Implications

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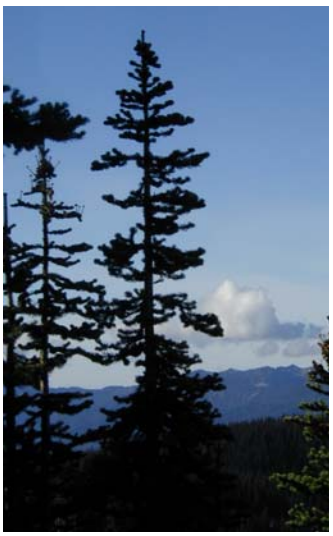

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Learning From Nature

With the onward march of science and technology, and the continuing quest for improvement, there is a growing curiosity about the world around us. The structures in nature are great lessons for human study. Only the most successful structural forms have survived. The resourcefulness of material use, conformity with mathematical proportion, underlying structural systems, and the profound capacity to respond to a variety of climatic and environmental forces, make natural forms tremendous exemplars to numerous fields of design. Close examination of structures in nature can be rewarding and surprising. As the following articles suggest "doing it nature's way" has the potential to change the way we practice design.

Biomimicry

"Biomimicry" has been a featured topic at a range of recent conferences and for good reason. This new methodology offers design, science, industry, municipalities, and even individuals a new way of accessing nature's intelligence and principles of design.

Biomimicry (from bios, meaning "life," and mimesis, meaning "to imitate") is a design principle that seeks sustainable solutions to human problems by consulting and emulating nature's time-tested patterns and strategies. According to biologist Janine Benyus (2002), author of the groundbreaking book Biomimicry, the core idea is that nature, imaginative by necessity, has already solved many of the problems designers are grappling with. Using nature's principles allow designers to create products, processes, and policies that are well-adapted to life on Earth over the long haul.

The science of biomimicry provides designers with a framework. In her book, Benyus offers the following nine basic laws of the circle of life, all of which resonate throughout her work and that of other biomimics:

- Nature runs on sunlight
- Nature uses only the energy it needs
- Nature fits form to function
- Nature recycles everything
- Nature rewards cooperation
- Nature banks on diversity
- Nature demands local expertise
- Nature curbs excesses from within
- Nature taps the power of limits

(Benyus, 2002, p.7)

With biological knowledge doubling every five years, designers now have the instruments and the capacity to mimic nature like never before. According to Benyus, if we adapt nature's design methodologies, if we ask, "how would nature do it," we will not only make great progress, but through reverse engineering we will find solutions to both common and complex problems.

Application

Consider what the early biomimicry adapters have accomplished. Companies, such as Interface, subscribe to The Natural Step, a framework for systems thinking and cause/effect relationships. It encourages behavior in harmony with the earth's processes. As a direct result of practicing biomimicry, Interface's David Oakey developed a carpet. *Entropy*, mimics the random patterns of the forest floor, yielding environmental benefits not found with other carpet tiles. Because the subtly-shaded carpet tiles blend together like leaves, without strict patterning, there is easier matching of replacement tiles, fewer discards, easier installation, all ultimately resulting in waste reduction. In this way, biomimicry can definitely benefit facilities managers and building owners.

Want to efficiently improve airflow in a home or commercial facility? Designers might ask a biologist how those organisms that must cool themselves by panting, moving air across a surface to evaporate moisture, do so with minimal energy expenditure. Benyus suggests that designers consider that birds pant and cool themselves by oscillating a pouch in their chests at an easily maintained resonant frequency. Perhaps windows could include a section of flexible slats that would oscillate at a resonant frequency maintained by occasional short bursts of electricity or, better yet, by the wind or the sun's energy.

Plants and animals may also give designers new ideas about old materials. For example, any child can tell you that peacock feathers are brightly colored. What a surprise then to learn that the only pigment these feathers contain is the brown feather pigment melanin. The deep colors we see result from the directional layering of the feather's keratin protein which, combined with the melanin background, causes the light to refract in such a way as to have us see the color. The "color" is structural.

Inspired by this natural design, a Japanese company has created reusable display signs; the surfaces of these signs are structurally altered through exposure to UV light, which changes the crystalline alignment of the material, throwing off color to display a desired message. These signs can be continually reused and imprinted with new images, eliminating the need to manufacture new signs or use toxic paints.

Scientists are now looking at the lotus leaf to develop new methods of keeping surfaces clean. Even in the midst of the muddy swamps where the lotus thrives, the lotus leaf's pores keep clean to allow it to breathe and conduct photosynthesis. Scientists have discovered that the surface of the leaf, which appears smooth to our eye, is covered with microscopic mountains. Having a jagged, as opposed to a smooth, surface means that rain easily washes away dirt particles because the particles teeter precariously on peaks rather than adhering to a smooth, flat surface.

The craggy surface of the lotus leaf also means that raindrops maintain a more effective spherical shape rather than flattening out and losing momentum. This insight has given rise to a novel type of building façade with a texture that has properties comparable to a lotus leaf; water droplets from rain will roll off the surface, automatically removing dirt as the rain washes over the surface. A German company, Ispo, is manufacturing such a product, called Lotusan. Amazing—yes!!

