
# Nature's Unifying Patterns

## Biology Examples and Design Applications

Nature's unifying patterns are an attempt to identify overarching lessons from the natural world that have profound implications for what and how we design. Taking these fundamental lessons into consideration is a key step in practicing biomimicry and helps distinguish biomimetic design from the broader category of bioinspired design. Doing so helps ensure that your designs will fit in well with all of life on earth.

For more information about the patterns, along with additional examples, please refer to the Biomimicry Toolbox website.

1. **Nature uses only the energy it needs and relies on freely available energy.**
2. **Nature recycles all materials.**
3. **Nature is resilient to disturbances.**
4. **Nature tends to optimize rather than maximize.**
5. **Nature provides mutual benefits.**
6. **Nature runs on information.**
7. **Nature uses chemistry and materials that are safe for living beings.**
8. **Nature builds using abundant resources, incorporating rare resources only sparingly.**
9. **Nature is locally attuned and responsive.**
10. **Nature uses shape to determine functionality.**

# 1 Nature uses only the energy it needs and relies on freely available energy.

Energy is expensive to organisms. The risk of using excess energy is death or the failure to reproduce. Therefore, organisms use it sparingly and make use of energy that is renewable, is found nearby, and doesn't require a lot of energy to obtain. Two major expenditures of energy for organisms are gathering food and growing or collecting the materials that make up their bodies and homes.

## Biology Examples

**Condor**
Condors are large, soaring birds that rely on rising warm currents of air in order to get aloft. Condors are huge, and it would take a tremendous amount of energy to propel themselves by flapping their wings. By riding thermals, they are able to glide all day looking for food. While gliding, the birds use the same amount of energy they would if they were just resting on their nests.

**Abalone**
The abalone's shell is 200 times stronger than our toughest high-tech ceramics. While our ceramics are made using very high temperatures, high pressures, and materials mined from the ground, abalones construct their shells at seawater temperature and pressure, out of minerals pulled from the seawater.


# Design Applications

**Bullitt Center**

The Bullitt Center in Seattle, Washington, USA, sets high standards for the use of low energy processes. It offers no parking to tenants but rather is centrally located and provides a communal bike room, thus encouraging low-energy commuting. Its sole elevator is positioned in a remote corner of the building, while a majestic central staircase encourages foot transport from floor to floor. Its glass walls optimize natural light in the building, even in rainy Seattle. Its timbers and other materials are locally sourced. Solar panels provide energy, the use of which is closely and responsibly monitored.

**Bicycle phone charger**

In some emerging economies, the majority of people live in homes without electricity, yet many also own cell phones. To charge their phones, people often have to travel long distances to charging stations. The bicycle phone charger, designed in Tanzania by Bernard Kiwia of Global Cycle Solutions (GCS), piggy-backs on the popularity of bicycles for travel in these regions and enables users to charge their phones on the fly by tapping into the free energy produced by the spinning bike wheels. Designed to utilize scrap bike and radio parts, the device relies on materials that are readily available in Tanzania and keeps "waste" out of the landfill.

*Image credits*

*Previous page: Condor, Guido da Rozze CC-BY-ND; Top to bottom: Bullitt Center, ©Nic Lehouse (used with permission); Bicycle phone charger, Global Cycle Solutions www.gcstz.com/product/.*

# 2 Nature recycles all materials.

In nature, one organism's waste or decomposing body becomes a source of food and materials for other organisms. While we talk about recycling, what happens in nature is more appropriately called upcycling.

## Biology Example

**Trees**
In nature, the recycling loop isn't direct. Wood doesn't directly become wood again. Instead, wood gets broken down into its various chemical components by a host of organisms, and then those components can be utilized by even more organisms. At every stage of a log's decay, some organism finds a use for the log. It becomes a shelter for some, a place to perform a mating dance for others, and a place to store seeds or acorns. Even before a dead tree falls, other organisms start breaking down the carbohydrates and proteins in the trunk and branches, drawing energy from them and creating by-products or waste that other organisms can use. Some fungi are able to break down a complex chemical compound called lignin, which few other organisms can handle. The fungus makes the components in lignin available to other organisms to use as building blocks for new chemicals.

