Voices of the Bioneers 2000

Janine Benyus: Biomimicry

Janine Benyus is a life sciences writer with a background in forestry and the author of numerous books including *Beastly Behaviors: A Zoo Lover's Companion; The Field Guide to Wildlife Habitats of the Western U.S.; The Field Guide to Wildlife Habitats of the Eastern U.S.; The Secret Language and Remarkable Behavior of Animals* and the groundbreaking book *Biomimicry: Innovation Inspired by Nature.* She lives in Montana and spoke at Bioneers in 2000 and 2003.

After writing the book, Benyus co-founded the Biomimicry Guild, a team of individuals that research, educate and consult about the possibilities of biomimicry. Information on the Biomimicry Guild, including a background on biomimicry, can be found on the web at www.biomimicry.net. Further resources are included in the margins as you venture into the world of Biomimicry with Janine Benyus. Enjoy.

Food for Thought

What is the relationship between modern science and indigenous knowledge?

Are they mutually exclusive or can they serve to benefit each other?

Life as teacher is alive and well. It's been a wonderful fall in the Rockies with gold leaves like I haven't seen in years. The quaking aspen is one of my favorite species: *Populus tremuloides*. I love that term. Tremuloides. It describes what this tree does: it quakes in the wind, and it sounds like bones rattling.

Some Native Americans' story is that the Great Spirit asked all the organisms to bow their heads in humility and the quaking aspen refused. So the Great Spirit said, "From now on when the wind blows, you will quake."

My scientist friends have another explanation. The stalk of the aspen that attaches the leaf to the twig is flat, so that when the wind hits it, the leaf splits the wind like a sail. That allows aspen to live up absurdly steep slopes in very windy places that would blow the leaves off most trees. It yields to the wind. It doesn't build cement structures; it yields to the wind. Both of those stories are about humility and adaptation.

Something else that's going on during this season is similar to what's happening in this room, and that is inter-species flocking. In the fall, winter's coming. It's going to be tough. Everybody's got to get as many food sources as they possibly can and put on fat for the winter. So birds that normally would not associate with one another, different species such as chickadees and warblers and woodpeckers, flock together and fly through the woods in packs.

They lay down their arms and they hook up in their diversity, in their difference. They hook up because they know that resources, i.e. various berries, are scattered throughout the woods and they know they can't find enough of them by themselves. If you think of berries as ideas, that's what we're like. A lot of different people getting together and saying "I've found some berries. I found an idea over here that may lead to sustainability," and we all go over to that

Food for Thought

Janine Benyus makes a point of reminding us that we are biological organisms, functioning within the same systems that Biomimicry looks to for advice and inspiration. Check your skills as a member of your species.

How much do you know about the biological systems that support you?

If you find yourself at a loss here, you may be interested in *The Way Nature Works*, by Jill Bailey, which is a nice primer for those who may have missed that lecture in school.

Some theorists posit that humans, as a species, have shed the restrictions of biological laws and natural constraints with our developments in thinking and technology. What do you think about this position?

Where do we, as a species, fit into the planetary picture of life?

What responsibility, if any, do we have for other forms of life?

Keep Digging

Want more? Check out these Bioneers thinkers and their books for additional inspiration.

Kenny Ausubel: *The Bioneers: A Declaration of Interdependence*

Paul Hawken, Amory Lovins and Hunter Lovins: *Natural Capitalism: Creating the Next industrial Revolution.*

Paul Hawken: *The Ecology of Commerce*

William McDonough: *Cradle to Cradle: Remaking the Way We Make Things*

David Orr: *Nature of Design: Ecology, Culture and the Human Intention.*

John Todd: *From Ecocities to Living Machines.*

William McDonough & Michael Braungart: *The Next Industrial Revolution.* Order the Video at: www.bullfrogfilms.org

idea. And then somebody else says, "Here's another idea." And we all go over to that idea. We're a mixed-species flock and winter's coming.

One of the ideas in that mosaic of ideas is *biomimicry*. I'd like to describe what biomimicry is and how it's being used.