Consider Your Options

According to Benyus, designers would do well to imitate biology. Look carefully, she says, and you'll see that the honeycomb and muskrat lodge contain structural advantages and energy efficiencies that humans have yet to improve upon. Mimicking the functional biology of cacti, snails, termites, pine trees, and even bone cells could lead us into a new age of buildings that sprout, grow, decay, and harmonize with surrounding environs.

Flowers are marvels of adaptation, growing in various shapes, sizes, and forms. Some lie dormant through the harshest of winters only to emerge each spring once the ground has thawed, and others stay rooted all year round—opening and closing as necessary to respond to changing conditions in the environment such as the availability of sunlight. They are the perfect metaphor for buildings in the future, because like buildings, they are literally and figuratively rooted in place, able to draw resources only from the square inches of earth and sky that they inhabit. The flower must receive all of its energy from the sun, all of its water needs from the sky, and all of the nutrients necessary for survival from the soil. Flowers are also ecosystems, supporting and sheltering microorganisms and insects like our buildings do for us. Equally important is that flowers are beautiful and can provide the inspiration needed for architecture to truly be successful.

In the future, the houses we live in and the offices we work in might be designed to function like living organisms, specifically adapted to place and able to draw all of their requirements for energy and water from the surrounding sun, wind, and rain. The architecture and design will draw inspiration, not from the machines of the 20th-century, but from the beautiful flowers that grow in the landscape that surrounds them.

References:

—Benyus, J. (2002). *Biomimicry: Innovation Inspired by Nature.* New York: Perennial.

—Birkeland, J. (2002). *Design for Sustainablility: A Sourcebook of Integrated Ecological Solutions.* London: Earthscan

—McDonough, M., & Braungart, M. (2002). *Cradle to Cradle: Remaking the Way We Make Things.* New York: North Point Press.

Nature's Proportion System

The Golden Section is intimately related to growth and nature. An egg, an apple blossom, a human face, a seashell—all embody Golden Section Proportions.

The Great Pyramid of Cheops is perhaps its most dramatic architectural expression, but the Parthenon's façade follows it as well, and Chartres Cathedral abounds in Golden Section harmonies. The Golden Section has been referred to as the Divine Proportion, the Golden Rectangle, or the Fibonacci Sequence (after Leonardo Fibonacci of Pisa who pioneered some of the early mathematical phenomena and its connection to nature). This proportion has come to be designated by the Greek letter Φ, "phi," for Phidias, the architect of the Parthenon.

The proportion of the Golden Section is: *a* is to *b* as *b* is to *c*; and *a* plus *b* also equals *c*. The ratio *a:b* is 1: (1+ √ 5)/2, or 1:1.618; so Φ equals 1.618.

AB/CB = CB/AC = 1.618

Phi proportions turn up constantly in growing forms. For example, the sea nautilus adds compartments to its shell as it grows. Interestingly enough, each new compartment is exactly 1.618 times larger than the previous compartment. Study the center of a sunflower or a daisy, and you will see the same principle at work. Florets compose the center of the sunflower and turn into seeds. The florets grow along logarithmic, equal-angular spirals. At each stage of growth, the florets progress at the same 1.618 proportions. Like other living things, the human body contains a rich system of proportions. When regulating lines are applied to the human body and face, one finds an absolute symphony of proportional harmonies. The following are a few of the simplest and most common: the height from a person's head to the feet equals the distance from fingertip to fingertip of the outstretched arms; the ratio of the distance from the feet to the navel to the person's overall height is the Golden Section, 1:1.61; the human body has numerous Golden Section proportions and permutations.

Proportion is the nature of architecture. The Golden Section is evident throughout history appearing in such architectural icons as Stonehenge, the Great Pyramid, the Parthenon, and Hadrian's Pantheon. In more modern times, phi has graced the proportions of Gothic cathedrals, Palladian villas, and the works of 20th-century architects Louis Sullivan, Frank Lloyd Wright, and Philip Johnson.

The Golden Section is a simple tool that may be used to enhance the meaning and beauty of an architectural work. Designing buildings with this knowledge automatically creates harmonizing, uplifting effects on those who experience them. When the structural lines of a building are designed according to the principles of harmonic proportions, a natural aesthetic beauty results—beauty that can benefit those who work, live, and play within those environments.

Recommended Readings:

—Lawler, R. (1982). *Sacred Geometry*. London: Thames and Hudson Ltd.
—Mann, A. (1993). *Sacred Architecture*. Rockport, MA: Element Books.
—March, L. (1998). *Architectonics of Humanism*. London: Academy Editions.
—Rawles, B. (1997). Sacred Geometry Sourcebook. Nevada City, CA: Elysian Publishing.

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Related Research Summaries

InformeDesign has many Research Summaries about humans' relationship to the natural and designed environments and related, pertinent topics. This knowledge will be valuable to you as you consider your next design solution and worth sharing with your clients and collaborators.

"Bringing Sustainability to Mass Tourism"
—*Cornell Hotel and Restaurant Administration Quarterly*

"Promoting Neighborhood Walking and Cycling"
—*Social Science and Medicine*

"Landscape Preference"
—*Journal of Environmental Psychology*

"Inspiration for School Design From the Past"
—*Design Issues*

"Tree Elements Affect Preference"
—*Environment and Behavior*

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Delores Ginthner, University of Minnesota (Parthenon, p. 4)
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