ENVD Mandala:
A Framework Provides Integration in Environmental Design

Ping Xu
University of Colorado Boulder
USA

Abstract

This paper explores a synthesis model of environmental design, applying Bertalanffy and Laszlo's systems philosophy to bridge gaps between majors. Demonstrating ancient systems thoughts, the Tibetan cosmic model of the mandala interweaves architecture within its landscape and cultural significance. Using this ancient model as a case study and elaborating research on environmental issues, this paper explores a general model of environmental design, the so-called ENVD mandala. The ENVD mandala provides a framework to integrate landscape planning, urban design, architecture, landscape design, and interior design, from large to small scales, from natural to the built environment. One space nests from other spaces. All spaces appear as isomorphic forms. Understanding the general spatial patterns helps integrate the different specializations. Elaborating principles and models that apply to systems would provide efficient teaching and learning for an interdisciplinary approach to sustainable environmental design.

1. Introduction

Extreme weather patterns and frequent natural hazards in recent decades have made environmental issues one of the most critical concerns in daily life. Environmental design is the process of designing human-occupied spaces and their environment, including city and regional planning, urban planning and design, landscape planning and design, architecture, and interior design. These design fields have their expertise and are often isolated from each other. Design professionals and educators are facing challenges in resolving complex environmental issues. An isolated design approach rarely provides solutions for avoiding future disasters. Places severely impacted by natural hazards prove that urban designers and architects mistakenly selected sites. When a building is damaged by debris flow, a new building is erroneously restored in its exact location. A significant factor was ignored: the existing landform pattern poses a threat to residents.

Roughly 180 years ago, landscape design and architecture were divided into two practices. Since then, contemporary architecture has often appeared in isolation from the landscape.

The lack of integration between the two fields is problematic in education and practice. Isolated perspectives create gaps between different design fields, not only impacting the site selection process but also design solutions. In contrast, historical design masterpieces appear as an integrative entirety. Unfortunately, some textbooks and courses often analyze the historical beauty as broken pieces of architecture, plant design, and topographic design…. Students have been trained to divide the environment into isolated parts. This approach is called the conventional model.

Educators have realized the problems of isolated disciplines in design education and explored new methods. An experimental approach, dubbed by the author as the "piling up" model, has not been successful. In this approach, a large amount of specialized knowledge and methods have been added to curriculums, which can exhaust and overwhelm students. Some students complained that it is difficult to grasp the essential concepts and design skills of professionals. The issues of the built environment cannot be resolved by simply "piling up" knowledge and disciplines of isolated specializations, as the built environment contains interconnected subsystems, including natural landscape, city, urban landscape, and buildings. As Laszlo [7]states:

"We need a synthesis model since the universe appears as an interconnected system of nature."

Synthesis models and systems theory would be new concepts for contemporary scholars but certainly not new in human history. According to Lazlo, systems philosophy can be traced to the roots of ancient thoughts, Western and Eastern [7]. As an excellent example, the cosmic mandala model structures the Tibetan Buddhist landscape above 3000 meters [17]. This paper adopted the ancient model of the Tibetan mandala as a case study, explores a contemporary general model of Environmental Design (ENVD), as described by the author, the ENVD mandala, a framework integrating landscape, urban design, architecture, and interior design.

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2. Methods

The research methods include the following components:

i. Literature studies. Studying the systems philosophy of Bertalanffy and Laszlo provides a philosophical base for this research. Research on the Tibetan mandala demonstrates the case study of a general model. Also, journal articles on natural hazards and healthy living offer a wide range of scientific knowledge for this approach.

ii. Field investigations. Investigations provide experiential study to examine theories. The analysis of the Tibetan mandala is based on field investigations in Tibetan temples and villages in China. Field investigations in debris flow impact areas in Colorado are also crucial in the practice of the ENVD mandala for climate adaptation and healthy living.

iii. Comparative study. Comparing general characteristics among the Tibetan mandala model and contemporary professional practices leads to a synthesis model -- “ENVD mandala” for sustainable environmental design. Furthermore, this study also includes comparing the synthesis model with the conventional isolated model and an experimental model of “piling up” specializations.

iv. The ENVD mandala model application. The practice of the ENVD mandala is utilized to examine its theory. Applying the ENVD mandala in teaching and learning to evaluate the natural and built environments furthers our understanding of the environment as an integrative system. To solve environmental problems, designers should explore a synthesis model to create a sustainable environment for the future.

3. Tibetan cosmic model of mandala

What is a mandala?

