DESIGN AT THE EDGES: A BUILT ENVIRONMENT ECOTONE MODEL

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ABSTRACT
Cultivating connections is a primary goal for educators and practitioners of landscape architecture. Through design and planning, we link people to places, to each other, and ideally, to the natural world. Now, with people in industrialized countries spending 90% of their time indoors (Allen & Macomber, 2020), the task of developing connections is more challenging than ever. In addition, our recent anxieties over environmental change, public health, and cultural conflict have created more societal tension overall. Building connections now requires innovative approaches that are responsive to current conditions and can transcend disciplinary boundaries. This study proposes a model of design in the built environment based on ecological principles. To date, a great deal of literature links ecology and design at the scale of landscapes or within pedagogy. The model considered here applies the ecological concept of "ecotone" in an examination of the edges between indoor and outdoor spaces. Through the adaptation of an existing framework for ecotones found in nature, we examine how design can emulate these edge conditions to connect spaces and build relationships. An analysis of award-winning biophilic design projects in relation to the model provides evidence that the ecotone concept offers a useful pattern for designing transitions between indoor and outdoor spaces. In addition, its application builds upon the concept of biomimicry and helps overcome our traditional siloed design methods to create a transdisciplinary style synergy between landscape architecture and other design disciplines, and more fully supports the human connection with nature (Kellert & Calabrese, 2015).

Keywords
Ecotone, Biomimicry, Biophilic, Transdisciplinary, Nature connection

1 INTRODUCTION

As humans, we separate and categorize to help simplify and navigate our environment. This helps us understand things but also limits how we move forward with new ideas within the confines of a singular perspective. In a diverse and quickly changing world, flexibility is key to survival. This is evident in nature, where organisms interacting with changing environments develop multiple survival strategies and adaptations. In particular, an ecotone, which in Ecology refers to the area where two different natural systems come together, illustrates how the interaction between categories can result in a unique and thriving environment of its own. As nature shows us, along the edges and at the boundaries of our categories lives opportunity.

One example where our divisions can prevent adaptation is within the practice of environmental design, the planning, and assembling of the built world around us. Traditionally, we have operated within distinctly different disciplines based on our categories of space determined by the ways that humans have adapted and changed the environment. The most prominent examples of these separate design practices are Interior Design (inside buildings), Landscape Architecture (outside of buildings), Architecture (buildings), Industrial Design (objects), and Graphic Design (media). Despite the silos that have been created in education and practice, all of these specialties interact and some of the most interesting and innovative ideas can happen at the junctures and in the spaces between.

Within the education and practice of landscape architecture, we aim to cultivate connections between people and place. We strive to find common ground and design systems within which humans and nature thrive together, blending elements from the natural and built environments for a new experience. Practicing in these intermediate zones affords us opportunities to work with other disciplines, as we integrate scientific, technical, and artistic solutions of design. Practitioners in natural sciences such as landscape ecology and social sciences such as behavioral psychology have informed solutions as a part of many design teams. Along with their specialized expertise comes a host of new ideas and considerations that are necessary for sustainable project design.

Connecting people to nature now is more challenging than ever, with people in the industrialized world spending 90% of their time indoors (Allen & Macomber, 2020). Many people, particularly in the United States, are accustomed to the controlled settings found inside – with programmable temperatures and lighting that maximize comfort but further disconnect us from natural patterns. The integration of indoor and outdoor spaces is a prime opportunity to draw from lessons that nature provides and reestablish what many consider an innate connection (see Section 1.2).