# Design Applications


*Boulder's waste diversion rates for 2013 show how much of its waste stream is reused, recycled, and composted, rather than being sent to a landfill.*


**Boulder, CO, USA**

The "zero waste" effort is growing in many municipalities. In Boulder, Colorado, USA, the city provides easy instructions for how to recycle just about any material that might normally end up in the trash—eyeglasses, lightbulbs, Christmas ornaments, books, children's toys, etc.—and includes details about this recycling effort in a city-wide awareness campaign around water conservation and energy efficiency. A robust city-wide composting program makes management of food and yard waste simple, and city residents have access to free compost that they can bring back to their gardens. A cyclic approach to waste management has taken on new meaning at the city's "recycling row" where residents can bring anything—mattresses, paint, furniture—for up-cycling, down-cycling, or recycling purposes.

**InterfaceFlor**

InterfaceFlor, which produces modular carpets, is the first carpet manufacturer to implement a process for the "clean separation" of carpet fiber from backing. This allows for a maximum amount of post-consumer material to be recycled into new products, with minimal contamination. Through their process, called ReEntry® 2.0, clean, post-consumer nylon fiber is returned to Interface's fiber supplier. There, in combination with some virgin materials, it is recycled into new nylon for use in new carpet fiber. At the same time, the backing material is crumbled and transformed into new backing. Plastics that can't be used for Interface processes or products are distributed to other industry suppliers for re-use in their material streams.

*Image credits*
*Previous page: Log, Flickr user "Lamerie" CC-BY-NC; Top to bottom: Boulder waste chart, www.bouldercolorado.gov; Interface recycled carpet, InterfaceFlor CC-BY-NC-ND.*

# 3 Nature is resilient to disturbances.

Being resilient is about having the ability to recover after disturbances or significant changes in the local environment. Nature uses diversity, redundancy, decentralization, self-renewal, and self-repair to foster resiliency.

## Biology Examples

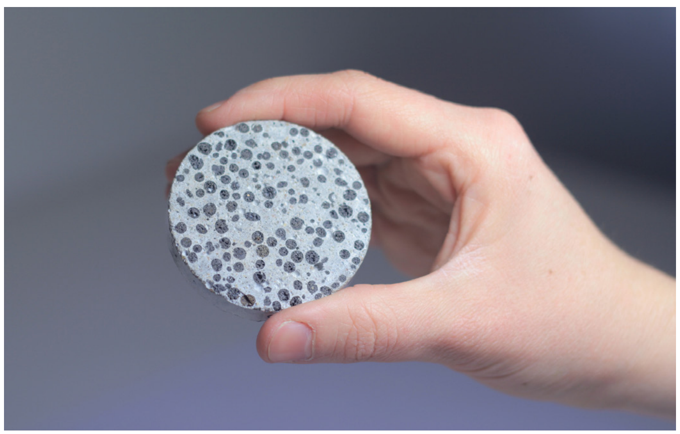
**Lodgepole pine forest**

Large fires swept across Yellowstone National Park, USA, in 1988. Afterward, the lodgepole pine forests were able to grow back because the pines have two types of cones: regular cones that open to release seeds in normal conditions and special serotinous cones that are sealed shut with a resin and open only when exposed to the high heat of a fire. This diversity of cones provides options for reseeding, depending on conditions. Each tree also produces many cones, and this redundancy ensures that the forest can still recover, even though only a relatively small percentage of seeds sprout. If an area is burned beyond the point where serotinous cones survive, seeds from other forest stands nearby may also contribute to regeneration.

**Prairie ecosystems**

In a prairie ecosystem there is a diversity of plant species that serve different functions in the ecosystem, such as nitrogen fixation, water retention, and soil stabilization. Resilience is enhanced because this variety of plants is spread throughout the prairie, and there are multiple representatives of each species and each functional group. Collectively, this

*Prairie landscape, Kansas, USA.*



*A sample of self-healing concrete.*

diversity serves as a pest management system, since many pests are plant-specific and cannot spread as easily between plants in a diverse ecosystem. The plants' abilities to survive different types of perturbations results in long-term survival of the ecosystem. In a drought, some species become more abundant while others become scarce. During wet years, this relationship switches. But the ecosystem still functions, providing ecological services.

