FIRST PRINCIPLE

SOLUTIONS GROW FROM PLACE

Ecological design begins with the intimate knowledge of a particular place. Therefore, it is small-scale and direct, responsive to both local conditions and local people. If we are sensitive to the nuances of place, we can inhabit without destroying.

SUSTAINABILITY IN TRADITIONAL CULTURES

In the year 563, Saint Columba left Ireland in a tiny rowboat, carrying with him the kernel of Celtic Christianity. He eventually landed on Iona, a tiny island in the Inner Hebrides off the west coast of Scotland. Hiking Iona, one is struck by the intimacy bestowed upon the landscape. Every hill, pond, beach, cove, bay, offshore rock, and cottage carries its history in its name. There is Dun's, “Hill-Fort of Iona,” with its little pond, Tobar na h'Atose, “the Well of Eternal Youth.” Ancient marble and serpentine rocks can be found at Port Carnan a'Ghille, “the Port of the Young Lad's Rock.” Garadh Dubh Staonaig, “the Black Dyke of Staonig,” is a stone-and-earth running wall that glides over the contours of the land. Over the
generations, cormorants have migrated across the sea to nest at Uahman Sgarhe, “the Cormorant’s Cave.”

The landscape of Iona is continually sung in the naming of its features. This intimate knowledge of place—of sacred springs, nesting cormorants, and ancient rocks—is the starting point for ecological design. It is local knowledge, attuned to the particulars of place.

Traditional place-centered cultures depended on their immediate surroundings for almost everything: water, food, shelter, materials, fuel, medicines, and spiritual sustenance. Instead of denying this interdependence with the living world, they celebrated it. Sustainability, built on patterns of long-term survival, was woven into the texture of everyday life. In the words of the Tewa Pueblo educator Gregory Cajete, “In each place, Native Americans actively engaged their respective environments, and in this engagement became participants with everything in their place. They affected their places and understood that their effect had to be accomplished with humility, understanding, and respect for the sacredness of their place and all living things of that place.” Stories, rituals, and rules gave members of these cultures detailed knowledge of their places.

This knowledge grows organically from a place itself. The poet Gary Snyder expresses it well: You “hear histories of the people who are your neighbors and tales involving rocks, streams, mountains, and trees that are all within your sight. The myths of world-creation tell you how that mountain was created and how that peninsula came to be there.” This knowledge provides the skills to take the pulse of place and foster its health. It concerns the creatures one meets on daily travels, the water one drinks, the trails one hikes. It is accessible to all, gradually accumulated over a lifetime of learning.

Unfortunately, we have largely lost touch with the particular knowledge of particular places, and the result is the placeless sprawl visible from any highway. “For most Americans,” says Snyder, “to reflect on ‘home place’ would be an unfamiliar exercise. Few today can announce them- selves as someone from somewhere. Almost nobody spends a lifetime in the same valley, working alongside the people they knew as children.” Ecological design requires us to once again engage our places, their joys and idiosyncrasies, their wind and water, their pulse and history.

Jerry Mander’s book *In the Absence of the Sacred: The Failure of Technology and the Survival of the Indian Nations* makes a strong case for the survival value of indigenous knowledge systems. Mander tells an instructive story about Inuit caribou hunting on the Ellesmere Islands of Arctic Canada. Conventionally trained government wildlife managers told the Inuit to hunt only large or male caribou. The Inuit argued that this would be catastrophic for the herds, but their opinion went unheeded. The Inuit prediction turned out to be accurate. Despite a far lower hunting limit than that of the previous year, the population dropped dramatically.

The Inuit hunters knew that in a harsh environment, older and larger animals are critical for a group’s survival. They have the experience and physical strength necessary to dig through the winter snow for food. The Inuit knowledge is grounded in careful observation of caribou behavior and is an appropriate basis for the ongoing stewardship of the caribou herd. As Mander concludes, “The sum total of the community’s empirically based knowledge is awesome in breadth and detail, and often stands in marked contrast to the attenuated data available from scientific studies of these same populations.” Given this level of care, it is perhaps less surprising that the Inuit have managed to survive for thousands of years in a difficult and fragile Arctic land.

