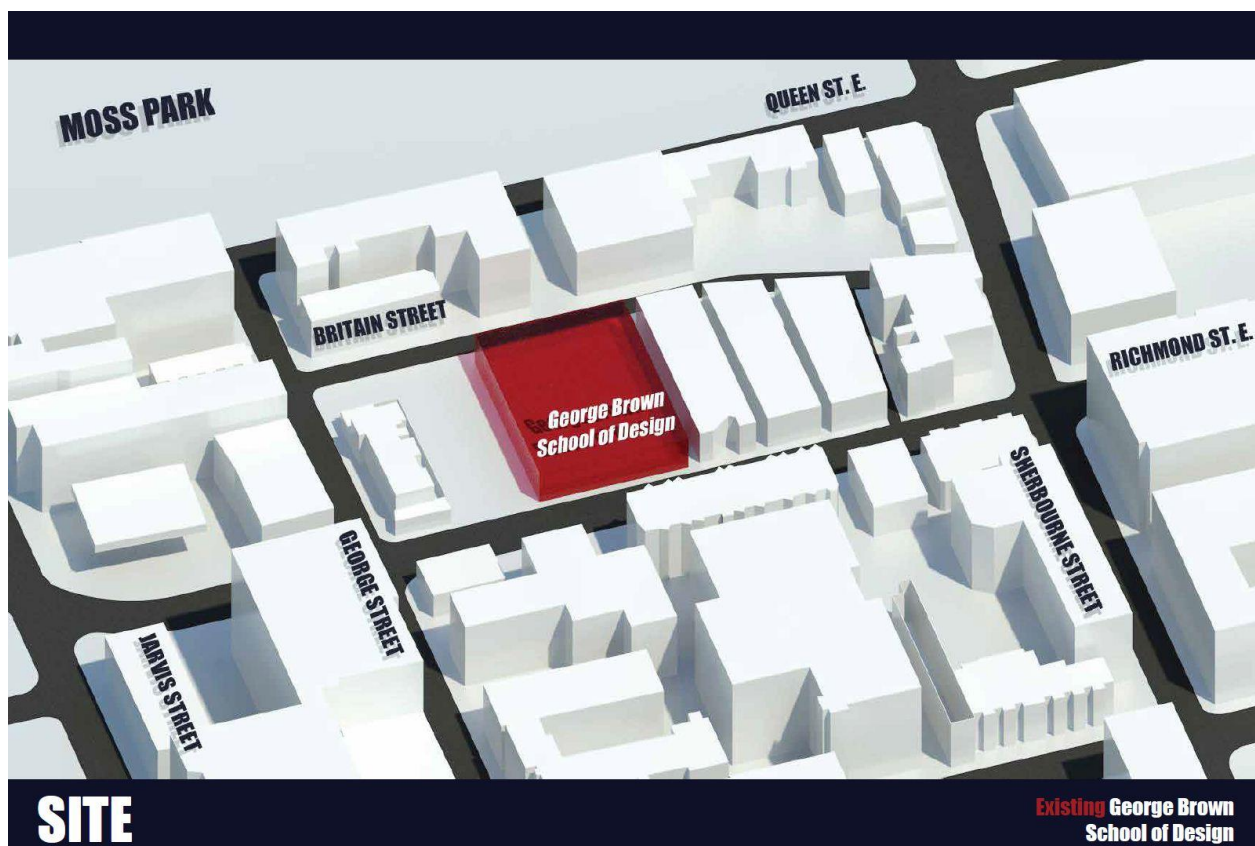


Figure 31 - George Brown School of Design Site

Programmatically, the design would include a myriad of new functions. The existing Design School that houses studio space, computer labs, classrooms and other design related spaces would be connected to the new structure via an intermediary space on the existing building's roof top, becoming the third floor of the unified structure. The new functions of this floor will act as a 'glue' to couple the existing school with the new Catalyst Center. This intermediary space will house a variety of functions used by both the existing school and Catalyst Center. A theatre is located on the furthest west point of the buildings cantilever, while a fabrication lab, kitchen, café, outdoor seating and vegetable gardens are located on the existing roof top space.



Figure 32 - Birds Eye View Looking East

Located on the west face of the existing design school is an existing parking lot used for the occupants of the design school. In my proposal, this parking lot will be relocated below grade, offering three new levels of parking for the existing building, new Catalyst Center, the public and other George Brown students and faculty. The space located above the newly constructed parking lot will become a new public open space, 'The Catalyst Quad'. A space which takes its name from

the new Catalyst Center, suggesting its purpose of becoming a space to initiate new and unexpected interaction between a variety of users.



Figure 33 - Existing George Brown School of Design Site



Figure 34 - South Facade

MUTUAL REINFORCEMENT

There are a variety of mutual reinforcement methods that have been incorporated into the design of the Catalyst Center. The first relationship is between the buildings themselves. The existing Design School is clad with masonry from the early 1900's. The new catalyst center contrasts with the existing structure with its contemporary use of glazing, mirrors and insulated metal paneling. The opposing materials juxtapose themselves as two separate entities, the existing building as the primary colour red, and the new Catalyst Center, the primary colour blue. The opposition and contrast allow for each element to couple and reinforce each other. The contrast between each entity strengthens their aesthetic impression and visual impact, enabling a coupling relationship between the two. If the Design School were to be demolished below, the visual impact created by the contrast between the two buildings would diminish the effectiveness of its presence and vice versa. This forms the mutually beneficial relationship, or symbiotic relationship, between the two architectural entities.



Figure 35 – Final Proposed - South Elevation

There are other material aspects of the project which mutually reinforce each other. The materials surrounding the bioswale in the 'Catalyst Quad' reinforce each other through the strong contrast between the green grass and concrete pavers with the concrete and fountain grass of the bioswale construction. The same juxtaposition is found between the light coloured pavers that run adjacent to the west face of the existing design school. Just as the mortar in the existing brick joints couple with each other, the contrasting colours and textures between the west building interface and the contiguous pedestrian path complement, reinforce and mutually benefit each other visually. If the path were to be constructed of the same red brick, there would be no contrast between each element and therefore no opportunity to mutually reinforce each other symbiotically.



Figure 36 - Bioswale Fountain

Mutual reinforcement is also achieved by paying close attention to the regulating lines of the existing Design School. As stated earlier, the continuation of building cornices, parapet lines and floor heights etc., is essential in creating a mutually reinforcing and coupling relationship between the old and new. This is achieved through a variety of methods with the addition of the Catalyst Center. First, the existing buildings structural masonry columns on the exterior dictate the spacing for each planter division on the third floor rooftop. This creates a continuity of the building lines, while the contrast between the brick and vegetation allows for a coupling and reinforcing visual effect. The Catalyst Center's vertical spacing of the façade is also dictated by the existing masonry columns. The column's linear verticality extends beyond the existing structure and is translated harmoniously into the mullions above. The north east portion of the existing design school extends about four meters above the rest of the building. This height dictates the floor to ceiling height of the new intermediary space of the third floor. This creates a continuity of the building's parapet line with the new Catalyst Center's soffit, as it rests on top of the extension. These design decisions ensure the preservation of the order established by the existing structure and create an urban coherence and visually display a proportionate and harmonic composition.

The symbiotic analogy of an epiphyte and an existing tree can be related to the Catalyst Center project. If the existing Design School is considered as the host tree and the Catalyst Center as an epiphyte, the Catalyst Center would grow out of the Design School non-parasitically. The symbiont relationship relies on their interdependence on each other. The Catalyst Center does not act as a parasite, sucking the life out of the existing structure, but instead has a mutually beneficial relationship with it through a variety of ways. The existing structure provides structural support for the new building, enabling it to be raised from the ground plane, while the new addition provides sustainable services for the existing that will be discussed later.

