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Modular Urbanism:

Combining modular and multi-scalar design strategies in creating sustainable landscape architecture design and construction processes

by

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A THESIS

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ABSTRACT

In the continued effort to fulfill its professional mandate to build sustainably, the discipline of landscape architecture has begun the transition from emphasizing site-specific design and construction (a "one-off" approach) towards more expansive methods that better address material efficiencies, life cycle performance, and end of life building practices through redevelopment, adaptive re-use and retrofitting. Within this context, this thesis asks how modular design thinking could offer an alternative approach, especially when combined with the multi-scalar techniques and principles of tactical urbanism and placemaking in the (re)design and construction of sustainable urban spaces. Often thought of as generic, repetitive, and monotonous, with regard to the built environment, this thesis will suggest that modular design thinking, at the site scale, has direct application to landscape architecture in not only (re)activating urban spaces, but in creating meaningful sense of place.

Highlights will include three interdisciplinary design case studies, that engaged community, and municipal stakeholders. This thesis will touch on the importance of interdisciplinary practice in the development of novel, specific yet scalable, adaptable yet economical forms of urbanism, and in doing so, develop possible alternative design processes in generating normative practices in landscape architecture design and construction.

Keywords: Modular design, Sustainability, Landscape architecture, Multi-scalar design, Placemaking, Tactical urbanism.

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Lastly, I would like to thank my family for giving me the opportunity to pursue my interests and complete this degree, and for putting up with me.

DEDICATION

This thesis is dedicated to the Salus, Slick, and Stan-Harold families, who believed in me and supported me throughout this journey.

And to Jane Durham who somehow managed to put up with all my ranting and raving.

And to thesaurus.com…I couldn't have done it without you!

EPIGRAPH

I would rather have questions that can't be answered than answers that can't be questioned.

-Richard Feynman

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PREFACE

Research background.

My interest in the subject matter for this thesis began after taking two classes with Prof. Kris Fox, during the second year of my Master of Landscape Architecture (MLA) degree at The School of Architecture, Planning and Landscape (SAPL), University of Calgary. I approached him with an interest in becoming a research assistant as I recognized shared interests in his areas of expertise, that include, cheap material economics, mass customization, fabrication, BIM, circular economy, and most importantly modular design thinking. I then began initial research and editing activities on several of his papers, one of which was about the implications of modularity on the design and construction of landscape architecture. As this was an underexplored area within landscape architecture discourse, I began taking an active role in expanding the investigation and recognized the possibility of further refining my research interests by developing a thesis. Upon graduation from the MLA program and wanting to continue my research, I was encouraged by Prof. Kris Fox to pursue the Mitacs Master of Environmental Design degree (MEDes) where I was accepted into the program, as the first SAPL, MLA student. This began my focused investigation on the potential benefits of modularity in the design and construction of sustainable landscape architecture.

CHAPTER 1

INTRODUCTION

1.1 Landscape Architecture

1.1.1 On Contemporary Landscape Architecture.

Landscape architecture is a diverse discipline that is concerned with the multi-scalar design, organization, and construction of outdoor spaces, from backyard gardens to municipal and regional master plans, that incorporate natural and synthetic materials and systems in creating multifunctional built environments (ASLA, 2020; CSLA, 2020; Holden & Liversedge, 2014). In combining social, ecological, and aesthetic perspectives, the practice of landscape architecture aims to create sustainable and resilient environments, through an interdisciplinary approach involving the fields of design, engineering, environmental science, and art (ASLA, 2020; CSLA, 2020; Treib, 2011).

Beyond the exclusive design of green spaces, and the arcadian narrative of "the middle landscape of humanized nature pleasantly suspended between extreme wilderness and crowded cities" (Thayer, 1994, p. 80), the landscape architect was "originally conceived as a professional responsible for divining the shape of the city itself, rather than pastoral exceptions to it" (Waldheim, 2016, p.166). Since it's inception as a profession, landscape architecture has been actively engaged in "ensure[ing] the development of more sustainable and resilient towns and cities, urban realm, transport systems, parks, squares, agriculture, forestry, energy and water system solutions as well as creating a greater sense of place and community" (Moore, 2018). Often overlooked or underappreciated, (Waldheim, 2016; Zuenert, 2017), the discipline of landscape architecture maintains a fundamental role in positively influencing human and environmental health and well being.

1.1.2 Landscape Urbanism.

This diverse approach in developing solutions to the challenges of the city has led to "a period of intellectual and cultural renewal" (Waldheim, 2016, p. 13) where "since the turn of the century landscape has been claimed as a model for contemporary urbanism" (Waldheim, 2016, p. 13) leading to the development of landscape urbanism theory. This reassessment of urbanism, through the lens of landscape, came in reaction to the generalized inability of modernist architectural and planning practices to meaningfully contend with the expanded challenges and complexities of contemporary urbanization, where the development of landscape urbanism discourse "can be read as a disciplinary realignment in which landscape supplants architecture's historical role as the basic building block of urban form" (Waldheim, 2016, p. 13). Additionally, landscape urbanism also combined and integrated several other established ideas and approaches from landscape architecture which include; a multi-scalar, ecological awareness in the understanding of the urban condition as a network of complex and adaptive systems; the importance and inclusion of flexibility and indeterminacy in developing and implementing design processes and outcomes; and an emphasized focus on interdisciplinary and expanded field practice (Almy, 2006; Mostafavi & Najle, 2004; Waldheim, 2006; Waldheim, 2016). Arguments aside regarding landscape urbanism's successes or failures in progressing environmental design practices, and its overall effect on the built environment (Duany & Talen, 2013), it has generated theoretical discourse and increased interdisciplinary awareness in addressing issues of contemporary urbanism resulting in inspiring, and evocative new perspectives in cultivating "complex proposals for complex problems" (Livesey, 2009). Landscape urbanism, like its progenitor, landscape architecture, both find common ground and purpose as "interstitial design discipline[s], operating in the spaces between buildings, infrastructural systems, and natural ecologies" (Shane, 2003, p. 4).

1.1.3 Landscape Architecture and Sustainability: An Introduction.

This convergence of natural and synthetic systems to the formation of contemporary urbanism also demonstrates landscape architecture's capacity for multifunctional, sustainable design. As a central mandate of the profession (CSLA, 2015), sustainability addresses, not only the environmental aspects of design but the social and economic implications, in aiming to create accessible, equitable and inclusive environments (Benson & Roe, 2007; Melby & Cathcart, 2002; Pallagrino et al., 2015; Thayer, 1994; Zeunert, 2017). With the combined rate of urbanization, where the majority of the global population now live in cities (United Nations, 2018) and, the effects of accelerating climate change (NASA, 2020), sustainably has become an essential component of environmental design practice (Ahern, 2012; Chiesura, 2004; Kirkwood 2001; Stitt, 1999; Zeunert, 2017). The proven abilities and expanded use of green infrastructure (GI), and low impact development (LID) strategies, where design, engineering, and ecology merge, have had a considerable effect in creating, multifunctional sites, that are not only economical but ecologically performative and socially integrative (Benedict & McMahon 2006; Birkland, 2002; Calkins 2011; Dinep & Schwab, 2010; Orff 2018). Sustainable practices can be implemented at a variety of scales and levels of complexity in improving the built environment, from the straightforward inclusion of softscape and planting design to more intricate streetscape, and stormwater management systems (Church, 2015; Endreny, 2018; EPA, 2010; NATCO, 2017). Sustainable design principles also contribute to minimizing consumption and waste through the conservation, reuse, and recycling of materials throughout the design and construction process (Calkins, 2009; Calkins, 2012). In response to prevalent uneven economic development and environmental resource degradation, sustainable design practices have rapidly progressed the adoption of renewable energy, closed-loop and circular economy systems, and lifecycle assessment, as viable and increasingly required alternatives to status-quo building practices (Braungart & McDonough, 2002; Calkins, 2009; Calkins, 2012; Kirkwood, 2001).

1.2 Thesis Research.

1.2.1 Thesis Focus.

In appropriately addressing the fluctuations and complexities of contemporary urbanism, and the increasing necessity for adaptive and responsive design capacities, further research into other suitable principles and methods, could contribute to the creation of more robust and effective, sustainable landscape architecture design and construction processes. The concept of modular design, having proven its effectiveness in Architecture, Engineering, and Construction (AEC), and numerous other industries, could provide expanded opportunity to the field of landscape architecture, in capitalizing on a resourceful and efficient approach to building.

Modular design, through its capacities of subset assembly and component exchange, allows for the recycling and reuse of material, parts, and entire systems. Fully integrating many sustainable design principles, such as design for disassembly (DfD), modular design allows for the possibility of built form to be assembled, and disassembled, to be reused, or recycled, in part, or, in whole, at alternative locations and times, considerably extending life-cycle and minimizing material waste (Calkins, 2009; Knaack et al., 2012; Smith 2010). The concept of modular design like the discipline of landscape architecture is multi-scalar, involving the ability to transition and translate design processes and outcomes, through a spectrum of scales (Baldwin & Clark, 2014;

Ethiraj & Levinthal, 2004; Russell, 2012; Salhieh & Kamrani, 2008) Similarly, landscape architecture's ability in understanding complex ecological systems, with temporal indeterminacy, mirrors the capacity of modular design to organize systems across networked modules, that exist independent of, and interconnected to, other individual and grouped modules of an entire system (Baldwin & Clark, 2014; Salhieh & Kamrani, 2008).

Although modularity is used in some building components within landscape architecture, such as paver systems, and furniture elements, investigations into larger scale, multi-site, integrative modular design, and construction processes, remains underexamined. This can be attributable to the common misconception that modularity contradicts creativity, through a focus on monotony and repetitiveness (Bernstien et al., 2011; Coleman, 2003; Knaack et al., 2012; Nieson, 1972; Smith, 2010), and the century-old "stigma of 'cheapness' and 'poor quality'" (Bernsiten et al., 2011, p. 4). Modular design is therefor, often misperceived as being incompatible with the design of unique, site-specific, attributes, and characteristics in generating community connection and sense of place. It is what Corner (1996) calls the "aporia of measure in the late twentieth century" (p. 33) in developing "the present-day incongruity,…between the instrumental, calculative, objective, standardized and formulaic on the one hand, and the sensual, poetic, subjective and contingent, on the other" (p.33). This investigation seeks to counter that misperception, not in favoring the modular over the site-specific, "but, rather that both need to be brought into a greater form of reciprocity" (Corner, 1996, p. 33).

1.2.2 Thesis Question.

The influence on contemporary urbanism by recent social, political and economic readjustments and upheavals, as well as a general response to failed modernist, and centralized state planning schemes, have shown that a combination of perspectives are required to design urban, public spaces that are meaningful and engaging (Groth & Corijn, 2005; Menin, 2003; Nemeth & Langhorst, 2014). This invariably has begun to include a capacity for flexibility and adaptability, in creating places that are both inclusively attractive to people, and responsive to surrounding physical, climactic, and social contexts (Ivers, 2018). In this way, modular design could be combined with other environmental design principles and techniques in developing sustainable landscape architecture practices.

In addressing these contemporary urbanism concerns, the question narrows to focus on formulating a site design process that can successfully combine multiple strategies and tactics, principles, and techniques, that support multi-scalar, multi-site interventions. This design process would allow for a spectrum of capacities from urban space activation, to more complex, design and construction of fully integrated, multifunctional infrastructures and environments.

Specifically, this thesis will focus on the formation of a specific site design process, which I am naming Modular Urbanism (Figure 1), in asking whether modular design can be combined with the principles and techniques of placemaking and tactical urbanism to create more sustainable landscape architecture. In doing so the research will examine advances in landscape architecture design and construction that fall between site-specificity and modularity. It asks the question: can modular design thinking offer an alternative approach to the design and construction of meaningful urban spaces in a way that aligns with the profession's mandate to build sustainably? In combining modular design with placemaking and tactical urbanism, can design and construction outcomes be more effective in addressing the complexities of contemporary urbanism in creating places out of spaces?

Thesis research will include the examination of three design case studies based on projects completed with Mitacs industry partner Kasian Architecture, and the University of

Calgary's (U of C) School of Architecture, Planning and Landscape (SAPL), that engaged both community and municipal stakeholders. The research will touch on the importance of interdisciplinary practice in the development of novel, specific yet scalable, adaptable yet economical forms of sustainable design, and in doing so, develop possible alternative methods in generating normative practices within the discipline of landscape architecture, and extending to associated fields of environmental design.

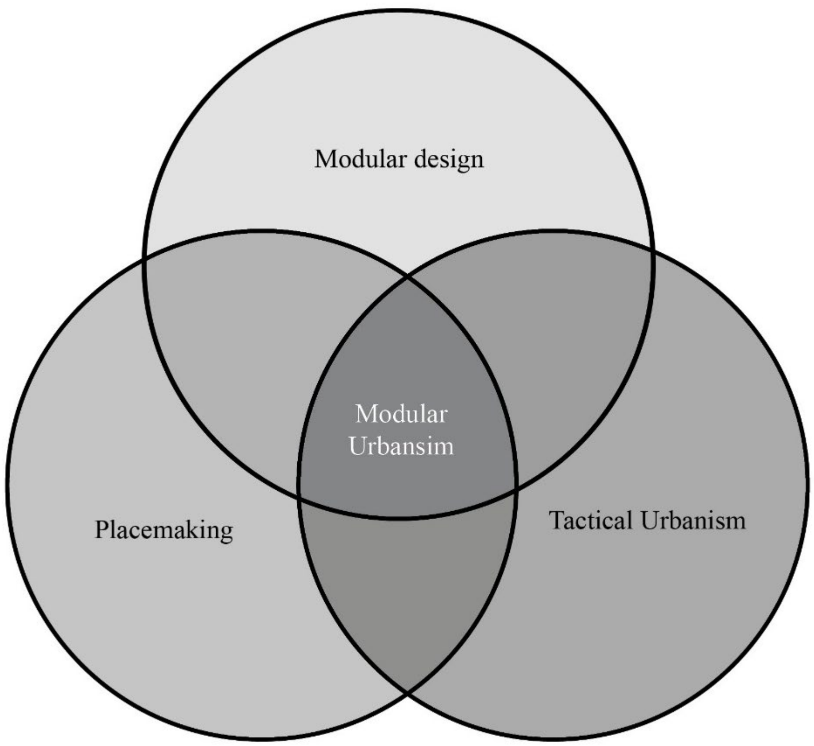


Figure 1. Modular Urbanism Venn diagram.

1.3 Methodology.

1.3.1 Research Design and Methodology Framework.

This investigation, in its broadest terms, aims to generate more sustainable forms of environmental design in landscape architecture, through the convergence of specific design and construction techniques, with multi-scalar, design concepts, principles, and methods. Furthermore, this aim seeks to specifically create stimulating, engaging, and activated urban environments, as Hirsh (2019) describes "that are essential for the wellbeing of an increasing number of inhabitants" (p. 25), as spaces of "negotiation and transculturation in everyday practice" (p. 25). As the process of design is critical to the execution of this aim, design research (Brink et al., 2014; Deming & Swaffield, 2011; Fraser, 2013; Joost et al., 2016), where "design may become research if it is planned and undertaken as a systematic process of inquiry, with a clear theoretical framework and research questions" (Deming & Swaffield, 2011, p. 128), will be the broadest lens through which this research methodology is developed.

1.3.2 Design Research.

Over the last several decades, design research has continued to gain legitimacy and provide specific benefits to the understanding and process of knowledge production, especially within the context of research and professional practice (Deming & Swaffield, 2011; Fraser, 2013; Joost, et al., 2016). Described by Mareis (2016) as the "practice turn" (p.35), professional practice design research is "profoundly concerned with the reciprocal relationship of practice and theory construction as well as seeks new ways of understanding knowledge production in research, in the mode of design-practical action" (p. 35). From the specific disciplinary perspective of landscape architecture, Deming & Swaffield (2011) argue that differences between design and research, theory and practice derive from "motivation and framing" (p. 50) in "finding a specific design solution to a situated problem and identifying a general principle that may reliably and clearly inform others in future, analogous situations that are at present unknown" (p. 50).

Deming & Swaffield (2011) continue their explanation in that:

> binary relations between theory and practice, and research and design, quickly recede before the very rich gradation of hybrid possibilities that stretches between the two extremes. In every case, and at the very least, design and research can and should inform each other. (p. 53)

This "gradation of hybrid possibilities" (p. 53) is also analogous to the Modular Urbanism design process developed for this investigation, in which seemingly mutually exclusive, binary design concepts can be understood, rather, as operations within a spectrum of collaborative association, which can then be applied to specific, practice-based, design problems. Practice-based, design research, as Anderson (2016) describes, "avails the constraints" (p. 42) of traditional project delivery and provides "the foundations in which combinations of design innovation, material research and making can begin a rethinking of how space and spaces, objects and technologies can function differently and be more sustainable within our societies and urban built environments" (p. 42). Considered accordingly, practice-based design research will be included in the over-reaching strategy, "focusing the unique agency of design process for research outcomes" (Deming & Swaffield, 2011, p. 206) in the hopes of systematically developing new knowledge in advancing the discipline of landscape architecture.

1.3.3 Literature Review.

A classification strategy in the use of the literature review (Deming & Swaffield, 2011, pp. 144-149) will also be utilized in chapter 2, in categorizing and establishing a baseline understanding of six of the investigation's component concepts as the initial "cumulative and consensual process of research" (Deming & Swaffield, 2011, p. 126). These will include the historical precedent of the Crystal Palace of 1851, sustainability, adaptive reuse, placemaking, tactical urbanism, and modular design.

This grouping and analysis of core concepts also serves as an opportunity to compare, contrast, and align similarities between ideas commonly perceived as distinctively separate. This initial stage of research will also contribute to the organization of a conceptual framework, which will lead to the practice-based design research solutions reviewed in the case studies.

1.3.4 Conceptual Framework.

Chapter 2 will also include a "logical systems" (Deming & Swaffield, 2011, pp. 223-235) research strategy in the development of a conceptual framework articulated as a Modular Urbanism Matrix (MUM), as a way "to frame logical conceptual systems…that interconnect previously unknown or unappreciated factors in relevant ways" (Groat & Wang, 2002, pp. 301–302 as cited in Deming & Swaffield, 2011, p. 223).

As Deming & Swaffield (2011) identify, one of the operational processes of this strategy can be understood as the method of "expanded field analysis" (p. 228) through an "analytical structure for mapping and understanding the composition of many fields of inquiry" (p. 228). As one important example, Deming & Swaffield (2011) point to the diagrammatic expression by Krauss (1983) as a way of "explaining the relationship between binary terms of opposition" (p. 228), that existed between landscape, architecture, and art. In doing so Krauss's (1983) expanded field framing device, reconfigured interdisciplinary boundaries, connections, and relationships in revealing alternative and enlightening cultural concepts (Deming & Swaffield, 2011, pp. 228-229). Deming & Swaffield (2011) maintain, "the significance of the expanded field is almost purely argumentative or speculative, yet its appeal as an analytic device for a wider range of purposes remains unabated. It is, in itself, a deductive model of possibility" (p. 229).

1.3.5 Case Studies.

In chapter 3, the descriptive, case study methodology, as a "projective design strategy" (Deming & Swaffield, 2011, pp. 205-221) will also comprise a central role in the research design of this investigation. The case study method has increasingly become an important form of research description, and evaluation within landscape architecture, for its distinct ability to pragmatically describe real-world and practice-based phenomena that are central to the applied nature of the discipline (Francis, 1999; Deming & Swaffield, 2011; Swaffield, 2016).

Francis (1999) defines it as "a well-documented and systematic examination of the process, decision making and outcomes of a project that is undertaken for the purpose of informing future practice, policy, theory and/or education" (p. 9). The method will be employed across three separate design projects implemented with professional partner, Kasian Architecture, as part of the Mitacs, Master of Environmental Design program (MEDes), in formulating "generalizable lessons or principles that can advance knowledge" (p. 10), with "an eye towards synthesis and patterns" (p. 10) that multiple case analysis can provide.

Francis (1999) also outlines the historical importance of case studies to the history of landscape architecture "in studies trying to refine or test emerging concepts and ideas" (p. 13), while advancing current normative practices and developing theory "that not only describe but also explain and predict future action" (p. 15). Deming & Swaffield (2011) also argue for case studies as one of the most common research methods within landscape architecture academia that allow for "clearly defined and achievable results" (p. 50). Furthermore, argue Deming & Swaffield (2011), the projective design strategy, in which design research; as the formalization and organization of design "operations", "interpretations" and "reflections" (pp. 209-220) into systematized analysis, is an ideal territory in which to engage the method of case study in landscape architecture, where the "investigations enhance our understanding of the relationships between the world as it is and the possibility of what it might become" (p. 209). The research methodology design is illustrated in figure 2.

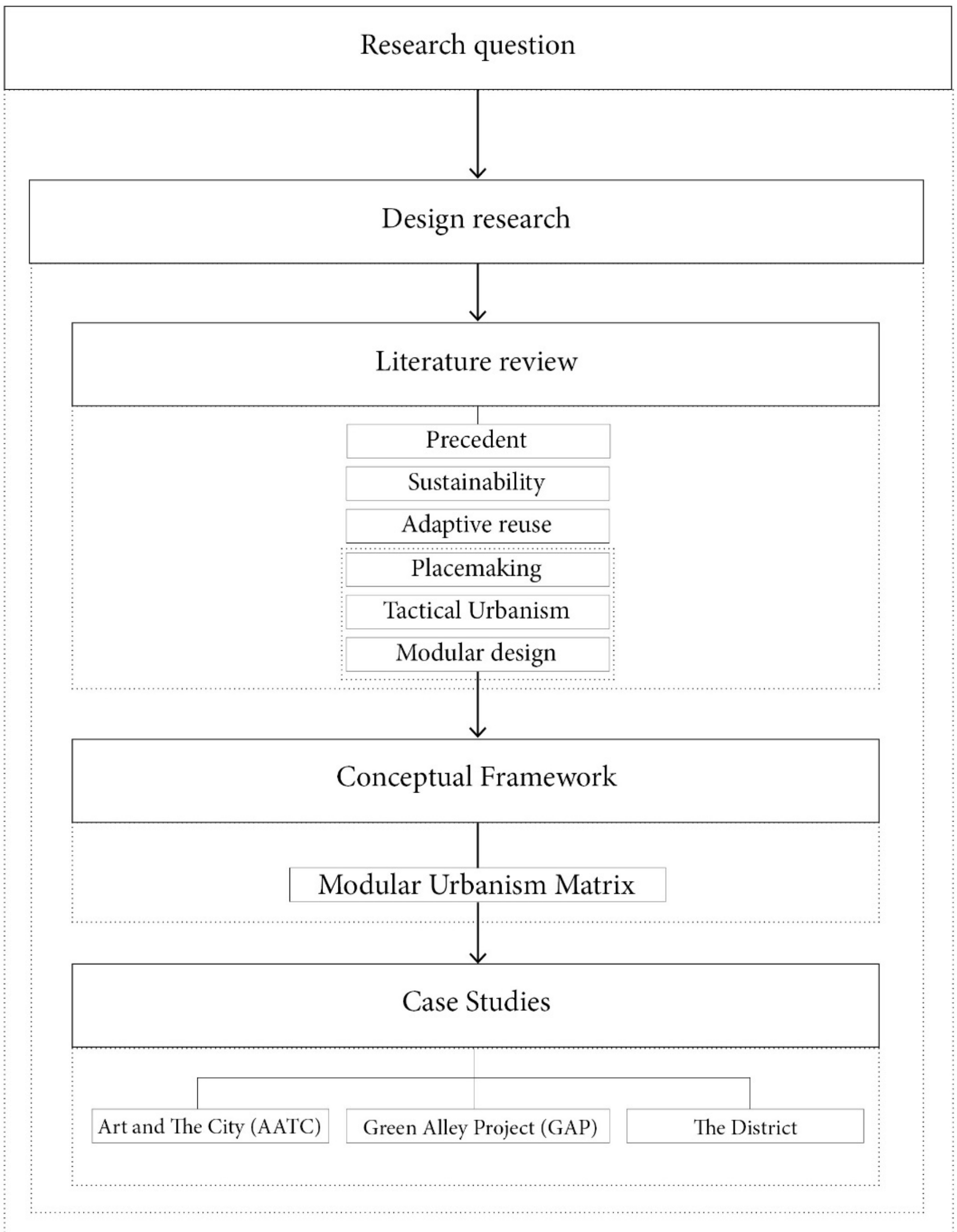


Figure 2. Research Methodology Design Diagram.

CHAPTER 2

REVIEW OF THE COMPONENTS OF MODULAR URBANISM

2.1 Review Introduction.

This literature review examines and connects the central themes, principles, and concepts of the research question. It consists of six component areas of relevance to the understanding of Modular Urbanism and its potential applications, examined further in the case studies chapter of this investigation. This review is not considered a complete or exhaustive set of definitions, but a precise and distinct grouping of specific conceptual characteristics that contribute to a foundational structure of how a Modular Urbanism process may be formulated.

The chapter begins with the historical precedent of the Crystal Palace which I argue as a speculative example of early Modular Urbanism where a landscape design perspective facilitated the capacity to combine modularity with multi-scalar design methods in generating sustainable building processes, resulting in an integrative and progressive project that remains influential to the present day (Bird, 1976, p. ix; McKean, 1994, p. 4).

The remaining concepts of the review are ordered according to scale, from the broadest scope to the increasingly detailed, beginning with sustainability and connecting through, adaptive reuse, placemaking, tactical urbanism, and finally, modular design. Each review is as specific as possible in addressing aspects that will contribute to a structural understanding of modular urbanism and its applications examined in the design case studies. The aim is to emphasize concise, and detailed definitions, under the disciplinary context of landscape architecture, in demonstrating their interconnectivity and creating an expanded conceptual field in which to produce novel forms of urbanism.

This understanding will then form the basis for the conceptual framework, as a way to visualize the relationships between the component concepts, bringing them into conversation with each other. The framework aims to demonstrate their contingency in developing Modular Urbanism as a dynamic design process capable of producing sustainable landscape architecture.

2.2 Historical Precedent.

2.2.1 Modular Design in the Historical Development of Landscape Architecture.

Modular design, construction, and manufacturing have become essential processes in the production of both technological products and elements in the built environment (Baldwin & Clark, 2014; Bernstein et al., 2011; Bertram, et al., 2019; Russell, 2012; Smith, 2010). From prefabricated homes and buildings to automobiles and personal computers, modular design has become crucial in driving technological innovation by revolutionizing both consumer choice and economic efficiency through processes like mass customization; where individual choice meets mass production (Baldwin, 2014; Kamrani & Sahiek 2002; Kieran & Timberlake 2003; Russell 2012; Smith 2010).

Within architecture, modular design has an extensive and acknowledged history of both theory and practice, stretching back almost a hundred years (Smith, 2010). Yet, modularity has a much less developed, or recognized relationship with the field of landscape architecture, even though it may afford specific benefits to the practice. It is therefore important to acknowledge and examine the rich, and under-appreciated history that landscape architecture has with modular design and construction, going back to the mid-nineteenth century. In developing a summary analysis of Joseph Paxton's Crystal Palace of 1851, the historical precedent will be outlined as an antecedent example of the application of Modular Urbanism, developed through a landscape perspective that combines both strategic and tactical design methods, in the execution of a modular system.

2.2.2 Joseph Paxton: Landscape Designer and Modular Design Innovator.

Sir Joseph Paxton (1803-1865), considered by many, "the greatest gardener of his century" (Chadwick, 1961, p. 269) gained notoriety designing and managing the Duke of Devonshire's opulent Chatsworth estate, where between 1830 and 1851, he would build more than twenty glass structures, honing his building technique, culminating in the construction of the Crystal Palace for the Great Exhibition of 1851 in London, England (Chadwick, 1961). Between 1821 and 1865, Paxton would be responsible for the design, planning, and construction of over 35 projects that included gardens, parks, cemeteries, and other suburban schemes (Chadwick, 1961, p. 260) as well as numerous horticultural awards and distinctions, most notably his flowering of the Victoria Regia Lily, and the cultivation of the now ubiquitous Cavendish banana (*Musa acuminate*) (Chadwick, 1961, p. 23).

As the quintessential nineteenth-century, proto-landscape architect, while in his day, professionally titled "Garden architect and landscape gardener" (Chadwick, 1961, p. 47), Paxton stands prominently in the lineage of the great English garden designers. Beginning with Lancelot Capability Brown, and ending with Paxton himself, who would influence Fredrick Law Olmsted's New York Central Park with his 1843 Birkenhead Park, in Liverpool (Chadwick, 1961, pp. 39-44; McKean, 1994, p. 14). Paxton characterized what would later be identified as the practice of landscape architecture through his multidisciplinary approach, as both a technical and artistic innovator in horticulture, landscape design, infrastructure, and planning (Chadwick, 1961, p. 72). He combined a Victorian “sure eye for procedure” through “observation, analysis, and experiment” (Chadwick, 1961, p. 72) with a progressive understanding of the interconnectivity between natural and synthetic systems. The Victoria Regia lily that he cultivated to such great success would inspire the two-way, spanning structural rib design, becoming the basis for the Crystal Palace modular system (McKean, 1994, p. 13; p. 20).

More specifically, the Crystal Place also presented modularity in two important ways. First, strategically, as a technological concept representing Victorian innovation and the ingenuity of the British Empire, and second, as an innovative building tactic in generating rapidly deployable, temporary, public event architecture.

2.2.3 Crystal Palace as Strategic Placemaking.

Above all, and by royal decree, the Crystal Palace was built as a strategic emblem, in what today, we might call national branding (Bird, 1976, pp. 1-28). It was the quintessential example of prosperity created by the industrial revolution, manifest through British Empire. As Bird (1976) writes, “Victorian progress was a god, and it was time for the god to be enshrined, at least temporarily, in a suitable temple” (p. 3). In Bird’s (1976) analysis, the Palace’s strategic display of technical prowess, projected to the world, through sheer scale and ostentation, the highest achievements of the day in science and culture (p. 1-13).