1.1 Learning from Nature

> *"… where a very small perception can produce astonishing results. If one accepts the simple proposition that nature is the arena of life and that a modicum of knowledge of her processes is indispensable for survival and rather more for existence, health and delight, it is amazing how many apparently difficult problems present ready resolution" (McHarg, 1992).*

Biomimicry (following nature's lead) has long been practiced in the fields of engineering, urban planning, and landscape architecture because of the interaction of those disciplines with, and within, natural systems. In 1969, landscape architect Ian McHarg described a clear application of its principles in his book *Design With Nature* (see quote above). McHarg finds an imperative for biomimicry in his chapter on "Sea and Survival," valuing how the people of the Netherlands adopted the fluid structure and dynamic function of dunes as a guiding model for living at the edge of the sea. In dune systems, he saw the coastal resilience value of their self-regenerating structure, sand trapping, and stabilizing functions.

Biologists E. O. Wilson and Daniel Simberloff and ecologists such as Richard Forman and Michel Godron improved the knowledge base for designing with nature through their research in biogeography and landscape ecology, new fields of study focused on the spatial relationships of organisms and ecosystems. Wildlife managers such as Larry Harris and planners such as Frederick Steiner then applied principles of landscape ecology to the design of wildlife preserves and regional developments that promoted natural resource conservation. Understanding how organisms and ecosystems move through and arrange themselves in space and time is a key to conservation planning, and analogous to how humans interact with each other and the built environment.

The Biomimicry Institute has further advanced discovery and design in this field. Their programs such as *Ask Nature* and the Ray of Hope Prize encourage students and inventors of all disciplines to look

to nature for inspiration and solutions. The results have sparked innovation in the design of everything from fashion to aeronautics and improved the scientific underpinnings of biophilic design.

1.2 Biophilic Design

Biophilic design, based on E.O. Wilson's writings on biophilia, is another way that nature is guiding design – specifically of the built environment. As defined by Wilson, biophilia is "the theory that we, as humans are inscribed with an innate affiliation with all things living" (1984:1). It is a method most often articulated in architecture and interior design, but for many landscape architects, the approach is neither new nor surprising. As stated by the authors of *Biophilic Design: The Theory, Science, and Practice of Bringing Buildings to Life* in the book's preface "although we present biophilic design as an innovation today, it was the way buildings were designed for much of human history" (Kellert et.al, 2008:vii). It is "how we design and build with nature in mind" (vii).

Our urbanized development has reduced the accessibility of nature which is so integral to human life. This biophilic hypothesis, although intuitive for many designers, is now backed by scientific research as a way to promote human physical health and mental well-being. Stephen Kellert's writings and the work of *Terrapin Bright Green* have expanded further on this design approach, providing evidence and tools for more integral incorporation of natural elements, patterns, and processes into the built environment (Browning & Ryan, 2020). These efforts to design with nature by allied disciplines align well with the practice of landscape architecture and provide opportunities to think beyond our traditional silos of design. Biophilic design, in particular, has become a method used by other disciplines to incorporate nature into the built environment for the improvement of human health. As landscape architects, we are equipped to design with nature as an integral part of our work and we can utilize our expertise to lead this transdisciplinary approach.

2 RESEARCH OBJECTIVES

This work contributes to the study and application of biophilic design to find creative opportunities at the edges of different categories of space, highlighting both a model as well as an approach. It asserts that the ecological feature referred to as an ecotone is a useful natural analog for designing transitional zones within the built environment, specifically between indoor and outdoor spaces. To support this premise, we utilize pertinent landscape ecology principles of natural ecotones and identify correlating qualities in the built environment. The resulting model unites design both in and outside of a building to encourage adaptability and nature connection in our constantly changing world.

A secondary objective of the paper identifies the design of indoor/outdoor transitions to be a prime opportunity for transdisciplinary work, particularly between the design disciplines of landscape architecture, architecture, and interior architecture. Although most built environment projects benefit from all three of these specialties, rarely do interior architects and landscape architects work directly together, either in education or practice. Both disciplines work with architects mostly in a multidisciplinary, or rarely in an interdisciplinary, way. "Transdisciplinarity occurs when two or more discipline perspectives transcend each other to form a new holistic approach" (Caldwell, 2015). Similar to the dynamic and flexible qualities of a natural ecotone, the aggregate of design disciplines creates something different (see Figure 1). New patterns and new relationships can emerge when we begin to focus on the in-between of our traditional categories of space, and disciplines.