INTERMEDIARY ZONES

Nikos A. Salingaros, in his book *Principles of Urban Structure* has laid out rules as to how components, urban or architectural, may be coupled into a coherent whole. His first rule posits that strongly coupled elements on the same scale will form a module and there should be no unconnected elements within a single module. (Salingros. 2005) Formally, the Catalyst Center forms a stratified module that couples with the existing Design School because of its similar scale. The new structure was intentionally designed to not over power the existing building, so the Catalyst Center rests on top of the design school with roughly the same floor area. The intermediary space acts as a catalyst joining the two building together, allowing them to couple.

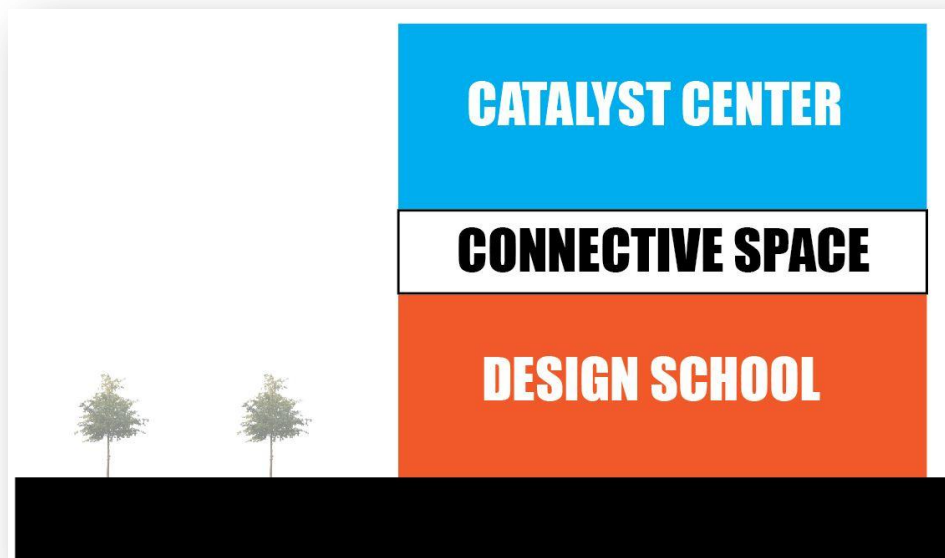


Figure 37 - Functional Module

Turning the parking lot into a connective pathway and urban space was designed with the goal of achieving urban coherence. Every city, including Toronto, is essentially a network of paths. To achieve a coherent city, it must be a malleable network that allows for connections on both the large

and small scale. Connections within the city vary programmatically and in scale, linking each element to each other. The 'Catalyst Quad' space works to connect the north side of Richmond Street to the south side of Britain Street. Its linear geometry offers a direct path through the site, with the building entrances and open space act as an intermediate space for coupling either side of the site. Within this intermediary zone, there are a variety of secondary elements which work to couple and reinforce connections between the public as well as the building occupants. The outdoor seating spaces allow for anyone to relax and enjoy their lunch, study or meet anyone who uses the connective space. The secondary elements are necessary for coupling and linking not only nodes found on the George Brown campus, but from existing pathways connecting to Moss Park a block north of the site. The cantilevering Catalyst Center will become a sort of nodal gateway and entrance to the north side of the campus, serving as the new heart of George Brown's campus.



Figure 38 - North East Entrance - Gateway to George Brown

The ground floor lobby space also acts as an intermediary space, easing the abruptness of the transition between the exterior Quad space and the interior of the Design School. It is composed of large glazing walls which reach from the ground floor to the bottom of the third floor. As noted earlier, a simple glazing wall does not allow coupling between interior and exterior spaces because of its informational ambiguity. A clear contrast between the interior and exterior provides a clear visual connection while disallowing a physical or aural connection to the exterior. The Catalyst Center's cantilevered western portion acts as canopy over the entrance to the lobby space. This slowly opens up to the exterior following the slope of the theatre above. The canopy creates a semi enclosed intermediate region that provides a visual differentiation and contrast between each space. The contrast between each allows for the interior lobby to couple with the streetscape, as the exterior canopied space acts as an intermediary zone between each element, much like the function of a Japanese Engawa. This same principle is applied to transition between the third floor café space and the exterior roof top patio. The high transparency of the glazing wall surrounding the café again denies the opportunity for coupling and mutual reinforcement between each element. A set back was created by cantilevering the Catalyst Center over a few meters on each face, creating another canopied, semi enclosed space, to ease the transition between the interior and exterior.



Figure 39 - Rooftop Patio & Vegetable Garden

Each floor of the Catalyst Center has its own intermediary space. It is located around the main circulation stair, providing a separate space between the third floor and the startup studio spaces. This space provides a mediate scale of social interaction and renders movement between the private startup studios, the public space of the café and restaurant and the existing Design School. This space is accessible not only as circulation space for the startup members, but for the public to roam through while visiting the café, roof-top gardens or theatre. The Catalyst Center is designed as a free plan building, offering a flexible space with a myriad of arrangement opportunities to suit each startup company's organizational needs.

To enter into a specific studio space, an access key would be provided to members of a startup company. Being provided with a key allows for twenty four hour access to the facility, increasing the vitality of the site throughout all hours of the day. The vertical circulation stair connecting the

third floor cafeteria to the fourth and fifth floor studio spaces is circumvented by intermediate spaces. It is a transitional space, provided with seating and drawing boards to allow for interaction between anyone passing through or exploring the space.

Within the private studio spaces are separate private kitchen spaces. These spaces are still integrated into the free plan of the studio space, but are divided by a glazing wall to eliminate distracting odors and noise associated with cooking and eating.