Biomimicry is innovation inspired by nature, looking to nature as teacher, but I have to offer one caveat before I get into it. And that is that even inherent in this language is the idea that we are not nature. We are looking to an "other" to mimic. But we are part of nature. We are biological organisms. When I talk about nature in this context, I'm talking about our biological elders, because essentially, we are a very, very young species. If the age of the Earth were a calendar year, and the beginning of the earth was on January 1 and today was a breath before midnight on December 31, we got here fifteen minutes ago in that whole year, and all of recorded history has winked by in the last 16 seconds. It is an eyelash on that timeline.

Bacteria bootstrapped themselves up out of the chaos in March of that year and in that time they learned to do amazing, amazing things. They do everything that we want to do, without polluting the planet and mortgaging the future. So yes, we are part of nature, but we're a very young species. When I look at technology these days, I don't say, "Technology: yes or no," I ask how well adapted a particular technology is. How well adapted is that product, that process, that policy to life on Earth over the long haul? That's the question that we really have to ask. Ninety-nine percent of species that have been on earth are now extinct because their products or their processes were not well adapted.

Life has developed a pattern language for survival: wood frogs can freeze solid in winter and then come back to life in the spring. You look at an organism like the Western hemlock, the denizen of our rainforest on the coast north of here. It has pores deeply embedded under its needles, so that the wind won't take water vapor away. At the drip line it combs moisture out of the fog, and 30 percent more moisture lands on the ground around the Western hemlock than anywhere else in the forest, so water goes into its roots.

Now isn't it interesting that a tree that lives in 100 inches of rainfall a year in some places has all those adaptations for drought? There's a couple of months during the year when the sun shines up there in the Northwest rainforest. That's a tough time if you're a tree. And if it gets cold in the winter, it's also harder to get water, so it has many adaptations for drought even though it's a rainforest species.

The snail travels on slime. This is a lubricant that absorbs 1500 times its weight in water almost instantly, allowing the snail, if it needed to, to climb up over a razor-blade and down without hurting itself. Banana slugs can do the same thing. We don't have anything close to that in terms of lubricant.

Keep Digging

To further explore Janine Benyus's statement, *"What life in ensemble has learned to do is to create conditions conducive to life,"* check out the Gaia Hypothesis and the work and theories surrounding it.

James Lovelock: *Gaia: A New Look at Life on Earth*

Lynn Margulis: *Symbiotic Life: A New Look at Evolution*

Food for Thought

"To mimic a natural system, you must ask how each product fits in—is it necessary, is it beautiful, is it part of a nourishing food web of industries, and can it be transported, sold, and reabsorbed in ways that foster a forest-like economy? If we can biomimic at all three levels—natural form, natural process, and natural system—we'll begin to do what all well-adapted organisms have learned to do, which is to create conditions conducive to life." – Janine Benyus

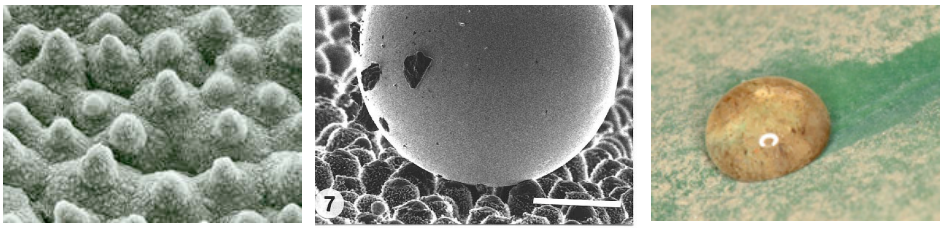
Excerpted from: "A Conversation with Janine Benyus", Forum for the Future. www.forumforthefuture.org.uk

A rhino horn that gets a crack self-heals, and yet it has no living cells in it. We don't know how it manages to do that, but what a great potential model for self-healing materials that wouldn't have to be thrown away.