The mandala, a Buddhist cosmic model, shows the universe centered around Buddha's dwelling place. Described in the ancient text, "Abhidharmakosa," by Vasubandhu (fourth or fifth century AD), the Buddhist cosmic model sheds light on the primordial beliefs attributing the origin of winds from the cardinal directions to collective actions. These winds filled space, giving rise to clouds that eventually precipitated water. Subsequently, hurricanes formed, shaping the golden Earth. At the center of this golden Earth stood Mount Meru, and atop its square summit region lay the palace of the leader of the thirty-three chief Buddhas. Positioned at half the height of Mount Meru, the sun and moon orbited, borne by the wind. Seven golden mountain walls surround Mount Meru, with each wall lower than the one inside. Rainfall between these walls created an "inner sea" of freshwater, while beyond the lowest golden mountain wall stretched a "great outer ocean" of saltwater, housing twelve continents. Human beings inhabited the southernmost continent. The great outer ocean, with its twelve continents, was, in turn, encompassed by an iron mountain wall [3]. Exploring the ancient texts describing the mandala provides valuable insights into the environmental and universal concepts of ancient times.

The representation of this cosmic model is manifested in both three-dimensional and two-dimensional mandalas. The three-dimensional mandala, found in various sizes, serves as a geographical model illustrating the Buddhist cosmos and Mount Meru. On the other hand, two-dimensional mandalas are either painted on cloth or leather or meticulously crafted on a flat surface using colored powder, offering a plan view of Mount Meru. An example of such a mandala painting is the "Tan Cheng," meaning "the altar city." This symmetrical diagram comprises nesting squares encircled by concentric circles, depicting the cosmic model in a plan view (see Figure 1).

Figure 1. Plan view of the Tibetan mandala

The nested squares symbolize the Buddha's dwelling, while the concentric circles radiate outward, representing the surrounding environment encompassing Buddha Hall, an iron wall, mountains, and oceans, extending infinitely. Mandalas, whether three-dimensional or two-dimensional, play a crucial role as aids in meditation, visualization, and liberation during ritual ceremonies. Moreover, they hold integral significance in the daily life of Tibetans, reflecting a deep connection to their cultural and spiritual heritage.

Mandala model shapes Tibetan cultural landscape

The author undertook journeys to Tibet in 1998 and 2002, investigating Tibetan temples and villages in Tibet and various provinces, including Gansu, Qinghai, Yunnan, Inner Mongolia, and Sichuan of China. Through extensive field investigations, she gained profound insights, realizing that Tibetan architecture, landscapes, and religious beliefs intertwine to create a sacred realm. In the Tibetan cultural landscape, the recurring mandala theme

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inspired her research that the mandala, as a spiritual vehicle and a general model, shaped Tibetan Buddhist architecture and landscape.

The cosmic mandala model as a design theme and concept appears in the Tibetan Buddhist landscape above 3000 meters. The mandala illuminates the foundational beliefs associated with the universe. The Qingzhang plateau, with its high elevations and harsh climate characterized by violent winds, serves as the natural backdrop for Tibetan culture and the mandala. The mandala concept also includes humans on continents around bitter and salt oceans, symbolizing human life's inherent sorrow and sinfulness. The primary purpose of meditating and circumambulating with the mandala is to purify and perfect the worshipper's life, offering an escape from the harsh realities of existence and ultimately guiding them towards eternal happiness in the Buddha's land in the next life.

Adapting to the challenging climate, the Tibetan people have systematically used mandalas to structure the spatial organization of Tibetan temples and their surroundings at various scales. The temple complexes nest in holy mountains encompassing the sacred land. Each complex typically comprises the Buddha's Hall, monastery, and stupas. In certain instances, stupas can also appear inside the buildings. An excellent example is the eighth-century Sangye Monastery. Here, the Buddha's Hall is centrally located, with four stupas positioned at each corner of the temple complex, safeguarding its sanctity. Encircling the entire arrangement is an outer wall, symbolizing the "iron wall," separating the Buddha's land from the secular world. In essence, the whole temple complex is conceived as a mandala (see Figure 2).

Figure 2. The eighth-century Sangye Monastery was created as a mandala

Figure 3 describes how the mandala model structured the Tibetan cultural landscape, including stone landmarks, stupas, Buddha Halls, monasteries, and temple complexes nesting in surrounding landscapes and holy mountains. Mandala presents ancient people with a way to perceive their natural and spiritual world. In turn, the mandala was used as a theme to create the built spaces. Following this mandala framework, the Tibetan built environment unfolds on a series of isomorphic levels, featuring plans towards the center—the Buddha's abode. Every level of space incorporates human circumambulations to complete the mandala (see Figure 3).