## Design Applications

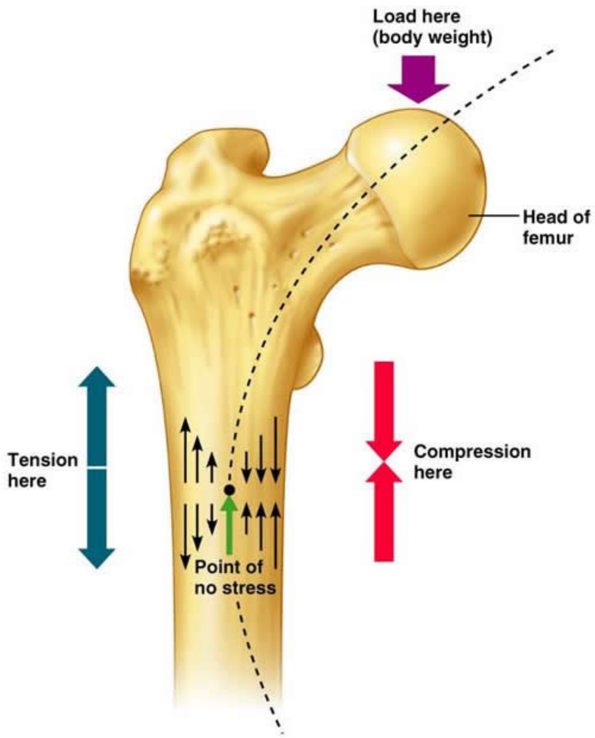
**Self-healing concrete**

Concrete is one of the most commonly used building materials, but it is prone to cracking. From large crack to hairline fractures, cracks weaken the structural integrity of concrete. Engineers have developed self-healing concrete by mixing bacteria into concrete to create a bio-concrete. The bacteria grow into cracks as they form, releasing calcium carbonate as a waste material, which fills the cracks. This example is a combination of biomimicry—mimicking the self-healing processes of trees and other organisms—and bioutilization, the use of an organism.

**Signapore's water supply system**

Singapore is a densely populated island nation that is vulnerable to having its water supply from the Malaysian mainland cut off by regional conflict. In response to this potential for sudden and catastrophic disruption, Singapore has developed a varied, redundant, and decentralized water supply system and a strategy that features conservation efforts to reduce demand, the desalinization of seawater, rainwater catchment basins, reclamation of wastewater to drinking water, and some piped water from the Malaysian mainland.

*Image credits:*
*Previous page: Lodgepole rebirth, Gyan Gunawardana CC-BY-NC-ND; Top to bottom: Kansas prairie, Eva Funderburgh CC-BY-NC; Self-healing concrete, UCL News CC-BY-ND.*




# 4 Nature tends to optimize rather than maximize.

Because energy and materials are so precious, nature seeks a balance between resources taken in and resources expended. That is, nature tends to optimize. Growth for growth's sake results in harmful side effects.

## Biology Example

**Bones**

Bones respond to stresses placed upon them by adding material (calcium) where more is needed to provide strength. This is why women are encouraged to do weight-bearing exercises to prevent brittle bones as they age. While a heavy bone may be stronger (e.g., the weight is maximized), the energy costs of the body carrying around extra weight is high. Therefore, if the body senses that the bone doesn't need strength in some areas, it removes the calcium (e.g., the weight is optimized).

## Design Application

**Tiny houses**

There is a growing community of people who are designing and living in ultra-efficient "tiny houses." Many examples are barely more than 100 square feet (or less than 10 square meters) but provide all the basic functions of a full-sized home using a variety of design strategies.

*Image credits, top to bottom: bone, www.midlandstech.edu; tiny house, Nicolás Boullosa CC-BY.*

# 5 Nature provides mutual benefits.

While there are many examples of predation, parasitism, and competition in nature, the prevailing relationships are those that are cooperative. Cooperative relationships may occur between two organisms or among many different ones. Some common types of cooperation are mutualism—where both partners benefit from the relationship—and commensalism—where one partner benefits and the other receives neither benefit nor harm. In the long run, even predation, parasitism, and competition, while harmful at the individual level, often have benefits at the systems level.

## Biology Examples

**Clark's nutcracker**

The Clark's nutcracker is a bird that has a mutualistic relationship with the white-barked pine tree in the western United States.The nutcracker is the primary seed disperser of the white-barked and other pines. In large cone-production years, one nutcracker is able to collect and store in the ground 3-5 times more seeds than she actually eats. The birds benefit through this relationship by getting high-calorie seeds to eat, and the tree benefits because the birds bury the seeds for storage at just the right depth to later germinate into seedlings.

