

Nature: A Paradigm for an Evolving, Sustainable Technology

SUSAN FROSTÉN

Philadelphia College of Textiles and Science

INTRODUCTION

The construction of a sustainable world is dependent upon several factors: resolution of the conflict between universal civilization and local cultures, the use of technology, and an understanding of the evolution of Western thought regarding humankind's perceived relationship to nature. These three issues interdependently affect the condition of our world. The predominant world view, which is the result of centuries of scientific development in Western thought, has led to universalization, which is possible because of science and technology. A sustainable world requires the acknowledgment of the need for a holistic world view in order to develop a process for construction of a regenerative environment. A paradigm shift in Western thought concerning humanity's relationship to nature is essential to the construction of a sustainable world.

The twentieth century has witnessed an emphasis on universalization as a stride forward for civilization. Universal civilization, according to Ricoeur, has been positive because it has made available to the masses "the freedom from want," "access ... to certain values of dignity and autonomy" and "the fight against illiteracy and the development of means of consuming."¹ The key which allows for the development of a universal civilization is "the scientific spirit" which "unifies mankind at a very abstract and purely rational level, and which, on that basis, endows civilization with its universal character."² Thus, science becomes the essential foundation for civilization.

In describing a probable model of the functioning of the universe, scientific theory metaphysically explains our relationship to the earth. Discoveries or theories in science which result in new paradigms can radically affect technology and civilization, as well as alter humanity's perception of themselves in relationship to the world. According to Frampton, "...civilization has been primarily concerned with instrumental reason, while *culture* has addressed itself to the specifics of expression – to the realization of the being and the evolution of its *collective* psycho-social reality."³

Twentieth-century Western civilization has been inextricably shaped by scientific thought which reaches back to ancient Greek philosophy. There are three underlying currents which has intensified into our present condition: the separation of humans from nature, the body from the mind, and the self from the world.⁴ This leaves any civilization or culture affected by Western thought disconnected and isolated from nature. This differentiation from nature also leads to a sense of superiority and entitlement on the part of humankind. Nature is viewed as mechanistic and de-animated, no longer a living entity. At this point, it becomes easy to view the earth as a commodity. Descartes' statement of "I think, therefore I am" leads to a split in the individual between the body and mind. Now, not only do people see themselves as distinct from nature, but the

individual is disconnected from his or her own body. The body has simply become a receptacle for the mind. Because of this, we no longer recognize our physicality as a means to comprehend our environment. The individual is further distanced from nature, and the body, like nature, is but a machine.

In describing the laws of nature, Galileo was the first to combine the use of mathematical language with scientific experimentation.⁵ This empirical, mathematical approach to the description of nature has remained an essential component of scientific theory. However, in taking this approach, science becomes only about the quantifiable. By eliminating the senses as non-quantifiable and therefore non-scientific, a distinguishable absence of importance is attributed to the unmeasurable. According to R.D. Laing,

Out go sight, sound, taste, touch and smell and along with them has since gone aesthetics and ethical sensibility, values, quality, form; all feelings, motives, intentions, soul, consciousness, spirit. Experience as such is cast out of the realm of scientific discourse.⁶

The cosmos becomes important only as it is measurable. However, it is often in the immeasurable that a new frame of reference is to be found.

With Einstein's theories of relativity, the possibility of humanity's perception of self and nature being altered is immense. His discoveries laid the ground work for a new scientific paradigm of the universe. However, modern architecture primarily latched on to the conception of the interrelationship of space and time. This is evident in the work of the Futurists as well as the Constructivists. Einstein's discoveries were mainly interpreted as the displacement of the individual in time leading to a scenographic approach to design. However, the vaster consequence resulting from the understanding that the pieces are dependent upon the whole has not yet been fully incorporated into the Western world view. Western civilization is only beginning to comprehend that humanity's existence is dependent on the sustained existence of the earth and that we are not distinct from nature.