One of my favorites is the hummingbird, an organism about the size of my thumb. It flies about 35 miles an hour, which is faster than you can get around San Francisco. They travel about 2,000 miles a year; they're long distant migrants. When they go down to the Gulf of Mexico, the lip of the Gulf, they find about 1,000 blossoms a day. They fuel up, and then they burst across the Gulf, 600 miles without stopping, on 2.1 grams of fuel. In the process of fueling up the hummingbird pollinates flowers, assuring itself that it'll have fuel next year, and that its offspring will have fuel. It pollinates as it's fueling up, and of course when it dies, its body decays and nurtures the roots of those flowers.

That's what we're looking to do, to emulate this amazing ability that life has to fertilize the soil, clean the air, clean the water and mix the right cocktail of atmospheric gasses that life needs to live. What life in ensemble has learned to do is to create conditions conducive to life.

The question, "What would nature do here?" is the key. For example, when we design a new way to clean something, we tend to get hung up in questions such as "What's the least toxic detergent to use?" or "What's the least energy-intensive method to do that?" But the real question a biomimic would ask is "How does nature clean surfaces?" Nature doesn't use detergent at all, and yet there are things in nature that need to be cleaned. One of the things is a leaf, because a leaf has got pores and it's got to breathe and it's got to photosynthesize. Scientists in Germany looked at the lotus, which grows in very muddy swamps and yet always looks dry and pristine and clean. They looked at it under a microscope and they noticed it's got this incredibly mountainous surface. If it had a smooth surface, dirt particles would adhere to the leaf and be very difficult to break off, and a drop of water would spread out but wouldn't take the dirt particles off. But because it's got peaks and valleys, dirt particles sort of teeter on the peaks. When a raindrop comes it stays spherical, and it lifts dirt off and it cleans the leaf. And it's not just lotus; it's most leaves as it turns out.



Electron microscope photographs demonstrating the self-cleaning effect on the Lotus (*Nelumbo nucifera*as) described above.
(Images from www.botanik.uni-bonn.de/system/planta.htm)

Keep Digging

Take an example from your day-to-day life – something that you use, think about, wear, eat, or ride everyday. It can be your breakfast, your shoes, your house, your daily commute – whatever. Imagine living in a Biomimetic world.

What are the natural forms that would be mimicked?

Imagine the natural processes that could be utilized during the production of this example.

How will it fit into the greater natural and human systems that exist in the world (i.e. labor, energy, transportation, waste, etc…)?

Food for Thought

In the same way that the edges of ecosystems are hot spots for life, diversity, and adaptation, so to are the overlapping spaces between separate disciplines and fields. Integrating biology and ecological understanding within all systems and disciplines is necessary for a biomimetic approach to the world.

If we accept this premise, how can we reconcile it within our educational system? Imagine the integrations and interplay between subjects and fields that could take place.

Consider your own education. Could you follow your educational pursuits in a manner consistent with the interdisciplinary goals and theory of Biomimicry?

What wisdom does the natural world offer to your field of interest?

The question then is not which detergent to use: It's how to keep things clean. There's now a company called Ispo in Germany that makes a building façade paint that when it dries has the structure of the lotus leaf, allowing rain to clean the building. This is the biomimicry paradigm. Nature uses free energy sources. In this case it uses the kinetic energy in rain to clean itself when it needs to.

And how does nature power itself? Obviously, not the way we do. Of course we all rely on photosynthesis. This whole room is being lit up right now by photosynthesis, but in this case it's plants from 65 million years ago that we have dug up, and now we're having this big bonfire. We burn one-hundred-thousand-years' of growth every year. That's not a normal decay pattern. It's like taking all the furniture in your house, piling it up, closing your windows, and lighting a match. We're making a bonfire with ancient photosynthesis. What we need to do is go to use current photosynthesis.

Why then haven't we looked at the leaf model for solar cells? We are starting to. The leaf has tens of thousands of tiny photosynthetic reaction centers. They're like little molecular-sized solar batteries and they are 93 percent effective, meaning that for every 100 particles of light that come, 93 are turned into sugars. That's highly efficient. Our solar cells, our PV cells, are clunky and cluggy in comparison.