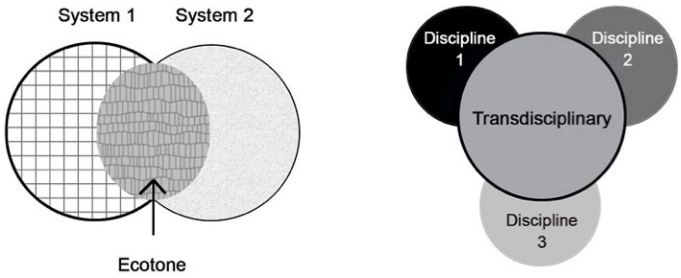

Figure 1. Simplified visualizations of an ecotone (L) and transdisciplinarity (R) highlight the integration of individual components as the area of focus

3 BACKGROUND

3.1 Ecotones and the Edge Effect

To landscape ecologists, an ecotone refers to the "overlap or transition zone between two plant or animal communities (when combined referred to as natural communities)" (Forman, 1995). Environmental planner and author Frederick Steiner described ecotones in more detail as "areas of integration" (2004:187), often rich with biodiversity. It is the interaction between separate categories, in this case, different ecosystems, that creates the variety and abundance in ecotones but they are also unique and valuable environments in themselves. These transitional areas create both tension and opportunity, serving as a particularly interesting paradigm for our changing world and adapting to climate change.

Part of the intrigue of ecotones has been described as the edge effect, where the outer boundaries of different elements and characteristics come together to create something altogether new. Edge effects can occur for a variety of reasons and can have different impacts on the species fully adapted to each system in which they unite. For example, the transition zone of a marsh (where water meets land) provides a home to a wide variety of organisms that would not thrive in either extreme (see Figure 2). This shoreline ecotone is a community of its own, illustrating the ability of nature to adapt to changing conditions over time where different systems interface.

Figure 2. Marsh ecotone at the interface of water and land

Natural Ecotones

Sandy shorelines, also called coastal strands or beach dune systems, are wide, dynamic ecotones where the edge of the sea overlaps the edge of the land. Neither fully marine nor terrestrial, the beach dune transition zone is both fluid and solid, containing qualities of both land and sea with storm tides periodically flooding and reshaping the land and upland plants and animals regaining their domains when the sea recedes. At the coastal system border of the edges between two vastly different realms, organisms find both sanctuary and opportunity, with small fish safe in the shallow surf zone, sun-loving plants taking advantage of the open sands, and land mammals, birds, and butterflies tracking the edge as a corridor for movement. The width of the beach ecotone can vary and is a measure of the force of ocean tides and waves interacting with the slope of the land, with wider zones found on high-energy beaches with low topography.

In contrast to these aesthetically tranquil landscapes, narrow ecotones with distinct, more fixed borders occur where the adjoining systems are dissimilar and have less overlap. Along the hard edges, from a scree slope of moving rock to the ocean or a thick forest edge at an open meadow, environmental conditions and resulting ecosystem structures change quickly and more drastically. Species interactions show stronger avoidance or preference behaviors between the two opposing systems as opposed to full utilization of the boundary area. With a more limited, narrow zone and fewer shared resources, the sharp edge offers less for wildlife other than a safe, convenient travel corridor, in comparison to greater values and opportunities in the wider ecotone.