One of the ancient cultures of the Pacific Northwest, the Kwaakiaul, practiced a remarkable form of “logging” that took wood from a living tree. When a tree was cut, “it was considered ‘killed,’ but a standing tree from which boards were taken had been ‘begged from.’ The straight-grained trunk was, notched 3 feet above the ground, then further up to the length of the desired boards. As the top notch was widened, yew wood wedges were pounded into the gap and down the sides, then a lever was
worked from the upper split to the bottom, freeing the new board without killing the tree.” Contrast this simple, humble practice with the destructive clear-cutting now bleeding life from the old-growth forests of the Pacific Northwest. Clear-cuts leave a lunar landscape, a treeless wasteland no longer able to keep soil in place or support wildlife. The difference between the two logging practices—“begging” from a standing tree and clear-cutting—is the difference between a fundamentally sustainable culture and a fundamentally unsustainable one.

The botanist Gary Nabhan has spent many years documenting the subtleties of indigenous agricultural systems in Mexico and the United States. These systems are exquisitely responsive to place, manifesting a rich knowledge of local soils, animals, climate, hydrology, and plant genetics. They often feature local crop varieties, called heirlooms, representing “distinctive plant populations, adapted over centuries to specific microclimates and soils. They have been selected also to fit certain ethnic agricultural conditions; the field designs, densities, and crop mixes in which they have been consistently grown.” For instance, Hopi blue corn is structurally suited to deep, eight-to-twelve-inch plantings in sand, at a level where moisture is available. This enables the corn to flourish in the difficult conditions of the Southwest.

Traditional agricultural systems typically enhance genetic diversity through well-established cultural practices. Nabhan stresses the importance of these practices: “Since heirloom vegetables are by definition those passed generation to generation through family or clan, they are best represented in cultural communities where a thread of continuity has woven through the centuries.” Over many generations of plants and people, a careful partnership between nature and culture allows hardy varieties to coevolve to meet the vagaries of the environment. In this way, cultural diversity and biological diversity are inextricably linked.

In many forests in India, local knowledge of native trees and their multiple roles has allowed an effective integrated system of agriculture and forestry. Trees are cut only sparingly, since the role of their roots in soil and water conservation is well recognized. Leaves and small branches are used for cooking, as well as for green manure and animal fodder. Medicines are gathered, fruits are eaten, and seeds are made into oils. Trunks and large branches are used for housing, commercial firewood, and timber, and for the construction of carts and agricultural implements.

Yet these forests rich in tamarind and pongia, jack and mango, are rapidly being replaced with eucalyptus monocultures. The range of original benefits from the forest is being reduced to a single cash crop: commercial timber. Why? The knowledge system with power, in this case “scientific forestry,” does not acknowledge the value of any forest productivity that does not take the form of marketable timber. While the foresters speak only of profits on timber, the response of the locals is “What do the forests bear? Soil, water and pure air?” Scientific forestry, unlike the local knowledge of the forest dwellers, “splits forestry from agriculture.” In the same way, we have allowed engineering, architecture, and other design disciplines to be split from the very local knowledge systems that need to inform them.

As these examples illustrate, traditional cultures have achieved their longevity by structuring the smallest details of everyday life around the need to maintain the integrity of the ecosystems upon which they depend. Since these cultures are closely bound to a particular piece of land, actions have local, rather than global, consequences. If ecological limits are approached, it is possible to draw back because they are immediately perceived in the form of catastrophic resource losses. Hunting rights can be temporarily revoked, or land can be left fallow for a time. Sustaining the health of land, season after season, requires constant adjustment, care, and appropriate forms of knowledge.

In the late twentieth century, there is a deep desire to regain a balance between culture and nature, to put certain pernicious technologies back in the bottle, and to question every aspect of the contemporary landscape. We cannot do this without making bridges to the ecological wisdom inherent in the practices of traditional cultures. As Cajete
suggests, “indigenous people have demonstrated a way of knowing and relating that must be regained and adapted to a contemporary setting.”

It is vital that we adapt traditional skills for respecting and preserving place to the possibilities and constraints inherent in our own technological culture.