One of the things that is best about this biomimicry is that it fills you with awe. It changes the way you view and value nature.

There are many very exciting examples of biomimicry in a variety of new fields. There are people doing what's called bio-rational drug prospecting, which is just looking at the clues in the environment. If you want an anti-fungicide, why not look for a leaf that's sitting in an environment that is full of fungus and yet is clear of fungi? Or if you're looking for an anti-microbial, look in the ocean because the ocean is full of bacteria. For instance, they found that sharks tend not to get infected when they are cut. It turns out they have an anti-microbial compound in their skin. Often I think we've got all this knowledge in biology and ecology, and we have all these people who want information but they don't talk to each other enough. That fertile crescent between intellectual habitats is where biomimicry thrives.

There's a field called industrial ecology that looks to living systems in nature as models to remake our whole economy. This is on the macro scale now. How do we remake our economy in this image of a living system? And what type of living system should it be?

There are rewards for cooperation and co-evolution. Organisms push each other. The flower pushes the hummingbird, and the hummingbird pushes the flower. But a habitat is a constellation of genomes. It's a constellation of life forms that the hummingbird needs, not just that flower. The hummingbird needs many, many things, and so it has to create conditions conducive to life in its environment. Life lives in the here and now but it lives for the future, and living for the future is stewardship. We need to design our economies and societies around these types of insights.

A lot of the research in biomimicry is years and years away from fruition, but it is a path, an approach. It requires us to keep asking: How does nature teach? How does nature learn? How does nature communicate? Quieting human cleverness is the first step, and then listening. As Wes Jackson says, 'When we begin to see nature as mentor, gratitude tempers greed and the notion of resources becomes obscene.' Instead of looking at nature as warehouse, we will learn to look at nature as teacher. Instead of valuing what we can extract from nature, we will value what we can learn from nature. We will realize unencumbered evolution is more precious than any vein of oil, so the rationale for protecting wild places will become self-evident. I know all of the statistics of destruction, but I've chosen to come at this out of love, because I love this place. And I want to stay here. I want to stay home.

Keep Digging

To further explore the idea of love as a governing principle in our evolution, check out naturalist and philosopher E.O. Wilson's landmark book: *Biophilia.*

To explore the natural history of love through neuroscience, pick up: *A General Theory of Love,* by Thomas Lewis, Fari Amini and Richard Lannon.

Biomimicry Resources and other ways to walk the Biomimicry path:

For a perfect primer on this and other similar fields, check out the second book in the Bioneers Book Series, *Nature's Operating Instruction: The True Biotechnologies.* Edited by Bioneers founder Kenny Ausubel with J.P. Harpignies, *Nature's Operating Instructions* includes a chapter on Janine Benyus and Biomimicry as well as many other remarkable Bioneers.

Visit the Bioneers website at www.bioneers.org to further explore this topic via articles, videos and audio tapes of Janine Benyus and many other brilliant thinkers from the Bioneers Conference Archives.

Janine Benyus and the Biomimicry Guild are online at: www.biomimicry.net. Her book, *Biomimicry: Innovation Inspired by Nature,* is the groundbreaking work on this topic. There are two free monthly e-newsletters available on the subject of Biomimicry. For more information on these, fill out the Biofeedback form on the Biomimicry.net website.

David Suzuki's television program, "On the Nature of Things," broadcast a two-part special on Biomimicry. The Canadian Broadcast Corporation maintains an informative and interactive website on the topic with audio and video clips. Access it at: www.cbc.ca/natureofthings/show_biomimicry.html. Copies of the program can be purchased through Bullfrog Films. Visit www.bullfrogfilms.com.

Wes Jackson's Land Institute is a leader in the field of Biomimicry and Agriculture. The Land Institute can be found in Salina, Kansas or on the Web at www.landinstitute.org. Wes Jackson is the author of *Becoming Native to This Place.*