*Mycorrhizal root-tips of* Amanita muscaria.

**Mycorrhizal fungi**

Mycorrhizal fungi have a mutualistic relationship with many plants. The fungi grow attached to plant roots underground and dramatically increase a plant's ability to absorb key soil nutrients, especially phosphates. In exchange, the plants feed the fungi attached to their roots with sugars generated by photosynthesis. The fungi's finer filaments and greater surface area allow the fungi to take in nutrients from a greater volume of soil, and their enzymes can make mineral phosphates usable for the plant. Some mycorrhizae also support plant nutrition by hosting nitrogen-fixing bacteria that contribute nitrogen that can be absorbed by the plant as well.


## Design Applications

**Masins building, Seattle, WA, USA**

The historic Masins Furniture building in downtown Seattle, Washington, USA, houses several social entrepreneurial organizations, including the HUB Seattle (a co-working business incubator), the Bainbridge Graduate Institute, and Organizational Systems Renewal, a non-profit organization. These organizations not only share space and infrastructure—and the associated expenses—but they also share ideas, projects, and clients for the mutual benefit of all involved, while keeping their individual identities and unique orientations alive.

**EmptyMiles**

Historically, over 24% of long distance trucks on the road in the United States carry no cargo on their return journeys. This increases the cost of transporting goods, results in unnecessary carbon emissions, and causes a host of other traffic, human, and environmental harms. EmptyMiles is a website created by Voluntary Inter-Industry Commerce Solution that enables companies to cooperate to fill empty trucks on their return journey with loads that can be delivered on the way home, improving the efficiency and effectiveness of the supply chain.

*Image credits:*
*Previous page: Clark's nutcracker, Flickr user "Scorpions and Centaurs" CC-BY-NC-SA*
*Top to bottom: mycorrhizal fungi, Nilsson et al. via BioMed Central Ltd. CC-BY; Masins building, courtesy of 220 & Change; Trucks, MoDOT CC-BY-NC-SA.*

# 6 Nature runs on information.

Organisms and ecosystems need to receive information from the environment and be able to act appropriately in response to that information in order to be attuned to their environment. This system of send, receive, and respond has been finely tuned through millions of years of evolution. Organisms and ecosystems incorporate feedback loops to gain information in order to survive. Feedback loops are utilized both internally within a body or cell and externally.

## Biology Examples

**Songbirds**
Young songbirds have brightly colored mouths, including some bright coloration around the edge of the beak that disappears as they mature. A chick opens its mouth wide to show the color, creating a bright target and a signal to its parent that it's hungry. It supplements this with raucous calls. The hungriest chick makes the most noise and opens its mouth the widest. This stimulates the parent to feed the one most in need. As the chick starts feeling full, it sends a less strong signal, or stops signaling completely, causing the parent to react to the next chick who is signaling the most. This is a feedback loop that takes place repeatedly throughout the day.

**Acacia tree**

On the African plains, groups of acacia trees have evolved a simple yet sophisticated sensory detection strategy to respond to threats from herbivores. When a giraffe begins browsing the leaves of an acacia tree, the acacia emits ethylene gas to warn the other acacia trees. Those trees receive this signal and respond, as part of a feedback loop, by also releasing ethylene gas, thereby warning other trees nearby. Detection of the ethylene also signals the acacias to manufacture and deliver a toxin in their leaves, as part of a response to further deter the herbivores.