Figure 41 - Ground Level

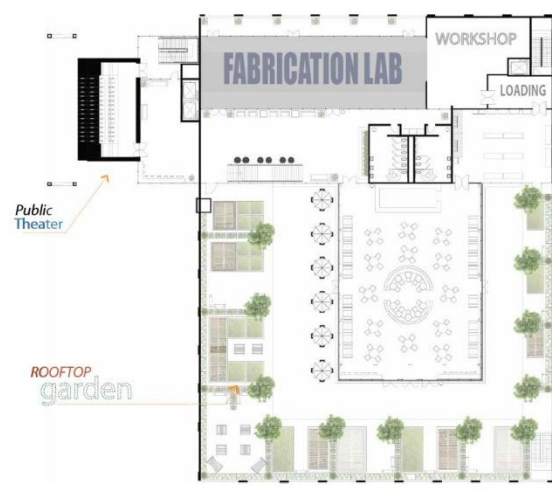


Figure 40 - Level Three

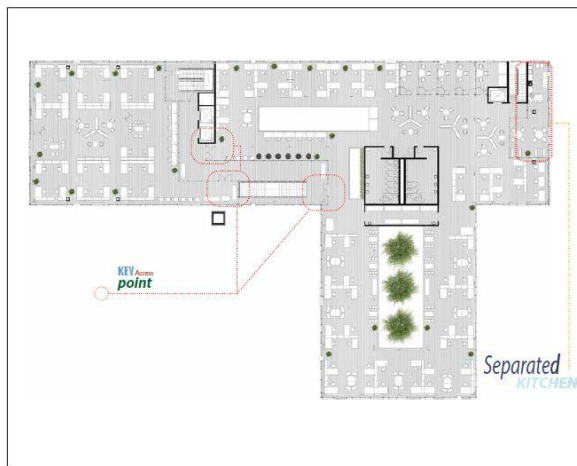


Figure 42 - Floor Four



Figure 43 - Floor Five

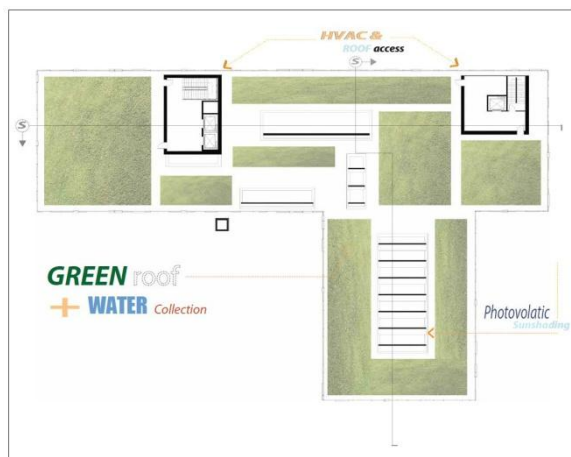


Figure 44 - Green Roof

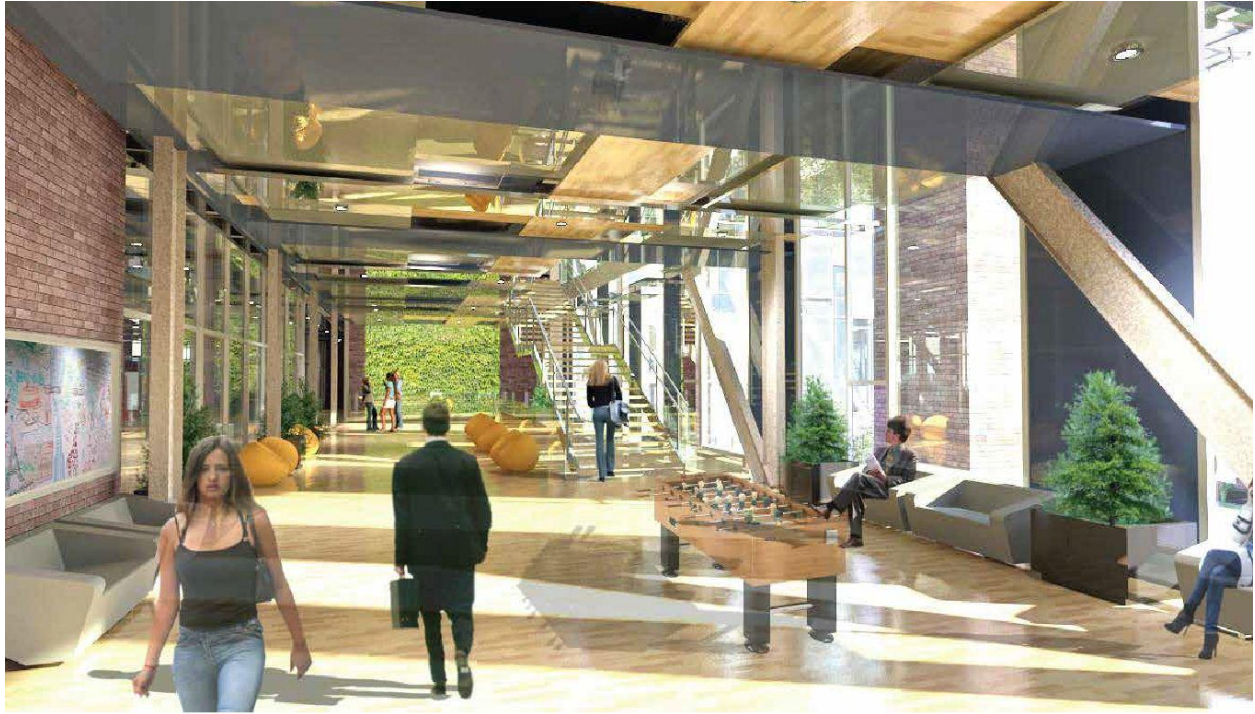


Figure 45 - Intermediary Circulation Space

URBANITY & THE NATURAL ENVIRONMENT

The visual and auditory connection between humans and the built surroundings determine an urban spaces success. Urban and architectural interfaces can increase visual and auditory stimuli by being designed with perforations or convolutions, instead of straight edges that lack depth and do not transmit geometrical information as well. There are three rules as stated by Nikos A. Salingros in his book, *Principles of Urban Structure*, that create successful urban interfaces. The first rule is to ensure the maximization of geometrical couplings between urban regions on either side of an interface. The second point is that any urban space must be designed to promote a catalyzing human interaction, and the third is a need for a sensory connection to the user. (Salingros, 2006; page 42)

The geometrical coupling has been achieved as stated before through the matching scales of the new and existing structure.



Figure 46 - The Catalyst Center & George Brown School of Design

The ability to connect building users and pedestrians to the ground plane has often been negated in the past by using plain concrete sidewalks and walk ways or banal surface materials with no visual connection or information presented to the user. Although other building materials such as brick are often used, it usually lacks any pattern or creativity. The new Catalyst Center will avoid this simplicity with a mixture of both permeable stone pavers and exposed aggregate walk ways with graphic mosaic patterns to create a more dynamic environment. The permeable paving surrounding the Design Quad's bioswale will collect runoff water from the existing site's ground plane, the existing design schools roof top, as well as the new Catalyst Center's roof and parking garage. The permeable paving in collaboration with the bioswale creates an interaction between the pedestrians and the natural environment. The excess rainwater collected will expel from a water feature located in roughly the middle of the Catalyst Quad indicating the beginning of the natural filtration process and adding a sensory connection to the user. The dynamics of the water feature will create a visible ecological and sustainable awareness and connection to passers-by and building

occupants. This connection can be considered symbiotic as both the pedestrians and environment are benefiting from the installation. Pedestrians are provided a great deal of shaded as well as sun exposed seating, and gathering spaces created to promote interaction between the building users. At the same time the environment benefits from the positive effects of natural filtration, the reduction of the urban heat island effect and from the awareness the community will acquire on the importance of our ecological sustainability. The Catalyst Quad tries to simulate a natural landscape with a variegated topography that provides seating and the intermixing of different plant life, strengthening the urban dweller's connection to nature and catalyzing an appreciation for protecting, conserving and enjoying the natural environment.

The existing parking lot on the west side of the existing Design School currently creates a disconnection between the urban environment and the buildings interface. The potential urban space has been replaced with a paved lot where the building occupants have to create a path among parked and moving vehicles to the entrance of the building. The current chaotic, undefined and disorganized lot would be excavated prior to the construction of the Catalyst Center and constructed below grade. This allows for a free and open urban public space with a water feature and bioswale, gathering space, bicycle racks, vegetation, shaded, covered and open space and a variety of seating areas. The distraction and cluttered organization of the existing parking lot takes away from the Design School's architectural features and does nothing for runoff water or connectivity within the neighbourhood. Instead, a new region of urban space is created, with less rainwater runoff issues and providing a throughway for pedestrian traffic north and south through the site.

The highly vegetated Catalyst Quad will act as green corridor connection to Moss Park a block to the north. The permeable pavers which surround the densely treed and bioswale area in the middle of the quad will act as an intermediary zone between the hard streetscape and the softer, shaded and

more natural area of the public space along the axis of the Quad. This will enable a coupling between the street and the elements of nature. By incorporating a bioswale and forest like urban space it enables the growth of various ecologies, a home for birds and squirrels and other natural elements within the city, conjuring a healthy, convivial and unified urban environment.

The contrast between the natural environment and the urban surroundings reinforce each other within the urban interface, fusing each into a homogenous entity.