BRINGING SUSTAINABILITY HOME

The skills required to build a sustainable community are already actively employed in our everyday activities. It is simply a matter of applying them in the right way. Imagine attending to water, energy, waste, and land as carefully as you would attend to your garden, your children’s education, or your money. If these skills are part of the fabric of everyday life, building sustainable communities is possible. It is one thing to read about some distant ecological calamity, and it is another to walk the land, see eroding streambanks, and bring the problem to the attention of the community. Sustainability begins in modest acts of responsibility.

In Berkeley, California, a group called Urban Ecology has begun to make the city streets speak of the land hidden beneath their surface. The Urban Ecologists have stenciled “creek critters”—frogs, salamanders, salmon, and other creek species—on streets above culverted creeks and painted the unambiguous warning “NO DUMPING—DRAINS TO BAY!” next to storm drains around the city. One can no longer dump motor oil down a drain without remembering that it goes to a creek and finally out to the San Francisco Bay. In a way, these stencils and warnings recall the deep reverence for this creek or that mountain intrinsic to traditional cultures. The citizens of Berkeley once culverted their creeks and buried their drainage systems, but now some other citizens are recalling these hidden veins, trying to be responsible for their health, and making others think of them.

Each such act, as modest as it may seem, contributes to a culture of sustainability—a shared awareness that can serve to regenerate the health of both people and ecosystems. We have already inherited the knowledge for creating such a culture of sustainability in the ecological wisdom embodied in traditional cultures. This wisdom can take root even in a highly technological culture if it is consciously nourished, cherished, and allowed to count for knowledge. Since sustainability is a cultural process, it depends on the everyday actions of ordinary people.

As we grow better at integrating sustainability into our daily lives, we will begin to find patterns of awareness and action that are analogous to those of the Inuit hunters or Hopi cultivators and yet are appropriate to our own situations. These patterns can inform us and offer us guidance, much as ancient stories and rituals have always done. If we re-create these patterns in a sufficiently rich way, they can perform several critical roles simultaneously: They can restore our ability to perceive health and nonhealth in ourselves and our places so that we may have some basis for judging the efficacy of our actions. They can break down the tyranny of inaccessible technical language and allow communities to work on difficult issues in a fully participatory way. They can strengthen, rather than weaken, our confidence in our immediate experiences so that we can speak from the heart about our own perceptions.

To the extent that sustainability is imposed by outside forces, it will fail. Sustainability cannot be mechanically replicated under different conditions. It will take endless forms, the very diversity of design possibilities helping to ensure that the whole patchwork quilt of technologies, cultures, and values is sustainable. Bringing sustainability home is about growing a culture of sustainability that is suited to the particularities of place.

VALUING LOCAL KNOWLEDGE

Local knowledge is valuable because it is appropriate. It is exactly what the Inuit need to live with the caribou or the Hopi to grow corn. It provides specific information about the climate, plants, trees, animals, water
flows, and everything else making up the texture of a place. If we are to minimize destructive ecological impacts in our designs, it is precisely this kind of knowledge that we need.

One of us once heard a story about a Chilean farmer's wife. Tasting her freshly made butter one day, she noticed that it was a little sour. Just from the taste of the butter, she knew the problem lay in the cow's diet and was able to recommend to her husband appropriate crops to correct the field's nutrient imbalance. Imagine cultivating a similar sensitivity in our engineering, in our building, in our agriculture!

Local knowledge may be found in the stories that make up a place. In his rich book *The Dream of the Earth*, the monk Thomas Berry celebrates the bioregional story of his own home, Riverdale, which lies in the Hudson River valley:

Tell me the story of the river and the valley and the streams and woodlands and wetlands, of the shellfish and finfish. Tell me a story. A story of where we are and how we got here and the characters and roles that we play. Tell me a story, a story that will be my story as well as the story of everyone and everything about me, the story that brings us together in a valley community, a story that brings together the human community with every living being in the valley, a story that brings us together under the arc of the great blue sky in the day and the starry heavens at night, a story that will drench us with rain and dry us in the wind, a story told by humans to one another that will also be the story that the wood thrush sings in the thickets, the story that the river recites in its downward journey, the story that Storm King Mountain images forth in the fullness of its grandeur.11

Solutions grow from place, out of these stories pollinated by the generations, by the blending of human nature and wild nature. As our stories are told afresh, our places begin again to inform our decisions and our designs. In the Mattole watershed in Northern California, locals have been working for many years to enhance the failing salmon run. They have designed their own hatch boxes, carried out extensive creek restoration efforts, and planted thousands of trees. A generation of elementary-

school children has released salmon into the wild as part of a watershed-based curriculum. The testimony of participant Freeman House is eloquent: "The salmon group worked from the assumption that no one was better positioned to take on the challenge than the people who inhabited the place. Who else had the special and place-specific knowledge that the locals had? Who else could have been expected to care enough to work the sporadic hours at odd times of the night and day for little or no pay?"