Beyond its physical structure, The Crystal Palace was also ground-breaking in its concept. It was one of the first and most prominent historical examples of a large scale, strategically planned, temporary, public event program, that collectively imagined and attempted to reflect a local, and national identity, through the development of the public realm (Bird, 1976; De Haan, 2017; McKean, 1994). It was an antecedent example of placemaking on a grand scale. And although it was headed by Prince Albert’s royal commission, it received no public or government funds and was financially supported by “chasing donations and having fundraising events” (De Hann, 2017, 1:15). This was accomplished through a series of committees, executives, and societies, whose membership consisted of the era’s fledgling middle class of engineers, financiers, and administrators. (Bird, 1976, p. 4-10; Chadwick, 1961; McKean, 1994, p. 4-5). The exhibition also capitalized on local and surrounding industrial expertise with the participation of various sectors; including the railroad, glass and iron industries, in design and construction of the cultural project, that brought the world to London, and the public to the Palace (Bird, 1976; Chadwick, 1961; De Haan, 2017). A total of 6,039,195 people attended the exhibition over its 141 viewing days, from May 2nd – October 11th, 1851, that included 13,937 exhibitors (Bird, 1976, p. 111). This, when the entire population of England was just under eight million people (Anderson, 1988, p. 21). At any one time, the building itself could accommodate over a hundred thousand people, averaging over forty thousand visits a day; made possible by affordable admission through a “differential pricing policy” (Bird, 1976, p. 112). This allowed for a wide cross-section of socio-economic classes to attend the exhibition, as Bird (1976) writes, where even in Victorian England with its “tradition of seeing the working class as the lower order” (p.114), the aristocracy rubbed shoulders with the laboring commoners in an orderly and maintained mutual respect “quietly enjoying the rare treat” (p. 114), that was the splendor of the Crystal Palace, where “duke and dustman could meet on equal terms” (p. 114). Another interesting and often ignored aspect of public realm development that was far ahead of its time, and as Brid (1976) writes, a “triumph of nature over frugality” in acknowledging our shared humanity, was the inclusion of three “refreshment rooms” (p. 70) that were provided on the ground floor. These precursory public washrooms would predate the London initialed public service by thirty years, when "city engineer, Sir William Haywood, came to the relief of the embattled citizens" (p. 70).

2.2.4 Crystal Palace as Tactical Intervention.

The Crystal Palace is understood as the world's first industrial modular construction (Bird, 1976, p. 43). It was regarded as a Victorian Era engineering marvel for its innovative use of materials and an exceptional example of still unsurpassed modular construction technique and ingenuity (Chadwick, 1961; Eekhout, 1990; McKean, 1994).

The 92,000 m^2 glass structure which was an assembly of repeated units, prefabricated in a factory then assembled on-site, represented its process as much as its form, "made manifest as a system – including conception, fabrication, shipment, assembly, dismantling, and reuse" (McKean, 1994, p. 21). It was sustainable before its time and precursor to the modern curtain wall (Petroski, 1992, pp. 151-153). The small dimension, high run, standardized modules (iron rods and glass panes) that came together to form such an impressively large and stable structure, exemplified the independence of, and interdependence to, an overall interconnected framework (McKean, 1994). It helped produce a paradigm shift in architecture "that beauty may be as simple as the functional means of production." (Smith, 2010, p. 8).

The entire structure was a kit-of-parts derived from a small number of simple framing, and strut component assemblies that included, sash bars, cast-iron columns, and ridge and farrow glazing (McKean, 1994, pp. 14-15). The modular system also included the patented Paxton Gutter, which allowed for proper rainwater and condensation drainage; an important design consideration when building an arboretum at the scale of the Palace (McKean, 1994, pp. 14-15).

The entire structure could be assembled relatively easily, and most importantly, was designed with the capability to be disassembled and reassembled again, in a different location, where in fact, the Crystal Palace was moved and reassembled in Sydenham in 1852 (Bird, 1976, pp. 119-133). The modular system also insured very little material waste throughout the manufacturing, construction, and assembly/disassembly process. The underlying modular unit was based on a foundational dimension of 8 ft., which was derived from the maximum length that plate glass could be produced and maintain its structural integrity (Bird, 1976 pp. 41-42). There were 3,300 supporting columns, 2,224 principle girders, and 18,000 panes of glass, all erected by teams of workers and horses (Bird, 1976, pp. 41-42).

2.2.5 The Crystal Palace as Modular Urbanism.

Although the Crystal Palace predates the invention of the terms placemaking and tactical urbanism, the preceding review aimed to illustrate the project as a historical precedent in grounding the concept of Modular Urbanism in actual, innovative, and influential building practices that were developed from a landscape perspective and accomplished with interdisciplinary vigor. It also demonstrates how modular design can contribute to compelling, site-specific built environments, that cultivate sense of place, through sustainable building practices, like design for disassembly.

The modular building method developed and refined by Paxton was perfectly suited to accommodate the structural needs of the massive 1851 exhibition. Through its sophisticated simplicity, its seemingly inexhaustible repetition, yet articulate variation, the Crystal Palace demonstrated how modular design could provide social, economic, and aesthetic value. It became admired for the unique environment it created for all who visited, as if the barrier between interior and exterior space had been dissolved (McKean, 1994, p. 32). Through its configurations of iron and glass, the application of modular design techniques created "that extreme rarity, a genuinely new perceptual experience" (Richard Lucae quoted in, McKean, 1994, p. 32), where "the effect of the interior of the building resembles that of open air…in which *atmosphere* is perceptible" (Mrs. Merrifield, Art Journal Catalogue quoted in, McKean, 1994, p. 32). And, all of it produced without the advantages of modern technology.

2.3 Sustainability.

2.3.1 Narrowing the Focus.

Sustainability has become a globally ubiquitous term with a multitude of meanings and definitions, transcending its environmental origins to penetrate the very social and cultural fabric of our daily lives (Caradona, 2014; Caradona, 2017; Kidd, 1992). And although still a fledgling global market in terms of total value, by some estimates, it will be worth over $12 Trillion annually, by the year 2030 (Elkington, 2018). It's everywhere we turn, and more often than not, it exists solely as overexposed marketing devise, pushed on an increasingly pessimistic consumer public, who surrender their hard-earned money for the veneer of living green (Kumara et al., 2012). From emissions cheating Volkswagons to uncompostable coffee pods, the examples are almost endless (Booker, 2020).

From the wide-ranging definitions that have developed from the Brundtland Report (Borowy, 2017; United Nations, 1987) which helped define and popularize the term, it has evolved to accommodate both ideological and political agendas, in which its inclusionary breadth is seen by its supporters as consensus building and by its detractors, as an over-wrought, clichéd term that could be applied to anything that needs green-washing (Benson & Roe, 2007; Johnston et al., 2006; Johnston, et al., 2007; Kidd, 1992). Nevertheless, when understood through the fundamental transformations of global climate change, sustainability is arguably the most significant and influential concept to have emerged over the past quarter-century in representing our collective concern for not only “the continued development and progress of the planet” (Kidd, 1992, pg. 3) but also, for the long term survival of our species. (Kidd, 1992, pp. 22-23). Maybe more importantly, as Thayer (1994) points out, the term’s recent emergence and popularization, beyond its status as “buzzword” (p. 232), “is as an inevitable response to the dynamic and increasingly dissonant tension between nature and technology in contemporary society” (p. 232).

From this perspective, Thayer (1994) defines a sustainable landscape as “a place where human communities, resources, and the carrying capacities of surrounding ecosystems can all be perpetually maintained” (p. 100). Yet, the goal of this examination of sustainability is not to find a single, all-encompassing definition, but rather, as Kidd (1992) suggests, to define the term through precision and context (p.3). The following analysis of the term will develop a frame of reference for sustainability related to the concept of Modular Urbanism and this investigation. It will focus on three central areas; concerns for future generations, the importance of social sustainability, and material efficiency.

2.3.2 Concern for Future Generations.

At it’s most basic, sustainability is “the ability to persist” or “the capacity to continue” (Melby & Cathcart, 2002, p. 9). Ecologically, sustainability was understood as carrying capacity, where access to resources in an environment would allow a specific population size to exist indefinitely (Brandt et al., 2013, p. 1127). If resources where mismanaged, or exploited beyond their capacity or “precise threshold” (Brandt et al., 2013, p. 1127) to regenerate, population size would be affected. More precisely, sustainability refers to our ability to persist, through the relationship and management of our environment, where the human consumption of resources is directly connected to future survival (Benson & Roe, 2007; Caradona, 2014; Caradona, 2017; Kidd, 1992, Thayer, 1994). As the influential Brundtland Report (United Nations, 1987) states, "Humanity has the ability to make development sustainable to ensure that it meets the needs of the present without compromising the ability of future generations to meet their own needs" (section 3, part 27). It goes on to emphasize:

> sustainable development is not a fixed state of harmony, but rather a process of change in which the exploitation of resources, the direction of investments, the orientation of technological development, and institutional change are made consistent with future as well as present needs. (section 3, part 30)

Sustainability involves a concern for the ability of future generations to survive and prosper through the awareness that the "interactions of population growth, resource use, and environmental degradation" (Kidd, 1987, p. 4) have created challenges that will need to be faced on a global scale. Simply put, in the era of climate change, sustainability is about taking responsibility for the future, by appropriate action in the present.

2.3.3 The Importance of Social Sustainability.

Although sustainability is popularly recognized as primarily an environmental issue related to climate change, its adoption within the field of economics through concepts like the triple bottom line (Elkington, 1998), where environmental, economic and social concerns are evenly weighted, have helped the idea of social sustainability gain prominence (Elkington, 1998; Spreckley, 1987). This was an expansion to include cultural, social, and even ethical issues with economic concerns, which Elkington (1998) emphasized as an equal and "critically important" (p. 84) component of any successful implementation of a truly sustainable capitalist economic program (pp. 69-99). Elkington underscored the interconnected nature of its social, environmental, and economic components as dynamic forces that require constant calibration under their respective "pressures, cycles and conflicts" (p. 73).

These tensions, which are often social and political in nature, must be addressed through an overall awareness of wider social issues and concerns, in developing social cohesion and trust between public, corporate and institutional/governmental sectors, or as Elkington (1988) states to "embrace wider measures of a society's health and wealth-creation potential" (p 85). It means understanding social sustainability indicators, and investment in human and social capital, where quality of life is differentiated from standard of living. This, Elkington (1989) points out, is the needed change in perspective from the mid-century "paradigm based on quantity objectives to a 21st-century paradigm based on perceived quality of life" (p. 93). Henn & Hoffman (2013) reinforce this perspective by emphasizing the need to "examine the deep connection between society and its built environment" (p. 10) by asking important questions concerning the alignment of social structures with both accelerating technological advances and erratic economic fluctuations.

Social sustainability is about creating built environments that support not only a high quality of life but also foster a sense of community through cultivating human relationship. But a distinction must be made between quality of life and access to cheap consumer goods. North American cities are filled to the suburbs with brand name, big box, strip malls, yet, continued patterns of much of our urban development in contributing to large scale physical and mental health problems is well documented (Beatley & Manning, 1997, pp. 30-33; Dunham-Jones & Williamson, 2011, p. 94; Frumkin et al., 2004; Lopez, 2011). Our reliance on the automobile, and its influence on the design and planning of our communities, and, as Thayer (1994) points out, on our landscapes in general where "a formulaic approach based on technical specifications and performance standards" (p.34) has confined much of our built environment, negating "aesthetically expressive, socially reflective, or ecologically appropriate variation" (p. 34).

The difficulty in understanding social sustainability, as Beatley & Manning (1997) describe, lies in the fact that terms like quality of life, and community are much more subjective than environmental and economic bottom line concerns, with strict capacities and hard numbers. (pp. 30-31). Understandably it is where human scale needs to be considered. Where specific components of social sustainability need to be defined and applied by communities themselves (Beatley & Manning, 1997, pp. 27-31), and where those same components "preserve and serve local communities rather than change or destroy them" (Thayer, 1994, p. 243). This equates to communities that not only have access to basic human needs and services, where necessities like housing, food, and healthcare are provided but supplemental access to stimulating experiences, whether in private work or public realm environments (Beatley & Manning, 1997; Hiss, 1990; Thayer, 1994).

Besides the application of fundamental urban design concepts like increased density, mixed-use zoning, and walkability, the development of sense of place (Carmona et al., 2003, pp. 96-107) is also important to socially sustainable communities. Sense of place is more than simply providing generic consumer amenities, as so many contemporary real estate developments now promise. As Beatley & Manning (1997) write, it involves cultivating a shared sense of belonging through the appreciation and promotion of local context and quality, whether historical or ecological (p. 32). Furthermore, they suggest the importance of "community landmarks" (p. 32), as "existing features that nurture a sense of attachment to, and familiarity with, place" (p. 32), where "special effort is made to create and preserve places, rituals, and events that foster greater attachment to the social fabric of the community" (p. 32). These feature locations may exist outside of the consumer marketplace, where economic exchange is necessarily the priority. They could be considered public gathering spaces, like town squares or plazas. Or, as Ray Olderburg's (1999) concept of The Third Place, as the inclusive hangout location, after home and work where "conversation is the main activity" (p. 26). These third place locations are where social bonds are strengthened and community connections created (Beatley & Manning, 1997; Dunham-Jones & Williamson, 2011; Hiss, 1990; Oldenburg, 1999).

2.3.4 Material Efficiency.

The ability to use construction resources and materials efficiently, in reducing or eliminating waste while allowing for multiple reuses, and extending material life cycles is one of the most important strategies in developing any sustainable building practice (Birkland, 2002; Calkins, 2009; Calkins, 2012; Crawford, 2011; Stitt, 1999). The recent popularity and application of concepts such as closed-loop systems and circular economy have helped shift building, construction, and materials manufacturing towards more sustainable practices (Culkins, 2009; Calkins, 2012). Closed-loop systems, Calkins (2009) points out, based on models of natural ecosystem processes, look to cycle waste, towards other parts of the system, where "every ingredient is safe and beneficial" (p. 47), in "turning outputs from every resource use into the input for another use" (P. 47).

This concept also recognizes the importance of addressing waste at the beginning of the design and building process, rather than at the end, where "products are designed for perpetual reuse or to be disassembled and component parts reused" (Calkins, 2009, p. 47). More specifically, the concepts of Design for Disassembly (DfD) is recognized as an important component to sustainable resource efficiency and reuse (Calkins, 2009; Calkins, 2012; Crawford, 2011; Knaack et al., 2012; Smith, 2010). DfD allows for build form to be deconstructed and reused at a future time and location, in part or in whole, where the operations of assembly and disassembly are designed into the process from the beginning. (Calkins, 2012, pp. 373-378; Crawford, 2011, p. 28). More specifically, Calkins (2012) outlines several important DfD principles in developing its beneficial effects, that also align with modular design thinking that includes designing with flexibility and adaptation in mind (p. 374). Calkins (2012) points out that resue is more effective if the design of a component or environment is flexible and adaptable in its function and program (p. 374). Calkins (2012) also emphasizes the importance of material choice where durability is paramount if multiple reuses are to be withstood (p. 374). Calkins (2012) maintains integration of standardization, and modularity are also important aspects if DfD is to be an effective building strategy, where component interfaces, sizes, and structures are to be easily modified, dismantled, and reassembled (pp. 374-375). Further, in this regard, Crawford (2011) highlights the importance of designing lightweight component assemblies (smaller groups of parts that fit together), to support DfD process efficiencies (p. 28) Calkins (2012) suggests serious thought should also be given to the design of detail scale elements and material finishes so that connections and contacts are easily accessible, ergonomic and durable (p. 375). Material specifications should also be considered, Calkins (2012) writes, for both their compatibility within the DfD process, and for their end of life, recycling potential (p. 374).

2.4 Adaptive Reuse.

2.4.1 A Landscape Perspective.

An argument could be made that landscape architecture is inherently a practice of adaptive reuse; where its spatial, and temporal, multi-scalar parameters are delineated by the influence of, and engagement with, natural ecological systems, and living materials, in which design concerns prioritize the unfolding of process over static, permanent states of form (Berrizbeitia, 2009; Brenwell, 2019; James Corner Field Operations & Diller Scofidio & Renfro, 2015; Latz, 2017; Saunders, 1998). Philosophically and operationally, there is no tabula rasa in landscape architecture, because there is always landscape in contestant transformation (Corner, 1999; Corner & Hirsch, 2014; Reed & Lister, 2014). The existence of the relationship between culture and nature predicates that the design of landscape itself is a human adaptation and that the forms in which those processes manifest are foundational to the intention of the practice (Conan, 2000; Stilgoe, 2015). The history of landscape architecture is the production and manufacture of landscapes, in simulating and synthesizing nature, from our simplest gardens to our most complex ecological reconstructions (Rogers, 2001; Swaffield, 2002). From this perspective, adaptation begins as soon as humans set foot on a landscape, whether today or thousands of years ago (Ellis, 2014; Farina, 2009, pp. 149-150). The progress of human civilization is the mastery of landscape adaptation and reuse (Kluiving et al., 2019). But as we know, it has come at a cost. We are now well aware that human habitation patterns and the dizzying speed of urbanization have had a profound effect on the ability of landscapes to sustain human needs (World Meteorological Association, 2020). This has helped advance the practice of landscape architecture in contributing to the healthy regeneration of landscapes, through the application of environmentally responsible and sustainable design and construction practices (Corner, 2014; Kennen & Kirkwood, 2015; Kirkwood, 2001). Often called retrofitting, adaptive reuse can be generally understood as "modifying previously built works in ways that improve their effectiveness and/or increase their functionality" (Fox, 2015 p. 9). Kirkwood (2001) describes it as the "productive use of exhausted and currently undervalued plots of ground" (p. 8). Within the discipline, this has taken the form of brownfield and post-industrial redevelopment and reclamation, and, ecological restoration and remediation. It involves, as Kirkwood (2001) continues, "the application of a wide range of site engineering and environmental technologies" (p. 8) which include, "landfill capping, onsite techniques of soil and groundwater clean-up, bioengineering" (p. 8) and the "alliance of biological and engineered systems" (p. 8).

2.4.2 Adaptive Reuse at the Building Scale.

Maneuvering through the "now popular art forms" of the "subtraction economy" (Easterling, 2014, p. 2), and towards more sustainable building practices, the concept of adaptive reuse has increasingly been used as an efficient, and cost-effective urban development alternative, in cities across the world (Douglas, 2006; Dunham-Jones & Willimason, 2011; Wilkinson et al., 2014; Wilkinson & Remoy, 2018; Young, 2012). Comprehensively, adaptive reuse can be understood as a management strategy in dealing with the interconnected effects of social, economic, and environmental reorganization generated by climate change, where flexibility, adaptability become key factors in the design, planning, and construction of the built environment (Douglas, 2006; Dunham-Jones & Willimason, 2011; Tam & Hoe, 2019; Wilkinson et al., 2014; Wilkonson & Remoy, 2018; Young, 2012). It is based on the premise, as Douglas (2018) writes, that buildings naturally change over time, both physically and functionally, whether their original purpose is preserved or changed, allowing for the "beneficial use of the property over the long term" (p. 7). Wilkinson & Remoy (2018) highlight the idea that "the original land use of the building is no longer economically or socially viable or desirable" (p. 7), where change can include "the capacity function, or performance, or, any intervention to adjust, reuse, or upgrade a building to suit new conditions or requirements" (p. 7). At its core, it is about saving existing building stock by making explicit adjustments to its physical structure, function, and purpose, so that value can be maximized. Douglas (2006) outlines several specific examples from "code “compliance, environmental enhancement” (pp. 7-9), and “spatial modifications” (pp. 7-9) to “reconfiguration of internal planning” (pp. 7-9), and “structure and fabric upgrading” (pp.7-9).

These changes have been generated by several influences, such as technological factors, in the development and advancement of building techniques and processes that include the “use of synthetic and composite materials” (Douglas, 2006, p.9). Additionally, key changes in urbanization, through both economic growth or disruption can alter financial investment patterns and “trigger the need for urban renewal programmes” (Douglas, 2006, p. 9), or other economic schemes that limit spending by replacing new construction with adaptive reuse as “a stop-gap measure to keep spaces leased” (Dunham-Jones & Willimason, 2011, p. vix). This includes, Douglas (2016) writes, a fall in demand for new building stock in cities that are experiencing economic difficulty, causing “an oversupply of offices” (p. 23), leading to “high levels of underutilization” (p. 23). This has led to commercial vacancy rates have been on the increase since the global financial crises of 2008 (Wilkinson et al., 2014).

As a prime example, the city of Calgary’s current downtown office vacancy rate of 27% (241 acres) is expected to rise to 29% by the end of the year, 2020. (Conolly, 2020). This has led some financial real estate investors to diversify their assets and focus on specialized core markets, where “creative leasing efforts, physical improvements, entitlement changes or realization of adaptive re-use strategies” (Speer Street Captial, 2020, para. 1.), focus their value. Expanding from the purely financial and economic causes, Douglas (2006), also points to adaptive reuse as an efficient way of dealing with aging building stock accumulated in many large cities and urban centers (p. 23) Douglas (2006) emphasizes, building adaptation is “essentially about responding to changes in demand for property” (p. 9).

Adaptive reuse is also widely recognized as an important component in the transition towards more sustainable building practices. (Bullen, 2007; Crawford, 2011; Douglas, 2006; Dunham-Jones & Willimason, 2011; Tam & Hoe, 2019; Wilkinson et al., 2014; Wilkonson & Remoy, 2018; Young, 2012). Bullen (2007) contends that adaptive reuse is a "superior alternative" (p. 22) to new construction, in its conservation of materials and energy. When considered against the waste streams produced from building construction and demolition (C&D) materials, at a combined 375 million tons, 90% (353 million tons) of which is produced from demolition alone, the environmental impacts of adaptive reuse becomes clear (EPA, 2020; LeBlanc, 2017). As C&D waste make up a quarter of the total solid waste produced annually in the US, (LeBlanc, 2017), adapting the build environment's design and construction practices, becomes paramount in mitigating the effects of climate change (Wilkinson & Remoy, 2018). Adaptive reuse, Crawford (2011) argues, then becomes a means of direct action in which multiple stakeholders at different stages of development, from "design and construction to operation and management" (p. 23) contribute to the expansion of a more sustainable built environment. Adaptive reuse retains the embodied energy within a building, and in most cases, is more cost-effective than new construction, through a massive reduction in material demand, manufacturing, transport, and use (Bullen, 2007, pp. 28-29; Crawford, 2011, p. 31).

Maintaining existing buildings also promotes "urban intensification" (Wilkinson et al., 2014, p. 95) or, density, through a more compact urban footprint, that reduces urban sprawl and decreases the need for greenfield development (Crawford, 2011, p. 28-29). Dense, urban, work and live environments also promote higher levels of physical activity and healthier lifestyles, where walking becomes the primary form of transportation, replacing the automobile (Crawford, 2011, pp. 28-29; Lopez, 2011). Crawford (2011) suggests adaptive reuse also holds many socially sustainable benefits, in building community and developing sense of place, by "revitalizing existing neighborhoods" (pp. 28-29), in "retaining streetscapes" (pp. 28-29), and "enhancing the aesthetic appeal" (pp. 28-29), of the build environments, in preserving heritage and cultivating local history and culture.

Like any other building practice that involves sizable financial investment and extensive deployment of resources, there is skepticism to be found regarding adaptive reuse, invariably economic in nature (Bullen, 2007; Douglas, 2006). But, Bullen (2007) also argues that hesitation or concern with implementing adaptive reuse on economic grounds has more to do with the "smokescreen" (p. 29), of masking current development side processes that are based on the desire for new buildings. The cache and glamour of building flashy, cutting edge architecture remain a major influence on the form in which our built environment takes (Koolhaus, 2014), where "adaptation of existing buildings is frequently considered to be less creative than producing a new building and therefore attracts less kudos." (Bullen, 2007, p. 29). As Brand (1995) points out, the profession of architecture is still dealing with the struggle between form and function (pp. 107-109). Particularly, he argues, the problem of architecture as art, where, beginning in the 1850s, the two became "clumped together" (p. 108), when, they are in fact, in deep conflict, in which functionality continues to lose to fashion and style (pp. 107-109). The newest and latest is much sexier, than the aging and deteriorating, whether unsustainable or not. But constraints also spur creativity and innovation (Acar et al., 2019). In understanding conceptually "that preservation is a progressive art form, an intellectual and design challenge of the very highest level" (Wigley, 2014 para. 3), the idea of adaptive reuse can be recognized outside strictly economic terms and be acknowledged for its potential as a socially connective, creative building strategy.

The uptake in this architectural building practice can be instructive to the discipline of landscape architecture in developing similar practices. As inherently sustainable, adaptive reuse building practices can have positive interdisciplinary repercussions. Innovative landscape building processes that are flexible, adaptive, and integrative, like Modular Urbanism (as will be detailed in chapter 3 design case study: The District), could improve overall project efficiencies, and contribute to the expansion of normative sustainable building practices that span across disciplines.

2.5 Placemaking.

2.5.1 Placemaking in Contemporary Urbanism.

As the disciplines of environmental design and its related fields have recognized, the city, as a pattern of human settlement, is far more than a convenient arrangement of landscape, infrastructure, and architecture, proximately positioned within a spatial boundary, as a singularly "functional assembly of interchangeable parts" (Friedman, 2010, p. 162). Rather, they have come to recognize the urban condition as an agglomeration of "organized complexity" (Jacobs, 1962, p. 433) composed of intricate networks of interrelated flows, connections, and relationships, intertwining to create a rhizome of history, memory, and meaning (Bacon, 1974; Gehl, 2011; Halprin, 1970; Koolhaas & Mau, 1997; Lynch, 1965; Rossi, 1984). But bromides and metaphors remain fleeting in describing the city, as Van Eyck (1962) succinctly expresses:

> A city, however, is a very complex artefact [sic] and, like all artefacts, fits no pseudo-biological analogy. It is a man-made aggregate subject to continual metamorphosis to which it either manages or fails to respond. Accordingly, it is either transfigured or disfigured. Our experience is founded on the latter, our hopes on the former – that is the

> plight we are in now. But we know this much, that transfigurative potential implies enduring and dynamic identity; lack of it: disfigurement, loss of identity and paralysis. (pp. 334-335)

The city is an urban ecosystem (Spencer, 2014) where the unrelenting process of urbanization has produced environments that have now supplied the majority of the global population with a shared, though diverse, human experience of the urban condition (Haas & Olsson, 2014; United Nations, 2018).

2.5.2 The Importance of Place.

In analyzing this complexity of the city, the importance of place becomes apparent in the formation of those human experiences and more specifically, to how meaning is derived from existing in a particular location, as both a physical connection to a coordinate on the surface of the earth, and as a conceptual model of identity, with the emotional and psychological connections that create the "layering of histories which sediment in place and become the bedrock for future actions" (Cresswell, 2004, p. 40).

Cities are about the making and remaking of social connections in the places we live. In this way, the concept of Placemaking becomes a central focus of *how* we live in cities (Project for Public Spaces, 2018). Placemaking is about understanding the specific qualities, conditions, and characteristics that produce affiliation, affection, and attachment to place. (Beske & Dixon, 2018; Project for Public Spaces, 2018; Thomas, 2016; Welch, 2017; Wyckoff, 2015). Pierce et al., (2011) express it as "the set of social, political, and material processes by which people iteratively create and recreate the experienced geographies in which they live" (p. 54). It applies to technologically advanced global megacities and informal settlements of the developing world alike (Kellet, 2003). Challenging our assumptions about poverty and human dignity, Kellett

(2003) argues that “the ingenuity and creativity refined against limited resource constraints.” (p. 87) in informal building practices, provides “great depth of meaning” (p. 89) and a “sense of purpose” (p. 89). This, in contrast, Kellet (2003) emphasizes, to the “hopelessness” (p. 89) experienced by many “groups in more affluent parts of the world” (p. 89). What Kellet (2003) and others (Adhya 2012; Palermo & Ponzini 2014; Thomson 2003) argue is the absolute importance of social and emotional connections that humans formulate in the process of placemaking, and that local contextual relationships and experiences of place need to influence the design and construction of the physical built environment. As a comprehensive, yet concise definition, Tullis (2017) contends “placemaking is the creation of a legible space within the city fabric with a distinct identity, one that has the power through its form and use, to transform into a memorable entity that’s attractive to people” (4:29).

2.5.3 Contemporary Applications.

The term placemaking has recently become popular through its use as a method of economic development (Welch, 2017; Wu, 2000; Wyckoff, 2017), and community revitalization (Markusen & Gadwa, 2010; Project for Public Spaces, 2018). It specifically gained popularity in describing an emphasis and re-examination of the importance of social interactions and relationships that contribute to the function of the built environment, which came in reaction to the political and economic shifts that were taking place around the turn of the millennium (Beske, 2018, p. 267). It was a re-focusing on analysis and interpretation of high-quality places, and in recognizing the creative potential that people have in formulating and manifesting those places (Beske, 2018, p. 267). To begin with, several common principles are often highlighted as central to what make successful places that include; walkability, connectivity, vibrant public realm, mixed uses, and unique character, or authenticity (Bain et al., 2012; Beske, 2018; Bohl, 2002; Thomson, 2003; Walljasper, 2007). This is also tempered with the need to reform zoning and land use laws, to allow for greater flexibility in revitalizing urban places (Bain et al., 2012; Besk, 2018; Bohl, 2003; Thomson, 2003; Walljasper, 2007; Welch, 2017; Wyckoff, 2015). The importance of pedestrian-focused, public realm space, as exemplified by the great medieval European squares and streets, as Bain (2012) writes, provides abundant historical examples of how placemaking strategies could adapt and transform currently underutilized right of way territory into activated, social places (p. 7-14).

2.5.4 Placemaking as Process.

Placemaking is as much a process as it is an application, that typically functions at multiple scales, but emphasizes the objective of long term, strategic change of communities and neighborhoods (Project for Public Spaces, 2018). It often seeks a holistic perspective in understanding the underlying structure of great places where social, functional, connective, and aesthetic attributes are understood as important parts to an interconnected framework of qualities (Project for Public Spaces, 2018). Wyckoff (2015) points out that each individual project and location will demand a specific and unique approach to implementation, but that its application is strongly connected to the planning and engagement process as an important component of any placemaking framework (pp. 36-37). Wyckoff (2015) also delineates four types of Placemaking including, standard, strategic, creative, and tactical (pp. 51-52). Tactical Placemaking is described as a combination of tactical urbanism techniques and lighter, quicker, cheaper (L.Q.C.) operations, which focus on public space activation through low-cost programmatic refreshment as the initial steps of a larger community implemented strategic vision (Wyckoff, 2015, p. 410). It is also through the economic lens that placemaking is commonly described as a strategic process that is accompanied by tools or guides, that can be used in its application, in fostering community improvement (The Project for Public Spaces, 2018; Welch, 2017; Wyckoff, 2015).

2.5.5 Creative Placemaking.

Markusen & Gadwa (2010) argue for creative placemaking as a tool for community revitalization in supporting community arts sectors, through the attraction of the creative class (Florida 2014), in socially anchoring a viable placemaking strategy (p. 3-6). Through an in-depth analysis of creative sector economics and case studies from across the U.S., Markusen & Gadwa (2010) outline creative placemaking as economic incubator and facilitator, whose benefits expand into adjoining economic sectors, through the development of cultural activities, envisioned as a “decentralized portfolio of spaces” (p. 3). In turn, these can act as vehicles for the adaptive reuse of local, built environments (Markusen & Gadwa, 2010, pp. 5-15). Markusen & Gadwa (2010) emphasize the “nurturing of distinctive qualities and resources that already exist in the community” (p. 4) combined with the need for private sector and government policy frameworks as important partnerships that need to be included in any successful creative placemaking strategy (pp. 18-23).