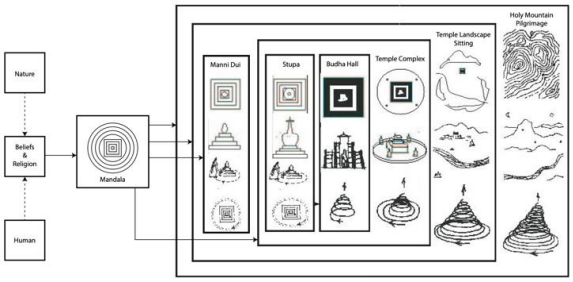

Figure 3. Mandala model structured the Tibetan Buddhist landscape above 3000 meters

With its religious theme, the mandala model is the unifying force behind spatial structures, blending landscape with architecture and intertwining religious meanings with human movements. Architectural design and symbolism infuse spiritual attributes into the landscape, while the landscape, in turn, acts as a matrix imbuing the architecture with sacred meanings related to time and space. The Tibetan Buddhist landscape successfully integrates architecture with its surroundings to create a meaningful cultural landscape.

Following the mandala model, the entire landscape is designed as a spatial unit, emphasizing the horizontal relationship between an architectural complex and its surrounding landscape. The mandala landscape spans multiple scales, encompassing micro and macro elements: sun, moon, stars, mountains, water, vegetation, and buildings. This holistic approach is evident from site selection and architectural design to external form and interior arrangement. Each spatial level mirrors an isomorphic form nested within a larger surrounding space, thus forming an interconnected entirety [17].

Ultimately, the mandala model demonstrates how ancient people perceived their environment as interconnected, integrating elements from the sky to Earth and people. These insights have inspired the author to explore a synthesis model integrating architecture and landscape design.

4. Synthesis model – ENVD mandala

ENVD mandala

Ancient philosophies emphasized holistic concepts, while contemporary approaches often focused on specialized knowledge within design disciplines, sometimes ignoring systematic

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relationships and environmental connections. Ervin Laszlo suggests a synthesis theory and methodology, advocating for a systemic approach that integrates specialized knowledge into a coherent whole [7]. Such perspectives offer a valuable direction for the ENVD mandala approach.

Inspired by the Tibetan mandala, the author describes the structure of the built environment with the diagram of the Environmental Design mandala, called the ENVD mandala (Figure 4). This ENVD mandala model would direct designers to conduct environmental analyses on large and small scales, from natural landscapes to city, urban, garden, building, and interior spaces. This approach considers the information input from other fields and provides feedback, applying specialized knowledge at every level. This approach follows the systems philosophy, a theory exploring "wholeness" to find common principles used in the system. It differs from the conventional analytical method of dividing a system into pieces and examining the details [7].

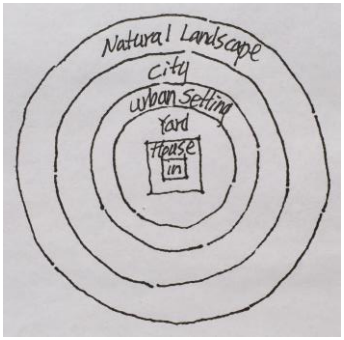

Figure 4. Diagram of the ENVD mandala

Different cultures and geographical conditions produce various forms of architectural space. For example, Western houses are often open to their surroundings, while Eastern courtyard houses are open to the center and defined by buildings. These two types are utilized extensively in their built environments, including gardens, neighborhoods, campuses, and cities. Nevertheless, the Western and Eastern built environments can be described with the ENVD mandala (see Figure 4). By considering each unit as an abstract concept and disregarding their unique characteristics, we can identify similarities in spatial patterns across different cultures, thereby enhancing integration between planning and design fields.

Nesting spaces

The ENVD mandala emphasizes the spatial relationship in the environment, which consists of complex and varied forms. A building includes many subsystems and is subsequently a subsystem of the built environment. In a built environment, buildings are surrounded by gardens, city, and urban and natural landscapes; those spaces fit one inside another and form nesting spaces. Every large space consists of small spaces. The boundaries of these spaces can be ambiguous. These nesting spaces of the built environment are beneath the sky and based on the Earth (Figure 5). Thus, the design at every level must consider the climate influences and geographic conditions. In this interconnected system, humans play a significant role. Influencing and relying on each other's designs and studies, architects, landscape architects, urban designers, and city and regional planners work together to create a functional and meaningful space for the inhabitants. By emphasizing the relationship among varying spatial units, this approach is comparable with the methods of contemporary landscape ecology. The horizontal focus of the relationship among spatial units makes landscape ecology unique [6].