The open Catalyst Quad corridor acts as a fractal interface in the urban fabric as discussed earlier. The opening or gap between the streetscape provides a permeable space that allows for a flow of interchange between pedestrians, members of startup companies, students and faculty. This space divides the pedestrian and vehicular domain allowing for elements to be situated and designed at a human scale. Walkways do not exceed three meters in width to ensure close proximity and coupling between pedestrians and each other. This is a necessary design strategy for creating urban coherence and not eliminating the opportunity for fractal coupling.

The spacing of each topographic-like concrete and chrome seating block reflects the same scale and spacing as the window mullions and panels on the Catalyst Center. As stated earlier, elements of the same scale have the ability to couple with each other, while their contrast in colour and material allows for a mutual reinforcement between the grade surface and the perpendicular building façade floating above.



Figure 47 - Facade Detail

COUPLING

The biological example given earlier, stated that the more variety of complex ‘molecules’ or elements there are within a single module or unit, the higher the probability of an ambiguous chance reaction between the two elements. This is an important aspect of the Catalyst Center’s philosophy.

Increasing the amount and variety of people within a single site (the existing George Brown Design School) and providing a variance of interactive spaces, will increase the probability of chance reactions between them. The Catalyst Center will add over one hundred startup company members to the site with more students, faculty and the public working in the third floor kitchen, rooftop gardens, fabrication labs and theatre. The Catalyst Quad and third floor intermediary space will bring the public onto the campus and into the building as another variable to the increased variety of potential human interaction opportunities. These opportunities, as discussed earlier, can act as a catalyst toward an ambiguous mutually benefiting reaction between each person. As stated earlier, the more variety of ‘elements’ increases the chance of potential reactions that may occur. By

intensifying the existing site of the Design School with added and differentiated program, there is an increased potential in symbiotic and coupling relationships to form.

Jane Jacobs had stated that: “The district must mingle buildings that vary in age and condition, including a good proportion of old ones so that they vary in age and condition, including a good proportion of old ones so that they vary in the economic yield they must produce. This mingling must be fairly close-grained.” (Jacobs, 1961; page 150). Jane Jacob’s ideas are based on an urban scale, but can be applied to the design principles of this thesis. The Catalyst Center is designed to incorporate the “mingling” of building types and time periods. The “mingling” of architecture here happens between the existing design school, constructed in 1909 and its contrast and coupling with the construction of the Catalyst Center. Here, the building was contrived to define a new working environment that is not characterized geometrically, tectonically or programmatically by the character of the existing structure. Instead, two juxtaposed structures varying in age, of roughly the same proportion “mingle” or are interdependent on each other through their “close-grained” relationship established through the variety of intermediary zones and couplings. The Catalyst Center is dependent on the Design School for structural support as well as access to building services. The existing structure is able to remain intact with its embodied energy retained, while being supplied with new energy generated by the Catalyst Centers solar panel façade.

Jane Jacobs also discusses a negative effect of diversity within an urban context. Her postulation is that problems occur when buildings or urban spaces are of disproportionate size. (Jacobs, 1961; page 234) An example would be the segregation of different functions of the city, industrial, residential, commercial, economical or public. Another example would be a tower accentuating itself among a conglomeration of small scaled units. The size imbalance between the tower and interface of the small scaled units disallows any sort of coupling. The Catalyst Center and George

Brown Design School are of the same proportionate size and couple with each other through inductive coupling illustrated in Figure 5.

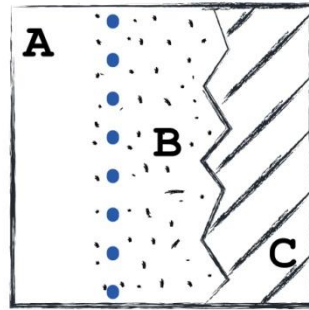


Figure E - Inductive Coupling → Common Third Element

Inductive coupling, as described earlier, displays the most obviously method of coupling found between the Catalyst Center and the existing George Brown Design School. Here the elements within the module are visibly contrasting, while having one shared boarder, and their own distinct boarders. In this diagram there are three elements within the module. The Catalyst Center's design is also divided into three elements. The existing Design School and the new Catalyst Center are coupled together by the intermediate region that acts as a “glue”, pairing the two buildings together. If the existing Design School is considered region A, and A connects to the intermediate region B, and the intermediate region B couples to The Catalyst Center, C, than A couples to C. This shows that there can be coupling between complex modules. Region A, could potentially be divided into multiple other couplings within itself. If within region A, there happens to be an existing internal coupling, those units can still be connected to other modules, simply increasing the network in complexity.



Figure 48 - Preliminary Render - Northeast Corner

Salingaros states that, “Order on the smallest scale is established by partied contrasting elements, existing in a balanced visual tension” (Salingaros, 1995; pg. 89). Every architectural element has the ability to be paired with others, but as stated earlier should begin with and always relate to the human scale. The smallest modules that dictate our urban fabric include paving stones, water features, doors and windows, vegetation, parking, columns, benches etc. and need to be situated so that they can couple with both other adjoining elements and any user of the space.

The coupling found in this project is currently formulated between the three entities, existing school, intermediary space and the catalyst center. In the future, with the ever increasing demand for space, the Catalyst Quad has the potential to become a site for a new architectural element to couple with the newly constructed Catalyst Center project. This would be another opportunity to fulfill urban coherence.

The pairing of both Catalyst Center and the Design School is dependent on both their position and formal qualities. The opposing elements are both physically connected as well as paired by common functions located within the intermediary zone on floor three. Just because the two elements are in juxtaposition programmatically, visually and architecturally does not mean that they couple with each other. Coupling can only take place if both elements have some sort of affect on the other. There are a variety of ways each building would affect one and other. The intermixing of startup members, faculty and design students within one site can be a catalyst to forming a variety of reactions, including new partnerships, businesses and designs companies. The theater space will be used for a variety of functions. It will be a space for the George Brown School of Design professors to hold seminars with students, a space for public speakers to lecture and a stage for startup companies to present their ideas to the public or potential clients.

Achieving symbiosis was a major goal for the design of the Catalyst Center, requiring a holistic approach to the design. Refraining from the dualistic approach of designing the parts separately to formalize the whole, the Catalyst Center was designed without the division between the two. A holistic approach to the design allows for a stronger relationship between the parts, the opposing buildings, and the whole, the entire site together. This is palpable in the Catalyst Center's design in a variety of ways. When designing the façade of the new rooftop structure, the window spacing relates to functional smaller scale aspects of the building, other than the exterior interface. The

façade is composed of a repeating pattern of four panels that span 800 mm, 1200 mm, 1500 mm and 1900 mm. The 800 mm panels are spaced to function as the operable windows of the building. The other spacings are wider to provide space for photovoltaic panels, transparent windows to allow natural daylight and to hide members of the steel structure enclosed within. Each panel protrudes from the façade with a different thickness, giving the façade a more variegated and textural appearance.

Simultaneously, this same spacing was used on the ground plane for the concrete blocks that traverse the bioswale. Not only is there a variety in the block thickness of spacing, but each height varies, creating an undulating ground plane, simulating rolling hills of a natural landscape. Each width provides a different function or type of space. The 800 mm blocks provide a low extrusion with space for a bench, while the 1200 mm blocks are raised from the ground plane providing a different type of seating environment. The larger blocks, 1500 mm and 1900 mm act as planters to house large American Beech trees and Red Maples shading the Catalyst Quad during the summer months. The pattern of the façade and the Quad's seating blocks were designed simultaneously and as a reflection of each other at the same scale allowing for a coupling between the two interfaces. Their variation in materiality creates juxtaposition between each, reinforcing each other. The bioswale is constructed of concrete blocks with various chrome and mirrored faces to cohere to the use of mirrored glass on the Catalyst Center's façade and the exterior of the theatre. As stated before, here a geometric coupling is achieved through interpenetration. Some parts of the façade, (the mirrored panels) interpenetrate with the ground plane, connecting the two. Visually, it will appear that mirrored panels of the façade have blown off and scattered themselves across the Catalyst Quad, interconnecting and coupling each other.