2.5.6 Placemaking Pitfalls: Missing Social Infrastructure.

This multip-scalar approach incorporating local community, business, and governmental level engagement, plays in contrast to a perspective of placemaking as the residual outcome of larger economic spheres of influence, which Wu (2000) argues, currently operates through the process of globalization occurring in China.

As a strictly centralized, top-down and accelerated approach to the implementation of placemaking through larger urban growth strategies of Chinese industrialization, Wu (2000), contends that “growth of inward investment” from a centralized government, “particularly its penetration into real estate development, has exerted direct impacts on the urban structure.” (p. 1359). As Wu (2000) points out, these “inward investments not only provide the capital much needed in the boosting of urban growth but also exerts a perception or ‘mentality’ of how to promote a local economy” (p. 1374), which inadvertently produced, “the severe problem of high vacancy rates” (p. 1375). This often culminated in the now-infamous Ghost Cities of China (Shepard, 2015), where vast urban construction projects on an unimaginable scale, checked off the placemaking boxes, replete with sophisticated public realm urban design, and monumental architectural splendors, existing without a public to appreciate their grandeur (Dunnell, 2020). This, Thomason (2003) argues, is missing the key component of context in attempting to generate the concept of sense of place in the built environment, where perhaps there exists the need for an “aesthetic precautionary principle which weighs against drastic change if the aesthetic consequences of a design intervention are difficult to gauge, but potentially catastrophic” (p. 70).

2.5.7 Sense of Place.

Sense of place (Hu & Chen, 2018) or genius loci (Thomson, 2003) is understood as the unique character of a place, converging the total physical, mental, emotional, and symbolic value that constitutes its meaning. It is, as Thomson (2003) writes, the appreciation of mystery and enchantment of place, beyond the often “instrumental way” (p. 75) in which we perceive the places we encounter. Robinson (2003) expresses similar sentiments in “the notion of center” (p.143), where a site’s physical elements also contain “it’s metaphysical basis where intentions are accumulated and tangibly expressed” (p. 143), in establishing “a phenomenological linkage that experientially combines them into an evolving organic entity” (p. 144). Robinson (2003) continues with an eloquent image “where meaning is given through comprehending our human condition as expressed by the drama of our actions, performed upon the stage of these places” (p. 144).

This metaphysical approach to understanding the essence of place in contributing to placemaking is also articulated strikingly by Cresswell (2004) in the description of the ephemeral nature of the everyday in the melding of perception, experience, and time where:

> Place provides a template for practice, an unstable stage for performance. Thinking of place as performed and practiced can help us think of place in radically open and non-essentialized ways where place is constantly struggled over and reimagined in practical ways. Place is the raw material for the creative production of identity rather than an a priori label of identity. Place provides the conditions of possibility for creative social practice. Place in this sense becomes an event rather than a secure ontological thing rooted in notions of the authentic. Place as an event is marked by openness and change rather than boundedness and permanence. (p. 39)

Friedman (2010) calls this “the re-humanizing effect of place” (p. 152), where place is experienced “from the inside out” (p. 152), and “transformed by those who dwell in the urban” (p. 153).

Pierce et al. (2011) in a slightly more theoretical approach, hold a similar view of the inherent socio-spatial-temporal nature of place and its significance in placemaking (pp. 58-59). In drawing on the writings of Doreen Massey (1944-2016), Pierce at al., (2011) detail her description of place as, “'bundles' of space-time trajectories drawn together by individuals through cognitive and emotional processes” (Massey, 2005, p. 119, as cited in Peirce et al., 2011, p. 58), which Massey names “throwntogetherness” (Massey, 2005, p. 140, as cited in Peirce et al., 2011, p. 58). Similarly, Pierce et al. (2011) refer to David Harvey's (b.1935) description of placemaking as an "iterative, evolutionary process of defining not just boundaries or territories, but the rules and norms against which socio-spatial practices are understood" (Harvey, 1996, p. 241, as cited in Peirce et al., 2011, p. 58).

Within the context of Modular Urbanism, placemaking must be understood as more than the implementation and organization of static, physical objects and spaces, perceived as enduring or permanent, but rather, should include the awareness of indeterminate processes that facilitate spontaneous, cyclical events of the everyday. Placemaking, and the structures, both physical and conceptual, that result from its implementation should encourage the improvisation of the everyday.

2.6 Tactical Urbanism.

2.6.1 Common Components.

Under the guise of "the crises of planetary urbanization" (Harvey, 2015, p. 96), in which humanity is currently faced with possible ecological collapse, regressive political and ideological realignments, and widening social and economic disparity; flexible and adaptive design and construction techniques have become increasingly important processes in the shaping of our postmodern, urban environments (Ellin, 1999; Gadanho, 2014; Webb, 2018). Tactical Urbanism (TU) is one of the techniques that has received both widespread investigation in the design and planning disciplines (Brenner, 2016; Courage, 2013; Gadanho, 2014; Lyndon et al., 2012) and attention from popular culture (Talen, 2015, p. 137) where it has grown into a "buzz phrase that engenders a sense of cool and a creative aesthetic" (Mould, 2014, p. 530). The phrase, tactical urbanism, which is compatible with a long list of other sub-genres and variations (Courage, 2013, p. 88; Talen, 2015, p. 135), and interchangeable with do-it-yourself urbanism (Douglas,

2014) will be adopted as the umbrella term for the grouping of techniques and principles that have become well known in neighborhoods across the world.

More a "general rubric"(Brenner, 2016, p. 130) than a definitive or agreed upon, unified theory, TU describes a common group of principles and techniques used in small scale urban interventions as a way of improving the "livability of our cities" (Lyndon et al., 2012, p. 1), using short term, temporary actions to help develop long term gains (Lyndon et al., 2012). It is most popularly understood as a community building and improvement tool, where citizen-led micro-urban alterations, promptly address local infrastructure deterioration (Lerner, 2014; Lyndon et al., 2012; Marshall et al., 2015; Pfeifer, 2013). It is analyzed through cultural and historical contexts (Courage, 2013; Douglas, 2014; Douglas, 2016; Finn, 2014; Talen, 2015), situated and contrasted against the institutional urban planning system (Mould, 2014; Silva, 2016), and critiqued through a socio-political lens (Brenner, 2016; Groth & Corijn, 2005; Iverson, 2013; Nemeth & Langhorst, 2014; Webb, 2018). Common components of the concept include:

- Small spatial, temporal, and budgetary scales, where interventions are usually immediate, temporary, and phased, and take place on local and "micro-local" (Courage, 2013, p. 89) levels.
- Participatory "from below" (Brenner, 2016, p. 130) citizen-led "informal actors" (Groth & Corijn, 2005, p. 503), community or local organization initiated (Lyndon et al., 2012; Pfeifer, 2013).
- Often includes unsanctioned or untheorized activities that are either against the law or in a legal grey area (Douglas, 2014; Douglas, 2016; Finn, 2014).

- Functional or aesthetic improvement that are often experimental in nature (Douglas, 2014; Lerner, 2014; Lyndon et al., 2012; Pfeifer, 2013, Talen, 2015).
- Experimental, responsive, action, and process-oriented, as opposed to planned and systematized (Lyndon et al., 2012, p. 2; Pfeifer, 2013; Talen, 2015)
- Response to failed, stalled, or inadequate governmental and institutional capacity as part of the "broader governance crises in contemporary cities" (Brenner, 2016, p. 130).

2.6.2 Historical Roots.

The roots of TU and its historical influences can be broken down into three main periods dating back to mid 19th century, recurring during the '60s and '70s and leading to its current resurgence today (Courage, 2013; Finn, 2014; Lyndon et al., 2012; Talen, 2015;). Going back even further, Lyndon et al., (2012) describe a historical precedent from 16th century Paris, with unsanctioned booksellers along the River Seine, called the "Les Bouquinistes" (p. 5) who "hawked the latest bestsellers" (p. 5).

Talen, (2015) outlines the use of TU as an "essential tradition of American urbanism" (p. 138). Dating from the 1850s and the explosive urban growth of an expanding U.S., the use of TU came as a reaction to the chaos and disorder of the city, where progressive, civic-minded groups and societies looked to redress the neglect and disregard of public realm spaces through small scale, informal repair and improvement (Talen, 2015, p. 138-139). This, Talen (2015) explains, resulted in interventions occurring on a "block by block, lot by lot basis" (p. 139), that included everything from aesthetic treatments of infrastructure, to street planting (pp. 138-139). These small civic improvement groups, writes Talen (2015), continued to grow through the end of the century, until by 1906, there where 2400 improvement societies throughout the U.S. (p. 139), that stressed a public interest in an "indigenous preference and a common vernacular" (p. 143).

Talen (2015) sheds light on interesting contrasts between this historical form of TU and the current version. Historical TU was interested in building towards a formalized practice for institutional and governmental adoption, where contemporary TU is about circumventing the shortcomings of bureaucratic institutions and governments. But, Talen (2015) continues, “the streams are connected by their emphasis on the human scale and the desire to hone in on what matters for the everyday, human-centered experience of urban living” (p. 144).

Finn (2014) traces the TU lineage to the experimental zeitgeist of 1960’s architecture, in the temporary and pop-up activities of groups like Archigram and Anarchitecture that coincided with the advent of advocacy planning (p. 386). These progressive practices, Finn (2014) writes, sought to recognize the inclusion of individual citizens within the institutional planning process, where participatory planning structures were beginning to enter formalized government programs (pp. 386-387), as in the form of the “citizen based model” (p. 387). During the 1970’s other designers like the landscape architect, Karl Linn (Linn, 1990; Linn, 1994) were highly influential in the use of TU with his conversion of abandoned and vacant city lots into usable public park space, as an early iteration of community-led urban intervention (Finn, 2014, p. 387; Talen, 2015, p. 137).

More recently, as outlined by Finn (2014), and Lyndon, et al., (2012), a resurgence of TU in Europe and the U.S., around the turn of the millennium, came in response to uneven economic growth and reoccurring recessionary contraction. Lyndon et al., (2012) describe three main factors, including the growth of the internet, demographic shifts, and the influence of the 2008 great recession (p. 2-3). The economic upheaval brought on by an injured world economy, writes Lyndon at al., (2012) forced stakeholders at all levels of institutional and government organizations to cut budgets and scale back projects, having considerable effects on the construction and maintenance of the built environment "forcing people to get creative with project funding and concentrate on smaller more incremental efforts" (pp. 2-3). TU principles of working around sanctioned bureaucracy in effecting local change fit in perfectly with the ethos of the day, in challenging established urban planning and development authority.

2.6.3 Filling in the Gaps: Tactical Urbanism as Process.

Silva (2016) suggests that TU was one of the only remaining methods with the ability to directly address urban issues at specific, intimate scales, which traditional planning and institutional organizations simply ignored or failed to recognize (p. 1042). Silva (2016) continues, this helped develop the creation of meaning for interventionalists, not though aesthetics, but through their simple implementation, autonomy, and involvement in the process of implementation (p. 1045). This, in turn, Silva (2016) writes, builds a direct (and most often), missing link between the interventions themselves, and the people that use and experience them, in the places they live (p. 1047). As such, local context plays a fundamental role in TU, often triggering intervention priorities and scope, where every response will be unique to the context in which it is activated. (Lyndon et al., 2012; Pfeifer, 2013 p. 7). This hopefully, according to Lyndon et al., (2012) leads to the development of "social capital between citizens and the building of organizational capacity between public and private institutions" (Lyndon et al., 2012 p. 2).

2.6.4 Tactical Urbanism as Planning Tool.

Pfeifer (2013) demonstrates how the use of TU has led to "low-cost test pilot projects" (p. 2) from municipal and other institutional bodies in developing cost-effective and participatory initiatives across North America (p. 13-56). Lyndon et al. (2012) also examine a list of case studies from across North America that illustrate (some now familiar) TU initiatives and interventions (pp.10–42). that have contributed to the “process of city-building” (p. 2).

Similarly, Douglas (2014) writes that TU practices promote cheerful interaction with the urban condition, a way of “playing with the city” (p. 13), where informal individuals and groups produce “contributions or improvements” (p. 6) through “forms of urban space intervention” (p. 8). To differentiate TU from possible confusion with the problematic enterprises of public art and crime, Douglas (2014) describes its “lack of destructive elements and self promotion” (p. 11), and points to its “active, functional and goal oriented nature”(p. 8), in representing “a simple willingness (and perceived right) to reshape the built environment on one’s own terms” (p. 12). Douglas (2016) in his ethnographical study (illustrating the proliferation and increased popularity of progressive urbanism thinking through the combined use of formal technical planning knowledge and TU), argues that the process of knowledge integration can provide inclusive benefits to multiple community, institutional and governmental stakeholders, helping many of the interventions transform from the “experimental to the resourceful” (p. 128). Similarly, Marshall at al. (2016) argue for TU’s place within a larger municipal planning practice as exemplified through its use in the Denver bike share system, in which a temporary, experimental intervention became a permanent city program and the first of its kind in the U.S.

TU initiatives may even breath fresh life into stale planning processes, as Silva (2016) points out, in providing “the energy necessary for an evolutionary way of planning” (p. 1049), but will need to address the discrepancies in capacities, most notably, how TU, an uncertain, informal, unplanned, and flexible process, fits within the larger institutional planning apparatus with a diametrically opposed order (p. 1049).

2.6.5 Remaining Questions of Tactical Urbanism's Resurgence.

If its innate advantage is the rapid and immediate response to small and micro-local issues, Silva (2016) asks how municipal scale planning will "integrate these local actions into a coherent fabric" (p. 1049). The contradictory notion of TU effectiveness within larger socio-political and ideological structures is taken up further by Mould (2014) in questioning whether TU has already been co-opted by the current neoliberal status-quo (pp. 532-533). This, writes Mould (2014), is the natural order of a market-led, capital economy, where any activity, even supposedly adversarial is "conquered or subsumed into the wider process of urban capitalism (despite being predicated upon a reaction against it)" (p. 532). This is proven in part, Mould (2014) points out, by the gentrifying aspect of TU, in which much of the latest craze and rise in its popularity is due to its adoption by a white, well educated, upwardly mobile, creative class, that has promoted TU aesthetic in their "once forlorn" (p. 523) neighborhoods, which inevitably "fuels the valorization of characteristics of the gentrifying process" (p. 532). Mould (2014) contends, this has simply led to the packaging and branding of TU activities into a commodified narrative and promoted in municipal and institutional policy that "politically neutralizes the interventionist and subversive characteristics of said activities" (p. 533). Brenner (2016) offers a similar concern in describing the TU dilemma in which it serves as more than simple "'camouflage' for the vicissitudes, dislocations, and crisis tendencies of neoliberal urbanism" (p. 135).

Although concerns are evident regarding the capacity of TU to remain an effective and robust form of participatory urbanism, beyond its popular rhetoric, there is still agreement of its beneficial effects on how citizens experience, interact and take ownership of the city (Brenner, 2016; Iverson, 2013; Mould, 2014). At what stage TU has been co-opted by the dominant socio-political order is arguable, but in the least, it has brought a new vision and awareness to local, street-level urbanism (Courage, 2013), where individual citizens can foster a sense of dignity and responsibility in engaging with the communities they live in, through a more “community oriented and ‘usable’ city” (Mould, 2014, p. 536). Brenner (2016) expresses an optimistic perspective in the possibility that TU, beyond the reorganization of local level urbanism through aesthetic treatments, will serve as a group of collectively shared principles that will continue to lead to critical questions about the city (p. 136). Specifically, Brenner (2016) suggests, this would require new understandings of not just design-oriented problems and solutions but the development of further “progressive policy” (p. 136), and its role in new potential forms of “efficient, transparent, inclusive and collaborative forms of government” (p. 136), where “alternative urbanisms” will need both “new urban space” and “new state spaces as well.” (p. 136).

Practically speaking, TU can offer small scale interactive and compelling design solutions, that are participatory and efficient. Within the Modular Urbanism framework, its street level, on the ground, legibility, helps express human authenticity. When integrated appropriately with other multi-scale design principles, like placemaking, TU can strengthen sense of place through tying, relatable, (micro) site-specific meaning into a larger program of local significance.

2.7 Modular Design.

2.7.1 Modular Design as Concept.

Modular design, within the context of complex systems, is described as a specific structural procedure in which a system is divided into smaller, associated subsets of systems, that function both independently from other subsets, while remaining connected and functioning interdependently, as a distributed, networked, complex of modules (Baldwin & Clark, 2014; Ethiraj & Levinthal, 2004; Russell, 2012; Salhieh & Kamrani, 2008).

Modular systems function through the interconnection across autonomous modules, or components, that cannot be regulated by a central, hierarchical “top-down model” (System Innovations, 2015), but rather through the adaptive capacity of individual modules to reconfigure and reorganize when necessary for the function of the entire system, in bundling and unbundling or plugging and unplugging (Balwin et al., 2014; System Innovations, 2015). Rather than a system of “sequential structures, each generic structure has its own easily recognizable matrix pattern” (Baldwin et al., 2014, p. 89). Modular systems can be developed, writes Sahieh & Kamrani (2008) by separating out, or “decomposing a system into its basic functional elements” (p.213), which are then further divided into their individual components “which can be mapped, organized, and interfaced, and recomposed back into a “modular system capable of achieving its intended functions” (p. 213).

2.7.2 Modularity in Product Design and Manufacturing.

Modularity has been an important concept in product design and manufacture, where “decomposition allows the standardization of components and the creation of product variants.” (Sahieh & Kamrani, 2008, p. 208). This allows for the “mixing and matching” (Sahieh & Kamrani, 2008, p. 208) or “plug and play” (Russell, 2012, p. 258) of modular components where distinct combinations of modular unit assemblies allow for an expanded product field, “with distinctive functionalities, features, and performances” (Sahieh & Kamrani, 2008, p. 209) that have become ubiquitous in today's consumer products (Sahieh & Kamrani, 2008), from iPhones to Toyotas.

The ability of modular design to address both discreet system detail and comprehensive holistic function provides it with several benefits in its problem-solving abilities. Its distributed, decentralized nature allows for collaborative problem solving across networked modules, allowing for concurrent modular progress across the entire system (System Innovations, 2015), where limiting the scope of interaction between elements vastly increased production speed (Baldwin et al., 2014, p. 43). Multiple problem-solving capacity at multiple points contributes to the comprehensive effectiveness of the entire system, where a reduction in development and production times leads to cost efficiencies (Balwin, 2014, pp. 90-92; Ethiraj & Levinthal, 2004, p. 162; Sahieh & Kamrani, 2008, pp. 225-226). This reduced dependency on the entire system allows modular designs to maintain longer life cycles through individual module reconfiguration, repair, and exchange (System Innovations, 2015) where the "mix and match flexibility creates options within the design and task structure." (Balwin, 2014, p.92). Modular design combines the flexibility of a system comprised of heterogeneous modules, interfaced to remain cohesively unified, allowing for both design standardization and customization (Salhieh & Kamrani, 2008, pp. 225-226), making it a highly sustainable and resilient (Balwin et al., 2014; Clune et al., 2013; Ethiraj & Levinthal, 2004; Russell, 2012; Salhieh & Kamrani, 2008).

2.7.3 Historical Roots of Modular Design.

Humans beings have historically incorporated modular design into many of their building practices in the pursuit of efficiency in creating more livable and enjoyable environments. The systemization of building technology in landscape modification and shelter building is well documented in the fields of history and anthropology (Ingold, 2013; Knaack et al., 2012, p. 13). The great pyramids of Egypt are but one early example of how modular design thinking can generate extremely complex and monumental structures (Henshall, 2018). But more commonly, modularity was used by many indigenous cultures as a way of maintaining mobility, flexibility, security, and economy (Knaack et al., 2012, p. 13). For thousands of years, nomadic tribes from Eurasia and North America developed adaptable structures like the snow house, the tipi, and the yurt, that were temporary, "light, transportable and easily built" (Knaack, et al., 2012, p. 13) in pursuit of hunting, or pasturing their respective herds (Nabokov & Easton, 1995). Knaack et al. (2012) offer the example of the Japanese tatami mat, as another traditional form of modularity in the history of the built environments, that was used as the "standard module of common architecture" for over a thousand years (p. 14).

2.7.4 Modular Design in The Industrial Revolution.

The Industrial Revolution, writes Knaack, et al. (2012), ending in the mid 19th century was an era of great influence on the development of modular design, in the great population movements from rural to urban areas that accompanied the "shift in technical socioeconomic and cultural conditions" (p.15), where "machinery replaced manpower" (p. 15) and the introduction of mass production rapidly transformed our productive capabilities forever (p 15-24). The most prominent example of modular construction from the era being, The Crystal Palace of 1851, designed by Sir Joseph Paxton (1803-1865), (as previously examined in this study's introduction). Through the rehearsal of his previous glass, and iron modular greenhouse structures, Paxton was able to refine a building system that was as revolutionary for its process and speed as it was for its aesthetic qualities (Bird, 1976; Knaack et al., 2012, p. 24).

The streamlined fabrication and construction process in which the Crystal Palace was manufactured and assembled, accelerated the completion of the structure which would normally have taken years, into an incomprehensively short eight months; a prodigious accomplishment of building, even by today's standards (Bird, 1976; Knaack, et al., 2012, p. 24; McKean, 1994).

This was only possible as Knaack, et al. (2012) points out, because of the application of a modular "kit of parts" (p. 24) that made up the structure itself, but also through the application of modular design within the construction process, through offsite prefabrication and the manufacture of repetitive modules that, instead of generating monotony, produce the aesthetic quality of a delicate rhythm (p. 24). As Knaack et al. (2012) emphasize, the significance of the building, besides its vital use of materials, and tremendous integration of multiple functions in encompassing drainage, operable ventilation, and natural light" (p. 24), was its rational extension of the construction process "from factory to site" (p. 24). McKean (2006) suggests that the building's great achievement lies not as much "in technological innovation, as in seeing the whole formation of the building as a system" (p.58).

2.7.5 Modular Design in Architecture.

Beginning at the end of the 19th century, the age of mass production and the refinement of the assembly line in the industrial manufacture of the automobile, "resulting in higher efficiency and lower costs" (Knaack et al., 2012, p. 15), would also influence the expansion of modular design well into the 20th century. This would carry over into architecture, where, inspired by the automation of the newly exploited manufacturing process, Le Corbusier would go on to develop his theory of modularity in Le Modulor (Le Corbusier, 1968), where he urged architects to "adopt the same spirit of rationality and functionality that guided the design of steamships, airplanes, and automobiles" (Russell, 2012, p. 270). As Russell (2012) continues, this eventually led to a more formalized process to adopt modular design within architecture and the building industry by the 1930s. But, Russell (2012) adds, this largely disappeared in the U.S. after the death of its early developer, supporter, and advocate, Alfred Farewell Bemis (1870-1936), and his Cubical Modular Concept (pp. 262-268). Interestingly enough, writes Russell (2012) "the architectural metaphor" (p. 273) of modularity would serve to highly influence other interested fields, like the military and eventually the electronic and computer industries throughout the second half of the twentieth century (p. 273). By the end of the millennium, this expanded use of the modular design concept would continue to infiltrate other fields of study. As Russell (2012) points out, "discourses of modularity had flooded technical professions and disciplines" (p. 258), from computer scientists, and economists, to teachers, and psychiatrists, to include "even the transformation of American military capabilities" (p. 259), where modular building practices had long been recognized for their agility, efficiency and temporality (Hall, 1948; Lopardo, 2008; Zdon, 2010). Modular design as Russell (2012) summarizes, provided this wide array of multi-disciplinary interest with not only needed tools to conceptualize and master complexity" (p. 280) but also, he posits, "perhaps a glimpse of the deep structure of nature itself" (p. 280).

2.7.6 Modular Design Misconceptions.

Modular building techniques would continue to develop in architecture through the post-war period in Europe and the U.S. in part, as a response to housing shortages, that included advances in techniques like, lift slab building, resulting in social housing programs, and prefabricated homes (Knaack et al., 2012, p. 16-29).

As architectural utopian ideals mixed with the ascending capitalist/statist ideology, and modernist comprehensive planning, with its "monofunctional zoning and the ruthless eradication of the vernacular" (Groth & Corijn, 2005, p. 505) the 1950s and '60s ushered in an era of problematic and failed social policies that attempted to mobilize the efficiencies of modular design into industrialized building (Knaack et al., 2012, p. 22-23). To the present day, modularity is still popularly associated with, specific, out of fashion architectural movements, outdated housing typologies, and long-ago demolished building projects that were "[deemed] socially and structurally deficient" (Knaack et al., 2012, p. 22-23). This residue, combined with the current cliched, pop culture perception and labeling of modernist/functionalist architecture with the vulgarized umbrella term of brutalism, has led to the view that modular design in the built environment is monotonous, and repetitive, generic, and de-humanizing (Colman, 2003, p. 212; Nissen, 1972, p. 12-21). Even with the current prevalence of a wide variety of modular building methods and processes in operation around the world, the AEC industries are still perpetually engaged in battling common misconceptions (Bernstein et al., 2011, p. 4; Knaack, et al., 2012, p.7; Nissen, 1972, pp. 13-14; Smith, 2010, pp. 66, 90). These combined elements could also, in part, explain the absence of wide-spread adoption of modular design practices within the discipline of landscape architecture. But as this investigation argues, the practice stands to benefit greatly from comparing and contrasting current AEC normative modular design principles and practices in the expansion and understanding of its own use of modular design.

2.7.7 Modular Design in the Architecture Engineering and Construction (AEC) Industries.

Modular design and construction within the AEC industries, much like the conceptual definition, breaks down whole building structures and their systems into component subsystems or modules as a way of simplifying complexity, where prefabrication, offsite manufacture, and assembly have become increasingly more prevalent within the built environment (The American Institute of Architects [AIA], 2019; Bernstein et al., 2011; Knaack et al., 2012; Smith, 2010), spawning the growth of institutions (Modular Building Institute [MBI], 2020; Modular Construction Council [MCC], 2020) and a robust field of academic research (Ahn & Kim, 2014; Bertram et al., 2019; Horman et al., 2006; Voordijk et al., 2006). This industry growth in modular design has been spurred by advances in technology and the "trend towards automation" (Smith, 2010, p. 67), through the employment of computer automated design (CAD), building information modeling (BIM), computer numeric controlled (CNC) and digital fabrication, in better addressing industry issues and "heightened concerns" (AIA, 2019) regarding safety, efficiency, cost, and customization, to name but a few. (AIA, 2019, p. 4-9; Smith, 2010, p. 67). As Bernstein et al. (2011) point out, sector use percentages of modular building processes are substantial, including, 49% of healthcare facilities, 42% of college educational buildings, and 42% of manufacturing buildings (p. 4). Knaack et al. (2012) argue that "just by observing the built environment, it becomes clear that most buildings were not designed by architects" (p. 116), but by "prefabricated building systems that included all necessary calculations and authorizations as part of the package" (p. 116).

2.7.8 Modular Design Building Process.

The modular building process typically involves the design of a structure through dissection of its constituent parts and systems, which can be manufactured offsite in a factory and prefabricated into assemblies and subassemblies, which are then transported onsite, where the subassemblies are put together forming the complete structure. (Knaack et al., 2012, pp. 99-115; Smith, 2010, pp. 107-172). It is a process that builds from the essential foundation of materials, through to components, to basic assemblies, to subassemblies (or panels), and into modules, created from the spectrum of building materials, "from wood kits to metal building systems to precast concrete" (Smith, 2010, p. 128), where "the separation of function is reflected in the separate modules (Knaack et al., 2012, p. 101). The separate modules themselves can be designed in various system configurations that allow for adaption.

The module assembly process also requires a robust arrangement of connections, which highly influence the proper function of the entire modular system (Knaack et al., 2012, p. 111). As Knaack et al. (2012) write, these connection nodes that unify assemblies with subassemblies and modules should enable “quick and easy assembly on the building site” (p. 111) where “complex connections need to work in simple ways” (p. 111).

The design of modular building systems requires a comprehensive initial strategy in streamlining multiple stakeholder involvement from the pre-design phase through to post-occupancy, where workflows and decision making processes require detailed coordination from AEC offices to factories and facilities, to the job sites themselves (Smith, 2010, p. 191).

Much of the reason that AEC industries are increasingly implementing modular design and construction is because of the multiple benefits to triple bottom line concerns, and the proven advantages as a sustainable building practice (Table 1), (Ahn & Kim, 2014; AIA, 2019; Bernstein et al., 2011; Horman et al., 2006; Knaack et al., 2012; Pasquire & Gibb, 2002; Smith, 2010). Quality and precision are understood to be improved through better offsite control of materials, fabrication, and manufacturing processes, through greater technical predictability, resulting in higher tolerance precision and less waste (Ahn & Kim., 2014, p. 250; AIA, 2019, pp. 13-15; Bernstein et al., 2011, p. 5; Smith, 2010, p. 81). The offsite prefabrication process also contributes to continual technical and procedural improvements (Ahn & Kim, 2014, p. 250).

Table 1. Evaluation of triple bottom line aspects of prefabrication vs. site-built systems (based on Horman et al., 2006)

Decision Factors	Prefabrication	Site-Built
Economic Issues		
Quality	More reliable quality can be achieved in a shorter amount of time (especially for large-scale projects) ✓	Less reliable (depending on the site conditions and the skill level of the labor)
Component and material supply chain	Long term supply chains for materials can be established	Supplies restricted to project-based purchases
Schedule Length and Reliability	Longer lead time, but reduced erection time and more reliable duration ✓	Shorter lead time, but longer construction schedule and less reliable duration
Coordination Time	Extra coordination needed between the site and the plant	More time for coordination and opportunities to adjust dimensions
Flexibility	Changes often cannot easily be made in the field	Limited adjustments can be easily made in the field
Impact of Changing Orders	May cause delay & extra costs: less controllable situation for large-scale projects ✓	May cause delay and extra costs: often can be better accommodated
Delivery and Shipping	Varies depending on the locations of the prefab. plant and the material supplier	Shipping fee needed for raw material delivery only
Maintenance Costs	Improved quality can lead to reduced maintenance and operations costs ✓	Defects due to site conditions can lead to higher maintenance and operations costs
Environmental Issues		
Quality	Improved quality can lead to improved performance ✓	Site defects can reduce performance
Material choices	A greater variety of specialty materials can be used due to more developed supply chains ✓	Material choices are limited to sporadic availability, and capabilities of on-site labor
Material Waste	Less waste due to use of larger raw material lots ✓	More waste onsite; extensive packaging for delivery
Transportation Energy	More gas consumption	Less gas consumption
Flexibility	Modular systems can be reconfigured more easily ✓	Minor onsite variations (dimensions, etc.) can be easily accommodated
Deconstruction	More likely to be easily disassembled for reuse or recycling ✓	Disassembly and separation is usually more costly
Social Issues		
Local Labor	Less local labor needed ✓	Can employ local labor to fabricate and install components onsite
Working conditions	Improved working conditions and more stable job market ✓	Variable working conditions and more sporadic job market
Skill level	Craft and technical skills needed	Craft and problem solving skills are elevated

Cost efficiencies are also proven benefits, through more accurate building processes, where reduced onsite assembly contributes to both labour and material savings (AIA, 2019, pp. 13-15; Bernstein et al., 2011, p. 5; Smith, 2010, p. 82). Component and module replacement and repair also extend structure life cycles, which also conserve building embodied energy and save material waste for an overall increase in overall return on investment. (Ahn & Kim, 2014, p. 250; AIA, 2019, pp. 13-15; Bernstein et al., 2011, p. 6; Smith, 2010, p. 82). Modular design practices also reduce schedule durations, sometimes as much as 30-50% (AIA, 2019, pp. 13-15) as prefabrication occurs offsite, in controlled and predictable conditions, which also directly affects labour productivity and safety (AIA, 2019, pp. 13-15; Bernstein et al., 2011).