Local knowledge is best earned through a steady process of cultural accretion. The knowledge of the careful farmer or rancher, with his or her long experience of soil, crops, livestock, and weather, is an irreplaceable design resource. So is the knowledge of a traditional earth builder, a craftsman, a fisherman, a bird watcher, or a rower. The collective memories of those who inhabit a place provide a powerful map of its constraints and possibilities. In a sense, ecological design is really just the unfolding of place through the hearts and minds of its inhabitants. It embraces the realization that needs can be met in the potentialities of the landscape and the skills already present in a community.

Sustainability is embedded in processes that occur over very long periods of time and are not always visually obvious. It follows that ecological design works best with people committed to a particular place and the kinds of local knowledge that grow from that place. This knowledge is slowly accumulated, season by season, through active engagement with the land. It concerns the humble details of a place, the smell of a field after the first fall rain, the derelict factory down the road, the cycles of decay and renewal, the surprise of previously unnoticed wildflowers. This knowledge is the prerequisite for maintaining cultural and biological diversity both within a local community and in wider habitats. Without local knowledge, places erode.

**RESPONDING TO COMPLEXITY**

Back in the late 1980s, there was a strong push for Star Wars, a blanket of satellites that could shoot down enemy missiles in a nuclear war. The
scheme relied on all kinds of fancy technologies including X-ray lasers, advanced radar systems, and attack and counterattack satellites. One of the most influential groups opposing the weapons system was the Computer Science Professionals for Social Responsibility (CSPSR). Their argument was simple: Given that a ten-line computer program probably won’t work properly the first time through, how can a weapons system requiring ten million lines of instructions ever be debugged? Testing such a program thoroughly is not possible because the exigencies of battle are numerous and unpredictable. CSPSR was arguing that Star Wars would not work because of the unmanageable complexities inherent in its design.

There are limits to knowledge and therefore limits to management. David W. Orr puts it this way: “The ecological knowledge and level of attention necessary to good farming limits the size of farms. Beyond that limit, the ‘eyes to acres’ ratio is insufficient for land husbandry. At some larger scale it becomes harder to detect subtle differences in soil types, changes in plant communities and wildlife habitat, and variations in topography and microclimate. The memory of past events like floods and droughts fades. As scale increases, the farmer becomes a manager who must simplify complexity and homogenize differences in order to control.” Stewardship is quite different from management: it requires wisdom, restraint, and, above all, a commitment to and understanding of a particular place. Without enough “eyes to acres,” stewardship is impossible. Careful attention to detail is lost in the rush to control ever larger and more unwieldy systems.

The emerging science of complex systems gives us a sobering perspective from which to view our own managerial crisis of complexity. Complex systems routinely undergo vast reconfigurations and realignments. Chaos theory tells us that even if we have an exact and deterministic model of a system that is completely closed to outside influences, we may have no hope of predicting its behavior beyond a certain time scale. The systems we deal with as decision makers and citizens are messier: We have imprecise models with lots of built-in randomness and plenty of outside influences. Without enough “eyes to acres,” we will be unable to respond effectively to subtle ecological feedback. We may be tempted to homogenize differences in order to control and manage complexity.

To understand the implications of chaos, let’s begin with the solar system. Hidden in Newton’s deterministic, clockwork model of gravitational interactions lies a long-term unpredictability. Computer simulations suggest that a single pebble passing through the fringes of the solar system will dramatically change planetary orbits over the course of millions of years. In other words, within this clockwork solar system lies the potential for the slightest perturbation to become vastly magnified. If we place Earth but a hair off course, that deviation will eventually be compounded to millions of miles. In a similar way, a butterfly flapping its wings in Madagascar can cause a hailstorm in Kansas two months later. This butterfly effect is inherently scale linking, allowing microscopic interactions to be amplified until they affect events even at a large scale. The microcosmos and the macrocosmos interpenetrate.