## Design Applications

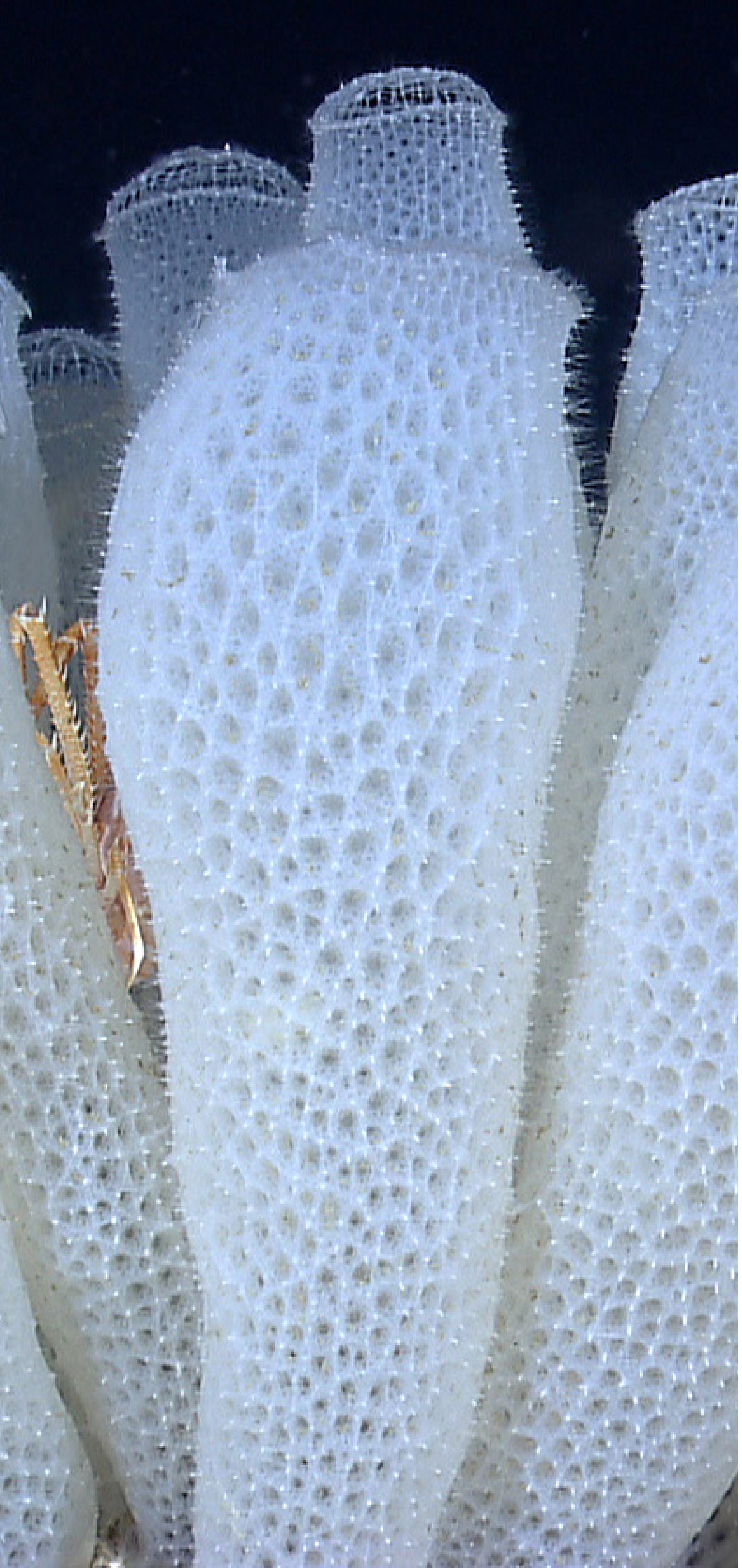
**Bullitt Center**

Rather than controlling temperature using a standard energy guzzling HVAC system, the Bullitt Center in Seattle, Washington, USA uses feedback to control indoor temperature in a more efficient way. The building features Schüco windows that open and close automatically, responding to inside temperature. (They also open if $CO_2$ concentrations become too high inside from people exhaling.) Occupants can manually override the windows, providing another feedback system in case there are outside noises or other signals the windows are not attuned to. Occupants can monitor their own energy use and thus find ways to modify and reduce their usage. The system also includes exterior sunshades that roll down if temperatures exceed the desired level.

**Regen Energy**

Regen Energy has developed a device that allows electrical appliances in a building to communicate with each other to minimize how much power the appliances collectively use at a given point in time. The device must satisfy any local constraints (e.g., a refrigerator must cycle on to maintain a minimum temperature) but simultaneously satisfy the system objective to reduce peak load. Rather than using a top-down approach, this decentralized approach to energy management offers a more effective means to manage supply and demand in a delicately balanced electricity system.