2.7.9 Modular Design as Sustainable Building Practice.

In addition, Smith (2010) outlines modular design as an inherently sustainable building practice, in utilizing specific strategies for life cycle efficiencies through the four scenarios of, "building reuse or relocation, component reuse or relocation,… material reuse in the manufacture of new components,… and material recycling into new materials" (p. 224-225) The strategies include:

- Design for Disassembly (DfD): The capacity for assembly, use, and disassembly, allowing for the reassembly of the structure in another location and time, effectively incorporating adaptability as a core function of the structure and avoiding demolition and material waste. (pp. 222-224)
- Design for Reuse: Building design to avoid the waste stream through a "range of possible end of life scenarios" (p. 224), where various materials and components are reused or recycled. Although this strategy may not allow for the full reassembly of the entire structure, it is designed to reuse as much of the building as possible (p. 225).

- Design for temporality and Design for Change: Designing structures and spaces that are multifunctional and flexible in avoiding over designed and over programmed architecture” (p. 225), allowing for functional adaptation and change through a phased use approaches (p. 225).

2.7.10 Modular Design in Landscape Architecture.

In differentiating its application from architecture, modularity within the discipline of landscape architecture primarily deals with the organization, design, and construction of outdoor space, where the idea of "place" (Hiss, 1990), takes precedence over the built object (CSLA, 2020; Kavanaugh, 2013, pp. 161-166). Although landscape architecture does deal with shelter structures, they are designed and built primarily within the context of a larger outdoor site, as part of a larger network of synthetic and natural ecological systems (CSLA, 2020). By using recent modular design practices developed through various AEC applications and methods, it is hoped that more sustainable landscape architectural design solutions can be developed through the balancing of site-specific aesthetic requirements with the adaptive and efficient techniques of industrial fabrication and manufacture (Bernstein et al., 2011; Knaack et al., 2012; Smith, 2010).

This also includes the possibility of hybrid approaches, where modular design and construction techniques are used side by side, and in conjunction with more traditional methods, in creating modular solutions that employ prefabrication, and mass customization in the design, not only of objects within a site, but also the spatial entities themselves (AIA, 2019; Farr, 2013). As such, there are several ways that modularity has been understood and applied in the context of landscape architecture. Far from the simple repetition of identical elements, writes Colman (2003), modular design, as "configurative multiplication" (p. 214) through a "persuasive basic unit" (p. 214) can achieve "dynamism rather than of monotony [where] legibility is assured throughout because parts are organized to emphasize reciprocal relations among them, thus rendering the whole comprehensible" (214). It is where the relationships between the components, assemblies, and modules, are as important as the elements themselves.

Within current practice, Fox (2017) sub-divides modular design systems into four categories from the singular unit, to more complex configurations that include:

- Simple Modular Dialogs - The module as unit: This grouping comprises a limited number of simple forms, single function, modular units that can be assembled into basic configurations and patterns. The group mostly consists of unit modular pavers systems used for pedestrian and vehicle circulation pathways, which may include specific aesthetic pattern configurations, and functional, low impact development, green infrastructure components, such as permeable pavers (Fox, 2019, pp. 18-25). Projects like The Climate Tile by Tredje Natur (Aouf, 2016) and, The Dynamic Street by Carlo Ratti Associati (Walsh, 2018) use modular design in creating tiling and paving systems in designing reconfigurable and interactive sustainable solutions to stormwater management and pedestrian safety and circulations issues.
- Complex Modular Dialogs - The module as kit-of-parts: This grouping consists of an expanded set of modules with increased formal variety and increased functional capacity, that together make up a kit of parts to be assembled into a functional modular system. This often includes multifunctional landscape elements combined into an interconnected system, where, for example, pavers, planters, and benches would form a single assembly of modular components (Fox, 2019, pp.25-34). GreenBlue Urban's (2019) ArborSystem combines stormwater management in a modular tree planting system that includes, "root

management, structural soil components, aeration, [and] irrigation" (para. 1), that can be installed into any urban environment individually or configured as multiple systems.

- Modular Subassemblies and Dialogs: This grouping increases the level of complexity into an expanded number of components, first configured into several smaller groupings of assemblies, which are them combined themselves into a modular system whole. These are best exemplified in the various industrially produced green infrastructure, stormwater management systems, such as modular rain gardens, and green roofs (Fox, 2019, pp. 35-42). Biomatrix Water (2020) creates modular floating "versatile interlocking ecosystems which can be configured to fit site conditions" (para 1), that combine "multiple benefits including habitat creation, urban water scaping, water quality management and wastewater treatment" (para 1).
- Flexible Mass Customized Modules: This grouping consists of complex systems with various levels of modular assemblies and multiple numbers of subassemblies that are all configured and networked into a cohesive working system. This level of modular complexity often included a high level of heterogeneity within the assemblies and subassemblies, where modular design unifies highly differentiated functions and capacities into a cohesive operational system. Modular designs at this level of complexity are often large, physical infrastructure projects and can include substantial organization and management system designs (Fox, 2019, pp. 43-50). Zwarts & Jansma Architects & OKRA Landscape's winning entry for the ARC 2010 Wildlife Crossing Design Competition in which they designed "a repeatable, modular structure" (Berkers et al., 2012, p. 378) where "flexible formwork" (p. 378) would be used in "creating variable

shells" (p. 378) through "cable nets…[that] can be re-used many times in varying forms" (p. 387).

Nunes et al., (2011) in echoing the preceding examples states that modular design's "greatest advantage is the possibility of continuous reinvention and adaptation to new techniques, new technologies and new operational wills in landscape" (section 6). Landscape architecture's capacity for adaptable and flexible design solutions in its understanding of ecological and cultural processes naturally accords and aligns it with expanded modular design practices and modalities. Johung (2012) aptly describes this affinity in which "modularity enacts a system in which parts expand and contract, and in which phenomenal mobility interpreted structurally into an organically emergent built form guides interchangeable units into and out of larger situated frameworks" (p. 77). It is a system, Johung (2012) continues, that can produce and respond to "variable user demand and function" (p. 77), and in a sustainable perspective can also "structurally anticipate the mobility of individual inhabitants across different sites as they remake spatial and social environments over time" (p. 77).

2.8 Conceptual Framework

2.8.1 Modular Urbanism Matrix.

The main goal of this conceptual framework will be to visually connect its central design principles and methodologies as a "generating formula" Zeisel (1981 p. 20) in articulating a Modular Urbanism Matrix (MUM). Landscape architecture will be the widest lens through which the composition will be focused, forming the background of the overall perspective.

Landscape Urbanism (Waldheim, 2016) will also be included in the broad scope perspective in establishing a theoretical grounding, which will focus on three aspects of the theory with direct relevance to the MUM. These include a contextual refocus on landscape as the foundational building block of the built environment (Waldheim, 2016, pp.50-68), "as the basis for understanding the forces shaping projects and to which projects must respond" (Duncan & Seltzer, 2010). Ecological awareness in understanding urbanization, prioritizing the importance of relationships and connections in all their forms and combinations, between humans and the natural world, other humans, and the built environment (Waldheim, 2016, pp. 187-184). Finally, in the emphasis on indeterminacy and process as central concepts that influence the cycles of existence of both natural and synthetic systems across multiple temporal and spatial scales, that inherently involves the understanding of flexibility, adaptability, and resilience (Waldheim, 2016, pp. 32-49).

To further help situate this domain, the concepts of placemaking and tactical urbanism will also play important structural roles in delineating the framework's conceptual parameters. In this way, a boundary of central concepts formulates a matrix in which new forms of urbanism can be understood.

Placemaking integrates into the framework as a broad-scale design and planning strategy that offers corollary capacity in understanding the complexity of urban environments, in contraposition to smaller scale, tactical urbanism, in completing the conceptual field.

2.8.2 Questioning the Dichotomy.

Modular design will operate as a novel deployment technique across this framework, opposite site-specific design, bridging between the strategic capacities of placemaking and the discreet abilities of tactical urbanism in completing the spectrum of the matrix. In doing so, the MUM can then be considered across multiple sites, in activating and transforming urban spaces. It allows for the incorporation of modularity into the design and construction process that addresses the needs of both specific sites and be reproducible, cost-effective, and adaptable enough to be applied in multiple locations, and scales. This framework aims at visualizing a potential spectrum of productive territory, as a method of “summarizing increased insight and defining areas where further research can increase precision” (Zeisel, 1981, p. 19).

2.8.3 Expanding Design Territory.

Finally, this conceptual framework suggests the contingency of the preceding components in creating a connected and expanded field in which to design specific yet scalable, adaptable yet economical forms of urbanism. This generating formula is especially valuable within the current climate of economic austerity that exists both regionally and globally in which the ‘more for less’ aphorism has become an incorporated necessity in the design and construction of the built environment (figure 3). This conceptual framework forms the base structure for this investigation’s proceeding three design case studies, in collaboration with SAPL and professional partner Kasian architecture.

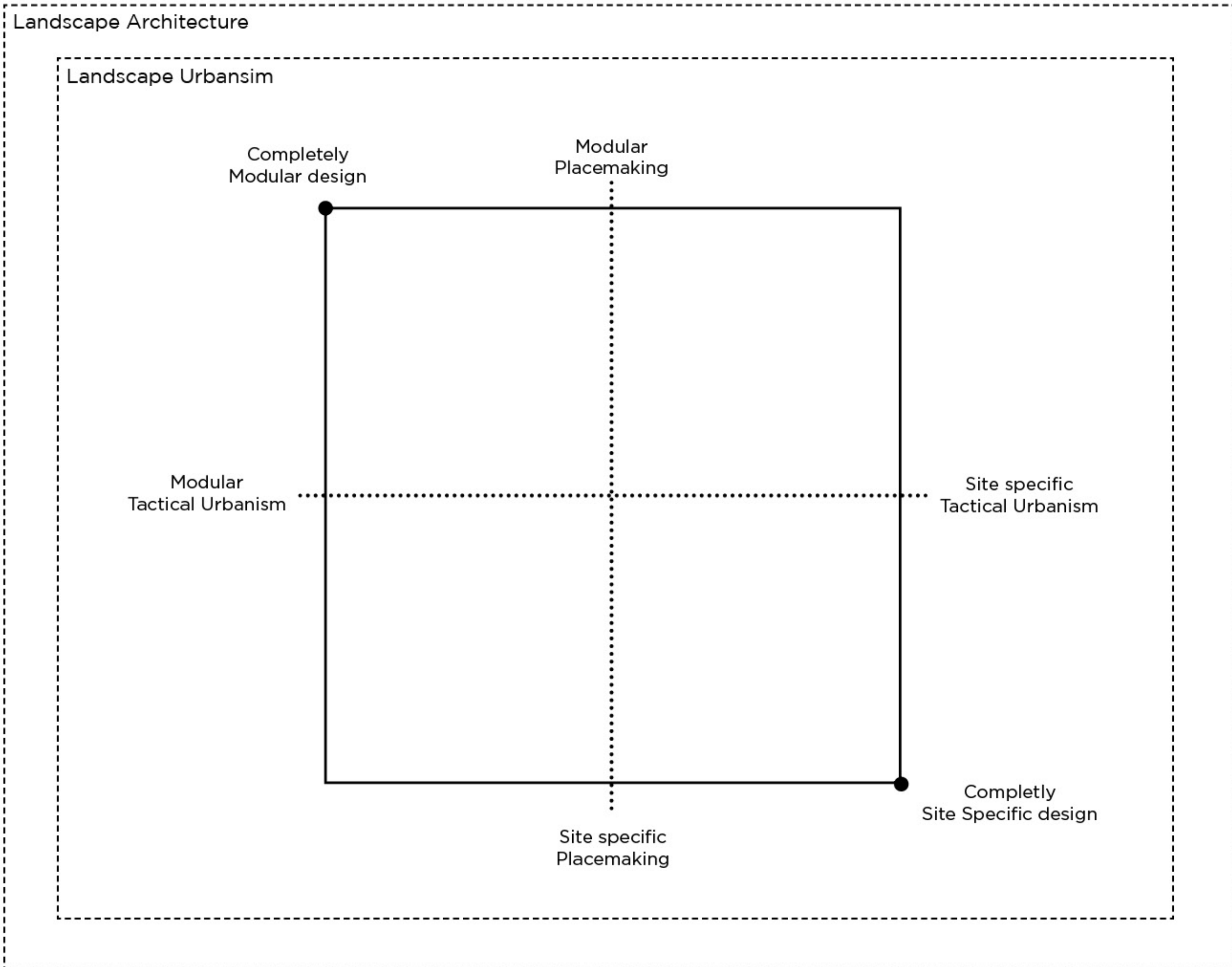


Figure 3. Modular Urbanism Matrix.

CHAPTER 3

DESIGN CASE STUDIES

Art and the City (AATC), The Green Alley Project (GAP), The District.

3.1 Introduction

The following three case studies are the culmination of the Modular Urbanism thesis research, examining how modularity could be combined with multi-scalar design elements in creating more sustainable landscape architecture design and construction processes. They were carried out in collaboration with SAPL and Mitacs professional partner, Kasian Architecture, over the last sixteen months, beginning in May of 2019.

The first two case studies, AATC, and GAP examine the application of Modular Urbanism processes, through integrating tactical urbanism techniques into their respective larger placemaking programs. Both interventions aimed to provide low cost, rapidly deployable design solutions, in adapting underused urban spaces throughout downtown Calgary for temporary transformation. Specifically, this resulted in capitalizing on two-dimensional materials deployment tactics in getting more for less, working under a restricted time frame and limited budget. In both projects, Modular design was implemented in the fabrication stages of designing the application processes, through the development of modular, kit-of-parts stencil systems. Although both projects had similar system designs, the results of on the ground testing, and prototyping resulted in different material deployment and application outcomes.

The third case study, The District, provided an opportunity to work with Kasian Architecture in designing a proposal for a fully integrated application of Modular Urbanism as part of a larger adaptive reuse development project. This involved the redesign of the development's central courtyard area, into a flexible and interactive public space, available for use by building tenants and the surrounding community. I would use it as an opportunity to build on the experiences of the first two case study projects, while also expanding the design into fully incorporated elements of green infrastructure and flexible space configuration through the application of modular design. This would include an onsite stormwater management system that integrated into a winter season placemaking community event and program, and a fully reconfigurable modular assembly system that combines, site furniture, planting, and public art, tactical urbanism elements.

3.2 Case Study 1: Art and The City, 2019.

3.2.1 Context.

Started in 2018, Art and the City (AATC) is an annual, guided, public art tour, through downtown Calgary, Alberta. The overarching idea of the event is to acknowledge and reveal the city's extensive and established urban, public art collection, in celebrating its contribution to local culture. Its overall aim looks towards "curating the art that exists in plazas, lobbies and spaces…in order to create an accessible and engaging 'gallery' of the city" (Kasian, 2018a). In devising a tour route through both interior and exterior public realm, art spaces, the project also looked to redefine public discourse regarding public art in Calgary, shifting the focus from financial controversy towards its enduring socio-cultural benefits.

3.2.2 Participants.

The AATC case study primarily involved three stakeholders that included, Kasian Architecture: Lifescape sector, the Calgary Downtown Association (CDA), and Trepanier Baer Gallery (TBG)

Within Kasian Architecture, The Lifescape sector was created as a way of refocusing on ground level environments and the importance of human scale, through the in-between spaces that are fundamental to the urban experience, as an "integrated way of thinking about how we holistically curate our ground-level environments and connected spaces inside and out" (Kasian Architecture, 2018b). Through this perspective, Lifescape supports the incorporation of associated practices and disciplines such as urban design and landscape architecture perspectives into the design of the pedestrian experience. Lifescape was engaged as the project lead in the design and implementation of AATC.

"The CDA is a Business Improvement Area under Alberta's Municipal Government Act and represents over 2,500 businesses in a 120-block area in the city center" (Calgary Downtown Association [CDA], 2020). The CDA is a proactive group of businesses that is primarily concerned with promoting and advancing both the economic and cultural aspects of the city related to the downtown area, through "generating dynamic spaces, places and integrated communities" (CDA, 2020). It is involved within the downtown community at various levels and capacities from policy support and development, to environmental improvement, to marketing and promotion. (CDA, 2020). The CDA was involved as a support resource in community and corporate coordination, engagement, and promotion.

One of Canada's leading commercial contemporary art galleries, Trepanier Baer Gallery (TBG) has been actively involved within the local art community since 1992. "Through its subsidiary Art to Public, the gallery also provides consulting services in the area of public art and has managed several major public art projects and commissions for corporations, civic entities, and private collectors" (Trepanier Baer Gallery [TBG], 2020). TBG was engaged as public art, route curators, and route leaders on the actual tour through downtown Calgary.

3.2.3 Description.

The AATC, 2019 program was part of a larger urban collaboration initiative that included five components:

- AATC guided art-walk tour.
- The University of Calgary, School of Architecture, Planning and Landscape's (SAPL) Green Alley Project (GAP), which aimed "[at] engaging the public and transforming Calgary's alleys into vibrant people places by adding street-level activity and enhanced stormwater management in an underutilized component of downtown infrastructure" (SAPL, 2019).
- Sketch Crawl and Design Matters Talk with Elizabeth Boults (UC Davis), and Chip Sullivan (UC Berkley).
- Beltline Urban Mural Project (BUMP), which led the commission and completion of a laneway mural from an internationally recognized artist.
- Urban Collaboration Initiative Event held to help promote and celebrate the various installations in recognizing their contribution to progressive city building.

AATC, 2019 'OFF-STEPHEN' consisted of daily guided art walks that occurred between September 20th- 22nd. The tour route included eight art stops throughout the downtown area (figure 4).

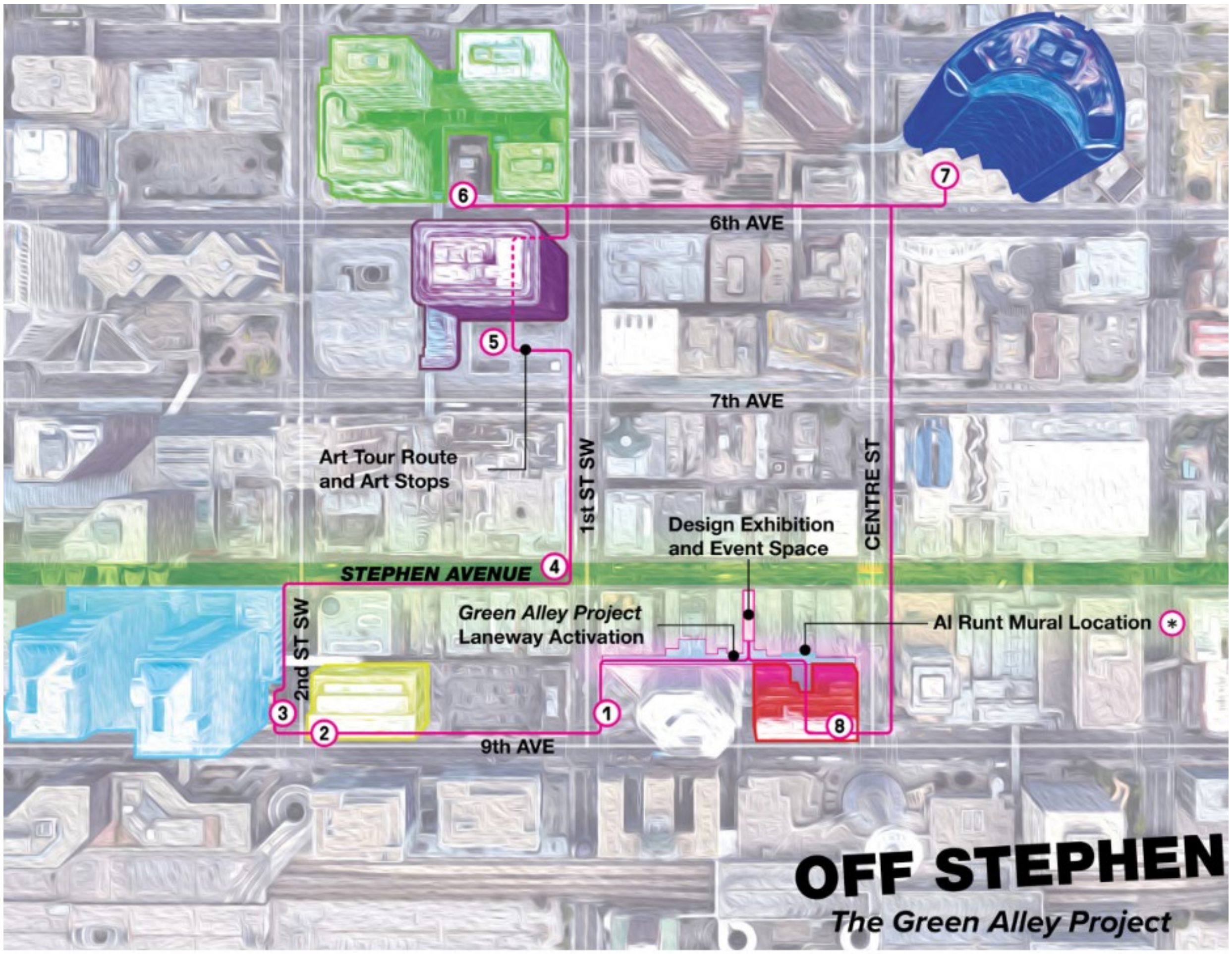


Figure 4. Map of AATC, 2019 art stops (AATC, 2019).

The physical tour route was also supplemented with a web-based, self-guided tour that was accessible through any mobile device and connected through QR codes on signboards at each stop. The signboards provided background information regarding the individual art works and the artists that created them. The eight art stops included:

- Art Stop 1: Jill Anholt, 2017. *Emergent*. The Edison Plaza.
- Art Stop 2: Beverly Pepper, 2010 *Nuova Twist*; Bryan Ryley, 2009. *Sun Meets Moon*; *C Train*. Bankers Court.

- Art Stop 3: Colette Whiten and Paul Kipps, 1991. *Weather Vanes*. Bankers Hall East Plaza.
- Art Stop 4: William Hodd McElcheran, 1981. *The Conversation*. Stephan Ave, Hudson's Bay, South.
- Art Stop 5: Micah Lexier, 2017. *The Trees*; *The Forest and The Trees*; Ben Rubin and Jer Thorp, 2017. *Herald/Harbinger*. Brookfield Place Galleria.
- Art Stop 6: Sorel Etrog, 1975. *Kabuki & Sadko.* Bow Valley Square.
- Art Stop 7: Jaume Plensa, 2012 *Wonderland.* The Bow Plaza.
- Art Stop 8: Walter May, 2017. *The Hatstack*. Le Germain Hotel.

The art stops were all located in public building plazas or public lobbies and galleries, spanning the large scale, highly visible and well known (art stops 1 & 7), to the more concealed and anonymous (art stops 3 & 8). Many of the plazas could best be described as spaces of transition, empty much of the day, mostly crowded during rush hour commute times and the lunch hour.

3.2.4 Design Intervention: Wayfinding System.

Under the guidance of the Lifescape team, I was to design and install an engaging, inclusive, and interactive wayfinding system for AATC 2019 guided tour, that would provide route access and direction to active tour participants, and, to expand awareness and attract outside interest from the general public. Wayfinding design parameters included:

- Low cost and cost-efficient, as the budget would be extremely limited.
- Temporary installation. One to two weeks in duration that needed to be easily disassembled or removed.
- Generate public interest. Expand appeal from creative class to a wider potential audience in emphasizing unique local culture. Inclusive rather than exclusive.

- Wayfinding as urban space activation tool. Develop the directional system in attracting people to underused urban spaces.

3.2.5 Design Concept: Anamorphosis

The anamorphic technique generates imagery that is unrecognizably distorted when observed from most angles, except when viewed from a single, predetermined, privileged perspective (Hosseini et al., 2017, pp. 276-278). In keeping with the central idea of changing the conversation about Calgary public art, the metaphor of shifting perspective was explored in developing an overall aesthetic. Through research into the use of perspective in art history, anamorphosis; the technique of graphical projection, more commonly known as forced perspective, was identified as a compelling approach in conceptually representing the metaphor (figure 5). The viewer literally must shift to a specific location to recognize the image. And, through the process of two-dimensional, oblique perspective distortion, the imagery, when viewed from the privileged position results in an optical illusion, where three-dimensional objects appear to materialize from two-dimensional applications (Hosseini et al., 2017, pp. 276-278). This technique would also capitalize on low-cost materials deployment while maintaining the potential for engaging and compelling interaction.

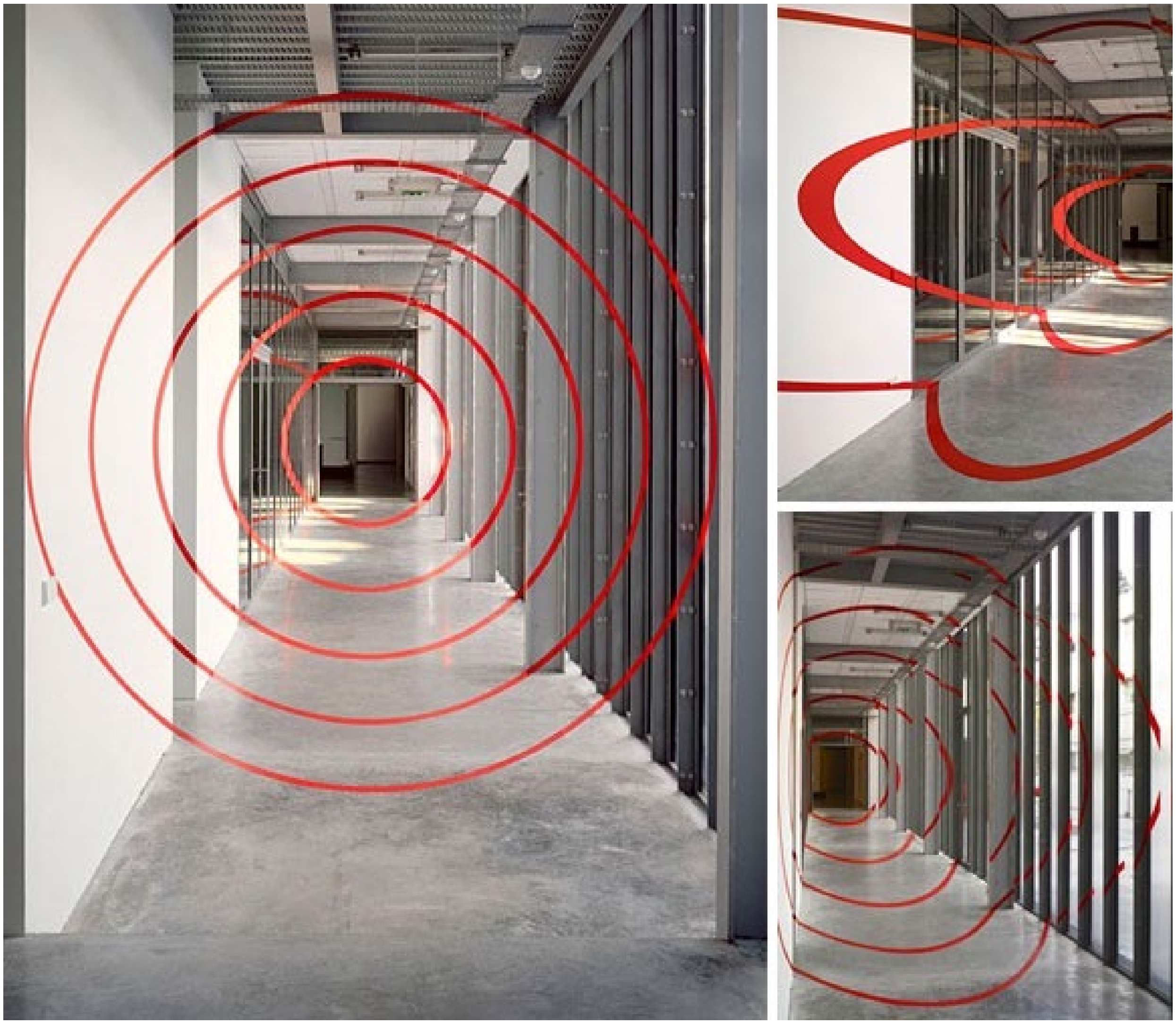


Figure 5. Example of anamorphic imagery: “Cinq Cercles Concentriques” by Felice Varini, Paris 2007 (Quinn, 2016).

3.2.6 Design Concept: Word Art, typographic messaging graphic.

The use of a typographical messaging system was developed as a way of creating a recognizable, and approachable graphic, that could be both interactive and inclusive, in attracting public attention towards the 2019 route. With the idea of being bold and playful, a word art text visualization system was created. It would identify the specific AATC 2019 art stops, while also garnering public curiosity towards their possible meaning, through the discovery of multiple installations throughout the downtown area, allowing for individual or serial experience. The typographic strategy configures the word ‘art’ into a grouping of different but associated phrases in expressing social and cultural connections in thought-provoking ways, through an articulated form of the commonly recognizable crossword/scrabble organization, while subconsciously suggestive of a doctor’s visual acuity test, in generating split-second puzzles (figure 6). Both the anamorphic technique and the typographic word art were then combined, expressed in bold color, to create simple mock-ups of the visualizations in each art stop location (figure 7).