4 METHODS

This research applies qualitative analysis in an exploratory study to develop a design model for transitions in the built environment that mimic edges found in nature. The study began with a literature review of ecotones and the ways in which they function and are structured. The review helped establish a framework highlighting the qualities of natural ecotones as described by the ecologists Richard Forman and Michel Godron. Using this established ecological framework, natural ecotone qualities were then adapted to their theoretical equivalences for projects in the built environment. In order to test the validity of the model and determine its applicability to designing for nature connection, three winners of the Stephen R. Kellert Biophilic Design Award (established in 2017) were examined. As a social ecologist and one of the first authors to focus on biophilic design as a method for human/nature connection, Kellert is considered a "pioneer in articulating and applying biophilic design principles to the built environment" (International Living Future Institute™ [ILFI], n.d.). The award winners are selected annually through the International Living Future Institute™ by a jury of design professionals as exemplary case studies in biophilic design. It is the only award of its kind and serves as a reliable indicator of success in the application of natural models to building.

Additional examples of existing built edges were reviewed in two environmental art installations (see Section 5.2). Both artworks illustrate the possibilities of creativity with an intentional focus on connections, creating in one case a visual focus on a natural edge, and a literal connection across a manmade boundary in the other. In addition, both move beyond the silos of traditional design and exemplify transdisciplinary work.

4.1 Ecotones and People

Edges are as dynamic for people and places as they are for wildlife and habitats, where the intersections of systems and spaces provide resources, pathways, opportunities, escape routes, and protection. Human interest in natural ecotones can be seen specifically in the draw of beaches. A wide safe beach zone from which to take in the immeasurable expanse of the ocean offers a sense of security for humans and other beach inhabitants. People are also drawn to the visual excitement of sharp edges, as evidenced by the number of annual visitors to the United States' Grand Canyon National Park (over five million) or the Cliffs of Moher in Ireland (over 1.5 million).

In the built environment, boundary-edge-ecotone concepts have been most often applied at the scale of urban and regional planning in buffer zones and transitions from rural environments to the urban core. Planners and designers also create these transition zones in heavily populated urban centers, partially as a safety necessity, separating vehicular and pedestrian traffic. The urban environment shares characteristics with natural ecotones with large open spaces, wide boulevards, and plazas having beach-like qualities as spaces to gather, take in views, and safely interact. Narrow city sidewalks with immediately adjacent buildings or walls resemble hard woodland edges to walk along or enter, making the area feel less hospitable for pedestrians to linger (see Figure 3).

As mentioned in the "Introduction," clear boundaries and edges do help people make sense of space. Edges are one of the five design elements necessary for humans to comprehend and navigate large areas as defined by urban planner and author Kevin Lynch in *The Image of the City*. The model proposed could possibly reframe the way that the built environment is perceived, encountered and experienced. The edges of identifiable spaces would not disappear but would be buffered with intentional transition zones, allowing the adaptation to changing conditions and possibly establishing a more hospitable setting where it is needed. How might professionals intentionally design human scale transition zones in the built environment to fully capture the potential of the spaces in between? As the authors state in the 1977 seminal planning text, *A Pattern Language*, "the mere creation of the boundary areas … will begin to give life to the subcultures between the boundaries by giving them a chance to be themselves" (Alexander et al., 76). This intriguing idea, encountered now in a fast-changing, mobile, and diverse world may be realized through the built ecotone model.

