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Building the Future of Buildings

By Onno Koelman

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Rocky Mountain Institute is now preparing to lead this next revolution, facilitating the integration of biology, engineering, and architecture into a whole-systems program for making fundamentally better buildings.

We now stand at the advent of a revolution that will change the way we conceive, design, and construct buildings. No longer shall buildings be devices to conquer nature; rather, they shall complement and restore her. The instigator of this revolution is an unlikely heroine: a soft-spoken, careful, articulate observer, teacher, and author named Janine M. Benyus (who also happens to be a member of RMI's Board of Directors). Benyus started out as an eager wildlife biologist, but now works as a "biological consultant" to several major corporations, teaching them how to learn better, smarter design from nature. She posits that there exists a tremendous database of tried and tested natural solutions all around us. Indeed, during 3.8 billion years of evolution, those natural solutions that didn't work were recalled by their "manufacturer," Mother Nature. Benyus's message is that if we just open our eyes and look in the right places, there are elegant, efficient, and eminently practical solutions all around us.

Benyus's exposition of these ideas is in her landmark 1997 book, *Biomimicry* (www.biomimicry.org). According to Benyus, biomimicry "refers to the new science that studies nature's best ideas and then imitates these designs and processes to solve human problems." The concepts of biomimicry are deceptively simple but profound in their implications. Simple, because the answers are often already present in nature "-we merely need to rediscover and apply rather than invent". Profound, because if we can rethink the way that we build and the way we manufacture it will allow us to improve our quality of life and not only do "less bad" to the environment, but actually restore it along the way. Benyus has distilled her thoughts into nine laws of the circle of life and basic sustainability. Nature (1) rewards cooperation and makes symbiotic relationships work; (2) fits form to function efficiently; (3) develops diversity of possibilities to find the best solution and survival; (4) recycles and finds uses for everything; (5) requires local expertise; (6) avoids excesses and "overbuilding"; (7) taps the power of limits; (8) runs on the sun and other natural sources of energy; (9) uses only the energy and resources that it needs.

Visionary companies are beginning to realize that not only will biomimicry be good for the environment; it will lead to more durable, comfortable, desirable, and effective products. For example, Nike is studying animal foot padding for the design of its shoes. If a mountain goat can run over slippery ice and rough rock due the handy mix of hardness and softness in its hooves, perhaps shoe soles could be made with similar properties.

By understanding how nature does things, the Atlanta-based carpet manufacturer Interface designed carpet tiles that copy the ever-changing pattern of the forest floor and thereby fit together without a noticeable pattern—put the tiles down in random order and they still fit perfectly. This modularity obviates excessive cost in repair and installation; when one high-traffic area tile wears out, just slip in a new one.

Biomimicry holds future possibilities in many other areas as well. Mechanical engineers might learn from sequoias, which lift tons of water hundreds of feet into the air without pulleys, levers, or machinery—using only the power of the sun. Spiders spin material much stronger than man-made Kevlar® out of digested insects, with no complicated, dangerous, or toxic manufacturing processes. But biomimicry's promise is not limited to materials science alone. It has implications for construction processes as well, especially since the building industry is a major contributor to environmental degradation in its current state. A revolution might be just what the doctor ordered.

Buildings use approximately 40 percent of all U.S. energy when you include all the embodied energy costs of initially extracting those materials, transporting them to, and later hauling truckloads of trash away from, a site. The construction industry produces up to 40 percent of the material that goes into our landfills. Given that humans are now prevalent over the entire globe, we no longer have the option of carrying our waste out of sight to get it out of mind. Does a forest carry away its waste? *Is* there any waste in a forest? The answer to both of these questions is no. How might we emulate forests in this crucial issue by making use of all materials and developing recycling processes that occur spontaneously, without constant human intervention? Answering this question of eliminating waste is vitally important—yet it encompasses but one facet of the biomimicry revolution.

So what might lie in store for us if the potential for biomimicry is fully explored? Imagine a building that, like a chameleon, changes colors to take advantage of weather conditions. Buildings that become darker during cold weather and lighter during warm weather would substantially increase their efficiency. The insulation in such buildings might, like a pelican's feathers, fluff up during cold weather and compact during hot weather, allowing cooling and heating processes to be maximized without pumping in additional energy. These buildings could have roofs that open like flower buds to allow ventilation during sunny weather but close to keep out the rain. If a rose bud can open and close without machinery, our buildings could too.

While these solutions might seem a bit far-fetched there are already many ways in which our buildings can, with present technology, mimic natural systems. Take principle one above: "nature rewards cooperation and makes symbiotic relationships work." A building can and should be a net contributor to its surroundings. Like a tree, it could provide and store energy using the technology of solar panels and fuel cells. It could collect and store water, and with the addition of two- or three-story edible landscaping (like Village Homes in Davis, California), it could be shaded for temperature control while providing delicious organic food for its inhabitants. Additionally, the typical waste streams and garbage that come from buildings (including wastewater and food scraps) could be fed into Living Machines™ and recycled, feeding the fish that swim in the pond under the waterfall in the naturally-illuminated and ventilated lobby atrium. These are just a few of biomimicry's building design possibilities.

RMI is well equipped to make an important contribution to the biomimicry revolution, especially in building construction. For over a decade, RMI has been a leader in the green development movement, fostering the design of buildings that are more energy- and resource-efficient. We are now preparing to lead this next revolution, facilitating the integration of biology, engineering, and architecture into a whole-systems program for making fundamentally better buildings. The staff of RMI's Green Development Services aims to bring biologists to the design table to help show engineers and architects where to look for inspiration, awe, and practical models for solving some of the building industry's most pressing problems. Biology is nature's treasure trove of outstanding models of sustainability—our job does not stop at preserving Nature; we need to look to her as teacher and role model.

Our goal is to foster buildings that are harmonious with their environments, efficient in their use of energy, and innovative in their use of building materials, but also better suited for human occupation and use. Some of the possibilities are surprising and include buildings that might one day be self-building, self-cleaning, and self-repairing.

The bio-logical revolution is coming.

Onno Koelman was RMI's inaugural Mineral Acquisition Partners (MAP) summer energy fellow researching biomimicry. He currently works with PAX Scientific, leading the way into the next industrial revolution using principles found in nature to streamline technologies across industries. He holds a BS in Mechanical Engineering from Stanford University.

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ABOUT THE PUBLISHER:

John Mlade is a green building professional researching and teaching biomimicry at Colorado State University and is a research assistant at the Institute for the Built Environment (www.ibe.colostate.edu). He is also a member of the Biomimicry Guild. Visit www.biomimicry.net for more information.

TO CONTACT THE PUBLISHER:

Email John Mlade at BioInspire@yahoo.com

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