Building materials that tap into nature's elegant, and harmless, designs

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Every year, about 15 billion tons of carbon dioxide are emitted into the atmosphere from concrete production alone. As cities continue to grow (according to the U.N., world urban populations are expected to increase by 84 percent by 2050), the amount of polluting building materials being created will increase right along with them.

And it isn't simply the materials that are causing problems.

A study and report titled "Buildings and Climate Change," completed by the United Nations Environment Programme (UNEP), revealed (PDF) "over 80 percent of greenhouse gas emissions take place during the operational phase of buildings, when energy is used for heating, cooling, ventilation, lighting, appliances, and other applications." The main problem with a building's lifetime of energy consumption is that the energy most likely is coming from a fossil fuel-powered plant.

How are we going to design buildings with harmless materials, both for our planet and the people occupying them? What can we use in our buildings to make sure their annual energy needs are kept to a bare minimum?

Working with Mother Nature

You might not be aware of this when walking through the park, snorkeling or even camping on a week-long trip through the mountains, but the nature you are enjoying is actually beautifully crafted architecture, made to serve and be beneficial to all the other living infrastructure surrounding it.

Trees absorb all the energy and water they need from the sun and the sky, and even can share nutrients with one another through a network of fungal connections scientists call the mycorrhizal network (the "wood-wide web"). When alive, they create habitats for other organisms in the forest and supply food for others. When a tree dies, it provides the forest floor with enough nutrients to jump-start the growth of new organic infrastructures.

Why can't our buildings get all their energy from the sun and water from the sky, provide habitat for birds and animals, and, when their life cycles are over, be broken apart to supply future buildings with growth materials?

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This is the general idea of biomimicry: If nature has had 3.8 billion years to develop the best possible designs for various ecosystems, why are we not copying them? How come our homes in Tucson, Arizona don't soak up and store water for the year during monsoon season like the Saguaro cactus? Why don't our commercial buildings change the tint on their outer shell during the day as the sun moves through the sky, much like the Namaqua chameleon does with its skin?

Technology can get us there

Natures designs are elegant, biodegradable and durable, but recreating most of these materials for our own purposes seems to be the tricky part — at least for now. Because coral is concrete's closest natural counterpart, it is being eyed by scientists as a great building material alternative.

While making concrete releases carbon dioxide molecules from the cement, coral fixes (or binds) an atom of carbon with every atom of calcium. This means, in theory, that if we could apply this process — known as biomineralization — to global concrete production, we could remove billions of tons of carbon from the atmosphere.

One company, Blue Planet, has claimed to have created a cement and aggregate production process similar to biomineralization. Its website stated that its technology "uses waste CO2 as a raw material to produce carbon-negative building materials."

Another biomimicry-based material, this time stemming from the wood-building material realm, is Columbia Forest Product's PureBond technology. This formaldehyde-free, soy-based plywood assembly adhesive originally was inspired by the way mussels grip onto rocks. An Oregon State University professor, Kaichang Li, found that mussels secrete proteins known as byssal threads, which provide superior strength and flexibility. Columbia Forest Products funded his groundbreaking research, which led to the creation of the PureBond adhesive. PureBond uses modified soy proteins to perform the same functions as the byssal threads.

Along with the advances in sustainable materials, biomimicry is also being used to inspire energy efficient passive cooling systems in buildings. In Harare, Zimbabwe, designer Mick Pearce used an interesting "home" found in nature to mimic for his project. The Eastgate Centre, a shopping mall and office block combination that opened 20 years ago, takes inspiration from termite mounds — particularly the way they maintain comfortable conditions inside without air conditioning.

To maintain a constant inside temperature of 30 degrees Celsius, the termites are constantly ensuring a draft of air is flowing from low openings to top holes — a use of the so-called stack effect (convective airflow from cool to warm). In the Eastgate Centre, cool air at night is allowed into the bottom of the building and starts the convective flow that vents the hot daytime air through vents in the roof. Cool air is also stored in hollow floors and baseboard vents and then released into offices the next day.

Sharing like the trees

In order to progress biomimicry and the amazing potential it has to create durable, sustainable and beautiful materials and designs, we must make like the trees and use our own "wood-wide web" to spread knowledge and ideas. This is why Verdical Group hosted the Biomimicry 2016 Conference in March — to gather leaders in the field, companies who are using nature in their designs, and others interested in the power of biomimicry in order to get the ideas flowing and the inspiring stories that led from it spread to hundreds of people afterwards.