With the scientific theories currently emerging, this shift in paradigms is occurring. Science has gone from being linear to being non-linear, absolutist to relativistic. The universe can no longer be reduced to the sum of its pieces. The mechanistic view of the cosmos has given way to an organic conception of a living, evolving universe where order arises out of complexity and each system is intertwined and interdependent with all others. In response to this, humanity's perceived relationship to nature is changing. In the same way that science has affected the culture of the past, it can do the same now. Western science has shown the interconnected essence of all living things to each other.

LOCAL CULTURES, NATURE AND TECHNOLOGY

In opposition to Western thought, most non-industrial cultures that live in harmony with nature do not see a distinction between human beings and the cosmos. Non-western cultures realize

The idea of land is inextricably linked to culture, society, the human body and spirit is a pervasive expression of continuity for all indigenous peoples on the planet. Indigenous peoples are inhabitants of a landscape that inhabits them. The interests of the land are identical with the interests of its inhabitants.⁷

As described by Amadou Hampaté Ba, a sage from Mali, "[we have] the deep conviction that everything in the universe is connected, nothing stands alone. Any violation of the sacred laws causes a deep disturbance in the cosmic balance, which results in huge upheavals on the earth."⁸ Native Americans also see humanity as a part of nature with all acting in unison. Humans can not impose their will without some ramifications. Often their buildings tend to echo natural forms and be integrated into nature. There is no word for "nature," as something distinct from mankind in many native languages, including the Quechua language of the Peruvian Andes.⁹ The phrase they use is "nuestra naturaleza," which translates to "our nature."¹⁰ Although Western science in this century has just now come to hypothesize this intricate interdependence, these indigenous people have known this for ages.

Although the twentieth-century civilization takes technological advantage of science, culture has not been fully affected by the corresponding world view. The prevailing world view and use of technology is still based on the seventeenth-century belief that "man" dominates "nature" and that the universe is a mechanistic, linear commodity. Technology in and of itself does not necessarily express this view. The view becomes the filter that imposes values on technology through its development and use.

One of the greatest conflicts that currently exists in the twentieth century is universalization versus particularity of place. Developing a process to approach the construction of a sustainable world is dependent upon the resolution of this issue. This resolution is not an either/or proposition, but rather how will the two coexist. Although universalization has led to the advancement of society through technology, it has often resulted in the marginalization of culture. In architecture, the International Style represented a universal reading which disregarded the site and local culture. The expression becomes so broadened that it becomes reductionist and devoid of meaning. The repetition of standardization does not allow for active stimuli to engage us. Looking to the past, great civilizations, such as the Ancient Romans, have arisen out of a local culture with distinct characteristics. However, they sometimes looked to foreign or external influences for the enrichment of the self rather than the application of standardization.

One way to find common ground for universalization and regional particularity is through technology. Technology is an essential part of local culture and is the means by which universalization is implemented. One "...can't separate the ideas from the tools; all culture has a technological basis."¹¹ Whether the technology being used is traditional tools or contemporary technics, it is the means by which human beings create their relationship with nature.¹²

The understanding of our emerging relationship with the earth creates a rational and value-oriented filter for the application of technology. If technology is used in a way that relates to the emerging paradigm, nature can become the inspiration for the use of technology. Following the ancient writings of Lao Tzu, "Man models himself on the Earth, Earth on Heaven, Heaven on the Way, and the Way on Nature."¹³ If we look to nature, the overall technology may be universal, but the application becomes site specific. In fact, nature can inspire technology systems as well as maximize the efficiency of energy systems. Nature can be seen as a type of organic technology. Although nature may be composed of repetitive ele-

ments, there is always variation between each occurrence and the possibility of awe. This leads to a living process for creating architecture instead of the implementation of a style. Style is a manner of signaling architecture, whereas process is a method of creating architecture. Style, although quickly identifiable, becomes a sign or shorthand for culture, rather than the substance of thoughtful exploration. Looking to nature for inspiration, "form is communication, the presentation of meaning."¹⁴ It is through form, which also provides a function, that different species in nature communicate with one another.

Natural systems can become inspirations for built constructions. However, natural forms should not be merely copied, but rather studied for their logic. There are certain basic characteristics which are inherent in the process by which nature constructs. Nature looks to existing materials for construction. Within this method, there is no lasting waste, but rather a cycle of waste from one system becoming food for another. For energy, nature uses the current solar income, rather than extracting from the past or borrowing from the future. The characteristic of nature which sustains and supports life is biodiversity. Essential to our appropriation of these techniques is the return to the use of the immeasurable and our senses to comprehend our environment.