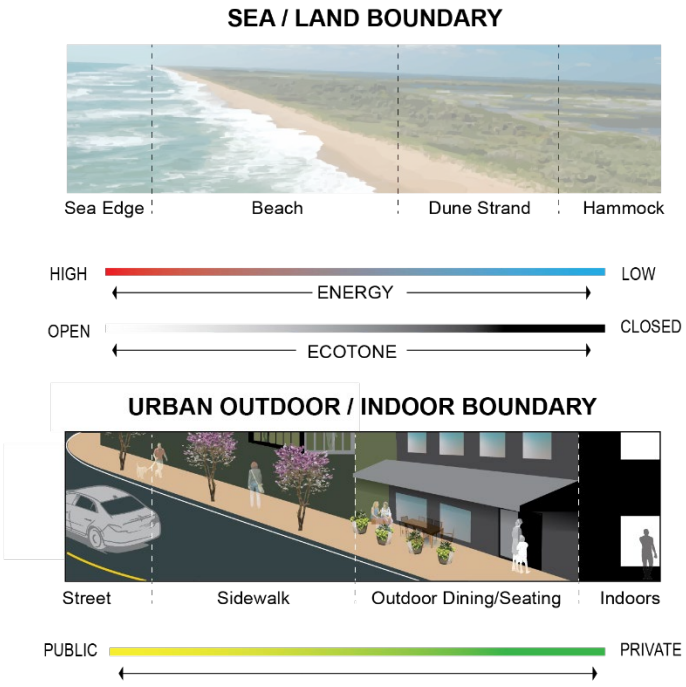

Figure 3. Natural and built ecotone transects

4.2 Qualities of Ecotones – from Natural to Built

Although naturally occurring ecotones can be drastically different depending on the systems that interact within them, some definitive qualities can be identified regardless of their setting. Because the forces of nature are much more diverse and unpredictable than the ones evident in a more controlled setting, it is not possible to literally translate the qualities of natural ecotones to the built environment. However, their qualities can be organized in a way that makes them more applicable. In the table that follows, these qualities are categorized according to Richard Forman and Michel Godron's framework for translating landscape ecology to human ecology (see Table 1). Their framework separates the qualities into three categories: Structure, Function, and Change (Steiner, 27).

Structure refers to the spatial relationship. According to landscape ecologist and spatial planning expert Anna Hersperger, the structure can include shape, size, origin, connectivity, porosity, and configuration (Steiner, 27). Generally, the structure is the form. The function is active, including the relationships of flow or movement within the system. This would include how energy, water, or nutrients travel through or within an ecotone. The function of these zones is especially important, serving as either a dynamic mixing zone of elements or a more tranquil buffer zone. Change is "the product of the interaction of function and structure over time" (Hersperger, 17). It is the dynamic relationship that occurs between the structure and function of a system. These different forms and functions are important in their relation to the levels of energy and the character of the interactions that occur within the transitions. For example, a narrow band between contrasting adjoining spaces might heighten tension while a wider area can slow time and calm interactions. Change is a constant factor within natural ecotones and can manifest in a gradual, even progression such as seen in the vertical layers of the woodland edge or the banded zones of a shoreline.

Table 1. Qualities of natural ecotones in Forman and Godron's framework

STRUCTURE	FUNCTION	CHANGE
Multiple scales, vary in width	Variety of organisms, biodiverse	Transition
Porous	Mixing zone	Adaptation
Flexible	Buffer zone	
	Active interaction between sides	
	Areas of tension, boundaries	

The framework above assists in the understanding of how each quality might apply to the built environment, with structure as the physical form, function as the users and program, and change as the actual use, reflected in the behavioral or physical responses of users within the space. The translation of qualities from the natural to the built environment can be seen below in Table 2.

Table 2. Qualities of built environment ecotones based on Forman and Godron's framework – the built environment ecotone model

PHYSICAL FORM (STRUCTURE)	PROGRAM (FUNCTION)	USE (CHANGE)
Size and shape can vary	Public space	Communication
Diverse materials	Mixed use	Movement
Porous	Gathering zones	Interaction
Not rigid	Safety / Security	Flexibility

What qualities of the ecotone structure, function, and change are important to design? For this proposal (to enhance connections between people and place) any qualities or elements that contribute to shared use of space by a diverse audience are vital. It would also be important to include a level of novelty that initially draws people into the space or a visual quality that distinguishes it from the adjacent areas it intersects. The next section provides an initial exploration of the model, comparing it to three past winners of the Stephen R. Kellert Biophilic Design Award.