*Image credits:*
*Previous page: Baby birds, Ken Slade, CC-BY-NC; Top to bottom: Giraffe and acacia, Baron Reznik CC-BY-NC-SA; Bullitt Center, Joe Mabel CC-BY-SA.*



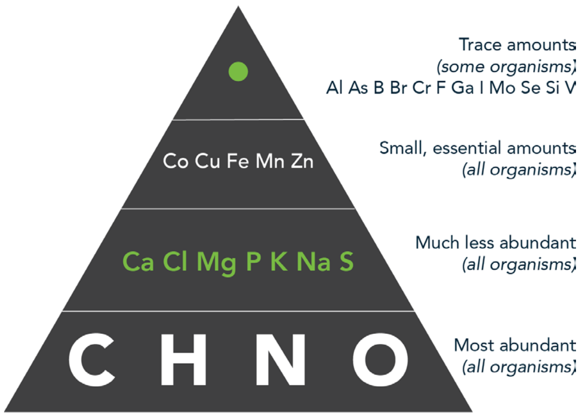
# 7 Nature uses chemistry and materials that are safe for living beings.

Organisms do chemistry within and near their own cells. This makes it imperative that organisms use chemicals, chemical processes, and chemistry-derived materials that are supportive to life's processes. Life's chemistry is water-based and uses a subset of chemical elements configured into precise 3D structures. The combination of 3D architecture and composition is the key to maximizing self-assembly, guiding chemical activity and material performance, and allowing for biodegradation into useful constituents when their work is done.

## Biology Examples

**Venus flower basket**
The Venus flower basket is a glass sponge that forms an intricate, beautiful structure using water as a solvent. The structure is made of silica, which the sponge pulls from seawater at ambient temperature and pressure. The Venus flower basket's glassy fibers transmit light better than industrial fiber optic cables, in part because trace amounts of sodium are incorporated into the fibers.

**Elements found in organisms**
There are 118 chemical elements in the periodic table of elements (with four of those yet to be confirmed), but nature does the vast amount of its chemistry using only 28 of them.




Eleven elements are found in all organisms, including four of the most abundant elements in the atmosphere—carbon, hydrogen, nitrogen, and oxygen—and seven that are much less abundant than those four. Five other elements are also found in small, essential amounts in all organisms (including some metals), and 12 elements are found in trace amounts in only some organisms. DNA (or RNA in the case of some viruses) is the molecule that contains the genetic instructions used in the development and functioning of all known living organisms. It is made up of only carbon, hydrogen, nitrogen, oxygen, and phosphorus, yet these few atoms are put together in unique ways to provide all the information needed to make every organism on earth.

## Design Applications


**Burt's Bees**

The company Burt's Bees has expanded its lip care line to include a range of shimmers, shades, and colors that were created, per a set of requirements, using a relatively small number of natural ingredients. For example, included in the brand's base lip balm are: beeswax, coconut oil, sunflower seed oil, peppermint oil, lanolin, tocopherol, rosemary leaf extract, soybean oil, canola oil, and limonene oil. In turn, the oils rely on a minimum number of raw materials and processing. The colored lip balm products also rely on a small range of natural materials to create a pallet of colors.

NALCO
An Ecolab Company

**Nalco**

The Nalco Company is one company seeking ways to reduce its use of petrochemical solvents. It received the U.S. Presidential Green Chemistry Challenge Award in 1999 for developing a water-based process for creating a polymer for wastewater treatment. Traditional oil-based emulsion polymers, which are commonly used for water treatment, introduce oil and surfactants into the environment. Nalco's polymers are manufactured in water-based salt solutions, eliminating the annual release of five million pounds of oil into the environment. In addition, the manufacturing process uses a waste by-product, ammonium sulfate, from another industrial process and is also more energy-efficient.

*Image credits:*
*Previous page: Glass sea sponge, NOAA, public domain; Top to bottom: Elements in organisms, ©Biomimicry Institute; Burt's Bees lipcare, via www.burtsbees.com; Nalco logo.*

# 8 Nature builds using abundant resources, incorporating rare resources only sparingly.

Nature's materials are abundant and locally sourced. This is true whether it's building something external to itself, like a termite mound or a nest, or assembling materials that go into a wing, shell, leaf, or horn. A few rarer minerals are also used, but these are found locally and are readily available.

## Biology Examples

**Caddisfly**
Caddisflies are aquatic insects. Their larvae gather local materials such as small fragments of rock, sand, shells, or small pieces of twig or aquatic plants to create protective cases held together by silk. Because they use local materials, the cases blend in, providing protection from predators. Caddisflies don't have to expend a lot of energy searching for materials, and they don't seek out rare materials, just abundant ones. Their food is also local, and often brought to them for free by the flowing water around their homes.