Issues which need to be explored in any construction are: the local context (including the climate, the topography, the local ecosystem, building precedents and the culture), the effect on the local ecosystem (including human, animal and plant neighbors, the earth, water sources, and air quality), determination of land use, energy, transportation, energy efficiency (including use of local sources and current income), life-cycle implications of materials, minimal waste discharge, and the integration of systems with the form. These are all adaptations of the processes which nature uses.

Indigenous cultures have always been aware of these principles. Their architecture can be a source of research for examples of optimizing the benefits of nature. Each culture looks specifically to their own environment in terms of availability of materials, energy, water, as well as their own needs and their continued survival beyond their own generation. However, their approach goes beyond attaching low technology elements onto a structure, but rather the technics become the form. Their architecture becomes a living organism and in this way also gains a sense of animism.

Critical Regionalism approaches the topic as a generator of meaning, not necessarily as an environmentally sustainable approach to design. This approach examines current architecture which may use universal technology but not a universal style. As a mediator to universal civilization, the strategy looks to communicate with the regional landscape and the culture in order to engender significance, as well as external influences for enrichment.¹⁵ Specificity of site, both cultural and environmental, becomes essential. In a critical eco-regionalist approach, by thoroughly examining the site, the existing natural systems of the site can also become the fundamental generator of a phenomenological design with technology responding to environmental and regional issues.

Although indigenous architecture can provide insight, it is not a model for our present situation. We need to practice and build within our own culture and time frame. Part of the context is living at the end of the twentieth century. If we perceive the universe as continually adapting and evolving, we need to consider the emerging, current needs of people and the resulting technology.

INTEGRATION OF NATURE AND TECHNOLOGY IN BUILDING

In looking at indigenous work, the construction of a bedouin tent is directly related to the needs of a nomadic life in a particular climate.¹⁶ The tent is light, flexible, easily erected, dismantled and transported to the next location, responsive to the ecosystem and derived from materials readily found and replaced. It adjusts to both diurnal and

temporal conditions. It provides shade in the desert during the day, protection at night and a shield from wind and rain with the materials adjusting to each condition. A nomadic condition which is a part of our current, universal civilization is the traveling exhibition. Renzo Piano Building Workshop's IBM Traveling Pavilion exhibits some of the same nomadic needs, however the pavilion now must respond to not only nature and people, but to the display of computers (Figure 1). Only a solution which involves an update in technology will truly satisfy all the requirements. Piano's pavilion also adjusts to specific environmental, site conditions. Using current technology, a computer simulation of the site considers local conditions.¹⁷ In this way, inserts can be placed within the transparent panels to control heat and glare. The sculptural, organic form composed of wood, aluminum, and a polycarbonate expresses the "ideal of a technology that emulated and embedded itself in nature."¹⁸ The structure of a leaf inspired the aluminum connector and wood strut joint (Figures 2 and 3). Piano finds the expression of the organic in the exploration of nature and current technology. Although advanced technologies are used, a feeling of a sensual character, texture and warmth are apparent. The computer amongst the plants in the greenhouse becomes the machine in the garden (Figure 4). The pavilion becomes an allegory of the ideal of contemporary human existence: humanity, technology and nature coexisting in the same system.



Fig. 1. Renzo Piano Building Workshop, IBM Traveling Pavilion, erection of system. (Courtesy of Renzo Piano Building Workshop.)