4.3 Testing the Model

In order to test the validity of the *built environment ecotone model* with designed and built work, three projects were assessed for comparison. The three projects considered are prior winners of the Stephen R. Kellert Biophilic Design Award, an international honor given annually since 2017 to built work that best exemplifies the "principles and benefits of biophilic design" (ILFI, n.d.). These award winners were selected because they share a common goal with the model, as the biophilic approach is a practice that not only designs with nature but also looks to amplify the relationship between people and the natural world. In addition, each of these projects involves indoor/outdoor transitions and include public space, yet they vary greatly in scale. The comparisons below utilize information from photographs, articles, and case studies, as the authors have not visited the projects in person. Brief descriptions of the projects are below, followed by a summary chart in reference to the model in Section 5.

The first project is the Khoo Teck Puat Hospital in Singapore (see Figure 4), credited to the architecture firm of CPG Consultants Pte Ltd and the design consultant RMJM. This public hospital project was the inaugural winner of the Stephen R. Kellert Biophilic Design Award in 2017. Khoo Teck Puat Hospital is over a million square feet of building set on 8.6 acres. A true "healing environment," the building opens up to and sits adjacent to a storm water pond creating a "green court" that runs between the v-shaped structure (Kishnani, 2017). The photographs reveal a lush, green, and heavily vegetated courtyard space, allowing interaction with and views of nature from the interior. The designers paid close attention to sun and shade patterns to ensure that there is plenty of natural light for the vegetation, including an active food garden on the site, while at the same time eliminating glare issues that could negatively impact the users inside. Water features, scented vegetation, and tropical plant species fill the green court and envelope the patients and staff that can utilize the outdoor breezeway as a main circulation path. The greenery extends

inside in various locations, further connecting the indoors with nature. Birds are drawn to the area, providing additional movement and life to a space full of plant growth and pond-cooled breezes.

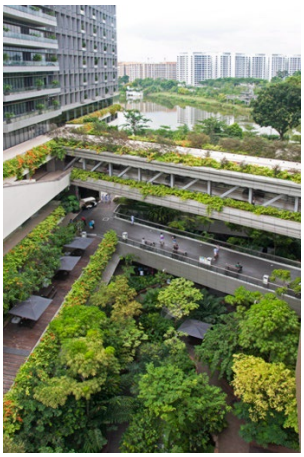

Figure 4. A view of the green court of Khoo Teck Puat Hospital
Image license: KTPH (https://commons.wikimedia.org/wiki/File:Link_bridge_at_KTPH.jpg), https://creativecommons.org/licenses/by-sa/4.0/legalcode

The Betty & Clint Josey Pavilion in Decatur, Texas won the Kellert award in 2018. The project team included Lake | Flato Architects, Biohabitats, TLC Engineering, and Lincoln Builders of Texas. Vastly different in scale from the 2017 winner, the pavilion is an educational facility 5,400 square feet in size on private, rural land owned by the Dixon Water Foundation. It is surrounded by native prairie lands that serve as the inspiration for the low, linear forms. Uncoated sinker longleaf pine is used for the majority of the building, highlighting the texture and grain of the natural material. The slatted wood provides visibility and air movement through the pavilion and movable doors allow for the building to literally open up to the outside. Broad overhangs create porch environments where people can stay covered from the sun but exposed directly to the winds and prairie landscape.

The Louisiana Children's Museum was the winner of the Stephen R. Kellert Biophilic Design Award in 2021 by the design team of Mithun and Arup engineering. The facility is 56,000 square feet on 8.5 acres in New Orleans, Louisiana. Within the project, two buildings are carefully sited over water and among the old growth trees to allow for natural ecosystem processes to remain active. Horizontal metal slats frame large porch areas that run along the edges of the building. Visibility is enhanced with this feature, along with the multitude of windows that overlook the adjacent lagoon. The educational facility includes a floating classroom, an edible garden, a café, store, and centers for early childhood education, parenting, and literacy. Programmed to be a true resource for the community, the museum does more than entertain and educate visitors, it provides a direct connection to the nature that surrounds it.