**Barn swallow**
Barn swallows construct their nests with local mud, building the nests on vertical surfaces and under the overhangs of structures such as barns and bridges to protect them from the rain. The mud pellets are built up to create a cozy and safe nest. The inner cup of the nest is lined with grass, hair, and feathers, all of which are found in the local environment.

*Adobe house.*


*Volunteers working on a Habitat for Humanity project.*

# Design Applications

**Adobe**

Adobe materials make up the oldest extant buildings on the planet. Adobe buildings are made by mixing straw and local sand, clay, or native soil with water to form bricks, which are usually dried in the sun. In addition to being an inexpensive and readily available material, adobe is durable and energy efficient. In climates with hot days and cool nights, the thermal mass of an adobe structure stores and releases heat slowly, averaging out the high and low temperatures of the day.

**Habitat for Humanity**

Habitat for Humanity exists in many countries around the world, and one of the most interesting aspects to their work is that they incorporate the use of readily available materials and resources into their projects. In East Africa, where the soil has a lot of clay, homes are usually built of home-made bricks. In Mongolia, they use huge rocks. In the South Pacific, they go into the rainforest to harvest a hardwood tree. Likewise, available human resources are thoughtfully employed—the whole community comes together to help with the labor, and specialists like masons and framers are brought in as needed.

# 9 Nature is locally attuned and responsive.

Chances of survival increase when individuals are good at recognizing local conditions and opportunities and locating and managing available resources. Survival also depends on appropriately responding to information garnered from the local environment. Organisms and ecosystems in a given location evolved in direct response to local environmental conditions.

## Biology Examples

**Termites**

Termites in the sub-Saharan region of Africa need a steady supply of fresh oxygen and a way to get rid of excess carbon dioxide, just as we do. If the termites and their symbiotic fungi don't have adequate ventilation in their nests, they will suffocate. The solution to their dilemma is in how they construct their mounds. The mounds, measuring 2 to 3 meters (3 to 10 feet) above the ground, act as a ventilation system.

Think of a termite mound as a giant pear with the fat end—the part with the termite nest and fungal gardens—buried underground. The thin part of the pear, the visible spire of the mound, consists of a central, closed-top chimney and a network of tunnels and air conduits. The mound's walls are made of porous soil. Porosity is important to the design, because what drives most of the ventilation system is the wind. As wind flows past a mound, a complicated pressure field is set up, with positive pressures at the leading face of the mound

*Atacama Desert, Chile.*

*Interface carpet tile manufacturing.*

and suction pressures at the lateral and trailing faces. These patterns force air in through the surface layers of the mound's leading face, and draw air out of the surface conduits at the mound's lateral and trailing faces. Because wind speed and direction frequently vary, air movement in the mound is neither unidirectional nor circulatory; rather, it's tidal, with air moving in and out, similar to our lungs.

Termite mounds are adaptive structures. As internal levels of oxygen, carbon dioxide, and water moisture change, the termites respond by adjusting the tunnels and the height of the mound. This maintains a balance, or homeostasis, within the mound.

**Desert plants**

Some annual plant species live in arid environments like the Atacama Desert in Chile, where rain may come only once every five years. These annuals don't have robust water conservation strategies but instead are highly attuned to the occasional presence of rain (as in El Niño years). Their seeds respond quickly by sprouting and growing rapidly only during these periods. They sacrifice water in these rare rainy periods to produce larger leaves to capture more sunlight, allowing for rapid growth. They also expend energy to grow flowers quickly to attract pollinators during the brief window of water availability. Because they are highly attuned to the presence of moisture, the seeds do not even attempt to sprout in years where there is inadequate rain, instead remaining dormant during any dry periods.

## Design Applications

**Just-in-time manufacturing**

Most carpet companies ship their products inter-continentally from their home region, but Interface has developed another model using regional production on four continents and just-in-time manufacturing to be more attuned and responsive to their customers in each region. Just-in-time manufacturing means that Interface manufactures most carpet it sells after it gets ordered, allowing for easy customization and avoiding stockpiling of inventory that is not needed in a particular region. Interface also produces many locally popular styles in each location, which might not be top sellers if produced in other regions.