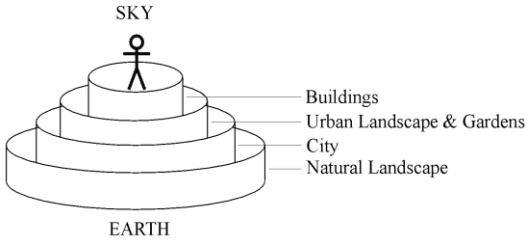

Figure 5. The environmental system contains nesting spaces

Isomorphic patterns

The Tibetan mandala model presents isomorphic patterns. It is these patterns that integrate architecture into those cultural landscapes. Seeking correspondences, we also find isomorphic patterns in contemporary environmental systems. Table 1 is a matrix comparing horizontal and spatial patterns in contemporary environmental design. In this matrix, the author summarizes the thoughts of Kevin Lynch, Richard Forman, and Carl Steinitz [15] and extends those patterns to gardens and architectural spaces.

Forman identifies the natural landscape that consists of corridors, patches, intersections, edges, and neighbors [6]. Lynch describes cities and urban spaces as roads, districts, and nodes, such as downtowns, plazas, boundaries, landmarks, and natural landscapes [9]. Inspired by the above scholars, the author describes isomorphic patterns in campuses, gardens, and various architectural spaces.

Campus and garden designs have similar spatial patterns, with roads and paths, subdivisions, main gathering places, lakes, and walls defining their boundaries. Various types of buildings, such as hotels and libraries, have strong isomorphic spatial patterns. Each type of building has an entrance, exit, hallway, and gathering node of a lobby or atrium. The external

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wall defines the boundary, and a yard with landscape design surrounds the building. The difference between the various building types is their district of rooms, which depends on their functional requirements (Table 1).

This matrix summarizes the spatial patterns of environmental systems, from natural to the built environments, from city, urban, and landscape design to architecture. Understanding the general spatial patterns helps integrate the different specializations and enhances the general concept of an interconnected system. In addition, elaborating principles and models applying to systems would provide efficient teaching and learning to an interdisciplinary approach to sustainable environmental design. According to von Bertalanffy and Laszlo, the general systems theory emphasizes the correlation or isomorphism in certain general aspects of "systems." Elaborating principles and models applying to "systems" provides an interdisciplinary approach to integration between systems [2] [7].

Table 1. Isomorphic and horizontal spatial patterns in environmental design

	Line	**Surface -** District	**Point - Node** Gathering place	**Boundary**	**Surrounding**
Landscape Patterns	Corridor	Patch	Intersection	Edge	Outlier Neighbor Spaces
City	Path Road	District	Node Downtown Plaza	Boundary	Landmark Natural landscape
Campus	Path roads	District Departments	Node Plazas Quadrangle	Campus wall or without wall	Neighbors Natural landscape
Garden	Path	Distract Subdivisions	Gathering area Plaza Entrance Exit	Garden wall	Neighbors Borrow a view
House	Hallway	Dinning Bedrooms	Living room Lobby Exit	External walls	Yard with landscape design
Hotel	Hallway	Restaurant Guest room	Lobby Atrium Exit	External walls	Yard with landscape design
Museum	Hallway	Exhibition sections	Lobby Atrium Exit	External walls	yard with landscape design
Library	Hallway	Reading area Stack room	Lobby Atrium Exit	External walls	with landscape design

Practicing ENVD mandala

Practice is an effective way to examine a theory. Applying the ENVD mandala model, the author, a professor of architecture and environmental design teaching an undergraduate program in Colorado, explores an approach to designing for healthy living. The professor draws the ENVD mandala diagram (Figure 4) on the whiteboard in each class and emphasizes it during desk critiques. After literature studies and lectures on systems philosophy, mandalas, climate adaptations, relevant scientific research, and field investigations, the class conducted the evaluation matrix. Combining scientific knowledge, students evaluate their residences from the natural landscape, urban setting, landscape design, and architecture to furniture arrangement.