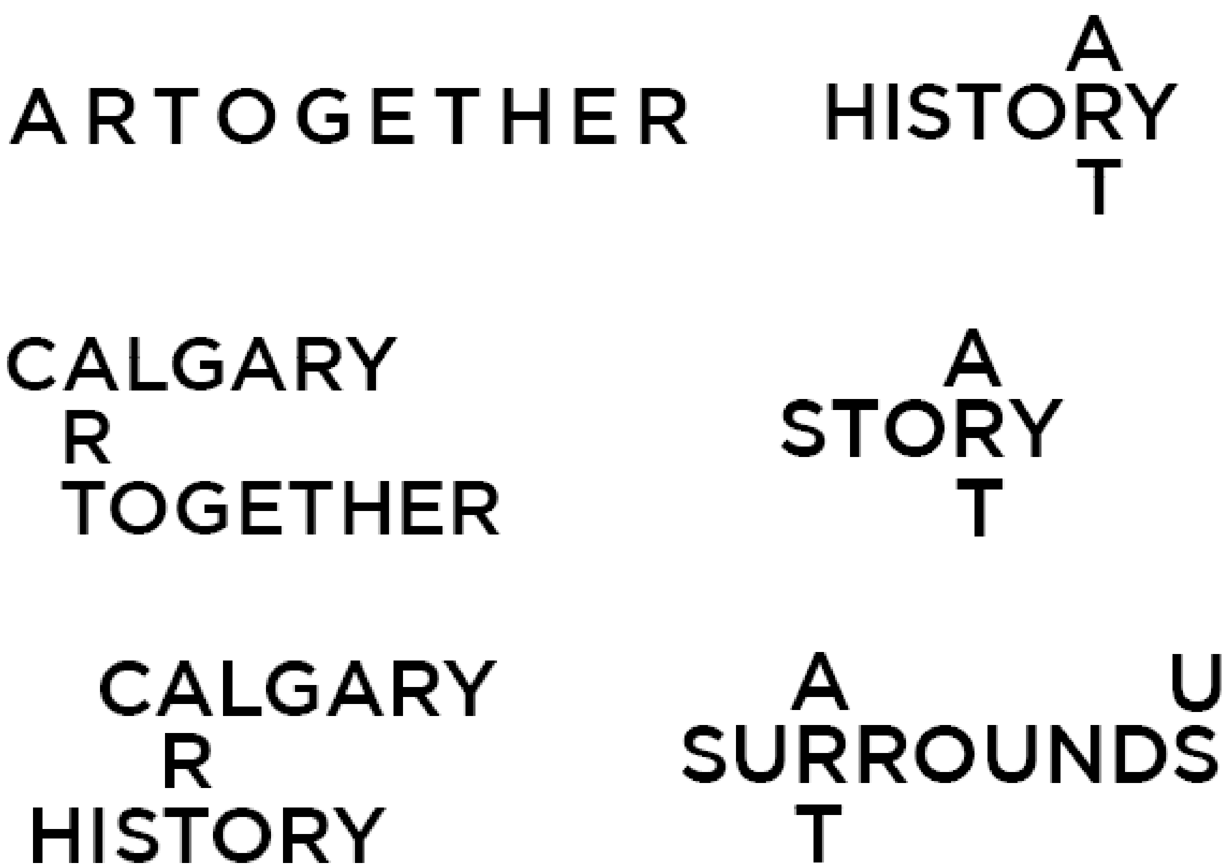


Figure 6. Various word art configurations that all incorporated the word art.

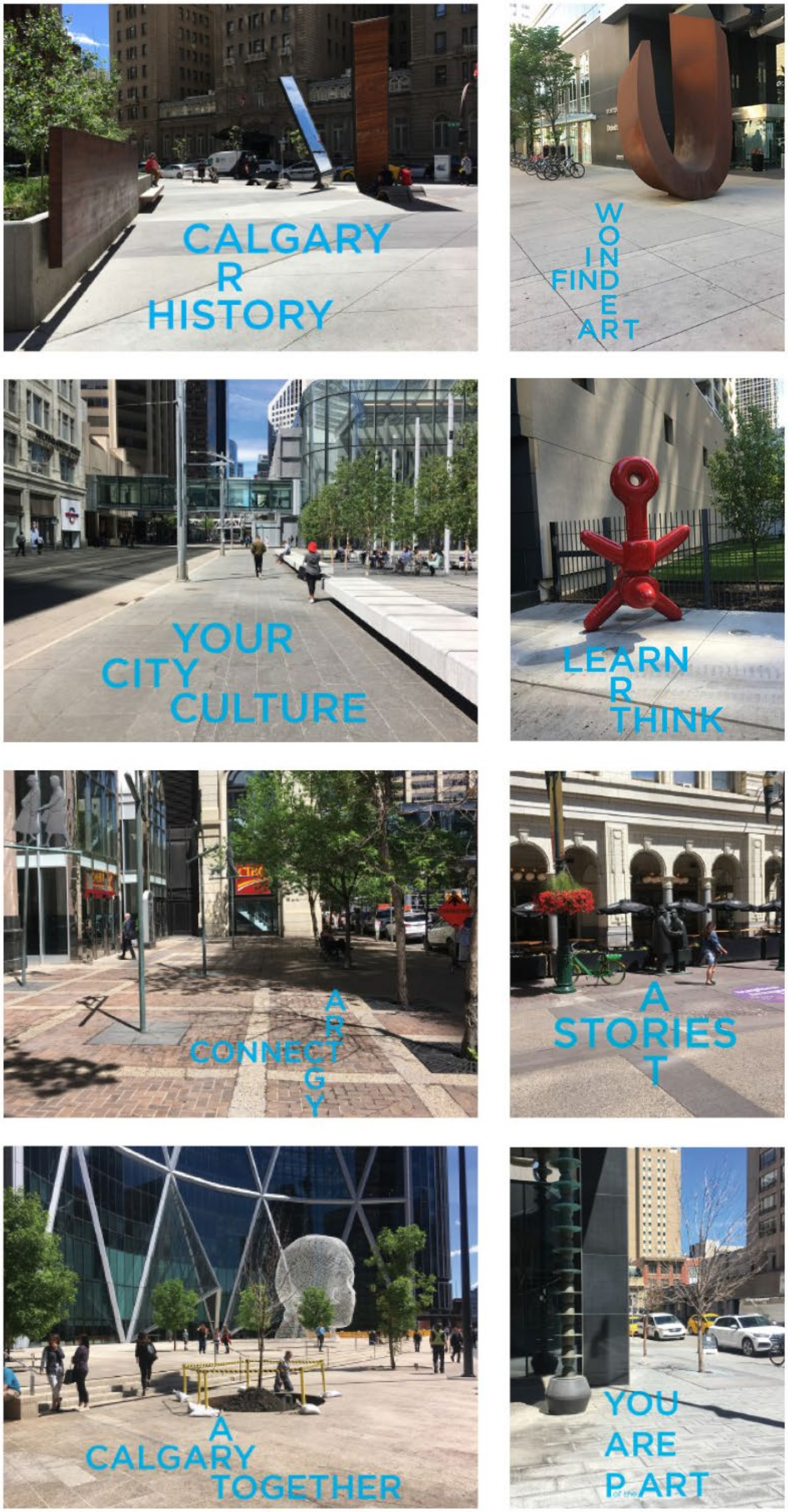


Figure 7. Preliminary mockups of the eight art stops.

3.2.7 Prototyping and Testing: Stencils and Digital Projection

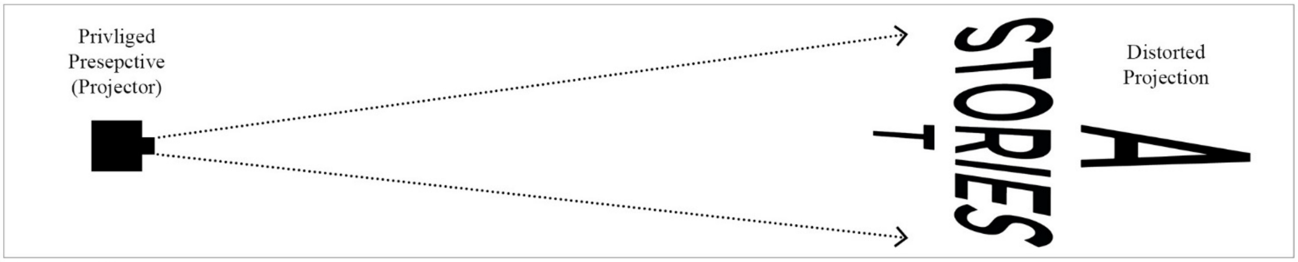
Two specific application methods of stencils and digital projection were explored in comparing installation time and accuracy. The combined techniques were then further developed so that the word forms could be laser-cut into stencils of component parts (kits-of-parts), to be assembled, on-site, and used to paint the word art onto the art stop location surfaces. The anamorphic technique was adapted to the word art configurations so that the optical illusion of the words would appear to stand up straight, in oblique perspective, which entailed distorting the words by stretching them dimensionally (figure 8).

Figure 8. Word art anamorphosis demonstrating distortion.

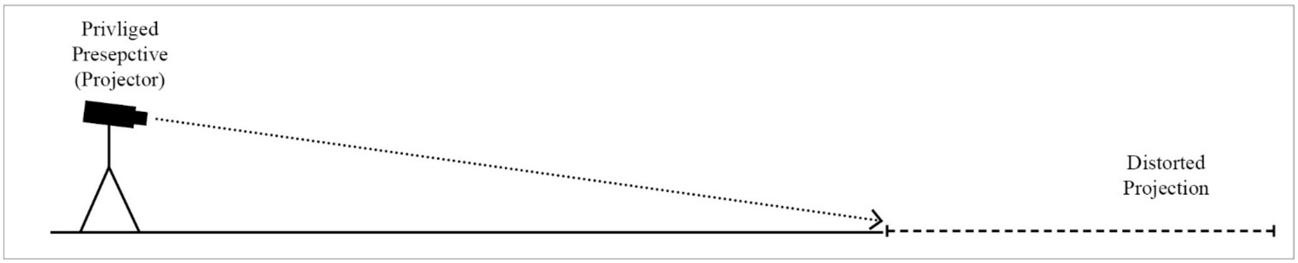
The forced perspective, word art configurations were then laser cut into their component parts using a large-bed laser cutter. They were then used for testing with temporary spray chalk (figure 9).

Figure 9. Kits-of-Parts fabrication process: 1. Cardboard (Ramboard) cutting medium. 2. Laser cutting Ramboard. 3. Complete laser-cut component. 4. Component assembly. 5. Complete component assembly (kit-of-parts). 6. Spray chalk paint application.

The alternative application technique of projection was also tested for its potential onsite flexibility in capitalizing on the anamorphic technique, where small adjustments could be made to specific site conditions that were not possible with stenciling. This application technique involved projecting an image of the word art onto a surface from the point of privileged perspective, resulting in a distorted oblique projection plane, which would then be traced, taped, and painted with spray chalk or temporary spray paint. (figure 10; figure 11; figure 12).



Projection Plan



Projection Elevation

Figure 10. Angled ground plane projection technique in generating anamorphic distortion.

Figure 11. Projection process (shop): 1. Projector angle towards the ground. 2. Taped word art from privileged perspective. 3. Distorted projection angle. 4. Chalk spray paint application in bright green. 5. Removal of tape revealing overspray. 6. Completed word art projection application from the privileged position.

Figure 12. Projection process (street): 1. Projector set up (with assistants: Jane Durham & Vuk Filipic). 2. Night-time word art taping process. 3. Follow up tape trimming process. 4. Plastic cover and spray chalk process.5. Word art reveal (with faint overspray). 6. Anamorphic word art, daytime.

This technique would allow for the exact positioning of the privileged perspective unique to each art stop site condition, but would require much more preparation and installation time in accurately taping the outlines of the word art by hand, covering open areas for over-spray, then spray painting the actual word art areas.

3.2.8 Testing Results

In comparing both stenciling and projection techniques, each displayed advantages and disadvantages best summarized as a trade-off between accuracy and preparation time, both of which were important considerations for the installation of the wayfinding system.

The stencil technique was much more labour intensive and time-consuming on the front end of the design process, with having to organize and format the word art for laser cutting. The actual laser cutting process was also time-consuming, which included several preparatory steps, from cutting the original cardboard material to laser bed size, to loading and operating the laser cutter, and finally, organizing and storing the final laser cut word art to avoid damage.

Installation was also surprisingly time-consuming. First, the laser-cut components needed to be laid out and taped together in place to formulate the entire word art configuration. Because of the nature of the laser-cut, cardboard material, and its propensity to buckle, weighted objects were required for corners and edges in attempting to keep the stencil as flat as possible in achieving a clean boundary-line when applying the spray paint. This added an entire additional step to the preparatory process that was extremely time consuming and problematic. It also presented issues with on-site installation in the acquisition, transport, and placement of multiple weighted objects. Because of the size of the stencils, even in their smaller component parts, the required stacking and rolling process for transportation and onsite installation, further exacerbated corner and edge material buckling, leading to additional preparatory time and effort.

The projection method's advantages directly addressed the aforementioned issues with the stencil application. The use of tape to contour the letterforms of the projection created extremely clean and crisp boundary lines that helped the completed word art configuration emerge dramatically from its grounded surface, benefiting the anamorphic effect. The trade-off came in the form of much longer taping and cutting operations, that consumed the majority of the entire installation process, and, which required a high level of detailed attention and skill in following a faintly projected, curved line with a tape edge, often requiring several attempts before achieving the desired accuracy. As the word art configurations became more complex, the installation time would increase exponentially. The other major issue is one of scheduling for onsite installation where the projection technique would need to be performed at night, after sundown to be able to see the projected images.

3.2.9 Design Revisions

In lending support for the wayfinding system as part of AATC 2019, the corporate property owners of the art stop locations collectively expressed concern regarding the use of paint that would be used for the word art configurations, and that any risk of permanence or expensive removal would prevent the project from proceeding. Some of the locations had just recently completed costly pedestrian pavement system installations, while others had already spent their allocated maintenance budgets.

After several meetings and conversations with the various project collaborators and property owners, and after detailed, hands-on research into various temporary paints alternatives, it was decided that a paint application would not be a viable material for the completion of the wayfinding system. Research was then completed into alternative materials with proven temporary and removable performance capacities.

After further research, it was deemed necessary to seek the services of a local signage printing, and installation specialist that were familiar with specific production, and installation processes that accompanied the highly specialized adhesive, vinyl cut materials that were to be used. After a walk-through tour of the art stop locations, it was then decided to go with a local signage vendor with extensive experience and a proven track record in supplying, and installing highly durable and safe adhesive materials. With the vendor in place, we were then able to secure corporate contributions in meeting the project's budgetary requirements. This design revision in the use of a printed adhesive material that could be cut to any shape allowed for further examination and articulation of the anamorphic effect within the word art configurations. This resulted in the use of shadows in the word art configurations to accentuate the forced perspective and the optical illusion of creating three dimensions (figure 12). Although a much higher cost, the printing on adhesive technique allowed for a 'prefabricated' level of control with the design of the word art configurations that allowed for exact manipulation of the imagery in achieving the desired anamorphic outcome. It also allowed for more flexible, and rapid installation scheduling, that could occur any time, on dry ground.

Figure 12: Art stop design revision mockups with shadows

3.2.10 Onsite Installation.

The installations of the printed adhesive, word art configurations were the fastest of all the application techniques (table 2) and were delivered with the same color matching acuity of any other large-scale full-color digital print output. The material (*walk and wall textured vinyl*) was slip-resistant and the adhesive powerful enough to remain cemented to the ground, even over uneven brick paver surfaces (figure 13).

Figure 13. Onsite, art stop, anamorphic word art installations, with shadows.

Table 2. A comparison of wayfinding application techniques.

Per Art Stop	Stencil	Projection	Digital Print Adhesive
Install time	2.5hrs	5. 5hrs ✘	.5 hrs ✓
Accuracy	Not accurate ✘	Very accruate	Extermely accurate ✓
Scheduling	Any time ✓	Night time/ after dark	Any time -dry
Cost	$150.	$90. ✓	**$1000** ✘
Paint material	any	any	None ✓
Reusable	Yes ✓	No	No

✓ Positive performance ✘ Negative performance

3.2.11 Modular Urbanism in AATC, 2019.

As previously outlined in the placemaking section of this study, both the process and the art of placemaking entails more than just the building of physical objects in specific locations, but must take into account local context in understanding the social, cultural and historical influences that contribute to the meaning of place. AATC as a reoccurring cultural event rooted in the local arts community, spotlighting currently existing cultural resources, and their importance to local urbanism, is an example of creative placemaking, where the decentralized connection of multiple cultural assets combine to provide a holistic understanding and appreciation of a distinctive local culture (Markusen & Gadwa, 2010).

The wayfinding system as functional component of AATC aimed to adaptively recreate the use of existing, underused, and anonymous urban spaces through the design of creative and interactive experiences, that connected to local cultural resources and the larger arts community. With the ambition of activating banal, and overlooked micro-urban spaces, through a vibrant and playful visual scheme, the wayfinding system attempted to employ human curiosity as an initial combustive spark in the process of social infrastructure development. As a small scale, multi-site intervention that offered inclusive, accessible, and interesting aesthetic encounters, the wayfinding system, through the design of word art configurations, also aimed at reflecting the larger, longer-term, AATC placemaking program through a walkable, connected and curated local cultural experience.

The wayfinding system also integrated several tactical urbanism techniques in both concept and execution. The word art configurations were designed as multiple, human scale, temporary urban interventions, in providing playful and interactive aesthetic experiences. Through the operation of the anamorphic technique in creating legible, eye-catching optical illusions and employing a distinctive bright color palette, passing viewers are enticed into interacting with the ground plane interventions. At the same time, this street-level aesthetic connects to the conceptual underpinnings of the larger AATC program of expanding conversation about public art in the city, translating the urban form of plazas, streets, and sidewalks into program. The city itself becomes gallery space. In doing so, the wayfinding system reflects a central tenant of tactical urbanism in implementing experimental interventions, inviting viewers to participate and engage with their urban surroundings in novel and unfamiliar ways. The design of the wayfinding system encourages casual and informal interaction with the streets, as a means of "playing with the city" (Douglas, 2014, p. 13), where micro-local

(Courage, 2013, p. 89) disruptions cultivate quick-time participation in the formulation of place identity and meaning.

Modular thinking played an important role in the design of the wayfinding system as part of the AATC program. It was conceptually instrumental in generating the idea of the word art configurations, where a governing framework allowed for creative variation and reconfiguration of specific messages and phrases. Each phrase was markedly different, but all existed within a standardized and structured format, where a balance between flexibility and constraint compelled creativity. Modularity was also an important component of the initial digital fabrication process, in the design of a kit-of-parts stencil system that was generated with the intent of making the process of installation more efficient and sustainable. Because of several complications associated with the fabricating the kit-of-parts stencil, where onsite material deployment was inaccurate, it was deemed an inferior method to the projection technique, that provided more flexibility and control of the final outcome.

Due to maintenance issues regarding the use of paint on the art stop finished surfaces, revisions were made to the final design process where a printed adhesive was substituted to guarantee its temporality and ease of removal. Although the aim was to design a modular kit-of-parts stencil system that could be reused for multiple interventions, the printed adhesive still contributed to project resource efficiency through digital printing, cutting, and the rapid onsite application, in avoiding the use of aerosol or other paint materials.

3.3 Case Study 2: Green Alley Project, 2019.

3.3.1 Context.

The Green Alley Project (GAP) is a three-year pilot research project that seeks to transform downtown Calgary alleyways into more engaging and usable social and cultural spaces, through a series of onsite interventions in collaboration with SAPL. The vision is to transform utilitarian alley spaces that are typically reserved for parking access, and garbage collection, into "vibrant people places [with] dynamic street-level activity and enhanced stormwater management in an under-utilized component of downtown infrastructure" (SAPL, 2019). As SAPL Dean, Dr. John Brown (SAPL, 2019) states:

> Urban alleys have the potential to be transformed from derelict service corridors into sustainable places that are amenities for the public…[where] collaborative research teams are taking a multi-pronged approach to investigate how focused and informed design can facilitate placemaking and economic value. (p.4)

Ultimately the program looks to "demonstrate long-term benefits of green alleys, and build momentum amongst stakeholders, policy-makers and the public, with a three-year goal of adding a new dimension to downtown Calgary's urban experience" (SAPL, 2019, p. 4).

3.3.2 Participants.

Since April 2019, the GAP was developed as a collaboration between SAPL and the CDA to invest in a progressive and innovative program that looked to, not only, physically transform under-utilized urban spaces, but investigate the potential revitalization through academic research and knowledge creation in "challenging the status quo in testing new concepts that can stimulate economic development or diversity" (SAPL, 2019, p. 4).

3.3.3 Description.

The GAP 2019 program (September 20-22), like AATC 2019 was part of a larger urban collaboration initiative that included five components:

- GAP 2019

- AATC 2019
- Sketch Crawl and Design Matters Talk, Elizabeth Boults (UC Davis), and Chip Sullivan (UC Berkley).
- Beltline Urban Mural Project (BUMP), which led the commission and completion of a laneway mural from an internationally recognized artist.
- Urban Collaboration Initiative Event. Held to help promote and celebrate the various installations in recognizing their contribution to progressive city building.

The GAP is defined as “an integrated spatial and functional framework for environmental, social, and economic sustainability.” (SAPL, 2019, p. 8). The goals of the project are:

- To restore natural hydro-ecological processes to improve watershed health and reduce the risk of flooding
- To enhance the quality of the public realm through the promotion of pedestrian-oriented back-lane commercial and cultural functions
- To leverage integrated aesthetic and functional public realm and infrastructure improvements to attract investment and talent, and, catalyze revitalization.

The shared goals of “green mobility (walking and cycling) and green stormwater infrastructure (natural systems) are synergistic and can co-evolve to bolster the resilience and vitality of the city” (SAPL, 2019, p. 8). It consisted of three interdisciplinary and interconnected component projects, each led by a different faculty member. They included green infrastructure, architectural interventions, and the focus of this study, tactical interventions. For the GAP 2019 edition, the alley to be activated was located between Le Germaine on 9th Avenue SW and the 100-west block of Stephen Ave in downtown Calgary AB (figure 14).

Figure 14. Plan of GAP location (red outline).

3.3.4 Design Intervention.

Working with the principal investigator, Assistant Professor Kris Fox, the tactical intervention installation (TII) was interested in understanding the capacity to which low-cost, two-dimensional materials deployment could act as a sustainable alternative to three-dimensional structures in efficiently activating underused urban spaces. Tactical intervention installation design parameters included:

- Two-dimensional materials deployment on the ground plane and other surfaces, in place of building three-dimensional structures as potential sustainable building practice.
- Temporary in nature, lasting over the weekend of GAP event weekend.
- Rapid installation and removal capacity.

- Cost-efficient (limited budget)
- Integrate with the other GAP component projects.

The design concept for the TII consisted of three interrelated components combined to activate the underused alley space (figure 15), through integrating aspects of both social and multimodal forms of circulation which included; the corner activation mural, the pedestrian pathway, and, the traffic calming application (figure 16).

Figure 15. GAP, 8 ave, SW alley location condition.

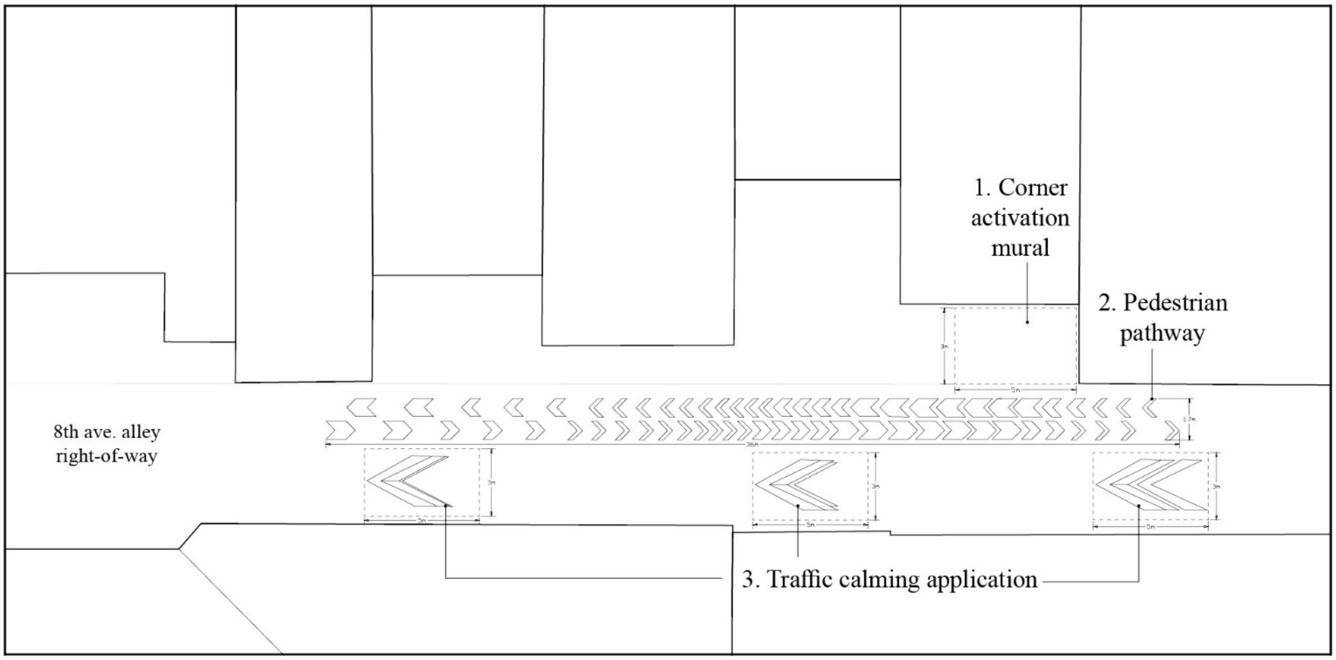


Figure 16. ITT Design intervention context plan: 1. Corner activation mural location. 2. Pedestrian pathway location. 3. Traffic calming application locations

3.3.5 Part 1: Corner Activation Mural.

This piece sought to combine the anamorphic techniques with a geometrically designed image in a monochromatic color pallet. This forced perspective ground plane and wall mural, encourages social media interaction, through smartphone engagement, using digital image capture technology. The geometric design, based on the illusion of floating cubes is also part of ongoing research into the possibility of low impact, visually provocative, 2D material applications in encouraging kinetic play, or gap-jumping by jumping from cube to cube (Fox & Brodie, 2020). "Anamorphic art and murals represent a low impact visually stimulating attraction by creating viable amenity spaces for the public and downtown businesses using inexpensive and temporary materials." (SAPL, 2019, p. 12) (figure 17; figure 18).

Figure 17. Corner activation mural design render.

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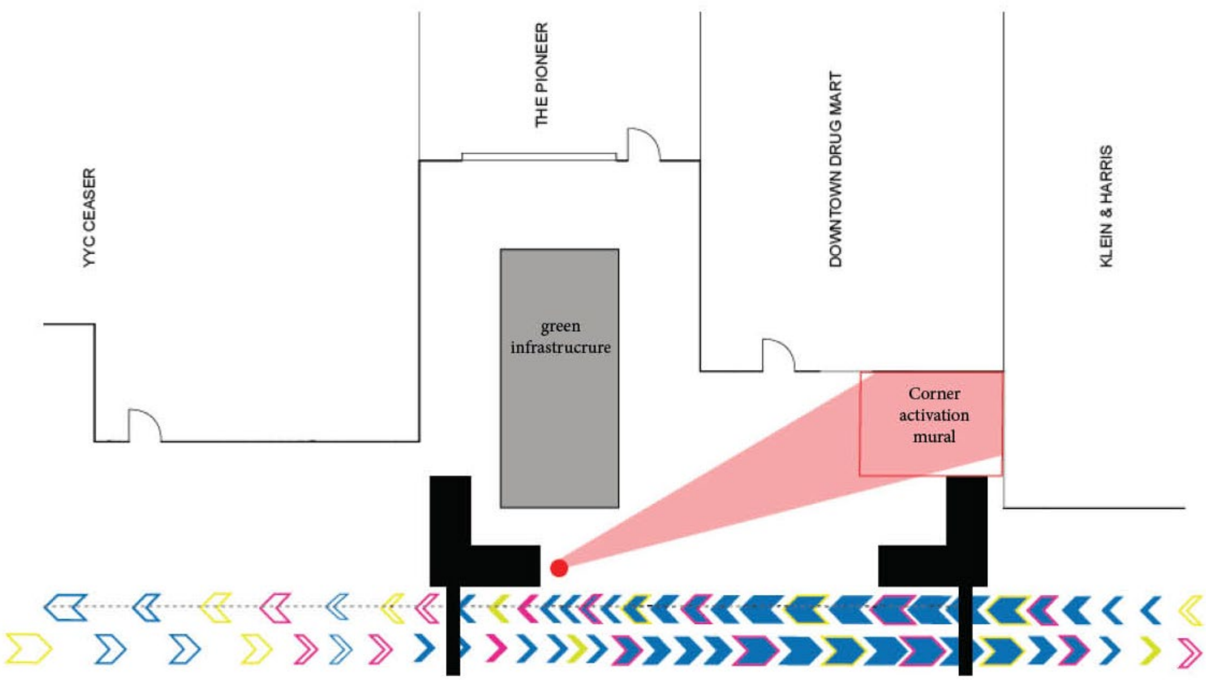

Figure 18. Corner activation mural context plan with privileged position (red dot).

3.3.6 Part 2: Pedestrian Pathway.

The 2D pathway application establishes a simple circulation route, using a multicolored, bi-directional chevron symbol to denote pedestrian movement. Designating a portion of the alley right of way, as a pedestrian pathway also helps expands the single function service corridor into an integrated bi-model circulation space through a low impact, cost-efficient, and visually stimulating 2D application (figure 19).

Figure 19. Pedestrian pathway design render (small multi-colored chevrons on right).

3.3.7 Part 3: Traffic Calming Application.

Operating in conjunction with the pedestrian pathway and the resulting increase in pedestrian circulation use within the alley right of way, the anamorphic technique was used to visualize the chevron symbol in generating a 2D, directional, traffic calming application. The use of forced perspective in developing traffic calming strategies, especially within urban pedestrian crosswalks, have become more popular over the past several years, resulting in pilot installation programs in many cities around the world including Calgary (Cole, 2019). Although further study is needed, these initiatives have proven to be popular strategies in developing multifunctional urban solutions in cultivating vibrant communities, and, as prime examples of how tactical urbanism and placemaking design strategies can positively affect community health in creating safer streets and public realm spaces (figure 20).

Figure 20. Traffic calming application render with anamorphic effect (yellow chevrons on left).

3.3.8 Design Amendments.

Through the process of obtaining permits for the temporary interventions with the city of Calgary Roads Division, several changes where required:

- Yellow was not permitted to be used within the interventions as it was deemed a safety color that only the city of Calgary could apply to roads.
- The traffic calming anamorphic chevron design was deemed 'unsafe' for motor vehicle operators and would be prohibited from use entirely.

- The bi-directional pedestrian pathway design was deemed unsafe for motor vehicle operators and would not be permitted.
- Amendments for use of the pedestrian pathway would include, a single direction chevron in the one-way direction of the alley, right of way (figure 21).
- The use of a single color other than yellow.
- The mural was approved pending approval of the property owner, which was obtained.