Figure 49 - Preliminary Render - Studio space

Another example where the part and whole were designed simultaneously is instantiated by the ceiling tile patterns within the Catalyst Center's studio and circulation space. They are a direct reflection and continuation of the spacing, colours and materiality of the exterior panels. This creates a continuity of the exterior façade, translating its pattern onto the ceiling. The north and south running panels extrude horizontally at a height of 3750 mm from the floor slab while the east and west panels are interwoven at a height of 3900. The continuing spacing of the façade into the dropped ceiling works to combine and couple the interior and exterior interface by fusing the 'parts' into a unified whole. This interweaving fosters a creative pattern against the ceiling, while providing space for HVAC integration as well as light shelves and direct and diffused lighting systems. The exterior façade is composed of blue metal panels, photovoltaic panels, mirrored glass and transparent and semi transparent glazing. As the ceiling tiles are to be a continuation of the exterior façade to achieve a unified composition between the part and whole. This works well, but for obvious reasons, photovoltaic panels are not a practical material for a dropped ceiling. In replace of

the solar panels, the ceiling tiles which extend from the photovoltaics are an extension of the hardwood flooring that is laid throughout the Catalyst Center. These ceiling tiles incorporate another aspect of the interior space coupling the floor and ceiling together. The juxtaposition of each material visually reinforces each other creating a mutually beneficial relationship between each element.



Figure 50 - Floor Five Studio Space

SYMBIOSIS & COUPLING OF FUNCTIONS

There are a multitude of symbiotic and mutually reinforcing relationships that are formulated by the various functions and spaces created within the Catalyst Center. The goal was to transform the mono-functional design school into a highly differentiated site. Negating the western rationalist notion of segregating the functions of a city, this building inter-mixes a variety of programs,

fostering social interaction and random encounters between various types of people. The Catalyst Center strives to subdivide, diversify, inter-mix and couple elements within its site. This creates flexible, adaptable spaces and symbiotic relationships that have mutually beneficial aspects for both the building itself and its users.

The first example is the relationship between the existing George Brown Design School and the members of the Catalysts Center's various startup companies. The Catalyst Center will house over 60 startup companies on the existing site. Their presence allows for an intermixing of intellectuals. The intermediary space on the third floor is a sanctuary for catalytic encounters. Students and startup members will have the opportunity to meet and interact with each other, creating the opportunity to learn and form relationships with each other. This interactive intermediary space brings the two groups of people together and could lead to future partnerships and foster new ideas. A symbiosis of information between each group is established through this interaction. Students will continue to stay up to date with contemporary methods of design, with the ability to share their knowledge with the postgraduate startup companies and vice versa. The spaces within the Catalyst Center and the intermediary space allow for a flexible learning environment, which accommodates both parties to design together, supplied with seating, drawing boards and open work and meeting space. The startup companies, being more experienced in the field are able to share information with the younger students. This oscillating transfer of information benefits both the startup companies as well as the students of the design school, forming a symbiotic relationship between the two.

Another symbiotic relationship is formed by the incorporation of the theater space. Startup companies will have a chance to use this space to present their ideas and products to students, other startups, as well as the public to receive feedback or to sell their work. Students once again have the

opportunity to learn from these presentations. The public also will benefit from the theatre space as they will have the opportunity to engage in student and startup company work. Members of the public may become potential investors in the startup's companies, benefiting from their success. Therefore, the theatre space is a necessary space for creating a mutually beneficial relationship between themselves and the public sector.

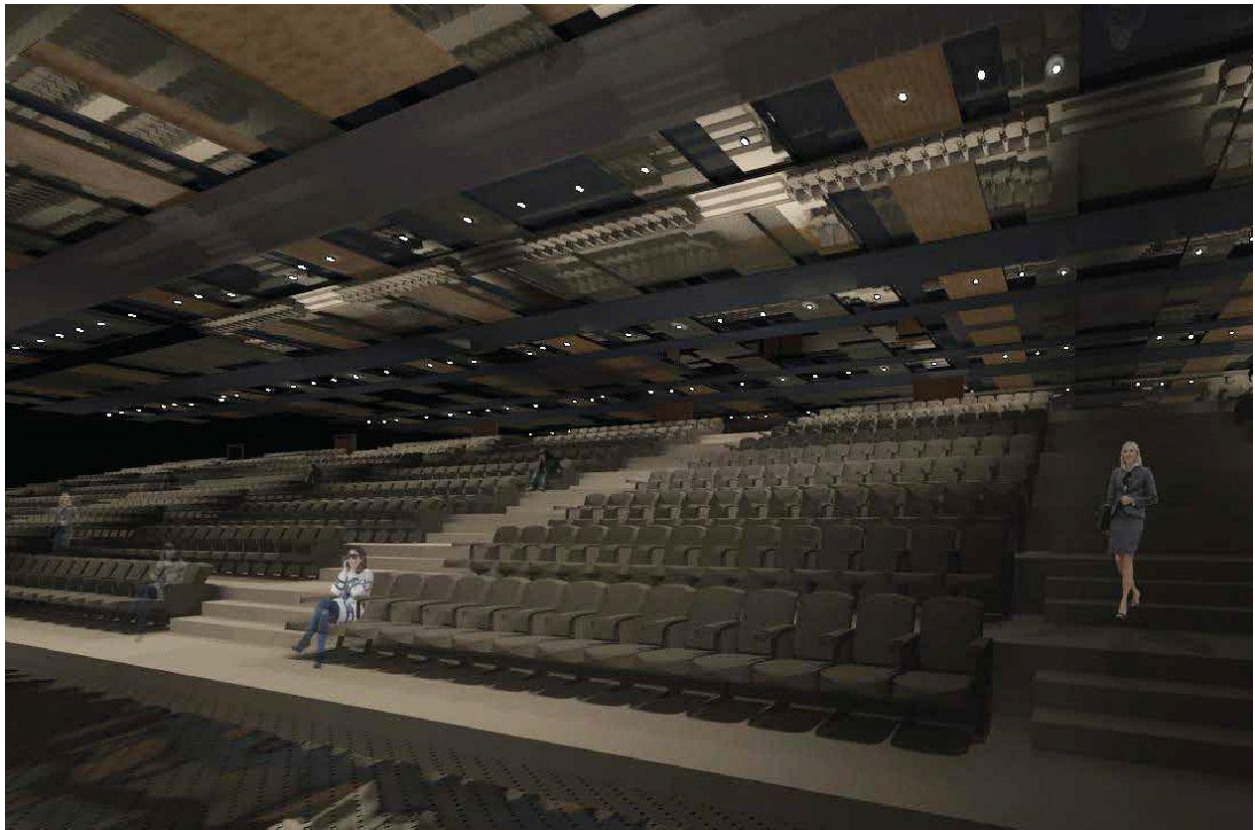


Figure 51 - Theater Interior

The theatre space will also be used for a multitude of public speakers. This space would not only accommodate design related public speaking, but could host speakers from any vocation or subject offered at George Brown. The theatre would provide a new platform for public speakers to lecture while benefiting the school, startup companies as well as the public through the transfer of information.

The intermediary space on the third floor also houses a fabrication lab that would be used by both the startup companies and the students of George Brown. This is another flexible space that can encompass human interaction between the opposing vocations. Here students and startups will inter-mix again sharing skills, information and ideas, allowing both groups to benefit from one and other. The fast pace of the fabrication lab fosters a creative, innovative and dynamic environment within the intermediary space of the third floor.