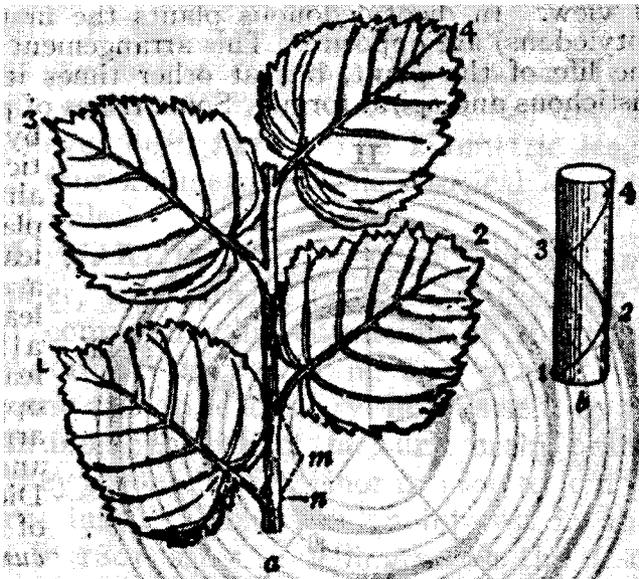


Fig. 2. Diagram of leaf.

A comparison can be made between the systems approach of the Bedouin tent and Richard Roger's Lloyds of London Bank. While the tent is made in such a way that pieces are easily replaceable, the same concept is used with Rogers' building, except now the pieces are not goat hair and wooden poles, but modern day mechanical elements. Rogers' approach is very similar to the systems view described by Laszlo. In response to a integrated view of the world as organized complexity, the systems theory "treats systems as integrated wholes of their subsidiary components and never as the mechanistic aggregate of parts in isolable causal relations."¹⁹ Looking to the logic of nature, Rogers' building is in response to the age.

Examining the use of mass and earth in native cultures, one can look to the underground dwellings of the Northern Chinese.²⁰ The soil provides natural insulation in all seasons. Although sunken, sunlight is brought into the space. Space above can be optimized for agricultural use. This use of natural materials for optimization of energy is adapted by Malcolm Wells in a house in the cold climate of Cape Cod. This house is sunk into the earth and uses soil on the roof as insulation. Looking to nature, the roof can now respond to the elements much as a natural slope would. Reflecting the same knowledge about insulating properties of the earth, Aalto uses a sod roof on the sauna at Villa Mairea. Aside from the functional properties, the application is also echoing the native building within his own country. In opposition to the rigorous, modern tectonic of the main house, the sauna is built according to the tradition of Finnish timber vernacular.

To make the use of grass roofs even more viable, a European company has devised a barrier system which lessens the depth of soil needed and reduces the possibility of puncture by the roots. This evolution in technology allows the use of this product in a widespread manner over large scale buildings. William McDonough and Partners has taken advantage of this for a corporate campus in

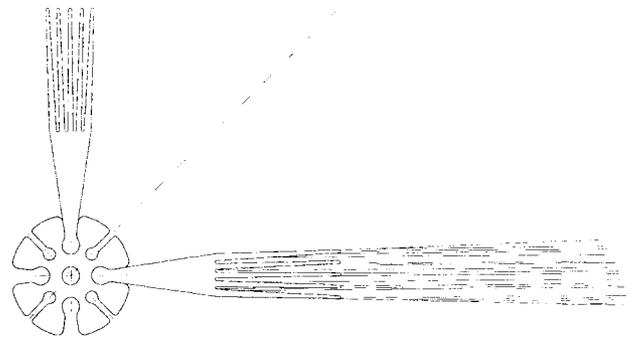


Fig. 3. Renzo Piano Building Workshop, IBM Traveling Pavilion, diagram of joints.

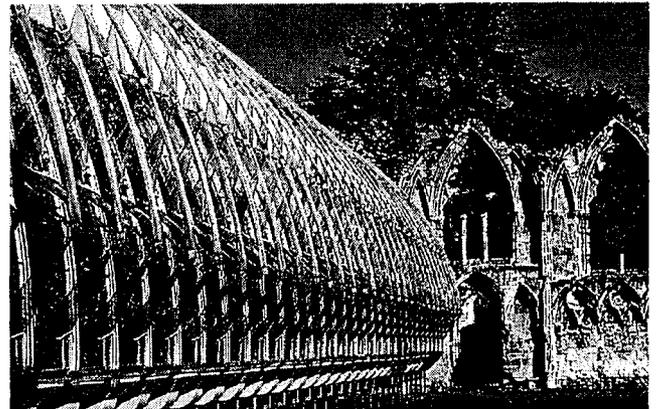


Fig. 4. Renzo Piano Building Workshop, IBM Traveling Pavilion. (Courtesy of Renzo Piano Building Workshop.)