Since the butterfly effect renders exact long-term prediction impossible, we need to ask new kinds of questions. We can use the butterfly effect as a way of understanding our own crisis of complexity. Very tangible policy issues around fisheries, forests, greenhouse emissions, and so on are infused with so much complexity that we cannot hope to model them accurately enough to yield precise, certifiable results. When we compound a system’s intrinsic capacity for enormously complex behavior with our own uncertain, incomplete models, we are left with a partial understanding at best. Perhaps we can peg a variable within wide limits or find certain loose correlations, but we are unlikely to be able to provide rigorous answers to key management questions. What climatic response can we expect from such-and-such level of carbon dioxide emissions? Is this truly a sustainable timber yield? The new sciences of complexity, far from increasing our confidence in answering such questions, are really telling us that systems are more delicate than we thought they were, and
that guarantees of safety for our environmental interventions will be difficult to find.

The limits to knowledge implied by complex systems suggest that we cannot scientifically “manage” systems beyond a certain scale. Without a sufficient “eyes to acres” ratio, we will be overwhelmed by complexity. Hence, a vital role is opened for those on the land to participate in decisions at all levels. The understanding we need to restore and work with ecosystems of all kinds is distributed among those who know those ecosystems well. Indian scientist and activist Vandana Shiva puts it this way: “The ordinary Indian woman who worships the tulsi plant worships the cosmic as symbolized in the plant. The peasants who treat seeds as sacred, see in them the connection to the universe. . . In most sustainable traditional cultures, the great and the small have been linked so that limits, restraints, responsibilities are always transparent and cannot be externalized. The great exists in the small and hence every act has not only global but cosmic implications.”* Humble local acts, each respecting the whole web of life, add up to a sustainable culture.

To increase the “eyes to acres” ratio, we need to change the way we think about knowledge and design. We need to scale our designs both to the limits of ecosystems and to the limits of human understanding. This immediately provides an opportunity to bring sophisticated forms of local knowledge into play. In turn, this local knowledge can inform the design process, providing it a high level of ecological sensitivity and appropriateness.

**DESIGNING FOR PLACE**

Only a few generations ago, it would have been absurd to suggest that one should design and build in ways that did not reflect local climate, materials, landforms, and customs. The design of human habitat was limited to local resources, abilities, and ways of doing things. Buildings tended to follow patterns that were well adapted to local conditions. Designing with and for place was the rule and not the exception.

Examples are provided by the indigenous domestic architecture that has developed in each climatic region. Desert villages across the world are built of thick walls of mud or stone with small windows, features designed to maintain cool interior temperatures. The dwellings are tightly clustered to shade each other. Huts in tropical deltas and forests are often raised up on stilts, providing welcome breezes and protection from the wet ground. Walls are woven and roof is thatched from local leaves such as palm. Roofs are steep to shed rain. The dwellings that evolved in the temperate forests of Europe and North America were built of logs and timbers, with steep roofs and overhangs to shed rain and snow. The nomadic herders of the plains of Asia, Africa, and North America evolved portable shelters consisting of light wooden frames covered with a double insulating wall constructed of animal skins.

In this century, tried and tested design adaptations to place have been abandoned in favor of standardized modern templates designed to be conveniently dropped into any situation and any location. As we have seen, these templates require extravagant amounts of energy and materials and destroy landscapes wholesale. They also erode local and regional differences. As the twentieth century comes to a close, places and cultures are being bulldozed into a planetary geography of nowhere. In this destructive context, the task of ecological design is to re-create design solutions deeply adapted to place. Both the lessons of indigenous design and sophisticated new ecological technologies are critical to this task.