Figure 21. Approved pedestrian pathway design.

3.3.9 Prototyping and Testing: Pedestrian Pathway Stencils.

A simple kit-of-parts in the form of a stenciling system was designed and developed specifically for the pedestrian pathway by digitally fabricating the chevron cut-outs with a laser cutter, from Ramboard material (cardboard flooring protection). An order of operations was established to allow for rapid installation where the stencil would then be augmented onsite with tape in helping generate clean lines when applying spray paint.

Figure 22. Laser-cut stencil, kit-of-parts.

3.3.10 Prototyping and Testing: Corner Activation Mural Projection.

Like the AATC projection testing, a digital projector was used to test the anamorphic effect and establish an order of operations for the painting process, taking into account the color palette and required drying times. The testing would occur indoors under controlled conditions and over an extended number of days, to allow for complete paint drying times, and testing out color compatibility (figure 23).

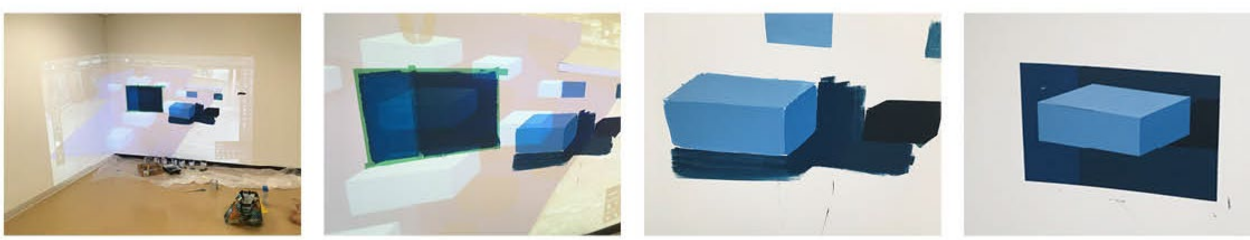

Figure 23. Color palette and paint material process testing on interior wall.

3.3.11 Onsite Installation.

Due to scheduling obligations, and the required need for darkness in using the digital projector, the painting times were divided between two six-hour installation periods on consecutive nights for a total of twelve hours of installation time (figure 24).

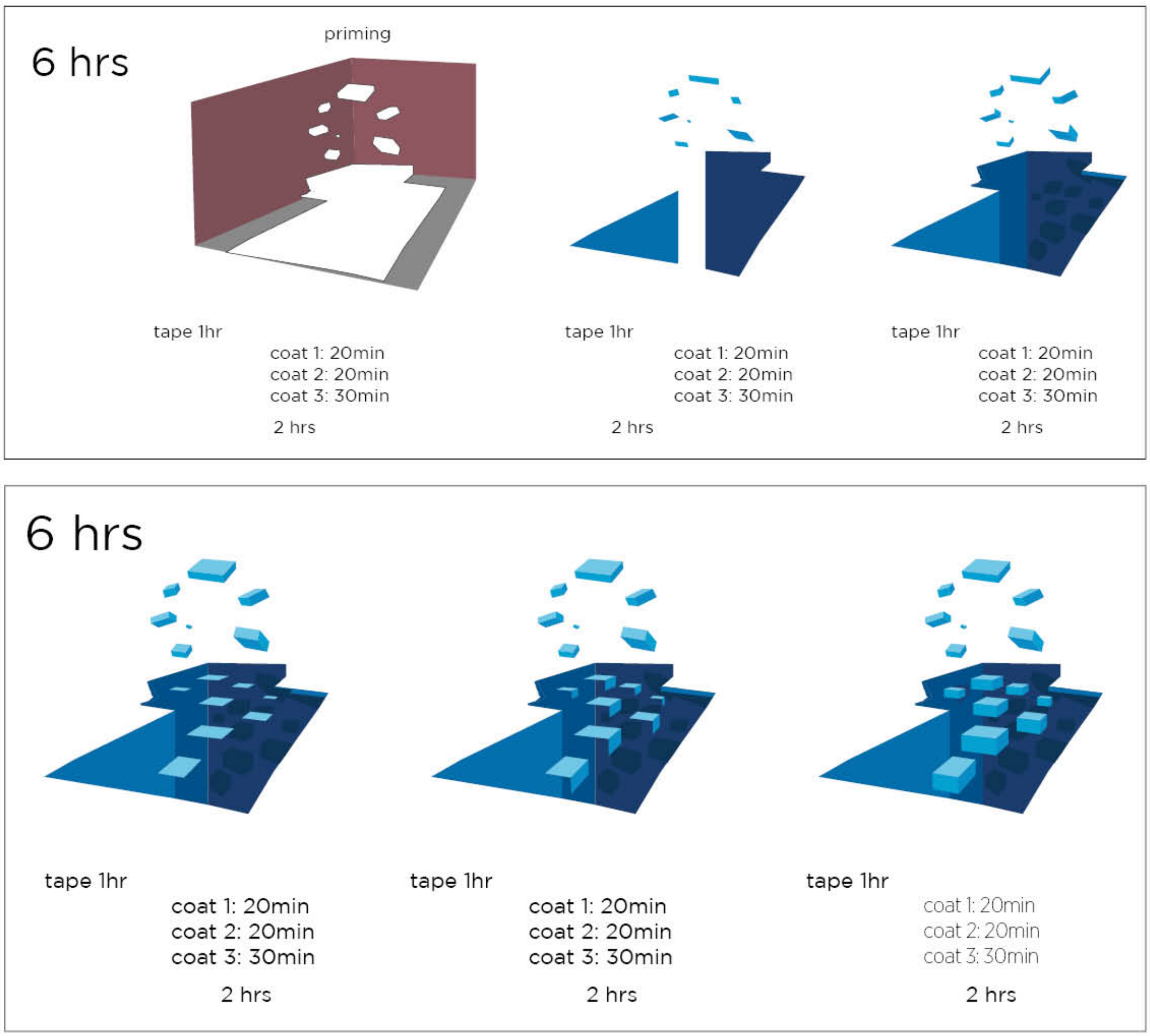

Figure 24. Corner activation mural order of operations, divided into two six-hour installation periods.

After having only completed one layer of priming, the first night installation period was prematurely terminated due to extensive rainfall, even after covering the area with waterproof tenting. Due to scheduling requirements, this resulted in having to finish the installation within one twelve-hour period on the night of September 19th (figure 25).

Figure 25. First-night painting attempt during rainstorm and next morning results. Plastic sheets were used to cover the initially completed undercoat (gray painted areas).

Painting started at approximately 8:00 PM on September 19th, as it became dark enough to use the digital projector and was completed twelve hours later, at approximately 8:00 AM on the morning of September 20th. Electric fans were employed to help paint drying duration and accelerate the overall installation process. A crew of eight fellow SAPL students worked in coordination on various tasks from painting, to taping, and site organization and support, expediting the order of operations process and facilitating its completion in under an extremely limited time-period with diminished contingency (figure 26).

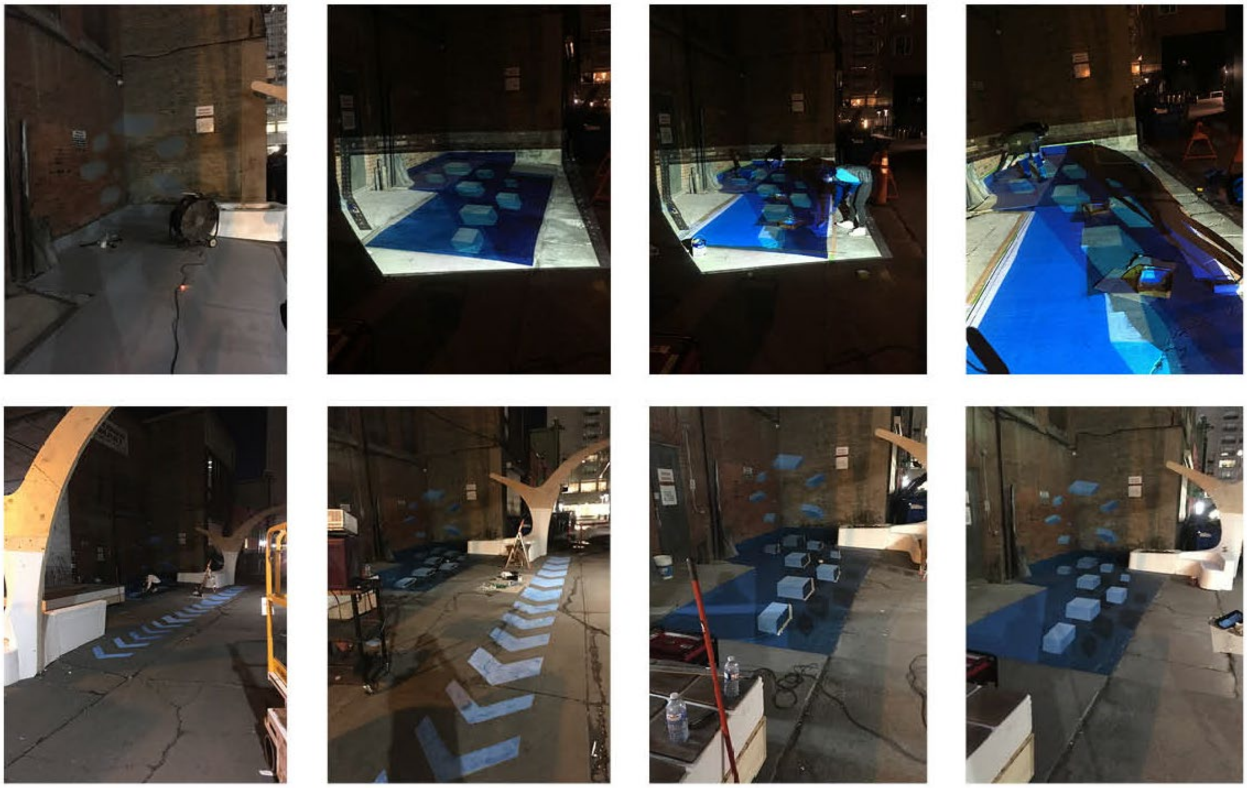

Figure 26. Second-night installation process from, drying, to projection to taping and painting.

The GAP was successful in attracting media attention in receiving coverage from local news organizations including Global, CTV, CBC, Livewire Calgary, and the Calgary Herald (figure 27).

3.3.12 Modular Urbanism in GAP, 2019.

The concept of Modular Urbanism was implemented in the GAP through the application of multi-scalar design principles and techniques. Although primarily understood as a tactical intervention, the TII was developed and operated within the larger context of the GAP placemaking framework.

The project combined the long term, multi-year, goal-oriented design, and intervention strategy, in driving the on-the-ground application of tactical urbanism techniques, to enhance urban public realm environment in cultivating sense of place and local culture (Thomson, 2003; Project for Public Space, 2018; Welch, 2017; Wychoff, 2015).

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SATURDAY, SEPTEMBER 21, 2019 ESTABLISHED 1883 POSTMEDIA

WHO IS THE REAL TRUDEAU?

Ultimate performance artist summons up some ugly shadows NP1

ALLEY REVITALIZATION

Kris Fox, assistant professor of landscape architecture at University of Calgary, jumps across floating blocks on G.A.P. Jump!, an urban space activation program involved in Green Alley Project on Friday. The project aims to revitalize downtown back alleys.

Figure 27. Cover of the Calgary Herald (09/21/2019 with corner activation mural with Prof. Kris Fox (The Calgary Herald, 2019).

The transformation of the alley, through a relatively small-scale implementation of stimulating, and interactive visual imagery, works in tandem with the larger-scale concerns of the overall GAP timeline, in effecting positive change in the local urban built environment. Through multiple stakeholder engagement, at the community, institutional and governmental levels, the intent of the TII was in meshing the multi-scalar design principles of both tactical urbanism and placemaking in generating GAP outcomes (figure 28). The application of interdisciplinary practice also helped showcase the tremendous potential in adaptive reuse of currently existing, mono-functional, urban spaces, that are often forgotten and ignored, into vibrant, activated, and multifunctional, social places.

Figure 28. Wide-angle context of the completed mural with a comparison of design render and onsite installation.

Using sustainable design methods, the initial GAP pilot program demonstrated the viability of multiple site capacity, as part of a potentially larger, area-wide, urban revitalization strategy. As an experimental prototype, using the tactical urbanism techniques of temporality, and rapid, low-cost, 2D materials deployment, the TII operated as a preliminary, tactile, and interactive, urban intervention, fully integrated into the larger context of the GAP placemaking project.

Although the application of modular design was less prominent, it played an important role in the organization and implementation of the TII. A modular design approach was used in both the pedestrian pathway, as a simple kit-of-parts stencil system, allowing for rapid and efficient material application, while also contributing to the design and organization of the order of operations for the anamorphic mural. Modular design thinking was applied to the decomposition, and reordering of singular, monochromatic, component shapes of the entire mural, into serially ordered groupings, or modules, effectively maximizing efficiency in generating the rapidly deployable, yet flexible application procedure. The modular design concept also contributed to an increased scalar transitional capacity in the application of multiple design principles and techniques, in which connective agility between holistic and detailed perspectives helped facilitate an interconnected and elegant design solution.

3.4 Case Study 3: The District

3.4.1 Context

Developed under the Lifescape sector of Kasian Architecture, The District is an adaptive reuse development situated in the inner-city community of the Beltline at 227, 11 Ave SW, in Calgary AB, owned by commercial property developer Speer Street Capital. The project includes the redesign of existing public realm, landscape, architectural and interior elements, centered around a newly built market shed in the site's central plaza and will include, mixed-use, ground floor, office, and retail space, combined with extensive amenity and pop-up artisan areas (Kasian Architecture, 2019a). As the site is located at the eastern edge of the Beltline community and surrounded by extensive arts and culture amenities, the project is ideally positioned to create a community gateway and hub that speaks directly to local culture. Specifically, The District actively incorporates its connection to Calgary's cycle path infrastructure into the redesign of both the public realm and interior architectural spaces. It also supports local business and the entrepreneurship of the city's growing brewery industry, by providing a "centralized hub" (Kasian, 2019b, p. 3), for breweries "to showcase their latest creations" (Kasian Architecture, 2019b, p. 3), in extending Calgary's current collaborative grouping of microbreweries, known as "the barley belt" (Kasian Architecture, 2019b, p. 4) into the downtown area. Through these initiatives, The District aims to strengthen the local community, by not only aesthetically updating a physical site, but by representing, and expanding local culture, and industry (figure 29; figure 30).

Figure 29. The District surrounding local amenities context map (Kasian, 2019a).

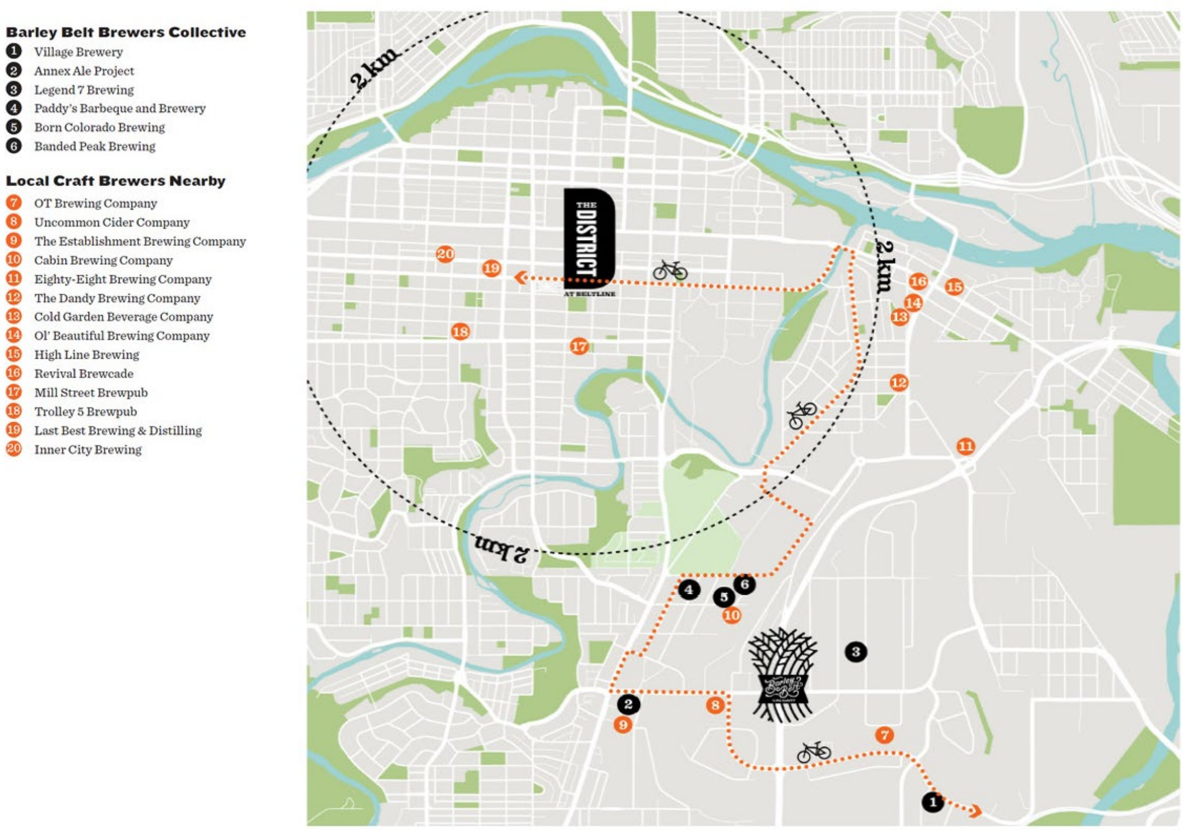

Figure 30. The District, Barley Belt context map with cycle routes (Kasian, 2019a).

Public realm design was an important factor in the overall adaptive reuse development in creating an attractive destination with a discernible sense of place. This included an extensive public art installation program, with large scale murals at several locations throughout the site. The central market shed area was designed to incorporate intimate laneways with local and seasonal kiosks. The entry, public realm areas were also designed with extensive bike storage, and accompanying plaza seating fostering active corners and frontages, while attracting people into the market shed area with compelling wayfinding and location signage (figure 31).

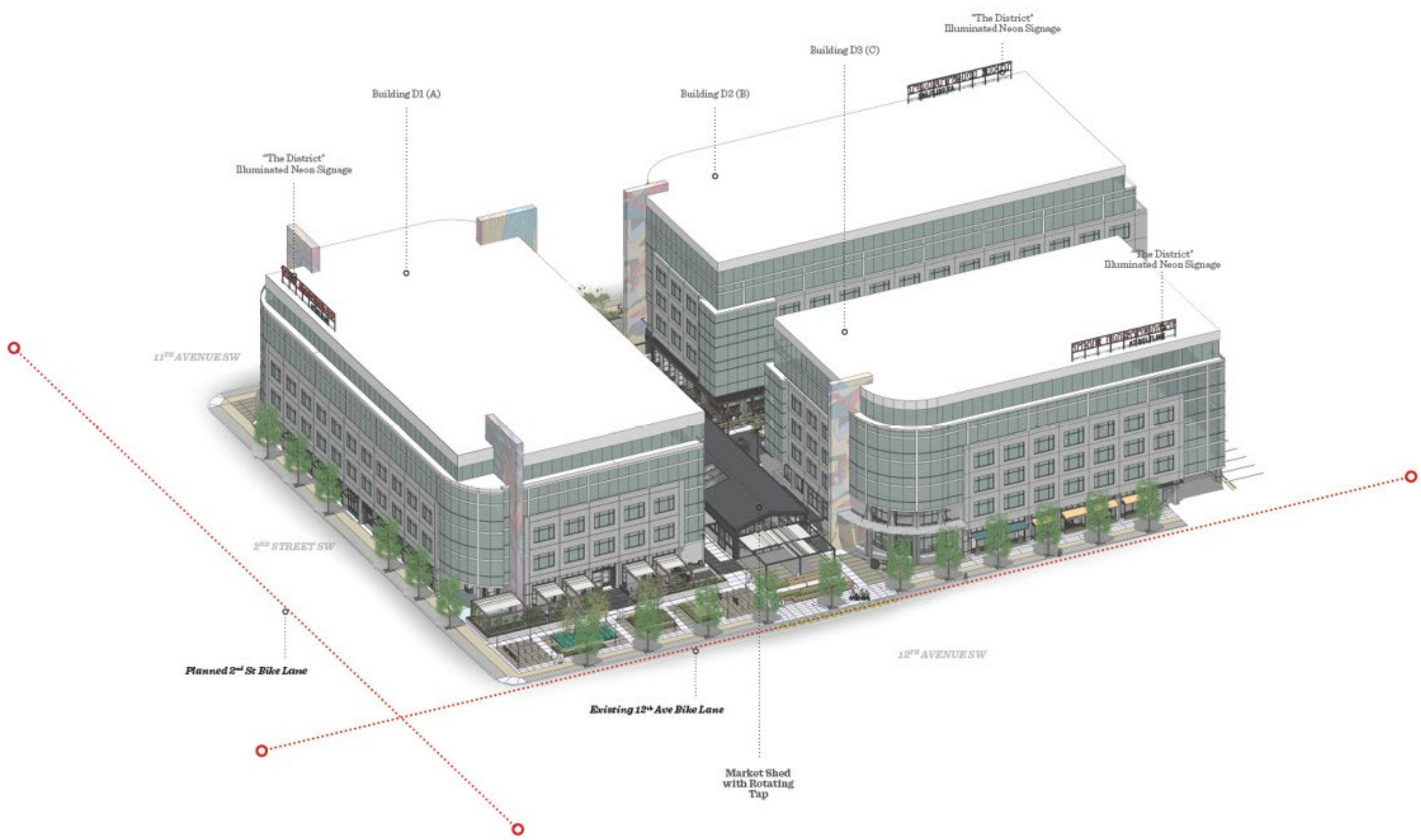

Figure 31. The District building scale Isometric diagram (Kasian Architecture, 2019a).

The District also contained an internal courtyard between buildings D2 and D3 that was intended to act as an open public space in which the various ground-level businesses and restaurants, including the market shed, would open onto. It was conceived as an intimate and hidden public amenity space that could be used by the building tenants for various events and gatherings, while also remaining a flexible, programmable space that could engage local public events, festivals, and celebrations. This central exterior public space would also contribute to the idea of the centralized community hub for both social and cultural connection (figure 32).

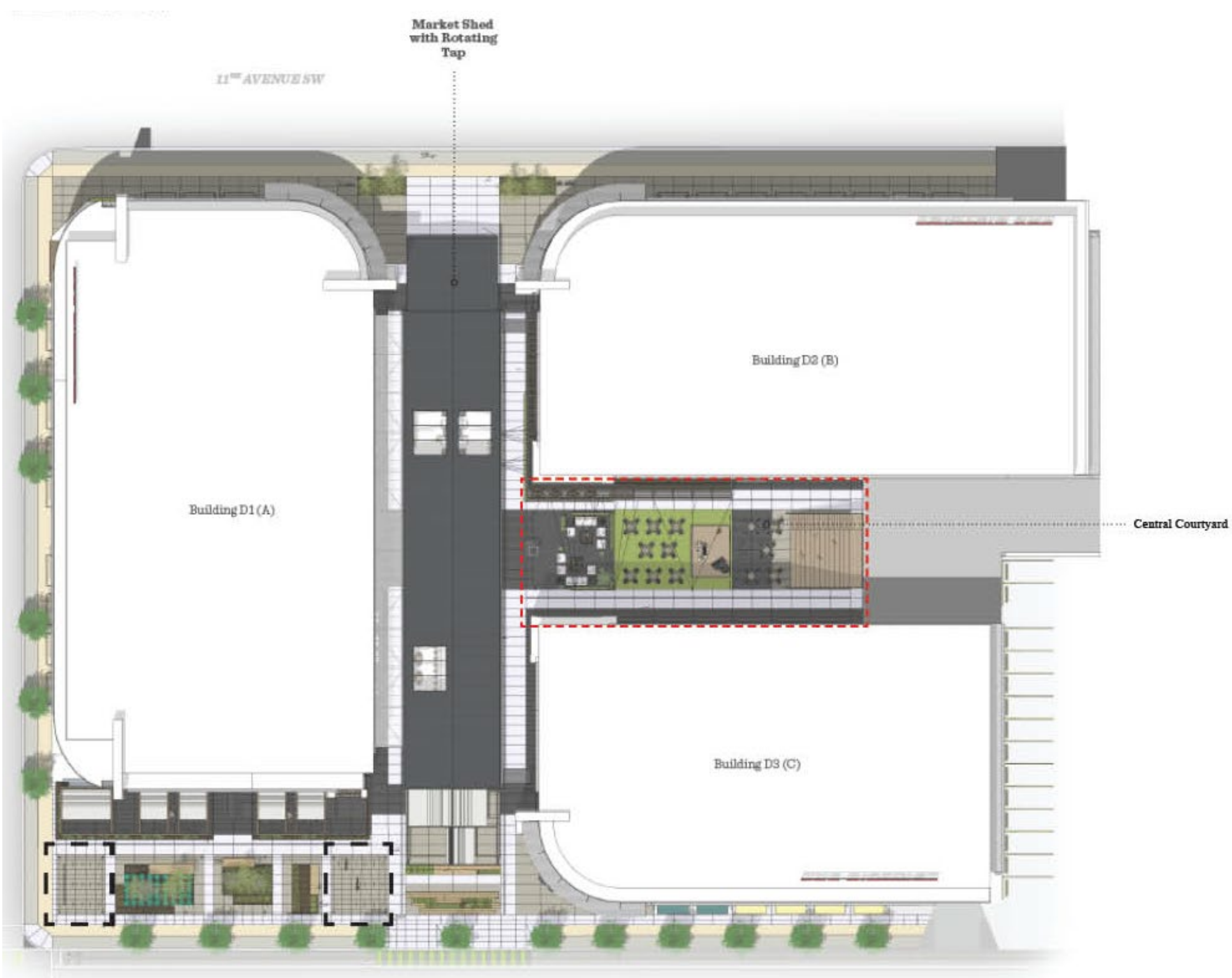

Figure 32. The District building plan and courtyard area (red dash) (Kasian Architecture, 2019a).

3.4.2 Design Intervention: Courtyard Redesign.

Working under the guidance of the Lifescape team, I was to develop an experimental conceptual design proposal for the central courtyard area that incorporated modular design. Kasian design goals included:

- Flexible, and programmable, dedicated open space for a variety of year-round tenant, and public events.
- Reconfigurable space design allowing for staged performance events, or, pop up markets, openings, and gatherings.
- Winter city design. Seasonal design and winter interest in attracting people into the space year-round, encouraging winter programming, events, and attractions.
- Activate space beyond weekday, rush hour, and lunch times.

Research Design goals included:

- Incorporate Modular Urbanism into the conceptual design of the courtyard in generating sustainable design solutions.

3.4.3 Courtyard Description.

The courtyard measures approximately 19m x 38m. It is shielded directly on its north and south and west sides by the six-story, D1, D2, and D3 buildings, with an extended, single-story connector building, spanning its east side, all of which keep almost the entire courtyard in shade, throughout the entire day, and protected from the wind. On the north side, there is a raised planter bed configuration in stone veneer, with lighting poles and intermittent bench seating, that spans the east-west length of the courtyard, and a curvilinear raised concrete planter bed on the south side that also spans the east-west length. On the east side wall, there is a large, triangular, raised, stone inlay planter. The ground plane surface is covered with a patterned paver configuration with accompanying segmented stone inlays that connect north and south planters. The reflective glazing of the three surrounding buildings helps to reflect light into the space (figure 33; figure 34.).

Figure 33. The District courtyard area (looking east).

Figure 34. The District courtyard area (looking west).

3.4.4 Design Concept: The District Modular Courtyard Design (DMCD).

In meeting the four design goals of flexibility, reconfigurability, winter season capacity, and space activation, the DMCD is made up of seven interconnected components, each using specific techniques and principles from the three design methods in representing the concept of modular urbanism. These seven components or assemblies include:

1. Ice tower and armature infrastructure.
2. Generative tile patterning system.
3. Modular installation paver.

4. Modular bench system.
5. Modular planter system
6. Mobile modular furniture system
7. Stormwater management system.

Each component was also designed within a temporal spectrum, from permanent to temporary in generating a responsive yet focused space for a variety of activities and programs. This temporal spectrum supports both the informal, quotidian use by local tenants and public, as accessible amenity space, and more formalized use by the surrounding community and city, as destination space for seasonal festivals and events (figure 35).

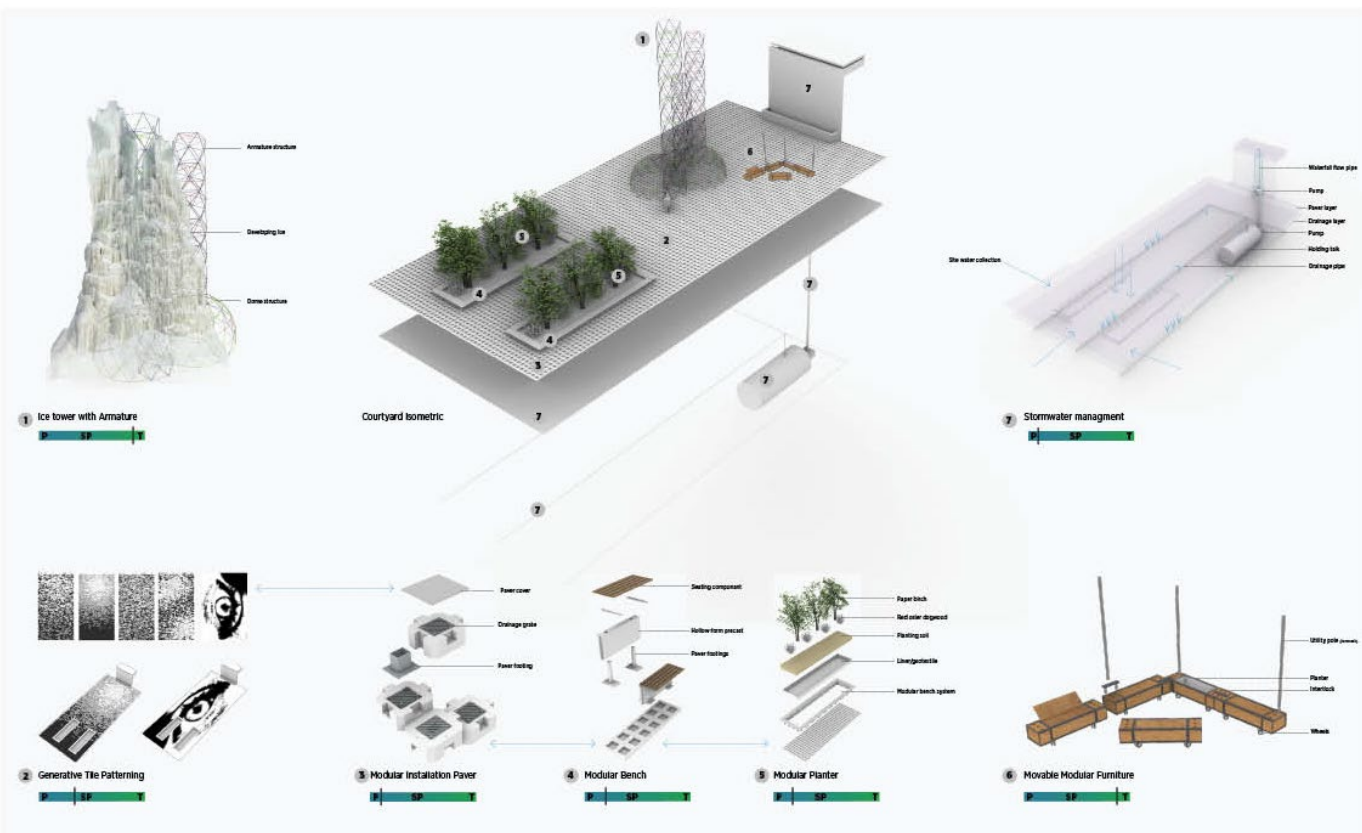

Figure 35. The DMCD (center) surround by the seven components elements.