5 RESULTS

Each of the three examples fits almost fully within the guidelines of the model, yet they reveal different ways that biophilic design can be adapted for built projects. Table 3 below summarizes the features of each of the design projects considered in comparison to the *built environment ecotone model*. The far left column includes the built equivalent of the Structure, Function, and Change components of the original Forman and Godron ecotone framework.

Table 3. The *built environment ecotone model* applied to biophilic design projects

Qualities	Khoo Teck Puat Hospital	Betty & Clint Josey Pavilion	Louisiana Children's Museum	Comments
Physical Form (Structure)				
Size/ shape varies	Y	Y	Y	Variation was between the three projects
Diverse materials	Y	—	Y	Natural materials woven with built
Porous	Y	Y	Y	Porosity includes visual and physical
Not rigid	Y	Y	Y	Responsive to the site
Program (Function)				
Public space	Y	Y	Y	
Mixed-use	Y	—	Y	
Gathering zones	Y	Y	Y	
Safety/security	—	Y	Y	Difficult to find information on security, high visibility is considered a safety measure here
Use (Change)				
Communication	Y	Y	Y	Encourages indoor/outdoor experiences
Movement	Y	Y	Y	Includes ventilation and circulation
Interaction	Y	Y	Y	Between inside and outside, uses, users
Flexibility	Y	Y	Y	Determined by activities included in the programming of the spaces

5.1 Design Implications

Based on the assessment above, there is a congruency between successful biophilic design projects and the *built environment ecotone model* proposed in this research. Although additional study is needed to fully understand the detailed implications and how they might contribute to design for connection, it is clear that the scale, program, and aesthetics can all be vastly different for projects to utilize and implement the model. Of the three projects assessed, the Louisiana Children's Museum aligns most closely with the model, with the Khoo Teck Puat Hospital just behind it and finally, the Betty & Clint Josey Pavilion. Interestingly, the two examples that most align with the model also aesthetically appear to be the most biophilic based on the amount of vegetation and water incorporated into the site and the building. The Josey Pavilion is an important example to include because its ecotone qualities have more to do with the use (change) than with the initial aesthetics of the structure. It proves there is flexibility in what is considered biophilic design as well as the design approach that can be used to reflect the model.

The results of the model application above allow for projects with a variety of materials and programs, in fact they encourage that diversity. Additionally, they illustrate how the flexibility of a built structure might be incorporated, with movable walls, openings to allow airflow, and room for natural processes to occur around, above, and below the building.

5.2 Inspiration in the Built Environment

Two temporary art installations also help illustrate the potential role of ecotones in the built environment. Despite being seen as environmental art, these installations are said to have transcended the boundaries of traditional disciplines, making them great physical expressions of the power of creativity and how it can be used to reframe how we see and connect us to the land and each other.

The first project is Surrounded Islands by Christo and Jeanne-Claude. Conceived and carefully planned over three years, this environmental art installation wrapped eleven spoil islands (constructed of

dredged material or “spoil” dug for the construction of navigation channels and placed in the open bay) in Biscayne Bay, Miami with 6.5 million square feet of bright pink polypropylene fabric. The iconic piece was described by the artists as “…a work of art underlining the various elements and ways in which the people of Miami live between land and water.” (Wolfe, 2019). A collaborative effort of the artist pair, attorneys, marine biologists, marine engineers, contractors, aerial photographers, elected officials, and regulators at all levels of government, the whole working process of its installation was a part of the final piece. As a “work of art,” “work” served as a verb instead of a noun, with the project constructed in a manner not to harm the environment and resulting in the removal of 40 tons of trash from the islands that were previously used for (illegal) dumping.

Purposefully placed at the boundary of land and water, Surrounded Islands highlighted the relationship between people and the sea in the Greater Miami area. Only in place for two weeks, the piece is thought to be one of the artist pair’s most iconic works. As author Shira Wolfe explains, the temporary installation “created a delicate symbiotic connection between art, city and nature” (2019).