Following the ENVD mandala model, students first evaluate natural landscapes, including mountains, hills, water, and orientation, because larger-scale considerations are crucial to avoiding future failures [15]. The class investigated high-impact areas of the 2013 debris flow near Boulder, CO. Debris flows originate at higher elevations. As a debris flow descends, it collects additional debris, gaining speed and power [16]. A narrow canyon with a steep slope or creeks can trigger debris flow [14]. Debris flow is one of the most dangerous natural hazards [5]. In the site at Chapel on the Rock, Allenspark, CO., the debris flow originated from Mt. Meeker, five miles away. The high-impact site in Jamestown is in the confluence area, particularly outside the curved flow.

Debris flow and wildfires could destroy properties and cause fatalities, resulting in substantial impacts on human health. Wildfires burn trees, releasing large amounts of carbon dioxide. After wildfires, the burned trees cannot filter pollutants or produce oxygen. Inhaling smoke and ash from large wildfires create serious health threats for the elderly, the ill, and those with heart or respiratory issues [1]. Extended recovery periods on burned slopes leave inhabitants more vulnerable to debris flow and natural disasters.

Students evaluate living conditions relevant to urban settings after analyzing large-scale landscapes. Research indicates road noise entering through bedroom windows could increase cardiovascular and hypertension risk [4]. Landscape design can also impact healthy living. People living in the forest tend to have lower heart rates, and the fresh air promotes lung health [13]. Extended exposure to water reflections could cause eye cataracts. Uncomfortable glare, direct light, high illumination, and high-contrast conditions can cause visual illness, including strain, irritation, and blurred vision [4].

Studies from public health publications on residence hazards have identified that the primary health risks are hygrothermal conditions, radon, falls, dust mites, tobacco smoke, and fires [11]. Furthermore, it is imperative to research the spatial factors of houses' orientation, position, and form as they impact human health and well-being.

A place with a triangular plan or section could make occupants anxious and stressed. A beam placed too low above a stair can cause a head injury. With split levels, one step built anywhere can increase the risk of injury. People should avoid inhabiting a basement as a living place as heavily polluted air and radon may exist in basements. Scientific research demonstrates that residential radon contributes significantly to lung cancer among residents [12]. Furniture arrangement also has significant impacts on a resident's health. According to students' experiences, beds pushed up against a window experience recurring headache. A bed next to a large window could increase the risk of the flu and other

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illnesses. When working at a desk, one's back should not be toward a door to remain secure.

According to scientific studies, common sense, and living experiences, students developed criteria for evaluating their residences. In addition, students created a series of furniture models to share with the entire class and arranged the furniture around in their apartment models during the professor's desk critiques. Several students who have a product design major wrote in their final essays that in this project, they learned furniture design and arrangement do not just consider the visual quality and styles but also the occupant's health and safety, which can be impacted by surrounding architectural, landscape, and climate conditions.

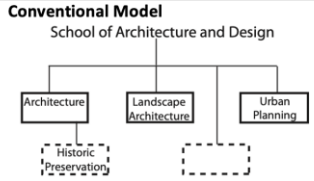
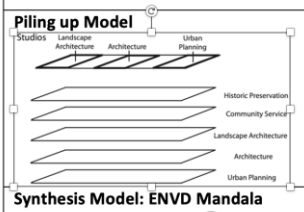
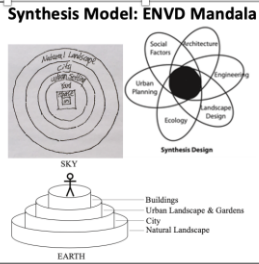
Following the concept of the ENVD mandala, from large scale to small scale, and natural landscape to architectural design, students evaluated their residences for healthy living. At the end of the semester, students often say, "Boulder is a mandala," or "My house is a mandala." It sounds familiar; Tibetans say every place is a mandala, a system. Applying the ENVD mandala in a design curriculum to evaluate the environment boosts understanding of the environment as an integrative system. Students engage in their education, and the professor is not only the knowledge deliverer but also a facilitator.

5. New educational direction

Practicing the ENVD mandala model demonstrates an example of applying this framework in design education to enhance healthy living in a built environment. The ENVD mandala can also be utilized with various themes, such as design with climate adaptation, which the author has practiced in her senior architectural studio. In addition, following the framework of the ENVD mandala, a history course in the built environment can replace several isolated history courses in city planning, urban design, landscape design, and architecture. Analyzing a historical design masterpiece would address multiple aspects, from climate to geographic conditions, from site selection to architecture, from gardens to buildings, from external form to interior arrangement, and from cultural traditions to political background. A synthesis approach provides efficient learning and enhances the understanding of excellent design with its natural, cultural, and social background, which is its original matrix.