An example of this approach is provided by an unbuilt design for the Ojai Foundation School by Sim Van der Ryn & Associates (figures 4–6). Ojai is about an hour’s drive east of Santa Barbara on the central California coast. The climate—hot, dry summers and mild winters—is typical of an interior Mediterranean valley. The site, a saddle on a grassy ridge, was located through a consensual community process in which
members silently walked the land until each found the spot that felt best to them. The program called for a “learning village” including student rooms, faculty residences, office, library, kitchen, dining area, and meditation hall. The plan is organized around a large central elliptical common space. Tiers of housing are arrayed on the south side of the ellipse with each tier shading the other. Common facilities are placed on the north side. The basic building material is soil excavated on-site. Six to 12 percent Portland cement (or fly ash, a waste product of electric power plants) is added, and the mixture is pneumatically rammed into reinforced formwork to make a two-foot-thick, durable, earthquake-resistant wall. This technology—known as rammed earth or pisé—is a modern adaptation of an approach used in China, Europe, and North Africa for centuries. The thick walls provide a thermal barrier that keeps interior rooms cool in hot weather.

The Ojai project also incorporates a passive cooling tower based on an ancient design. Throughout the Middle East, breezes were caught in towers and channeled over water pools to create a simple form of evaporative cooling. The Environmental Research Laboratory at the University of Arizona has developed an improved version of this design. A small amount of water is misted through baffles at the top of the tower to cool the air, which then flows down to the tower’s base in a constant, refreshing stream.

Water is scarce in Ojai, an area with low annual rainfall. Rain falling on the rooftops is channeled to a concrete reservoir under the common area, where it is stored for later use to irrigate the orchard and garden. The plumbing system sends sewage to a septic tank and recycles kitchen and bath water (graywater) in the garden. The low electrical demand is provided on-site through photovoltaic arrays.

A very different response to a very different place is demonstrated in Sim Van der Ryn & Associates’ design for the Lindisfarne Association Center in Crestone, Colorado. Located in the foothills of the Sangre de Cristo Mountains in southern Colorado, the site experiences extremely cold, windy, but sunny days in winter and a short, warm summer. Place
prescribed a design that both maximizes the warming winter sun and minimizes the freezing winter winds. The design is a long, south-facing rectangle with lots of glass. The north wall and roof, both heavily insulated, are covered with soil to reduce the effect of wind and to stabilize temperature. The basic materials are primarily local rubble stone dumped into forms and pine timbers harvested from local trees killed by bark beetles. In spite of extreme winters in which wind chill can reach -60 degrees Fahrenheit, the space, heated only with an energy-efficient wood stove, remains above 55 degrees. This design makes extensive use of passive solar principles and technologies. Simple tools now available allow designers to predict year-round sun and shade patterns at a given site.

Ecological design begins with the particularities of place—the climate, topography, soils, water, plants and animals, flows of energy and materials, and other factors. The task is to integrate the design with these conditions in a way that respects the health of the place. The design works when it articulates new relationships within a context that preserves the relevant ecological structure.15

Consider wetlands. Their internal processes enable them to absorb nutrients, detoxify substances, and remove pathogens. Artificial wetlands—known as constructed wetlands—are now being seeded and maintained specifically to purify wastewater. When a constructed wetland is carefully matched to the level and type of wastewater it will receive, it can both reclaim nutrients and provide exceptionally clean water. In this way, some of our own wastes can be integrated within existing ecological cycles. The constructed wetland creates a new waste/landscape relationship that keeps nutrients on-site, prevents downstream water from being polluted, and provides additional habitat.

Ecological design works with the inherent integrities of a given place, recognizing that the extent to which we rely on far-flung resources is the extent to which we are no longer accountable to our own place. It is possible to temporarily live far beyond our local means, but only at the expense of destructive ecological subsidies from somewhere else. According to the plant geneticist Wes Jackson, we are “unlikely to achieve anything close to sustainability in any area unless we work for the broader goal of becoming native in the modern world, and that means becoming native to our places in a coherent community that is in turn embedded in the ecological realities of its surrounding landscape.” By integrating design within the limits of place—as in the case of constructed wetlands—we make it respond to these ecological realities.

Twenty years ago, solar architect Steve Baer pointed out the “clothesline paradox”: We drill for oil in Alaska, send it through pipelines, refine it, and ship it to an oil-fired electrical utility. The oil is burned, producing steam to push turbines that generate electricity. The electricity is sent out to the grid, traveling hundreds of miles with transmission losses along the way, and thence to your clothes dryer. Here the electrical energy is converted to the mechanical energy of the revolving drum and the thermal energy of the heating coil in your dryer, allowing your clothes to dry. On the other hand, you could have just hung your clothes out to dry on a clothesline!