Also, located within this space is a small restaurant and cafeteria space with an outdoor patio and garden. Students from the existing George Brown Culinary School will have the opportunity to practice and continue their studies in a real life situation. The rooftop garden will be tended to by the students and volunteers from the community and harvested to provide food for the school and public. Design students and startup companies will be immersed in the growth and harvesting process, again strengthening their relationship with natural ecologies and sustainable practice. A symbiotic relationship is established between the culinary students and the design students/startup companies. The culinary students benefit by being provided a working plane to continue their culinary work experience while providing the Catalyst Center with locally grown meals.



Figure 52 - Preliminary Rendering - Rooftop Garden Space



Figure 53 - Preliminary Render - Rooftop Patio & Garden

The occupants of the building will also benefit from the newly provided rooftop patio space that acts as an intermediary space between the interior of the building and the rest of the city. This space is designed with a variety of seating arrangements. Spaces are organized for group meetings, barbeques, individual reflection and even spaces with hammocks for a place to take a break from their work load inside. All of this takes place within the vegetable garden space, again strengthening and reinforcing the relationship between the building occupants and the natural environment.



Figure 54 -- Preliminary Render - Rooftop Patio & Garden

SYMBIOSIS OF BUILDING SERVICES

Today our ever increasing demand for living and working space within the city should lead to the preservation, conservation and renovation to existing buildings. The Catalyst Center has been conceived with this in mind. The Catalyst Center is an urban rooftop intensification project that will interact symbiotically with its host structure, the George Brown Design School. The two elements are fused together, each providing a beneficial characteristic to the other. Following the analogy of the epiphyte and an existing tree trunk, the Catalyst Center acts like an epiphyte as it grows out of

the existing Design School non-parasitically. The new structure blossoms from its rooftop, reaching four stories above the streetscape, collecting solar and wind energy as well as rainwater. This eliminates its reliance on the existing school for these aspects of its building services. Since the Catalyst Center is growing out of the existing building, its services can potentially be extended to the new building including the HVAC, plumbing and electrical. This benefits the existing building as well as the environment as it saves the embodied energy in the demolition, manufacture, mobilization and construction of a new structure. The new addition is reliant on the existing building for structural support, allowing it to rest on top of its host, providing space for its new functions as well as collecting energy for itself and the existing.

With the construction of the new addition, the existing roof-scape, as well as the Catalyst Center's roof will collect rainwater and provide both buildings with a grey water supply. The collected grey water would be utilized in the buildings toilets and also used for irrigation of the Catalyst Quad's vegetation. Excess rainwater would be diverted to the bioswale on the ground plane for natural filtration as mentioned earlier. A mutually beneficial relationship is formed between the new and old building. The new building provides grey water to the existing, while the existing building allows for an extension of its plumbing infrastructure to the new building. The already in place connections to city water systems eliminates the costs and complications of the Catalyst Center tying into the city's water-mains.

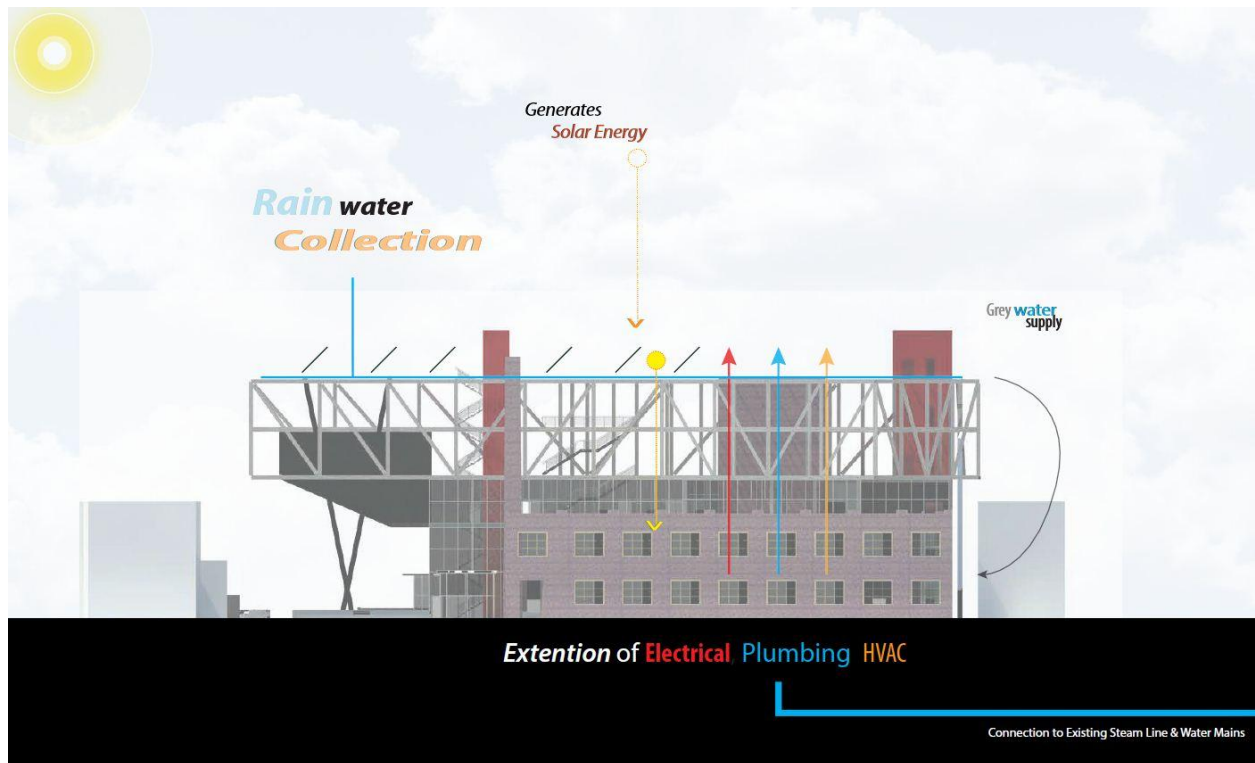


Figure 55 - Environmental Symbiosis



Figure 56 - Preliminary Render - Main Circulation Path, Catalyst Quad

The Catalyst Center's façade is made up of mirrored, transparent and semi-transparent glazing, metallic panels and photovoltaic panels. The solar energy generated by the new façade will benefit the existing structure by providing it with any excess energy it acquires. The rooftop addition will benefit, as stated above, by being supplied with an already in place electrical system.