Surrounded Islands is applicable to this study for several reasons. Primarily, it is a unique example of the purposeful design of the space between. Its flexible and porous materials move with the wind and water without causing harm to the natural systems in which it is located, making it adaptable to changing conditions. Additionally, it is engaging. The hot pink color and grand scale create a contrast to the bay that can be seen from multiple vantage points. It challenges us to think about that interface in a new way, and even serves as an environmental precognition of the Great Pacific Garbage Patch, the literal islands of plastic waste now in the North Pacific Ocean between North America and Japan.

The second piece, Teeter-Totter Wall, was a temporary installation by Ronald Rael and Virginia San Fratello placed at the border between the United States and Mexico in July 2019. Another work of public art, it resulted in three large metal see-saws that were utilized by residents on both sides of the border wall for interaction and active play. This intervention created a direct physical and emotional connection between the people on opposite sides of a literal wall and political divide, even if only for 40 minutes.

This work is another intriguing example of the intentional design between boundaries that can cause us to reframe how we perceive our surroundings, but this time the edge and the ecotone are fully manmade. The installation exhibits its own edge effect, invoking tension and opportunity, where seemingly opposite elements come together to create something new. It simultaneously serves as a piece of art, an active play element, and a social statement. And although it was only in place for a short time, the images of Teeter-Totter Wall live on through social media and the internet – a thought-provoking work that is still garnering public conversation.

Each of the projects described above exhibits multiple functions of an ecotone (see Table 1) drawn in both natural and humanistic features of edges. Both can be considered a mixing or buffer zone, they either augment or stifle active interaction between sides and they simultaneously create tension and opportunity for users (or viewers). They serve as studies of how to actively manipulate a boundary and create new opportunities at the edge, in the space between our definitive categories. Interestingly, neither intervention was suitable for the long term, highlighting the temporality and flexibility that must often be included where two different systems meet and interact. This is a consideration of the *built environment ecotone model* as well as it occurs between a more controlled (interior) and a highly dynamic (outdoor) type of space.

Coincidently, hot pink was the color used by the designers of *Teeter-Totter Wall* and *Surrounded Islands.* Each project utilized the vibrant chroma for different reasons, but this similarity highlights one of the tools that can be activated by designers to connect seemingly opposite spaces. Color, materials, texture, and pattern are means by which the design of the built environment can imply contrast or correlation. These tools can be used to reinforce an existing relationship or suggest one that is not otherwise apparent.

6 CONCLUSIONS

The *built environment ecotone model* is a design solution to consider for transitions between indoor and outdoor spaces. As in nature, intentionally designed ecotones in the built environment would vary in size and scale based on the uses they merge and the connections they intend to make. In some locations, a narrow and more abrupt edge might be appropriate to emphasize contrasting features. Several

programmatic uses would particularly benefit from a wider transition zone as a method to offer users more connection to their surroundings. For example, connecting students to their campus, site, and natural context in an educational setting would benefit their learning, making schools an especially suitable location for the proposed design model. Likewise, we know the multitude of health benefits of nature, establishing medical facilities as another ripe opportunity for new and unique connections between people and place.

We are currently working within traditional definitions of space and by way of siloed disciplines that no longer embrace the realities of our unpredictable times. Perhaps this is partly a result of being stubborn and not adapting in real-time to evidence of climate change, health pandemics, and social unrest. We propose that to flourish, people must begin to embrace new design models and methods, and that nature serves as the best example.

7 DISCUSSION

As mentioned in Section 1, landscape architects often work in what might be considered an ecotone between the natural and built environment. The integration of nature into human space is a focus of our work and our method of connection, even if we are not always focused on the same transitional qualities that are present in natural ecotones. The *built environment ecotone model* provides a jumping-off point for expanding the purposeful transitioning of the edges into other creative opportunities such as interiors and applying not only aspects of spatial composition but also those of color, light, sound, and materiality. In addition, the necessary collaboration within diverse and varied design teams to implement the built ecotone model offers opportunities for transdisciplinarity.

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