The clothesline paradox is a good metaphor for our inability to perceive locally available solutions. The clothesline replaces reliance on a distant and ecologically unsound energy system with an everyday ambient resource: warm air. In the same way, ecological design replaces conventional resource-intensive approaches with information-rich, locally adapted solutions. We begin with the particularities of place and ask, What can be done with ecological integrity here? How can we provide energy in this region? How can we provide water without adversely affecting hydrological cycles? How can we provide shelter without destroying forests?

Of course, the solutions will vary strongly from place to place. It is a matter of listening to what the land wants to be. It is said that in order to restore native vegetation, one begins with the area where it is most strongly established. Weed out non-native species, making space for the natives. In a few seasons, the range of the natives will increase, and they will bring their own propitious microclimate with them, eventually allowing them to recover much of their original vigor. It is a simple
method, predicated only on a knowledge of local vegetation. In a similar
way, ecological design seeks to gradually restore the healthy functioning
of the landscape by allowing its original processes to return.

We are not proposing some kind of stylistic “regionalism” in design.
We are speaking of paying rigorous attention—in the design process it-
self—to flows of matter and energy, to the characteristics of soil and cli-
mate, and even to the subtleties of habitat. Choosing to honor the in-
tegrity of ecological processes places strong constraints on design, and
these constraints must be met locally as well as regionally and globally. By
doing this, we can create systems that mesh so closely with nature’s own
regenerative processes that they begin to actively participate in them.

The common camel exemplifies the appropriateness to place that per-
vades nature’s own evolutionary design. In the early morning, the camel
browses vegetation for moisture. Some of this water is metabolically
stored for later use in its fat layer, which doubles as a highly effective
thermal insulator. During the day, the camel’s own body is used as a
thermal mass, and its temperature is allowed to increase to a threshold
unusually high for mammals. Throughout this process, the camel mini-
mizes water loss by producing concentrated urine. When the upper
threshold of body temperature is reached, a special adaptation allows the
camel to dry out while maintaining the health of its blood cells. When the
temperature finally drops, the fat layer can be concentrated in the camel’s
humps, reducing its insulating effect and permitting faster cooling.

The camel’s various adaptations—metabolic water from fat, concen-
trated urine, variable body temperature, low water loss in blood,
humps—allow it to function effectively in the harsh desert climate. The
camel, through its very physiology, can withstand extremes of tempera-
ture that would kill most organisms. It is exquisitely adapted to place.\textsuperscript{17}

In contrast, sealed, centrally heated office buildings are like ostriches
with their heads in the sand, doing everything but responding to place. If
we begin to think of buildings themselves as \textit{organisms} with functional re-
lationships to their environment, new possibilities emerge. In designer

Day Chahroudi’s vision, the building is a “one-celled organism whose
environment contains all the necessary nutrients and also some hostile el-
ements . . . . Using the selective permeability of its roof or walls the
building exhibits homeostasis, perhaps the most basic property of living
things.\textsuperscript{72} The selective permeability is obtained by coating the inside of
an ordinary window with a heat-reflective layer. The window lets in light
but traps reradiated heat. This helps to allow a building, with proper
solar orientation, to adapt itself to the local climate. In such a design, the
harsh walls favored by industrial designers become softened to biological
membranes, echoing the camel’s adaptations. The building stays warmer
in cold weather and cooler in warm weather.

Knowing the details of local climate is often the key to place-
responsive architectural design. The Bateson Building in Sacramento was
designed by the Office of the California State Architect with the explicit
goal of reducing energy consumption by 75 percent (figures 7 and 8). In
most office buildings, the biggest energy requirements are for artificial
lighting and air conditioning. The Bateson Building relies primarily on
daylighting through a floor plan in which no desk is more than forty feet
from a natural source of light. A careful study of climate data showed that
while the city often experienced a week of days over one hundred degrees
during the summer, evening temperatures dipped into the fifties because of
cool air creeping up the Sacramento River from San Francisco Bay.
This became the heart of the climatic design strategy. The square-block
building was designed around a large, four-story atrium under which was
placed hundreds of tons of rock. During summer days, the building’s
heat is absorbed by the thermal mass of the rock. At night, large fans flush
the thermal energy stored in the rock out into the cool evening air. The
building is also provided with motorized shades that block incoming
sunlight as necessary.