California (Figure 5). The site was the last remaining example of the oak savanna ecosystem that had once been prevalent in the developed area. In order to preserve this ecosystem, the green layer is raised in the air by use of a grass roof system. The form of the building derives metaphorically from the grasslands of the California coastal foothills. The roof becomes a rolling terrain planted with local sedum. The gentle curves of the roof reflect the logic of nature in dealing with the natural elements (Figure 6). The positive attributes include purification of the air by the vegetation, reduction of excess water runoff, insulation for both heating and cooling, protection from the northern wind and camouflaging of the building with the landscape. The building responds to its region not by looking to the built environment, but by reflecting on the local ecology.

The utilization of wind as power by windmills has been in existence at least since the twelfth century. In Finland, because of the abundance of forest, the windmill would be completely constructed of wood to mill grain in agricultural areas. In Greece, because of the cultural connection to the sea, sails would be used on the arms to drive the pumping of water. The contemporary problem is to update this use of wind power to generate emissions-free electricity. Traditional windmills are not powerful or efficient motors as they are intermittent and variable. In order to make these wind turbines effective for creating electricity, the machine needs to be able to withstand the assault of extreme environmental elements and optimize the ability to catch the wind. Familiar to the California landscape, the blades and shaft of the wind turbine are now engineered and made out of durable, contemporary materials. Beyond the generation of power, there is a poetic that speaks of the connection between humanity's tools and the forces of nature, as well as the connection of our lives to sacred cycles and the rituals of time. It accentuates nature and our dependency on it.

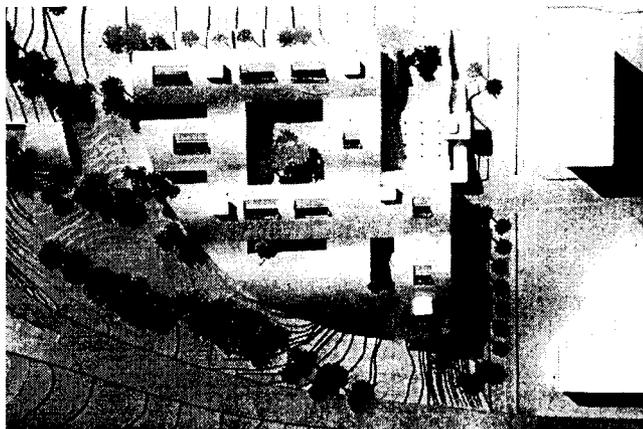


Fig. 5. William McDonough and Partners, Corporate Campus in California, early site model. (Courtesy of William McDonough and Partners.)

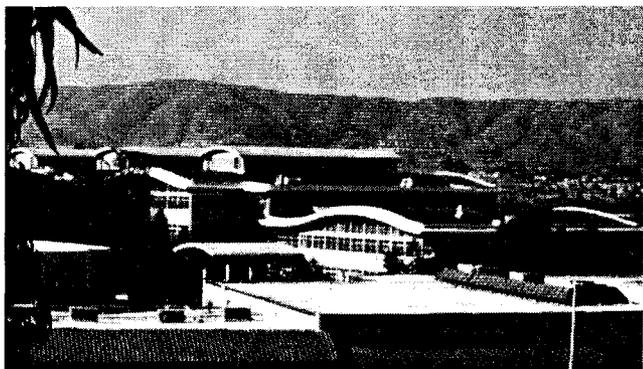


Fig. 6. William McDonough and Partners, Corporate Campus in California. (Courtesy of William McDonough and Partners.)

The proposed design of the Natural Environmental Center by Susan Maxman Architects in association with Andropogen, is generated by responsiveness to site. The center is located in Tinicum Marsh in Philadelphia. The most striking natural system of the existing site is the marshland which cleanses the water of impurities. Looking to this system, a solar aquatic remediation system, or "marsh machine," becomes an essential part of this educational facility. Held within a green house, this ecologically derived tool provides fertilizer for plants, acts as an aquarium, cleanses and recycles greywater within the building system, and discharges excess as irrigation. Once again, the natural environment becomes the context and generator of cultural meaning.