3.4.5 Component 1: Ice Tower and Armature.

The central idea of the ice tower was to create a winter specific design feature around which an annual winter event or festival could take place. It would be centered around the formation of a monumental ice sculpture that would be generated during the coldest months of the year. The feature becomes a way of flipping the common practice of public realm programming during warm summer weather, towards an emphasis on the winter season. The ice tower would act as a local attraction throughout the formation process and culminate in a programmed unveiling, that could integrate with other city winter season initiatives.

The ice tower itself is made up of two main components that involve two distinct building processes; building the underlying armature structure, and then freezing water onto the armature structure to create the monumental ice sculpture itself (figure 36).

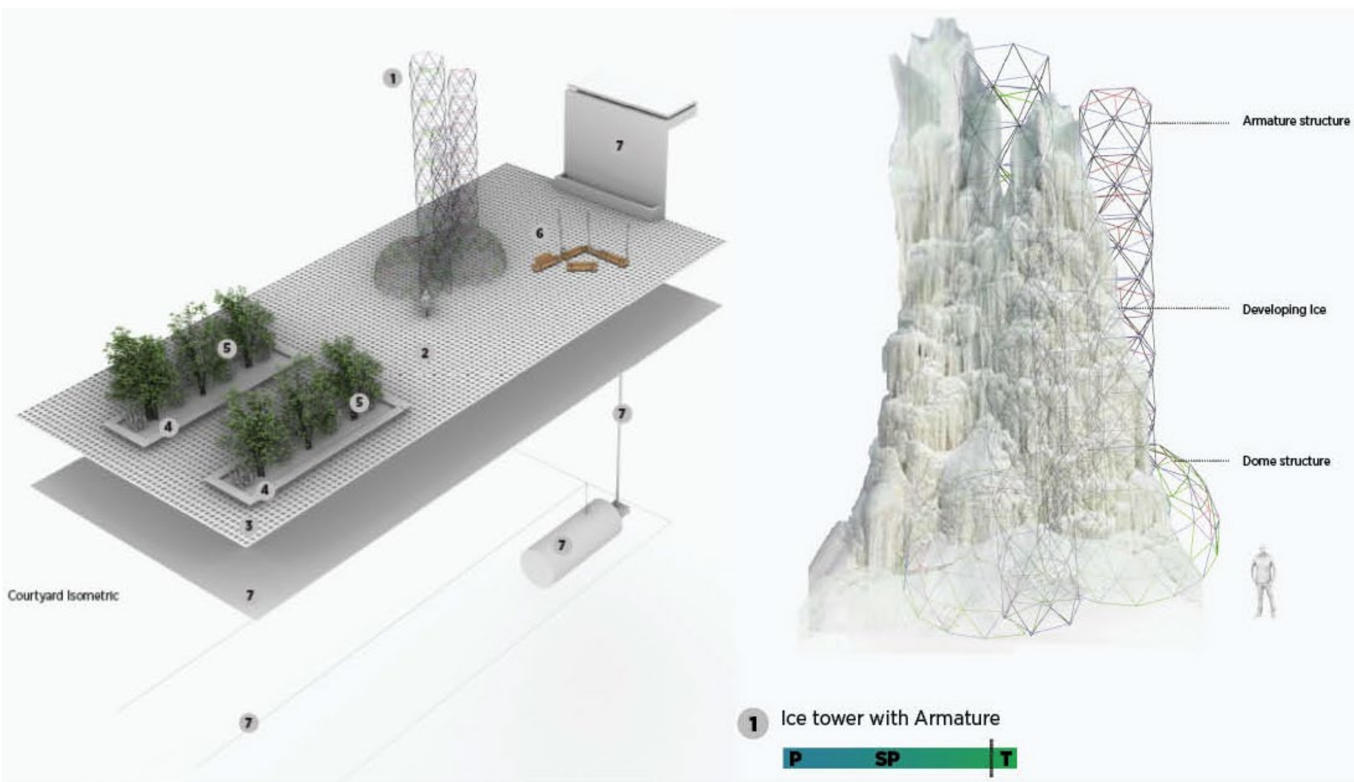

Figure 36. Ice tower with supportive armature structure.

The use of ice as material and the formation of the ice tower will also serve as a catalyst to connect the to the larger-scale discourse on ecological sustainability and climate change. Most notably, the cycle of the ice tower formation process, through onsite stormwater collection, freezing, and subsequent melting, and recollection, mimics the larger planetary hydrological cycles and draws attention to current issues like accelerating arctic ice melt. The Ice tower aims to develop a unique, annual placemaking event that can be celebrated for both its aesthetic ingenuity and its sustainability in contributing to the social, environmental, and economic progress of the city (figure 37).

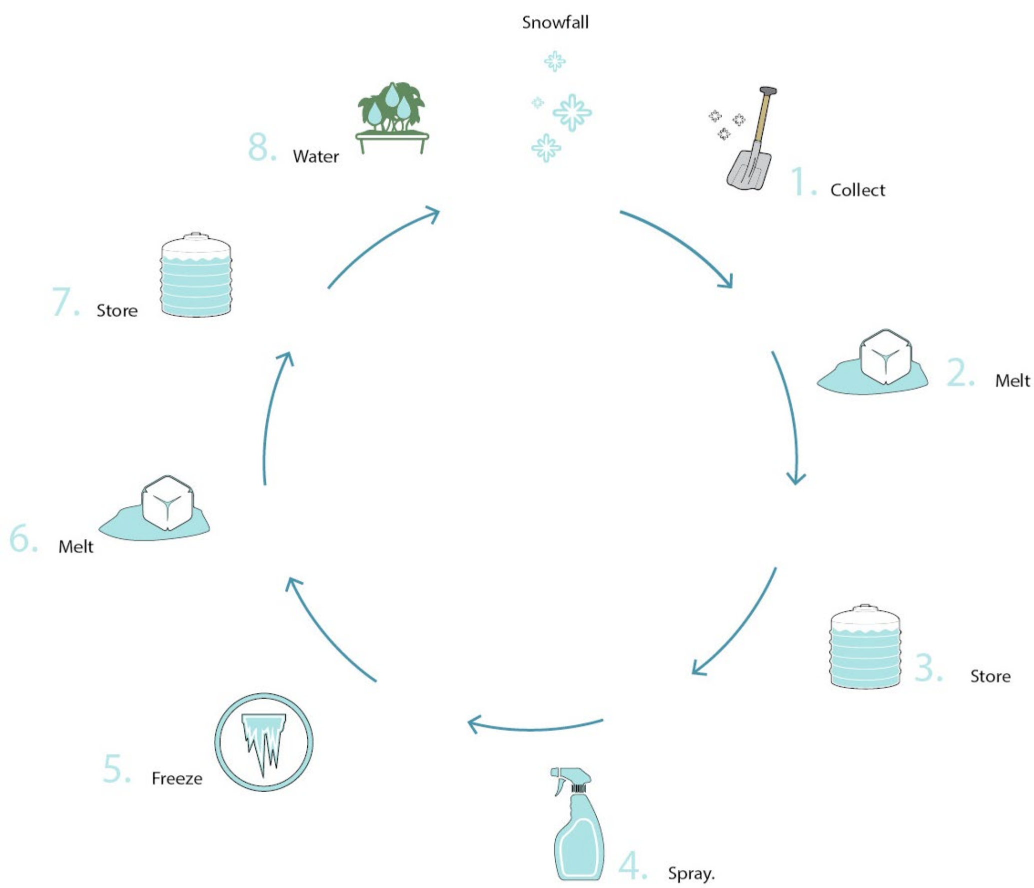

Figure 37. Ice tower sustainable water cycle.

The ice tower is based on the innovative work of Indian environment engineer Sonam Wangchuk (b. 1966) who invented the Ice Stupa, or artificial glacier, as a way of conserving water for early season farming in the Himalayas, due to restricted water availability as a result of climate change (Himalaya Institute of Alternatives Ladakh [HIAL], n.d.; Wangchuck, 2020.). The Ice Stupa's vertical conical shape allows for the prolonged freezing of winter runoff in preserving the ice water, in a high volume, low surface area form, controlling the rate if melting into the early spring months, and allowing for its precisely timed use in local crop irrigation. (HIAL, n.d; Wangchuck, 2020). An Ice Stupa is formed through the simple process of spraying a mist of water (using Pascal's Law of fluid pressure) onto support material and building up ice layers to form a tower (HIAL, n.d.; Wangchuck, 2020) (figure 38; figure 39).

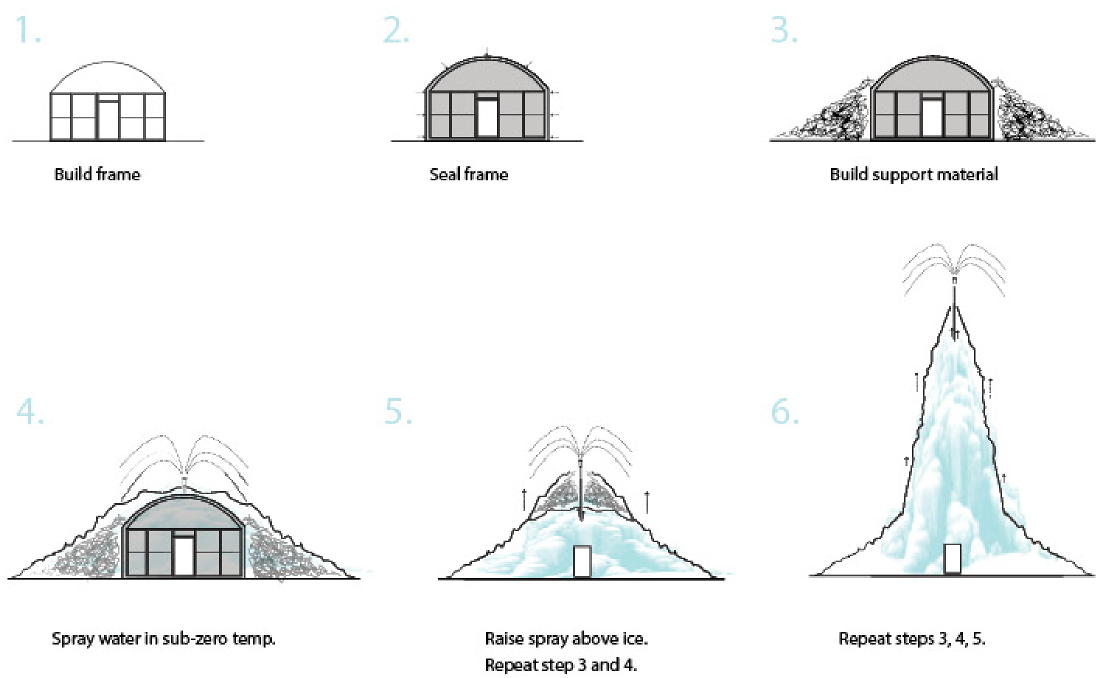

Figure 38. Ice Supa generating process (based on Wangchuck, 2020).

Figure 39. Onsite ice stupa process, from frame building to spraying and ice accumulation in forming the tower (HIAL, n.d.).

The Ice Stupa techniques would be refined and adapted to the specific needs of the courtyard environment, which would possibly include an extensive scaffolding, spray control system, and due to site constraints, would most likely require a mechanical water pump system.

As will be discussed in more detail in the seventh component, the water volume needed to generate the ice would be stored and used in the winter, as part of the site stormwater management system, that cycles collected stormwater through a waterfall system in the warmer summer months in establishing an integrated, multifunctional and sustainable design.

Initial ice tower dimensions and process freezing time was based on researched Ice Stupa capabilities through simulation models (Denes, 2020). As this initial exploration was limited to concept design, further structural engineering and site slab capacity calculations would be required, as specific site condition simulations.

The armature structure was included in the ice tower design to provide structural stability and ice formation control as a refined technique derived from the Ice Stupa method of spraying water onto the natural support material of Sea Buckthorn branches (*Hippophae rhamnoides*), which contributed to the ice developing its distinctive frozen form. This led to research into synthetic materials and potential modular structural framework systems, that included industrial scaffolding and pipefitting. But, their orthogonal limitations severely constrained the structural possibilities in designing more complex and expanded framework forms.

An initial attempt was made at developing a proprietary geometrically diverse framework system but was not pursued, due to project scheduling limitations. This led to the discovery of Zometool (Zometool, 2020), “a mathematically-precise plastic construction set for building a myriad of geometric structures, from simple polygons to Platonic solids, from models of DNA molecules to geodesic domes…” (Hill, n.d.) most often used in educational and classroom settings (Zometool, 2020). The Zometool modular system allowed for extremely complex geometrical structures and forms to be assembled with rapid ease and presented itself as a system that would provide the ice tower with the balance of stability and reconfigurable flexibility allowing infinite recombination of amateur structures in creating unique, annual, ice tower forms. After contacting the manufacturers of Zometool and introducing the ice tower project to one of their creators, Paul Hildebrandt, it was discovered that there existed a human-scale version, called BigZome systems, which seemed ideal for the needs of the Ice tower, as it was structurally proficient (figure 40).

The BigZome system would allow for the reconfiguration of new armature structures and forms every winter season, with the possibility of expanding considerably beyond simple tower structures. It would also allow for the assembly and disassembly of the structure, to be maintained, reused, and rebuilt over numerous consecutive seasons, saving on costs, without sacrificing on aesthetic quality. The use of a system such as BigZome would also allow for the generation of structures year-round, within the courtyard space, in building informal, tactile, and interactive play structures, and provide opportunity to use the system in more functional, programmatic ways, in creating kiosks, shelters, and staging. As with the above Ice Tower, the next stage in determining the viability of the BigZome system would be through extensive experimentation and prototyping, where issues related to safety regulations and accessibility would need to be addressed (figure 41).

Figure 40. Zometools construction set (left), (Zometools, 2020), and Bigzome system (right) (Hildebrandt, 2017).

Figure 41. Courtyard ice tower design renders.

3.4.6 Component 2: Generative Tile Patterning System.

Working in conjunction with the notion of a connected modular paver, this component integrates a creative and artistic element to the overall conceptual design. This system, at its most basic, is a series of colored, materially pliable, tiles, that fasten onto the top of the modular paver unit. When installed collectively, the tiles can be arranged into pixilated images and patterns, that would cover the ground plane of the courtyard. With the use of parametric software to develop the pixilation patterns, visually stimulating, and engaging imagery could be created as an innovative ground plane intervention. The generated imagery could be developed through various seasonal or programmed event themes, as well as through tenant, or community participatory design processes in supporting local community engagement with the courtyard space. The tile system would also be designed for rapid installation and removal, through a simple clip mechanism that would attach onto the grate component of the modular paver (figure 42; figure 43).

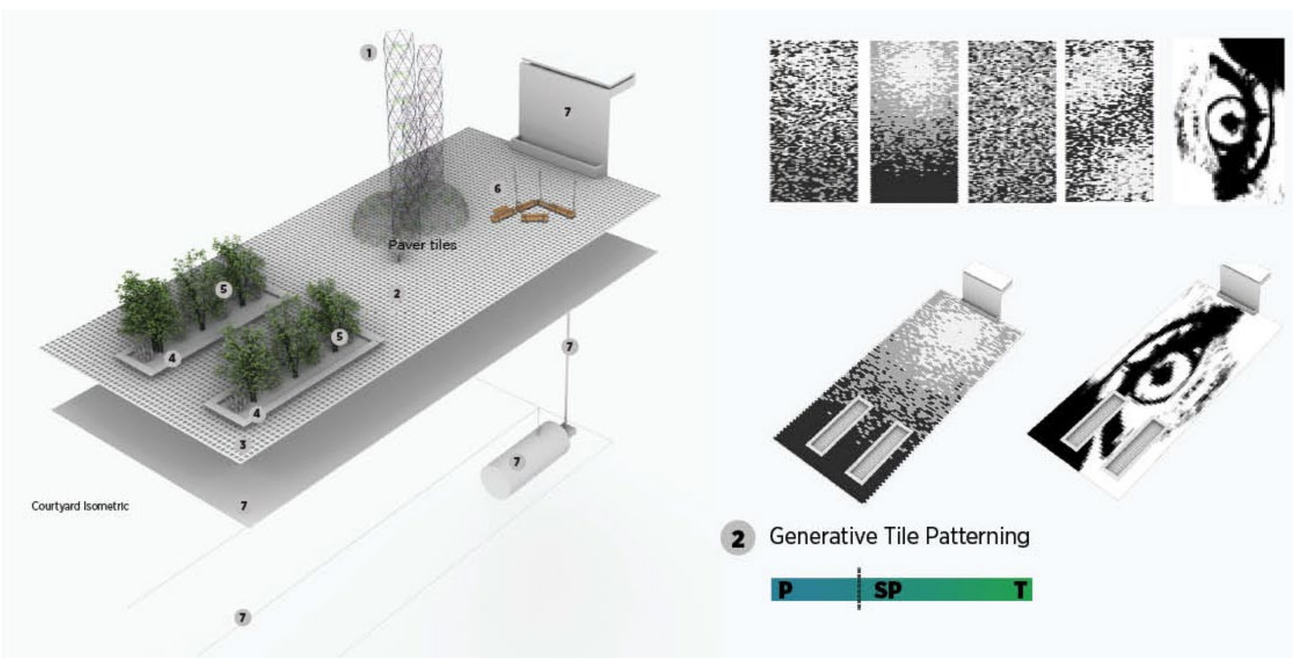

Figure 42. Generative tiling system as ground plane public art opportunity.

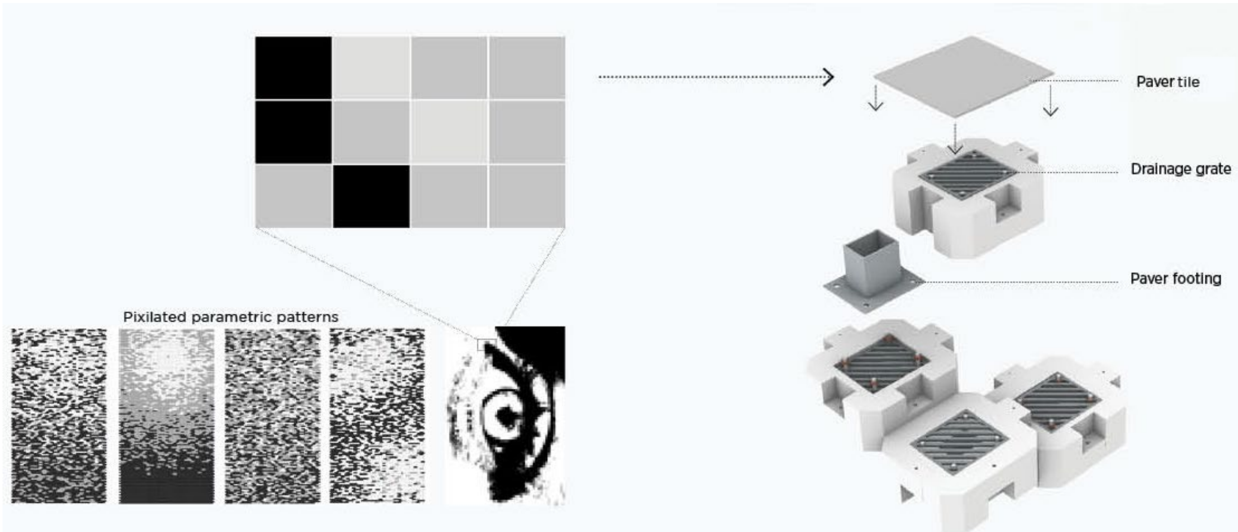

Figure 43. Detail of tiling system interface with the modular paver.

The tiling system could also be installed in specific areas or sections of the ground plane surface and is not required to be applied to the entire courtyard, or, to every modular paver, as the modular paver system is designed to operate without them. The tiling system serves to provide an innovative aesthetic experience to viewers, both at grade and through prospect views from the courtyard's framing, six-story, D2, and D3 buildings, while also providing multifunctional material alternatives for ground cover, when variable rigidity or plasticity is required. The easily installable, modular capability of the tiling system, within the context of programmed events and gatherings, could also provide temporary, spatial delineation and organization capacities, as an adaptable wayfinding system.

Beyond further research into materials and dimensioning, concerning issues of structural support and safety, the tiling system would need a robust organizational structure, including a substantial installation, storage, and maintenance plan, in coordinating a complex system with a vast amount of individual parts.

3.4.7 Modular Installation Paver (MIP).

I chose to use a design for the paver developed by fellow SAPL, MLA student Emma Broadie, derived from her work in Prof. Kris Fox's second-year construction course. It was adapted as a multifunctional, modular unit that is part green infrastructure, and part adaptive infrastructure, in literally forming the base layer on which the rest of the DCD is secured. As a concrete, interlocking modular unit that is interchangeable, it operates as a sustainable, building block, connection component, in addressing stormwater management, temporary structural capacity, and social and cultural public realm interaction (figure 44).

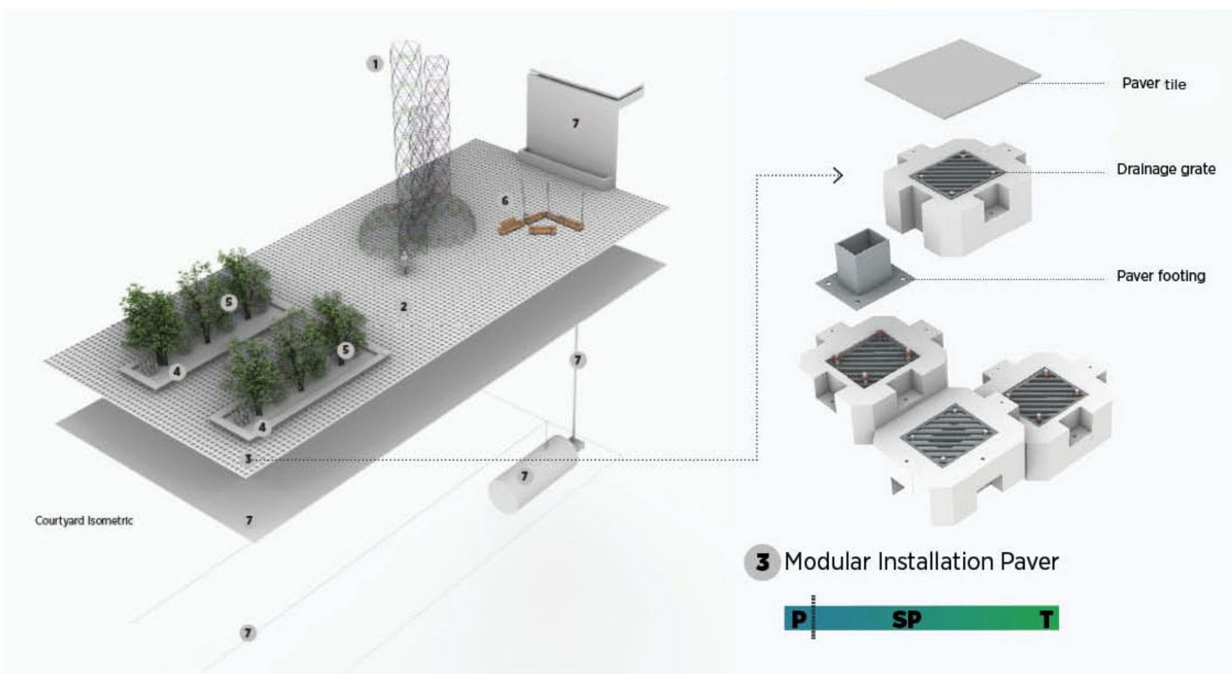

Figure 44. MIP component displaying interface and connection capability (derived from Brodie, 2020).

3.4.8 MIP, Stormwater Management.

The MIP unit was designed with a central canal for drainage, equipped with bi-level, stainless steel, drain grates to control debris. The extended, central canal design allows for increased drainage collection volume, creating additional permeability and avoiding typical hardscape, surface runoff. The surface-flush, drain grates ensure that small debris is also suspended at a preliminary stage, avoiding further system backup. The MIPs are the first stage of a larger downstream stormwater management system (component seven) that can store and recycle onsite stormwater through a warm-season waterfall and, the previously described, winter season, ice tower. The MIPs allow for optimal surface drainage in any configuration they are used.

The MIP central canal design also uses the same surface flush grate bolts to connect to footings for temporary structural elements, as the stabilizing base for complimentary modular components and assemblies, from simple light pole stands to more complex assemblies, such as benches or planters (components four and five). Each MIP provides the capacity to connect to the ground plane, allowing for extremely adaptable, surface fastening, and securing configuration potential, supporting the assembly of complex structures like the ice tower armature, and allowing for their disassembly and reconfiguration year after year. In utilizing principles of design for disassembly and temporary, transformable space configuration, the MIP provides the grounding for creative spatial thinking in reconstructing the courtyard space into a community place.

3.4.9 MIP Collaboration.

The MIP was a collaborative design process between SAPL, MLA student Emma Brodie, and myself, in which her original configuration was iteratively advanced until it could be fully integrated into the overall modular system. As the foundational component of the courtyard design, the collaborative process was extremely valuable in helping to articulate system function and strengthening the overall outcome, through the consideration of an alternative viewpoint. The collaborative process also helped identify specific strengths and weaknesses, and advance progress more rapidly than working alone. Working in partnership was also beneficial in maintaining project perspective while moving across project scales in understanding modular component and assembly interfaces, and how the MIP would optimally function within the whole, modular courtyard design.

3.4.10 Modular Bench Assembly (MBA).

The MBA was designed and included in the overall CDC as an example of an increasingly complex, component assembly module, with the flexibility of operating as a permanent fixture or, as a temporary, seasonal, or event and program installation. The single MBA module was designed as an example of a basic seating unit, customizable and configurable to the specific needs of the user. Within the courtyard context, the MBA module could be installed anywhere on the MIP surface, as a single, or multiplied unit, and configurable into a myriad of orthogonal forms, generating more complex assembly modules (component five), where nested assemblies can be mixed and matched (figure 45).

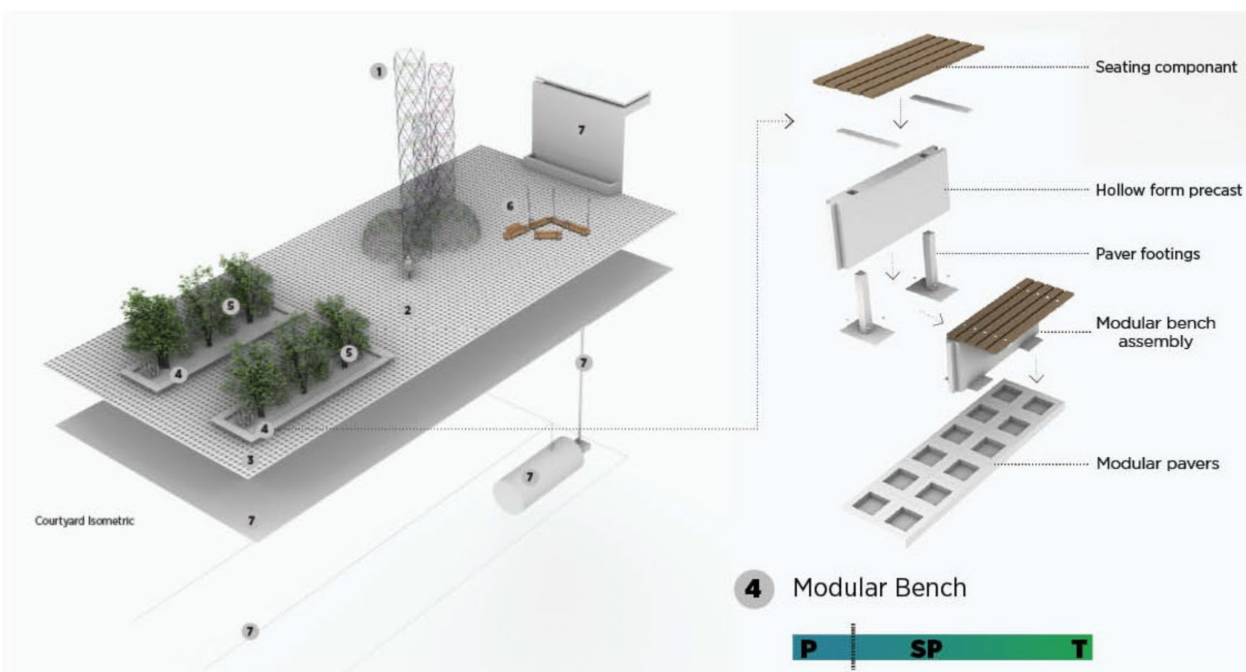

Figure 45. MBA displaying subassembly interface.

The materials, (GFRC concrete and wood), and aesthetic choices for the MBA were based solely on economy and efficiency in paring down a basic, repeatable bench unit, with accessible DfD and reconfiguration capabilities. An alternative variety of aesthetic forms and styles could be incorporated into the design of a modular bench system, functional within the DCD, allowing for a diversity of aesthetic design choices to operate within the courtyard at any one time. The hollow form, precast, GFRC panel, and seating design, also operates as a multifunctional modular component of the larger raised planter box system (component five), where onsite underground parking made inground planting design within the courtyard prohibitive. And, although designed with DfD and a reconfigurable capacity, the complexity of the MBA installation process, makes them more operationally efficient if implemented on a semi-permanent to permanent basis, fostering the simplified design of supplemental, modular assemblies for key courtyard objects, like benches or tables.

3.4.11 Modular Planter Assembly (MPA).

The MPA is a modular extension of it is subset MBA, in which multiple bench assemblies are connected, and configured to create above-ground planter boxes in integrating ecological connection and function into the DCD. As below ground planting design was not possible due to onsite underground parking, a modular alternative was developed to allow for greater spatial flexibility and adaptability, especially regarding the ice tower design and its seasonal requirements (figure 46).