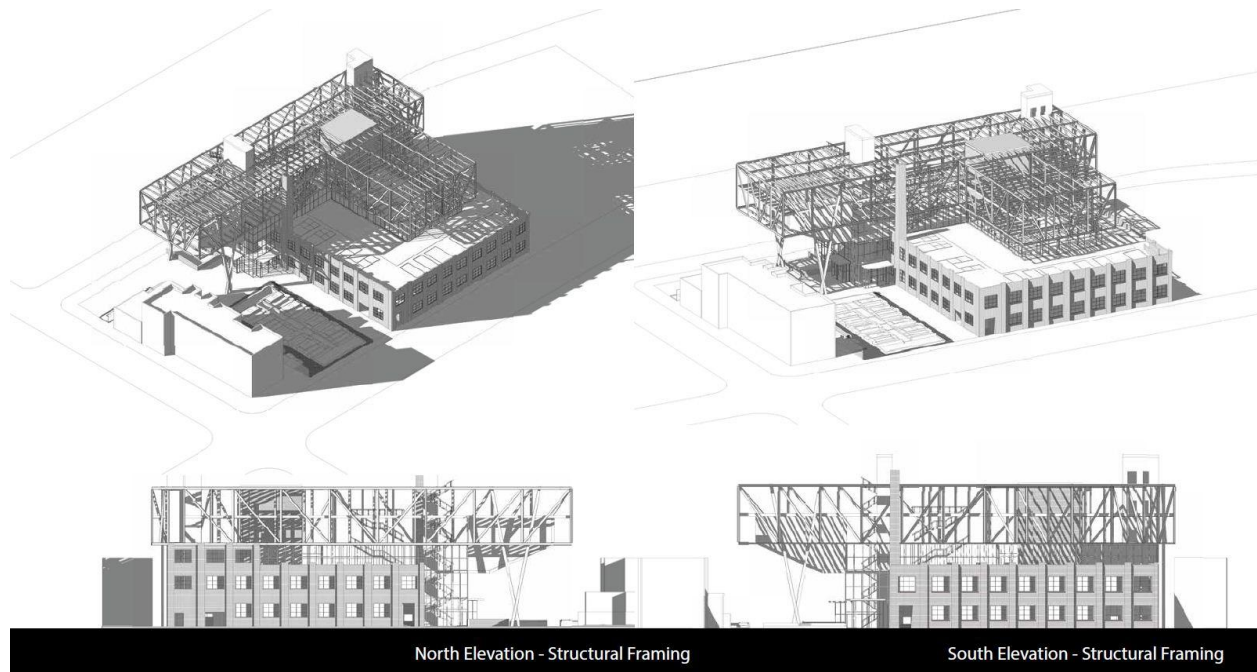


Figure 57 - Structural Steel Framing

HUMAN INTERACTION, STRUCTURE & MATERIALITY

The Catalyst Center does rely on the existing Design School for structural support, but in an entirely parasitic way on top of its roof. The bulk of the structure is supported by columns on either side of the Design School. A two story truss system extends from either side connecting only to the extruded rooftop space of the north east corner. The southern portion of the Catalyst Center, located above the cafeteria, however, requires some extra structural support. The steel frame is designed to exert the least amount of force upon the existing structure with the intention of being

symbiotic and non-parasitic in construction. The steel frame is a lightweight solution to this problem and allows for juxtaposition in each building's structure, allowing for a coupling between each other. The exterior materials of each building, again in contrast with each other, enable this coupling and reinforcement as stated earlier. The exterior blue panels fuse and blend into the sky on a clear day, while the mirrors blend the structure into the sky allowing it to constantly acquire new reflected images as the weather changes or as other buildings are constructed within its reflective context. This makes the addition appear weightless and helps to eliminate any overpowering qualities between the building in relation to the existing, ensuring coupling and reinforcement between the units.



Figure 58 - North Elevation

The variety of mirrored surfaces around the Catalyst Center engages the building user in a direct relationship with the building. Salingros stated that a successful urban interface or architectural element requires a sensory connection to the user. (Salingros, 2005) While the use of blue and mirrored panels are to create an illusion of an extra light weight structure, there are mirrors found throughout the project for the purpose of connecting the user to the architecture itself.



Figure 59 - Interior Cafe Rendering

The café's dropped ceiling as well as its central circular seating area is clad with mirrored panels. The mirrors extend themselves into the soffit that surrounds the café on the rooftop patio. This creates an ambiguous ceiling plane, doubling the dynamism of the space and interconnecting the buildings users even more, through another geometrical dimension. The same concept is applied to the ceiling tiles that extend in from the exterior to the interior studio spaces, adding a visual connection between the individuals working in studio.



Figure 60 - Theater Entrance

The sloped theater space that floats above the north western portion of the Catalyst Quad is also clad in a mirrored glass. This slope serves as a canopy to the entrance of the lobby atrium and is angled to display a reflection of the pedestrian dynamics of the Quad space. As one approaches the building entrance they are displayed with an overhead image of themselves, and the space in which they are passing through. This transfer of information, from the architecture to the pedestrian, conjures a spatial awareness and sensory connection between the pedestrian and the building itself. At the same time, a coupling can take place between the relationship of the lobby and the streetscape through its own reflection.

Mirrors are also scattered across the concrete block faces surrounding the bioswale. These patches of mirrors reflect other spaces traversing the bioswale pathways. It creates an illusory effect of holes in the landscape, like the porous gaps of a fractal urban interface. Attracting the building user to establish a relationship between themselves and the architecture in the same way the theater does.



Figure 61 - The Catalyst Center

CONCLUSION

In conclusion, the Catalyst Center achieves urban and architectural coherence through a variety of symbiotic, coupling and mutually reinforcing relationships. The “incubator” space for design companies integrates itself on top of the existing George Brown School of Design as an ‘epiphyte’ like organism that grows out of the existing rooftop non-parasitically. Instead, its presence benefits its host, the Design School, as the Design School mutually benefits the Catalyst Center.

Through the juxtaposition of materials and the identical scale of each building, the two elements are able to form a unified module or unit that couples and reinforces each other, connected by its intermediate zone. Each element complements and imposes positive effects on the other while therefore benefiting each other and forming a symbiotic relationship. The past reinforced the present and future, the existing Design School reinforces the future Catalyst Center, while the Catalyst Center will mutually reinforce the existing Design School. A harmonious visual composition is achieved by respecting the regulating lines, scale and proportions of the existing context, creating a cohesive unit.

The intermediary spaces of the project, including the Catalyst Quad and the third floor connective functions promote and initiate human interaction of a multitude of levels. The theatre, fabrication lab, kitchen, café, outdoor patio seating and vegetable gardens, used by the Catalyst Center, the existing Design School and the public, act as the ‘glue’ that brings together the two building elements. The Catalyst Center increases the vitality of the site by bringing in hundreds of new startup members, students and the public, increasing the chance for chance encounters that can blossom into beneficial and productive relationships. The element of variety is ubiquitous throughout the Center. There is variance in everything from the use of materials, to the various

types of people who work and study here. The different working and learning environments foster ambiguous innovation and collaboration.

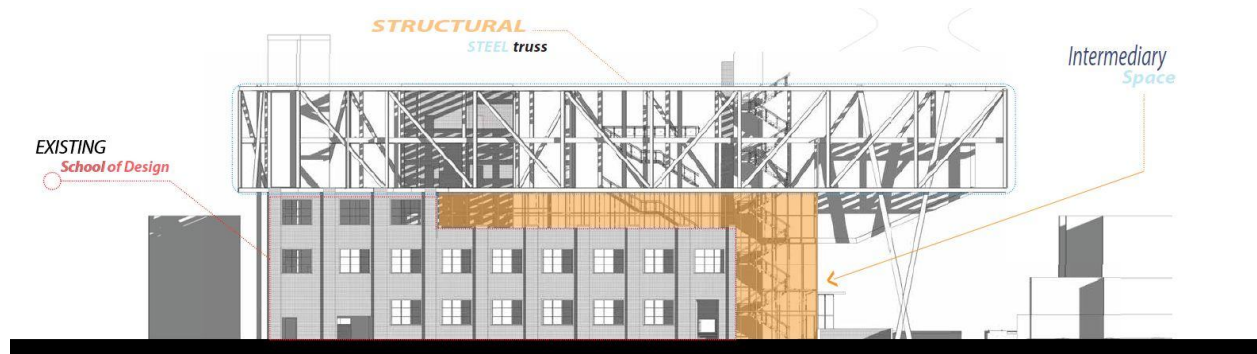


Figure 62 - Steel Structure

The Catalyst Center integrates the coupling between architecture and human interaction through the use of informative design methods such as the mirror panels. A coupling between pedestrians and natural ecologies is established by their strengthened relationship to the natural environment through exposure to the bioswale and rooftop vegetable garden.