Inspiration for the design of Herman Miller's Midwest Distribution Center is intimately linked with the layered landscape of the region. In examining the local conditions, William McDonough and Partners discovered a series of horizontal and vertical layers (Figure 7). Horizontally, the layers are additive and move from existing homes to new hedgerows and woods, to fields and landforms, to the

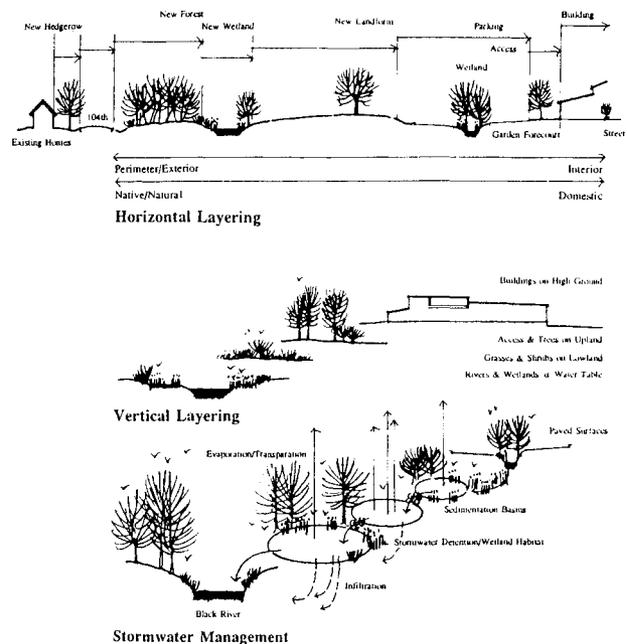


Fig. 7. William McDonough and Partners, Herman Miller, Miller SQA Facility, site analysis by architects. (Courtesy of William McDonough and Partners.)



Fig. 8. William McDonough and Partners, Herman Miller, Miller SQA Facility. (Courtesy of William McDonough and Partners.)

building and parking.²¹ Vertically, the layers progress from the river to the wetlands, and from low lying land to uplands where the facility is placed (Figure 8).²² The approach to the building is through these series of layers of landforms. The building's facade is composed of layers as well. These layers are vertical concentric planes that follow the natural ridge of the site. The first layer is that of the lower office block. The second is the glass atrium over the street which is followed by the factory space beyond. The linear form cuts down on its perceived bulk and allows for needed surface area for truck docks. Not only is the building linked to the landscape, but the landscape infiltrates the building. All areas receive natural light and natural ventilation. The intent is to maximize social interaction between the inhabitants of the site, including humans, wildlife and vegetation. The landscape and the building are linked physically, visually and environmentally.

AN EVOLVING PROCESS

Following the natural pattern, environmentally sustainable architecture should look not only to the conservation of the existing world but to its regeneration. Universal civilization should not be mistakenly construed to imply uniformity of culture. Just as nature employs biodiversity, we should look to the particularity of place. A multitude of cultures can exhibit the aspects of renewal and regeneration that occurs within biodiversity. However, merely mimicking indigenous cultures would ignore the contemporary needs of humanity. The principles can be explored and updated with environmental and technological information that is current. By examining the specific, ecological character of a region, the local needs, constraints and opportunities of the surroundings can be discerned. In some instances, the organic reasoning for design may be intrinsic to the place, while in others, it may be a more abstracted, general condition. In either scenario, nature demonstrates a tried process whose logic can become the inspiration for a growing and changing architecture. If the process of design is inspired by nature, the result itself will take on a life of its own and will contribute to an evolving, sustainable environment.