Applying the general system theory, research on the ENVD mandala explores a new educational direction, synthesizing previously separate design majors. The synthesis approach presents more advantages than some methods currently practiced in academic institutions, such as the conventional and "piling up" models. Table 2 compares the methodology and capabilities of the three design education models to resolve environmental problems (Table 2). Conventional architectural education has developed over centuries and established curriculums supporting professionals. However, this conventional approach has produced designs with isolated specializations, generating gaps between majors. While the "piling up" approach attempts to overcome isolations among planning and design fields, its method mixes up different specializations from various fields, failing to research integration between fields. As a result, students complained they were overwhelmed with a tremendous amount of knowledge and did not get enough training in their design skills. Thus, using general models is critical to developing a synthesis approach. According to the systems philosophy, elaborating principles and models applying to "systems" provides an interdisciplinary approach to integration between systems [7].

Table 2. The synthesis model provides a new direction for environmental design education

Educational Models	Methodology	Capability to Solve Problems
Conventional Model 	Conventional and isolated specializations conventional analytical method dividing a system into pieces and examining the details	It is weak in solving environmental problems. Sometimes, the isolated design can lead to failure during a natural hazard.
Piling up Model 	Sum of knowledge of various specializations	It realizes the environmental problems but is weak in design skill training, which can be problematic in providing solutions.
Synthesis Model: ENVD Mandala 	Systems philosophy Applying Synthesis general model and interdisciplinary	Applying systems theory, this synthesis model enhances interdisciplinary approach to sustainability design.

6. Conclusions

The Tibetan mandala demonstrates the ancient people's perception of their environment. Like Tibetans, ordinary people today perceive a strong image of their environment, which is intuitive and integrative, often different from what professionals have. As Kevin Lynch states, designers should understand and consider the way ordinary people perceive their environment, the image of which derives from the perceptions of the people who use the place [9]. The Tibetan mandala presents inhabitants'

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perceptions of the environment that people have lived in for thousands of years. The integrative nature of ancient thought provides excellent value for contemporary practices in environmental design. Unsurprisingly, students present great interest in and receive the integrative concept well. Thus, they skillfully apply the ENVD mandala to evaluate their living environment.

As an ancient systematic model of environmental design, the Tibetan mandala structured the Buddhist landscape, adapting to harsh plateau climates above 3000 meters. Ian McHarg states that ancient people adopted natural laws based on thousands of years of experience to survive [10]. Also, Levi-Strauss states that vernacular design methods have tremendous value for sustaining civilizations [8]. Moreover, compared with contemporary design methods, the Tibetan model demonstrates different ways of thinking about the environment, organizing its elements, and ultimately perceiving built places within the surrounding landscape. Those areas often offer significant potential for further research toward a synthesis model of environmental design. Insight into ancient practices has inspired this ENVD mandala model.

The ENVD mandala shares common characteristics with the Tibetan mandala models. First, each model can structure integrative spaces at various levels, from city, urban landscapes, gardens, and buildings to interior spaces. In each space, human activities are significant. Second, dealing with an entire site as a spatial unit, these models emphasize the horizontal relationship between buildings, gardens, urban landscapes, the city, and natural landscapes. Third, these spatial units form nesting spaces. All places are beneath the sky and built on the Earth. Thus, the design at every level should consider the climate influences and geographic conditions. In this interconnected system, humans play a significant role. The ENVD mandala model provides a broad and integrative basis for environmental design. Finally, the ENVD mandala model allows designers to instill themes into various scales to create a meaningful and sustainable environment for the inhabitants.

Weaving in social and cultural values and adapting to the natural environment, the ENVD mandala model would shape cultural landscapes where architecture and landscape design are not separated. Architectural design can instill social and cultural attributes into people's perceptions of the landscape. The landscape, serving as a matrix, imbues architecture with meanings of time and space. In a cultural landscape, architecture is not only included but is a crucial element in generating meanings. The two design fields of architecture and landscape design share common principles, particularly in the design process.

The ENVD mandala model introduces a synthesis approach to environmental design education, bridging gaps in diverse fields. Isomorphic spatial patterns exist in natural landscapes, cities, gardens, and architecture. Understanding the general spatial patterns helps integrate the different specializations. Elaborating principles and models that apply to systems would provide efficient teaching and learning for an interdisciplinary approach to sustainable environmental design. Being rooted in ancient systematic thoughts and elaborating planning and design disciplines, the ENVD mandala model encourages students to cultivate systems thinking, an essential mindset in the contemporary world.

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