The coupling between public and private space, interior and exterior space and streetscape with pedestrian space is achieved through differentiation and the transition through intermediary zones. Moving the parking underground, opens a network of landscaped pedestrian pathways connecting Britain Street on the north to Richmond Street East, on the south. A new gateway and urban space is contrived as the “Catalyst Quad”, becoming the new heart of George Brown and a campus destination.

The Catalyst Center was derived by the intention of designing a space that initiates new and unexpected interactions on a variety of scales and between a myriad of elements and building users. This was possible by formulating a building based on symbiotic, mutually reinforcing and coupling

relationships. The Catalyst Center has been designed with mutually beneficial and reinforcing relationships in a variety of ways and has therefore created a building of architectural coherence.

In terms of sustainability, the new structure benefits the existing building by supplying it with natural energy through geothermal, wind and solar techniques. Simultaneously, the existing building provides extensions of its HVAC, electrical and plumbing services, as well as provides structural support for the new structure. The new structure collects and filters rainwater for both the new and old structure, while benefiting the environment with the natural filtration system of the bioswale at grade.

As seen in this thesis there is a multitude of opportunities for symbiotic, mutually reinforcing and coupling relationships in the world of architecture. Designing with these principles will lead to the conception of more engaging, creative, sustainable and cohesive buildings and urban spaces. The fusion and coupling of opposing elements eliminates the missed opportunities of creativity and chance reactions between people and spaces. Instead, it embraces the ambiguous state of intermediary spaces and catalytic elements. The symbiosis or mutual reinforcement of these various elements allows for an ever changing dynamic balance between the two opposing elements. This fosters a healthy, convivial and coherent environment.

This thesis has shown how symbiosis can occur between two opposing elements or organisms allowing them to work together to produce something positive for each other. Any two elements have the opportunity for mutual reinforcement through their form, scale, colour, texture or patterns. The more extreme their juxtaposition the stronger they may reinforce each other. Reinforcement accentuates each element strengthening their perception in the geometric field and forming them into a unified entity. This thesis also touches on the importance of variance in architecture in order to increase the opportunity for chance reactions or symbiotic relationships to form. The probability of

two elements forming an inter-relationship with one and other is increased with the addition extra elements. The symbiosis of these various elements allows for an ever changing dynamic balance between the two opposing elements.

This occurs when there is the presence of an intermediary space, where both elements are accepted and neither transcends the other. Here, common and contrasting elements strengthen and benefit from each other forming a symbiotic co-existence without eliminating aspects of each other. In all symbiotic relationships, some aspects of both elements are shared within these zones, regardless of their differentiation or opposing ideologies. This forms the intermediary spaces that have proven to allow ambiguous reactions to form, enabling a chance for the creation of a positive architecture and relationships within space. Understanding these concepts of mutual reinforcement, symbiosis, coupling and the use of intermediary spaces, can allow for a more cohesive, coherent, ambiguous and dynamic architectural and urban environment.

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LIST OF FIGURES

Figure 1 - Costa Rican sloth slowly climbing an epiphyte covered tree (Personal Photo)	6
Figure 2 - Natural Symbiosis - Plover Bird & Crocodile.....	7
Retrieved from: http://blog-pontiflex.wpengine.netdna-cdn.com/files/2009/04/symbiosis.jpg	
Figure 3 - Intermediate Zone AB Figure 4 - Intermediate Zone Example.....	8
Figure 5 - Architecture & Ecology	9
Figure 6 - Remains of the Parthenon's Portico (Personal Photo)	10
Figure 7 - Renaissance Garden	12
Retrieved from: http://francetoursllc.com/images/5%20villandry%20renaissance%20gardens.jpg	
Figure 8 - Melbourne Central.....	21
Retrieved from: http://www.kisho.co.jp/154.htm	
Figure 9 - Section through Melbourne Central	21
Retrieved from: http://www.kisho.co.jp/154.htm	
Figure 10 - Kunsthalle Bremen, Germany.....	24
Retrieved from: http://www.stylepark.com/en/news/symbiotic-architecture/324939	
Figure 11 - Kunsthalle Bremen, Building Section.....	24
Retrieved from: http://www.stylepark.com/en/news/symbiotic-architecture/324939	
Figure 13- BLC Intermediary Space.....	26
Retrieved from: http://www.dezeen.com/2010/08/23/blc-headquarters-by-atelier-hapsitus/	
Figure 12 - BLC Headquarters, Beirut	26
Retrieved from: http://www.dezeen.com/2010/08/23/blc-headquarters-by-atelier-hapsitus/	
Figure 14 - Rem Koolhaas Design for the Whitney Museum, NYC	27
Retrieved from: http://www.thecityreview.com/whitneykoolhaas2.jpg	
Figure 15 - Symbiont Green Wall.....	31
Retrieved from: http://www.ecofriend.com/entry/eco-architecture-symbiotic-green-wall-makes-construction-sites-sustainable/	
Figure 17 - Mixed use Tower.....	32
Figure 16 - Mixed Use Tower Section	32
Figure 18 - Suspended Rooftop Dwelling – Migrating Landscapes	33
http://www.blogto.com/arts/2012/02/migrating_landscapes_brings_wood_city_to_toronto/	
Figure 19 - Suspend Dwellings (Personal Photo).....	33
Figure 20 - Initial Design - Suspended Dwelling	34
Figure 21 - Preliminary Design Proposal – Catalyst Center.....	35
Figure 22 - Third Design Proposal Section	35
Figure 23 - Floor Four Studios & Circulation Space / Birds Eye View & North East Corner	36
Figure 24 - Cafe Interior.....	37
Figure 25 - Ground Floor Lobby	37
Figure 26 – Under Theater – Northwest Corner.....	38
Figure 27 - North-west Corner.....	38
Figure 28 - Site Map - www.google.com	39
Figure 29 - Site Map.....	40
Figure 30 - Birds Eye View Looking North	41
Figure 31 - George Brown School of Design Site	41
Figure 32 - Birds Eye View Looking East	42
Figure 33 - Existing George Brown School of Design Site	43

Figure 34 - South Facade.....	43
Figure 35 – Final Proposed - South Elevation.....	44
Figure 36 - Bioswale Fountain.....	45
Figure 37 - Functional Module.....	47
Figure 38 - North East Entrance - Gateway to George Brown.....	48
Figure 39 - Rooftop Patio & Vegetable Garden.....	50
Figure 42 - Floor Four Figure 43 - Floor Five.....	52
Figure 40 - Level Three.....	52
Figure 41 - Ground Level.....	52
Figure 44 - Green Roof.....	52
Figure 45 - Intermediary Circulation Space.....	53
Figure 46 - The Catalyst Center & George Brown School of Design.....	54
Figure 47 - Facade Detail.....	57
Figure 48 - Preliminary Render - Northeast Corner.....	60
Figure 49 - Preliminary Render - Studio space.....	63
Figure 50 - Floor Five Studio Space.....	64
Figure 51 - Theater Interior.....	66
Figure 52 - Preliminary Rendering - Rooftop Garden Space.....	68
Figure 53 - Preliminary Render - Rooftop Patio & Garden.....	68
Figure 54 - – Preliminary Render - Rooftop Patio & Garden.....	69
Figure 55 - Environmental Symbiosis.....	71
Figure 56 - Preliminary Render - Main Circulation Path, Catalyst Quad.....	71
Figure 57 - Structural Steel Framing.....	72
Figure 58 - North Elevation.....	73
Figure 59 - Interior Cafe Rendering.....	74
Figure 60 - Theater Entrance.....	75
Figure 61 - The Catalyst Center.....	76
Figure 62 - Steel Structure.....	81