NOTES

- ¹ Paul Ricoeur, *History and Truth* (Evanston: Northwestern University Press, 1965), pp. 275-6.
- ² *Ibid.*, p. 271.
- ³ Kenneth Frampton, "Towards a Critical Regionalism: Six Points for an Architecture of Resistance," in Hal Foster, ed., *The Anti-Aesthetic: Essays on Post-Modern Culture* (Port Townsend: Bay Press, 1983), p. 17.
- ⁴ Charlene Spretnak, "Resurgence of the Real: How a new perception of body, nature, and place is transforming the world," *Utne Reader*, August 1997, p. 60.
- ⁵ Fritjof Capra, *The Turning Point: Science, Society, and the Rising Culture* (Toronto: Bantam Books, 1982), p. 55.
- ⁶ *Ibid.*
- ⁷ T.C. McLuhan, *The Way of the Earth: Encounters With Nature in Ancient and Contemporary Thought* (New York: Simon & Schuster, 1994), p. 25.

⁸ *Ibid.*, p. 16.

⁹ *Ibid.*, p. 29.

¹⁰ *Ibid.*

¹¹ Richard Critchfield, *The Villagers: Changed Values, Altered Lives: The Closing of the Urban-Rural Gap* (New York: An Anchor Book, 1994), p. 12.

¹² Paul Ricoeur, *History and Truth*, p. 272.

¹³ Lao Tzu, *Tao Te Ching*, trans. D.C. Lau (Middlesex: Penguin Books, 1963) p. 82.

¹⁴ Ian McHarg, *Design With Nature* (New York: John Wiley & Sons, Inc., 1992), p. 169.

¹⁵ Kenneth Frampton, "Towards a Critical Regionalism," pp. 20-1.

¹⁶ Kaizer Talib, *Shelter in Saudi Arabia* (London: Academy Editions, 1984), p. 27.

¹⁷ Peter Buchanan, *Renzo Piano Building Workshop: Complete Works Volume One* (London: Phaidon Press Limited, 1993), p. 117.

¹⁸ *Ibid.*, p. 110.

¹⁹ Ervin Laszlo, *The Systems View of the World: The Natural Philosophy of the New Developments in the Sciences* (New York: George Braziller, 1972), p. 14-15.

²⁰ Michael Moquin, "Adobe, Rammed Earth, and Mud: Ancient Solutions for Future Sustainability," *Earthword: the Journal of Environmental and Social Responsibility*, Issue Number 5, pp. 26-7.

²¹ William McDonough Architects, *Phoenix Designs Project* (New York, 1994), pp. 5-6.

²² *Ibid.*

REFERENCES

- Buchanan, Peter. *Renzo Piano Building Workshop: Complete Works Volume One*. London: Phaidon Press Limited, 1993.
- Capra, Fritjof. *The Turning Point: Science, Society, and the Rising Culture*. Toronto: Bantam Books, 1982.
- Critchfield, Richard. *The Villagers Changed Values, Altered Lives: The Closing of the Urban-Rural Gap*. New York: An Anchor Book, 1994.
- Frampton, Kenneth. "Towards a Critical Regionalism: Six Points for an Architecture of Resistance," in Hal Foster, ed., *The Anti-Aesthetic: Essays on Post-Modern Culture*. Port Townsend: Bay Press, 1983.
- Laszlo, Ervin. *The Systems View of the World: The Natural Philosophy of the New Developments in the Sciences*. New York: George Braziller, 1972.
- McHarg, Ian. *Design With Nature*. New York: John Wiley & Sons, Inc., 1992.
- McLuhan, T.C. *The Way of the Earth: Encounters With Nature in Ancient and Contemporary Thought*. New York: Simon & Schuster, 1994.
- Moquin, Michael. "Adobe, Rammed Earth, and Mud: Ancient Solutions for Future Sustainability," *Earthword: the Journal of Environmental and Social Responsibility*, Issue Number 5.
- Ricoeur, Paul. *History and Truth*. Evanston: Northwestern University Press, 1965.
- Spretnak, Charlene. "Resurgence of the Real: How a new perception of body, nature, and place is transforming the world." *Utne Reader* (August, 1997).
- Talib, Kaizer. *Shelter in Saudi Arabia*. London: Academy Editions, 1984.
- Tzu, Lao. *Tao Te Ching*, trans. D.C. Lau. Middlesex: Penguin Books, 1963.
- William McDonough Architects. *Phoenix Designs Project*. New York, 1994.