*Motorcycle traffic in Uganda.*


*bePRO helmet*

**bePRO helmet**

Although motorcycles and motorcycle taxis are a dominant form of transportation in East Africa, few drivers and passengers wear helmets and many people are injured each year. Industrial designer Vanja Steinbru's research in Kampala, Uganda, revealed a number of reasons for lack of helmet use, including the fact that helmets are expensive and not designed for hot climates—they are uncomfortably warm and heavy and cover the ears, impeding drivers from hearing potential customers and fellow travelers. Understanding the need for a design that fit the context of users in East Africa, Vanja partnered with local experts and a Norwegian sports helmet company to design a helmet attuned to local conditions. The bePRO helmet design is much more lightweight than a traditional helmet, includes integrated ventilation, has holes for hearing, and features adjustable sizing. It will be locally produced using a readily available fiberglass composite, meet safety standards, and be affordable. Further emphasizing a design attuned to its context, the helmets feature exterior graphics by popular local artists.

*Image credits:*
*Previous top to bottom: Atacama Desert, Terry Feuerborn CC-BY-NC; Manufacturing via Interface company blog; Above: Motorcycle traffic and bePRO helmet, via www.norskform.no.*

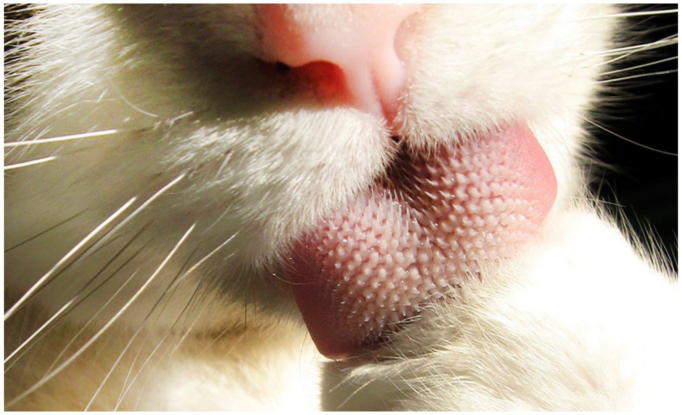
# 10 Nature uses shape to determine functionality.

Nature uses shape or form, rather than added material and energy, to meet functional requirements. Stated another way, form follows function. This allows an organism or ecosystem to accomplish what it needs to do using a minimum of energy and resources.

## Biology Examples

**Venus flytrap**

The carnivorous Venus flytrap is well known. Unwary insects are trapped when the plant's cup-shaped leaf snaps shut. The mechanism, called snap instability, resembles half of a tennis ball flipping inside out. When open, the leaf sides are convex or rounded. When triggered, the opposing leaf surfaces snap inward, forming a cavity and closing up. There are small hairs or cilia along the edges of the leaves. A slight disturbance of the cilia by an insect triggers the instant collapse of the leaf. The plants are so sensitive that they are able to distinguish insects from raindrops. Also, the leaf does not close unless two adjacent cilia are moved or one cilia is touched twice, which saves the plant energy by preventing false alarms.



### Cat tongue

A cat's tongue has small barbs, called papillae, that make it easier for the feline to remove meat from the bones and tissues of the small prey it captures. The tongue is also used for effective grooming, which is actually a survival skill. After a cat devours its prey, it grooms itself in order to remove any lingering evidence of the kill, so as not to attract larger predators to the scent. Whether a cat is cleaning prey or cleaning itself, the tongue is able to do most of the work due to its barbed form.

## Design Applications

### Shinkansen train

In Japan, the nose design of the high-speed Shinkansen electric train is based on the shape of the kingfisher's beak. The shape of the train's nose solves two problems the engineers were having—noise and energy efficiency. The older design was shaped like a blunt-nosed bullet. When the high-speed train entered a tunnel, it pushed a pressure wave ahead of it. When the train, and the wave in front of it, emerged from the tunnel, it created a loud sound like a sonic boom. The new design uses shape to meet the function of preventing a pressure wave, and reduces drag on the train, thus saving energy.

### Tre Table

Created out of one continuous sheet of wood, the Tre Table by Isaac Krady takes the notion of multifunctional furniture to a whole new level. The unique contoured shape of the design allows the table to be used as a coffee table, an end table, a computer desk, a dinner tray, or even a laptop stand and a magazine rack.

*Image credits:*
*Previous page: Venus flytrap, Orin Zebest CC-BY; Top to bottom: Cat's tongue, Torbak Hopper, CC-BY-ND; Shinkansen train, Marco Carrubba CC-BY-NC-ND; Tre Table, via www.morfae.com.*