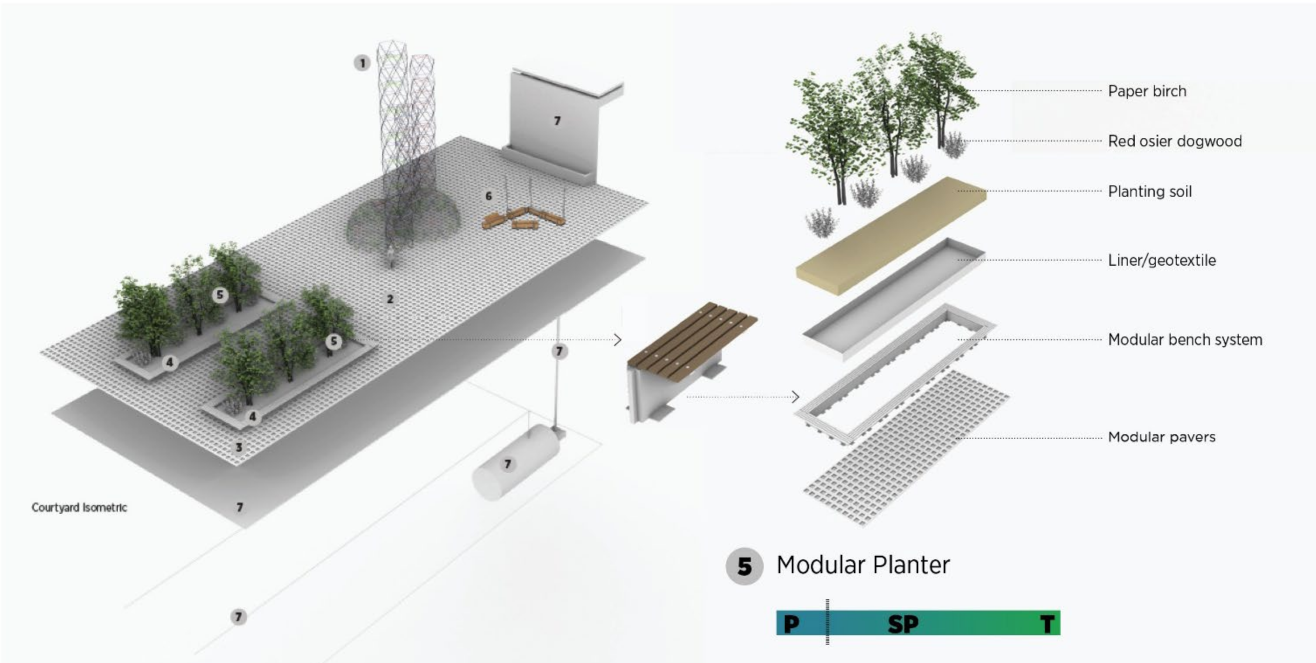

Figure 46. MPA as an assembly of MBA subassembly.

The MPA allows for reconfiguration of the courtyard planting scheme in addressing seasonal climate variation. It also permits for adaptable, experimentation in discovering optimal spatial organization, regarding courtyard microclimate and public circulation flows, allowing the planting design to capitalize and integrate with site-specific parameters (figure 47).

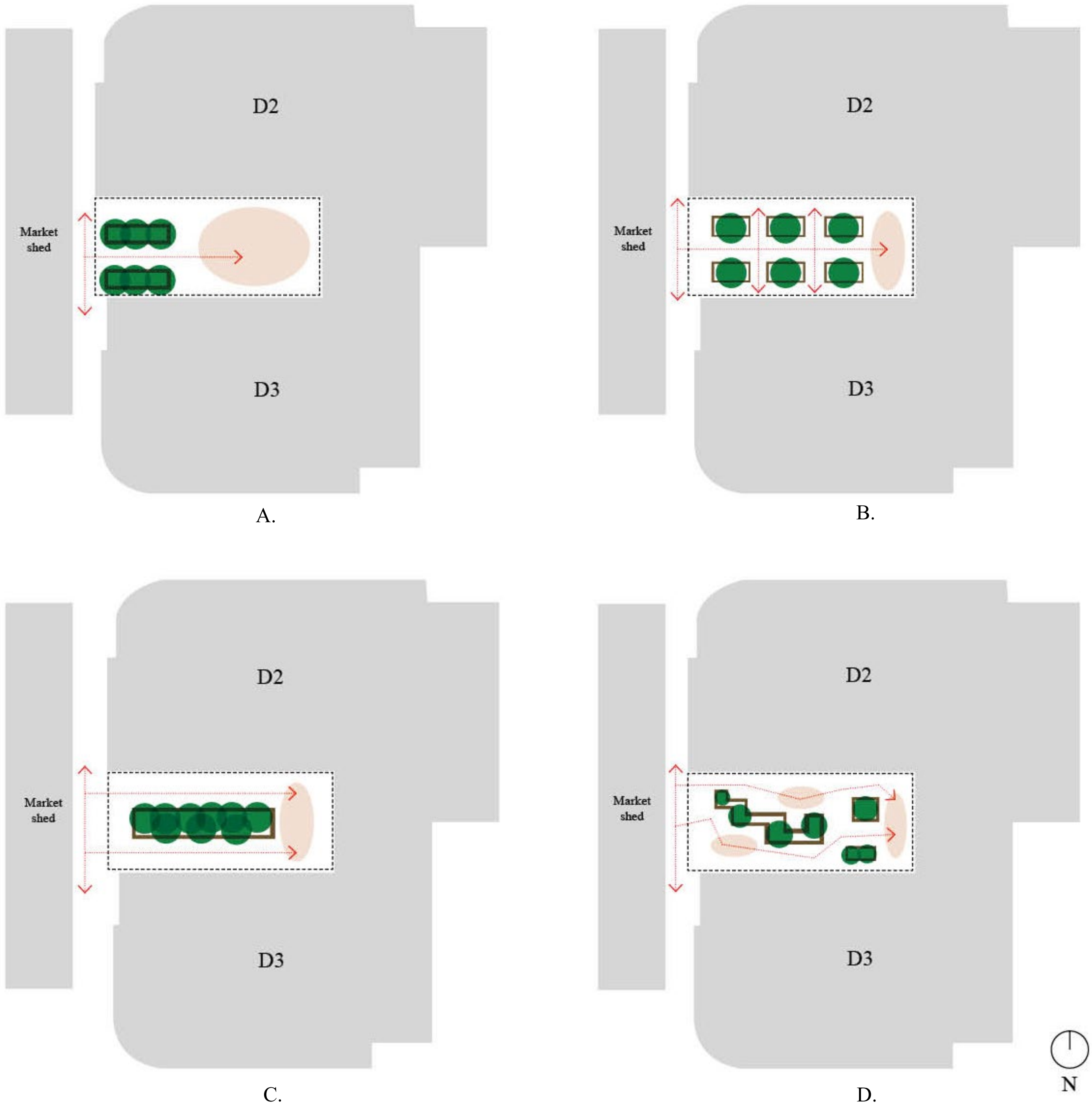

Figure 47. Various MPA configurations: A. Present design, entry canopy. B. Geometric spread. C. Central Island. D. Organic flow.

3.4.12 Modular Planter Assembly Planting Scheme.

By including a planting design element within DCD, special consideration was given to the use of appropriate plant species in addressing onsite growing constraints through consultation with SAPL, MLA Prof. Mathis Natvik. Lower soil volumes, combined with year-round shade, significantly limited the viable tree and shrub species able to thrive within the courtyard. This, combined with the requirement for low maintenance and upkeep contributed to an extremely resourceful and concise, initial planting palate consisting of a single native tree species and a single shrub species and potential grasses (Natvik, 2020) These species included:

- Paper birch (*Betula papyrifera*).

Known for its bright, white, paper-like bark, it has multiple seasonal interest and color from green in the spring to yellow and orange in the fall, and white in the winter. It grows well in above ground, low volume soil planters (Eagle Lake Nurseries, 2020a) (figure 48).

Figure 48. Paper birch in planters and natural surroundings (The Garden Glove, 2018).

- Red Osier Dogwood (*Cornus stolonifera*).

Known for its bold red winter color, it is a hearty all season shrub that is adaptable to most soil conditions and grows well with other plants, requiring little to no maintenance. Dogwood would also contribute to seasonal color contrast against the white of the paper birch (Eagle Lake Nurseries, 2020b) (figure 49).

Figure 49. Dogwood displaying multi-season interest (Fine Gardening, n.d.)

- Blue Grama (*Bouteloua gracilis*).

An important native prairie, bunch growing, perennial short grass, with delicate leaves and contrasting seed heads. It grows green to grey in summer, turning beige as it becomes dormant. (Ladybird Johnson Wildflower Centre, [LJWC] n.d.). This wispy, delicate, and drought-tolerant grass would add textural contrast against the structural color of the larger paper birch and Dogwood species (LJWC, 2012) (Figure 50.).

Figure 50. Blue grama displaying seasonal contrast (Plant Select, 2020).

The planting design also integrates multifunctional ecological processes into DCD, not only creating aesthetic, cultural/natural connection but also in utilizing natural processes as part of the courtyard's sustainable stormwater management component. The softscape, planting beds contribute to delaying stormwater runoff, through absorption, storage, and filtration, not only slowing it down and alleviating pressure on municipal stormwater systems but improving it's health and quality, in returning it our local streams and rivers.

3.4.13 Movable Modular Furniture (MMF).

The MMF is a multifunctional, rapidly deployable, and connectable, furniture module that includes, adaptable planting, utility, and amenity capabilities. It was designed as an agile seating unit, that can be manipulated and moved informally for use by individuals and groups. It can be rolled to a corner by a child, to read a book, or connected into bench rows, for programmed event seating. It supports spontaneous use and integrates the highest level of flexibility within the DCD, in configuring the courtyard space (figure 51).

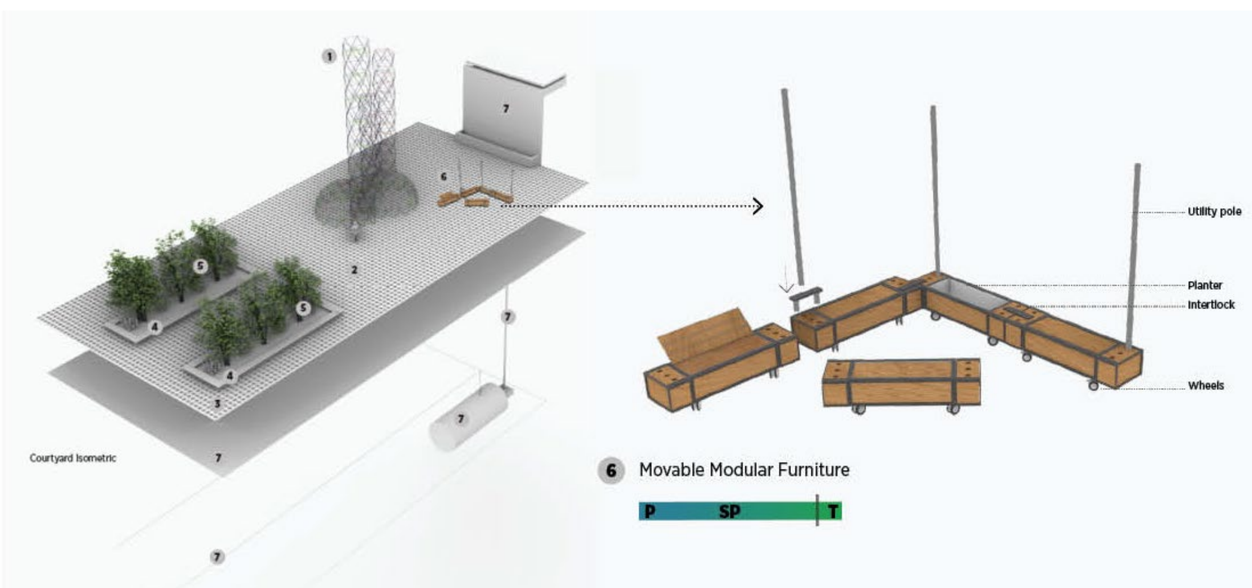

Figure 51. MMF within the courtyard context.

The MMF encourages social connection through informal yet customizable, congregation. Users can rapidly relocate and maneuver them into any configuration needed, from face-to-face conversations, to impromptu, outside office meetings, and presentations. This maneuverability also allows for social distancing. The planting and utility aspects of the units also allow for a more integrated aesthetic experience, where private contemplative sitting or relaxing in a hammock can be mentally and emotionally regenerative practices. The MMF can also be deployed as seating, in more formal organization, for a variety of larger events and gatherings like celebrations, musical performances, and other seasonal programming and events (figure 52).

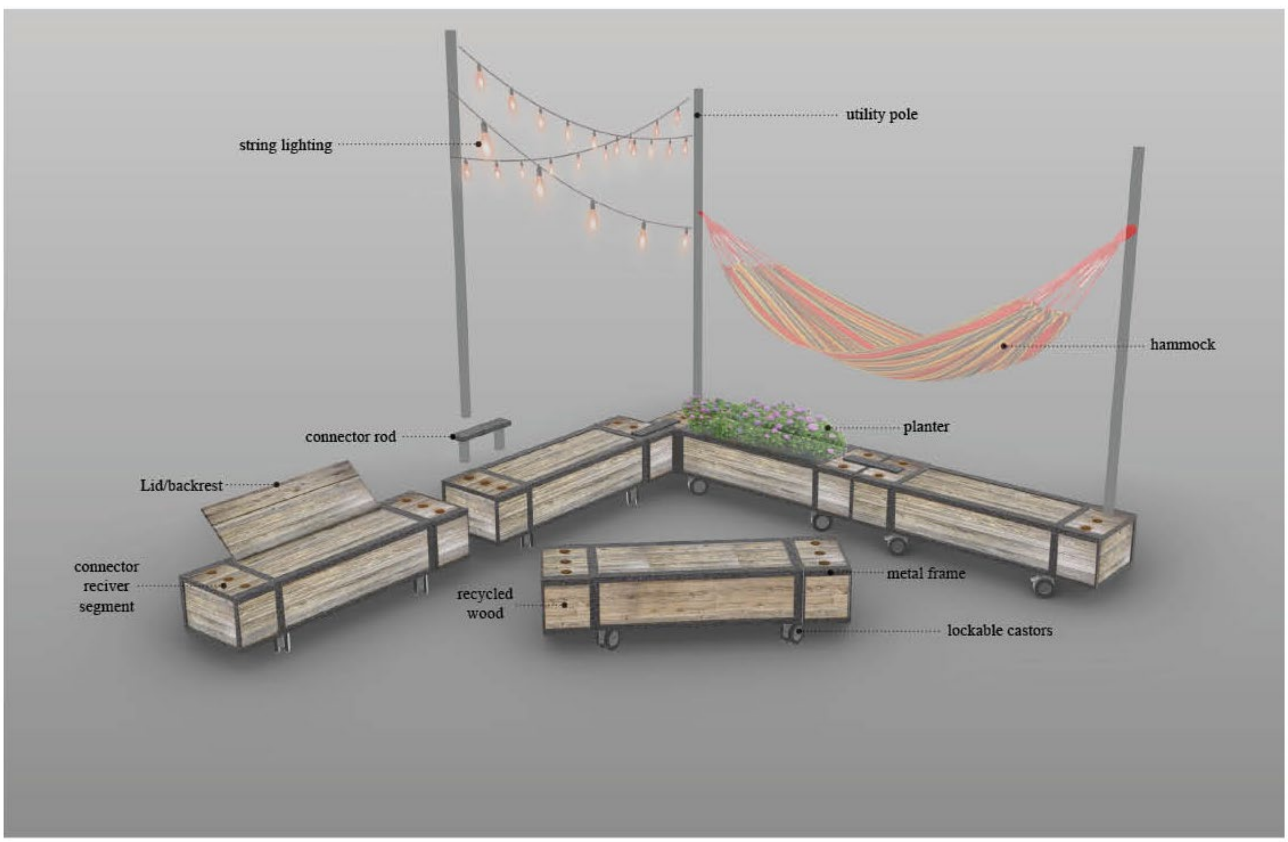

Figure 52. MMF detail displaying its multifunctional capabilities.

As mobility, and ease of use are MMF design priorities, precluding direct modular interface to the DCD and specifically the MIP, its basic metal frame design is adaptable to adding specific connections, in fully integrating its modular capabilities with the other system components and assemblies.

3.4.14 Stormwater Managements System (SMS).

The SMS was designed as a multifunctional, self-contained, hydrological system that combines sustainability and placemaking into operational green infrastructure. The SMS captures, stores, and recycles onsite stormwater as part of the interconnected modular design system employed in the DCD. Courtyard surface runoff is captured through the MPA, and MIP systems, which directly interface with a subsurface sheet drainage layer that collects and directs water-flow to discharge pipes installed above the subsurface parking slab. The pipes then carry the water to an underground holding tank ($52m^3$ volume capacity) located in the parkade. Water is then mechanically pumped into the beginning of the courtyard waterfall cycle, effectively using onsite stormwater to help create public amenity and an engaging community asset (figure 53; figure 54).

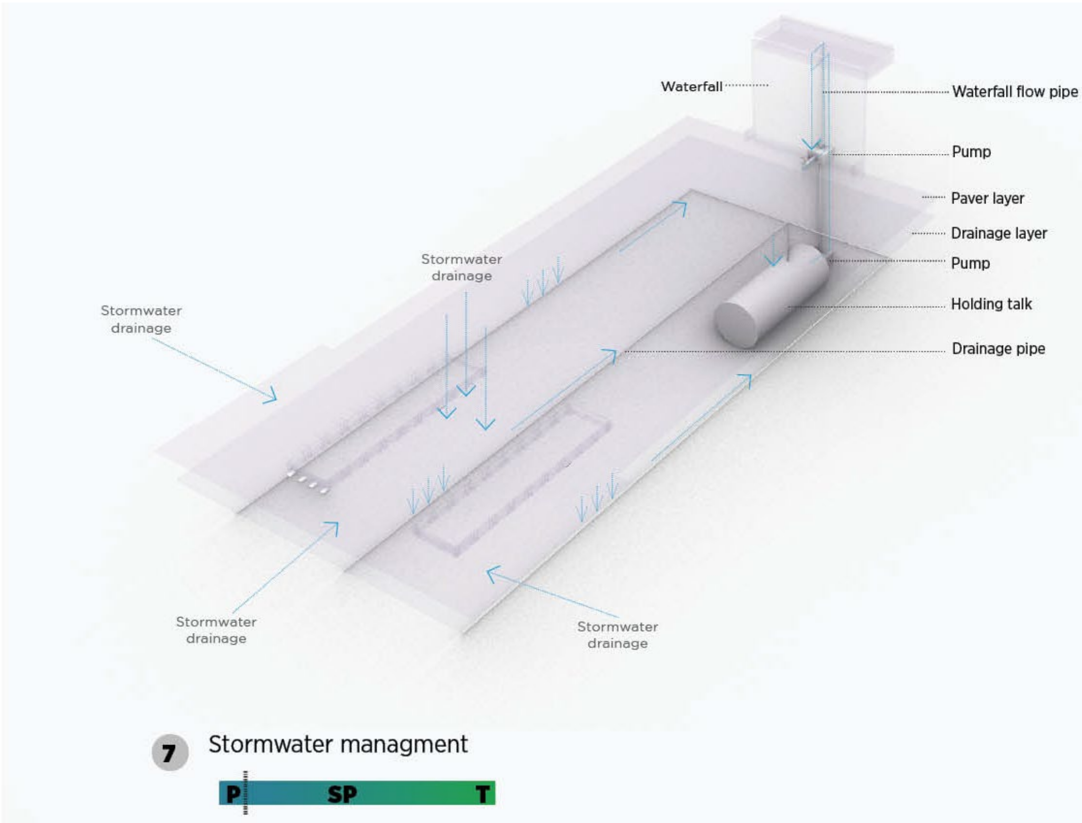

Figure 53. SMS with water-flow process.

Figure 54. SMS waterfall design render.

3.4.15 Seasonal Operation.

During the warmer season months, the SMS would operate to supply stormwater to the waterfall system. During the colder winter season, waterfall operation would intermittently discontinue, and onsite stormwater and snow would be collected and stored to supply the formation of the Ice tower. The natural melting process would then cycle the water back through the SMS, where it could be stored and eventually recycled into the waterfall system.

Further site engineering research, testing, and hydrological modeling, in acquiring accurate system capacities and requirements for the SMS system would be compulsory in assessing the viability of a functional and efficient system. This would also help determine the overall modular capacity of the SMS and its interface with the larger DCD as a whole, where further investigation into specific SMS requirements and articulation of constraints, could provide reciprocal benefits in developing adaptive, modular system integration. The important focus remains that the application of multi-scalar design principles and techniques, through the method of modular design can create sustainable, built environments that are socially integrative and aesthetically engaging.

CHAPTER 4

CONCLUSION

4.1 General Summary.

This thesis was an initial attempt to investigate how modularity could be effectively used in the design and construction of more sustainable landscape architecture, when combined with multi-scalar design principles and techniques, through the convergent design process termed Modular Urbanism. As outlined throughout this thesis, at its core, the initial idea behind the concept of Modular Urbanism was to understand how modular design could operate as a catalyst in generating efficient design solutions, that both address triple bottom line sustainability, while providing aesthetically innovative and creative alternatives that contribute to local, site-specific sense of place. The design concept was formulated through the examination of a literature review, in which placemaking and tactical urbanism where situated within a broader scope of sustainability practices and organized through the design of a preliminary conceptual framework and design matrix. This framework formed the bedrock of an expanded field design process that contributed to three experimental design projects examined through the case studies.

4.2 Revisiting the Thesis Question.

At the heart of the thesis question is whether a process like Modular Urbanism can help bridge the gap between site-specific quality and reproducible quantity in developing more sustainable building practices within landscape architecture. Distilled even further, it asks if the design concept can serve as a more efficient building alternative by providing 'more for less' in extending project life cycles, improving usability, and saving costs. The preceding research has shown the initial answer to be yes. As a qualitative design research inquiry, this study demonstrates that design processes like Modular Urbanism in which modular and multi-scalar design principles are combined, hold potential in generating alternative sustainable building practices.

4.3 Contributions of the Literature Review.

Through the literature review, the various multi-scalar design concepts were ordered and examined in an effort to demonstrate their interconnectivity and to suggest the importance of their association and interaction in developing the concept of Modular Urbanism. Through this perspective, the importance of including multi-scalar design concepts and principles became central to generating a design process capable of producing robust and responsive design solutions. Modular design, as building method, with placemaking as a larger scale design concept, and tactical urbanism, as a smaller-scale design concept, were combined to better address triple bottom line sustainability. These combined elements, in forming a conceptual structure, allow for adaptable application, capable of addressing the various social, economic, and aesthetic constraints that may be encountered on any given project. Other important concepts such as adaptive reuse were included to emphasize how Modular Urbanism could be integrated with existing sustainable building practices in associated fields. Although adaptive reuse is primarily understood as an architectural, building scale practice, its increased adoption as a viable building alternative will have residual effects on landscape architecture, where more projects will require integrative adaptive strategies in providing sustainable options for the design of urban spaces.

4.4 Analysing Modular Urbanism through the Case Studies.

The design case studies demonstrate specific applications of Modular Urbanism in providing alternative, sustainable design solutions. Although all three of them utilize the same process, they all emphasize slightly different aspects of Modular Urbanism in their outcomes.

4.4.1 Modular Urbanism in AATC and GAP.

The AATC and GAP case studies examine how Modular Urbanism was applied in developing novel, low-cost, and rapidly deployable design solutions for temporary interventions, that were mainly focused on reactivating specific urban spaces. These cases studies resulted in applications that emphasized small scale tactical urbanism techniques, fully integrated within a larger placemaking program. Modular design techniques were used in the development of 2D materials deployment strategies, in the design of specific kit-of-parts systems, with the intention of saving material costs and reducing installation times. Modular Urbanism allowed for a holistic approach in recognizing and applying specific design techniques to create an interactive and engaging urban experience.

4.4.2 Modular Urbanism in The District.

The District case study builds on the work of AATC and GAP in articulating the Modular Urbanism Process and fully implementing its potential in the design of sustainable urban spaces. The use of the Modular Urbanism process in the design proposal for the District courtyard demonstrates how modularity, placemaking, and tactical urbanism can converge in forming a self-contained, fully integrated infrastructural system, in addressing triple bottom line sustainability. It connects site-specific, placemaking, seasonal event, and program, through the application of modular and tactical urbanism techniques, where stormwater management links to the formation of local culture through community engagement and participation. The modular design system employed in the proposal contributes to both long-range annual placemaking interests, such as seasonal festivals and events, as well as shorter-term flexible space configuration and activation, encouraging increased multifunctional use. The use of multi-scalar design techniques and adaptable modular design systems provide the capacity for open-ended design configurations with indeterminant durations, that could foreseeably be determined by participation from building tenants and the surrounding community.

4.5 Important Considerations from the Study.

Through the development of the three cases studies the concepts of flexibility, temporality, and up-front investment became important considerations in understanding the application of Modular Urbanism.

4.5.1 Flexibility and Temporality.

Flexibility and adaptability are inherent capacities of Modular Urbanism in that modular design is a process of interchangeability, and exchangeability, through, and, across modules and assemblies, that allow for sustainable processes like DfD to occur. Combined with multi-scalar design concepts, Modular Urbanism has the capacity to generate an expanded variety of design solutions. But flexibility and change must be built into the design outcomes from the beginning, or the process risks redundancy. If The District were built using the Modular Urbanism proposal, for the process to be effective, long term schedule allowances would need to be incorporated to allow for the reconfiguration and experimentation of space organization. Change would need to be planned. It would be a considerable waste if the Modular Urbanism process was used to design and construct an urban environment only to remain permanently frozen in its first configuration. This process of built-in change would also contribute to testing and experimentation of DfD processes, in developing a viable and robust system that significantly extends project and material life cycles.

The Modular Urbanism process functions optimally with the understanding that it is primarily one of temporality, in which there may be no permanent, enduring design outcome, or solution, but multiple possibilities and configurations, that can occur over an extended period of time.

4.5.2 Up-front Investment.

All three case studies required substantial up-front investment in both time and resources, in designing and testing of the Modular Urbanism process. This becomes especially apparent when integrating the three design concepts of modularity, placemaking, and tactical urbanism into a single coherent design direction, where scalar nuance becomes an important consideration. The Modular Urbansim process requires substantial front-end planning and organization for design testing and prototyping. Because of the integrative nature of Modular Urbansim, the first stages of design organization are instrumental in establishing system capacity moving forward. Adequate time and resources should be dedicated to the beginning stages of the design process in allowing for design integration, and to avoid, rescheduling, material waste, and cost overruns at later stages of the design process.

4.6 Study Limitations and Future Directions.

This initial study was a qualitative introduction to Modular Urbanism using various methodologies to investigate its potential as an alternative sustainable design process in landscape architecture. It serves as a starting point in laying a foundation for further investigation into how Modular Urbansim, and other similar, multi-scalar modular design processes, might hold potential in creating more effective sustainable landscape architecture. As such, this study would need to expand its methodologies to include a qualitative design component in developing more formalized data. This could be achieved through formalized experimentation, as well as through prototyping and digital fabrication.

Due to the Covid-19 pandemic, The District case study remained a paper-based design proposal, where prototyping of the various components and assemblies of the MU system would considerably expand the yield of research data and knowledge creation. As such this would be an important next step in any proceeding research.

Both AATC and GAP case studies also demonstrated the problems of scalability in the modular design kit-of-parts testing and prototyping phase. As scale increases with the use of modular design techniques so too does complexity. As shown in the two case studies, the design and implementation of modular techniques actually increased project time and material usage, emphasizing the need to specifically address the application of modular design techniques at specific scales, especially when considering human application at multiple sites.

Further study would also include development of the Modular Urbanism Matrix in further articulating the relationships between the constituent elements of the design process. Although the current visualization advances an initial graphical understanding, further development would aim at allowing for its direct application to multiple sites through a quantitatively developed framework, where sites could be plotted based on specific criteria. The Matrix presented here is a work in progress that contains further Modular Urbanism process enriching potential.

Developing this potential would also contribute to a better understanding of specifically how and when Modular Urbanism could be used most effectively. This relates to the idea of understanding the specific tipping point between site specific design and modularity when Modular Urbanism would be the ideal process to use. This would be especially important in gaining a better understanding of Modular Urbanism's multi-site potential, in determining questions of scalability. Further study would help determine the parameters for an optimal use of Modular Urbanism across multiple sites, and further articulate an understanding of the balance between site-specific and modular design across a multiple number of different sites.

As a concept that operates from a landscape perspective, further study would also include the expanded integration of ecological and green infrastructure design and construction, as important components of the Modular Urbanism design process. The discipline of landscape architecture is uniquely suited to meeting the challenges of contemporary urbanism, (increasingly dominated by the accelerating effects of climate change), through its relationship and understanding of natural systems. This disciplinary knowledge would be fully integrated in developing sustainable building practices that can both generate and preserve natural urban ecosystems.

4.7 Final Thoughts.

The Covid-19 pandemic has magnified and expanded the challenges of contemporary urbanism, where the design, organization, and function of public realm space was already under contention from multiple socio-cultural perspectives. And this is to say nothing of the momentous political and social transformations that are currently taking place in those very same spaces, through the demonstrations for racial justice and equality. In both cases, public presence has become a matter of life and death, and the importance of public space design amplified.

The challenge for the discipline of landscape architecture is to leverage these new challenges into opportunities to expand and strengthen its fundamental capacities to create meaningful and compelling urban environments. Beyond mere social distancing, the design and organization of our public spaces must incorporate, from the beginning of the design process, integrative, equitable, and accessible capacities to an increasingly diverse and multi-cultural citizenry. Monofunctional public spaces and urban environments that address single stakeholder concerns are recognized to be unsustainable and contribute to social disconnection and material and resource inefficiency. This study and the development and investigation of Modular Urbanism aims at designing urban environments that provide enriching aesthetic, cultural, and ecological experiences, through a multi-scalar and flexible landscape approach. The resulting design process, through the integration of multiple design perspectives, is focused on providing viable and inclusive design options and possibilities, as solutions, rather than linearly designed, static, and all too soon, singularly banal design outcomes.

The concept of Modular Urbanism capitalizes on modular design as the foundation of its structure in developing a framework that is concise in its parameters but fosters imagination and creativity. In what Fredrick Law Olmsted called "common place civilization" (as cited in Shutkin, 2001 p. 30), Modular Urbanism looks to the possibility of increased citizen engagement and interaction through the design of public space, that ultimately enriches our shared humanity, by reconnecting the fragmented, through the cultivation of simple, everyday experience.

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