Just as the camel fits its desert niche and well-designed solar buildings
fit their climates, ecological designs fit their places in rich and surprising
ways. The knowledge needed to create them is inevitably place-specific.
Already in the 1940s, Lewis Mumford proposed anchoring education at all levels with a kind of "regional survey." This survey becomes "the backbone of a drastically revised method of study, in which every aspect of the sciences and the arts is ecologically related from the bottom up, in which they connect directly and constantly in the student's experience of his region and his community." It embraces a careful study of both the local environment and the businesses, institutions, and people that make up a place.

In Austin, Texas, Pliny Fisk and the Center for Maximum Potential Building Systems (Max's Pot) have rigorously pursued the implications of Mumford's "regional survey." Max's Pot's most fully realized project to date is the Laredo Demonstration Blueprint Farm, a two-acre farm at the edge of Laredo, Texas. This project responds to the climate, mineral re-

sources, vegetation, and soil of its region, which lies in a transition zone between the arid Southwest and the prairie grasslands. The farm, located near the Rio Grande, features a small orchard, shaded areas for growing, several storage sheds, cisterns, wind generators, and an on-site treatment system for agricultural wastes.
Max's Pot begins every project by looking to the ecologically appropriate designs indigenous to other biomes—biological regions—around the globe that have a similar climate and vegetation (figure 9). In Texas, the scrubby mesquite tree is regarded as a nuisance and ruthlessly cleared away. In the badlands of Argentina, though, it has long been used for floor tiles. On the Laredo farm, mesquite tiles are used for permeable paving. In a similar fashion, the farm's cooling towers in the storage sheds—similar to those in the Ojai design—were borrowed from Iran.

Max's Pot seeks regionally appropriate building systems that are "predicated on the uniqueness of place." These systems catalyze local economies because they create local jobs right from materials extraction through processing and actual construction. At the farm, crops are shaded by a flexible network of poles, cables, and polyester panels. The poles are old oil-rig drilling stems found in a nearby junkyard. The farm's sheds were built with straw bales, a readily available agricultural waste. The roof supports are a clever latticework of locally fabricated thin steel trusses and decking. Concrete floor slabs will soon be mixed on-site with the locally available minerals pozzolan, lime, and caliche.

The design of the Laredo farm clearly grows from place, responding to the area's unique constellation of factors: Generators utilize the wind, cistern catchment systems capture rainfall, the crop-shading system and cooling towers provide protection from the sun, and agricultural wastes are treated before reaching the Rio Grande. It also uses local resources—vegetation (mesquite tiles) and minerals (caliche, lime, pozzolan, iron trusses)—and locally produced wastes (straw bales). Max's Pot is "mining for the knowledge to capitalize on local resources . . . and local farmers, metalworkers, and builders to sustain the small Blueprint Farm community and, by extension, dozens of such settlements on the periphery of existing cities." By responding in an information-rich, energy-poor, and materials-frugal manner to a demanding landscape, the Laredo farm minimizes destructive ecological impacts.

At a large scale, basic issues become imponderable puzzles. What "economic value" should be assigned to the biodiversity of a tropical forest? What is the "optimal" level of greenhouse gas emissions? In each case, we seek an overly simple quantitative answer to a swelter of complexity. When we return to a human scale, these problems begin to resolve themselves. Design is accountable to place when we can read the consequences of our actions right on the landscape. It is not accountable to place when it relies on hidden, far-off ecological subsidies ranging...
from the destruction of forests to the poisoning of waters and acidifica-
tion of lakes. Neglect occurs in one place at the expense of intractable
problems somewhere else. A project like the Laredo farm works because
it is firmly grounded in the constraints and opportunities of a particular,
well-defined region.

NOTES

3. Ibid., 25.
7. Ibid., 72.
10. We are indebted to Katy Langstaff for her provocative notion of a “pattern for sustainability.”
15. Thanks to Katy Langstaff for some helpful discussions on the related notion of structure-preserving transformations.
20. John Todd originated this phrase.