Imitation of life

Biomimicry copies ideas from Mother Nature (looks like she should have filed that patent after all...)

BY JOY LANZENDORFER

In New Mexico, a new kind of ceramics modeled after the abalone shell is so strong, it's shatterproof. In the United Kingdom, a new piece of equipment imitating the Namibian beetle harvests 10 times the water from fog than other fog-catching nets. And scientists partnering in the United States and Australia are developing solar cells that work like a leaf, in the hopes of producing energy through water and sunlight—just as a plant does.

These are some examples of biomimicry, a growing field that uses nature as a model for technological advancement. While people have always looked to nature for inspiration when it comes to technology—you have only to compare an airplane with a bird to know that—biomimicry looks deeper at the systems of nature—from photosynthesis to skin cells—to design new products and technologies.

One of the leaders in this new field is Jay Harman, CEO of Pax Scientific in San Rafael. Although biomimicry was first coined by scientist Janine Benyus in her 1997 book *Biomimicry: Innovation Inspired By Nature*, Harman was thinking about the concept long before that. In fact, the idea first occurred to him 28 years ago when he was working for the Fish and Wildlife Service in Australia.

At the time, Harman was tired of seeing his conservation efforts go to waste by the government handing land over to bauxite mines. Repeatedly, he saw the same land he had worked to maintain be stripped by commercial interests and "ruined forever."

"I started thinking that if the world is run by accountants and people who are only interested in the bottom line, I would have to find a way to show them that there are more profits in imitating nature than destroying it," he says. "So I left the Fish and Wildlife Department and started making companies around that."

Fast-forward to Pax Scientific, Harman's company devoted to increasing energy efficiency based on structures he observes in nature. The technologies are being used in everything from fans to mixers to boats, and Harman says there's no end in sight to the possibilities. Today, Pax, which means "peace" in Latin, is one of the key members of the biomimicry field. Benyus even sits on its advisory board.

The Secret of Efficiency

As a boy, Harman spent a lot of time at the beach. He became interested in marine life, particularly how fish swim or seaweed moves. It seemed amazing to him that seaweed, which he could break off with his hands, could survive the most violent storms. After studying it, he eventually discovered that it survives because it takes the path of least resistance—it changes shape in the water, moving with the flow instead of against it.

"I spent years figuring out exactly what that shape is," he says. "Seaweed looks chaotic with its twisting and bending all over the place, but it is all varying over one particular shape—the twisting top."

The twisting top, or spiral, has fascinated thinkers from Plato to da Vinci to Einstein. It's found throughout nature, in hurricanes, sunflowers, mollusk shells, even our own skin cells, which are shaped like tiny funnels to help the body perspire. But while the spiral has been used in mathematics, when it comes to design and technology, the shape's potential has virtually remained untapped.

***Poached Idea:** Harman wants to imitate the heat-saving design of eggs in new thermodynamic technology for computers.*

So Harman reverse-engineered a whirlpool. He used the drain in his bathtub to figure out the geometry for the exact path gas and fluid—specifically water and air—take when they move. Harman now had the math to reproduce that path in any technology that interacted with fluids. He had unlocked one of the basic secrets of nature.

"It applies to everything," he says. "It's a fundamental operating system of energy efficiency. I found it applied to every type of industrial equipment there is, and it is more efficient than anything humans have ever done."

For centuries, people have assumed that fluids go in a straight line, but as it turns out, nature rarely uses straight lines.

"A great example is the cardiovascular system," Harman says. "It has miles of veins going throughout the body, not a straight vein in the body, and yet the heart is one of the most efficient pumps there is. So on one hand, you have science trying to go straight, and nature trying to take the path of least resistance."

The company has listed 31 potential markets for the technology, ranging from propellers to mixers to fans. In all cases, Harman says his technology is more effective than existing technology. Take Pax's Lily Impeller, a propeller that looks like the flower; it can improve city drinking water, while at the same time cutting the energy bill to do so by up to 85 percent. In 24 hours, the Lily Impeller can move 1 million gallons of water using less energy than it takes to power a single household light bulb—and all because it moves water in its own natural pattern.

Next, Harman is turning his attention to eggs. The egg, he says, is a masterpiece of design for conserving heat. Although it's made out of very thin material, the egg holds a tremendous amount of warmth. Its shape both distributes heat evenly while protecting the egg from rolling out of the nest (since the tapered end makes it more likely it will roll back in). And on top of that, it's recyclable.

"When the egg hatches, there's nothing left behind rusting away," says Harman. "The other birds come along and eat the shell, and that shell grit is used for creating more eggs."

Pax will imitate the egg in new thermodynamic technology. The plan is to make machinery more capable of holding and releasing heat, starting with the computer.

Cooling is the most expensive part of running a computer. Most of the machine's energy goes to "heat sinks" and small fans that keep the computer from overheating. If a heat sink were more like an egg, it might disperse heat more efficiently, and that (combined with better fans) could make a major difference in how much energy computers use.

"Computers accounts for 2 to 3 percent of the U.S.'s energy bill," says Harman. "That's a lot of energy. So, if you find a way to increase efficiency, it could affect the whole nation's energy bill."

Spreading Out from Marin

The work Harman and other scientists have been doing is catching on. Companies all over the world are looking to nature for answers to human problems. As biomimicry gains credibility, venture capitalists are starting to invest in research and development for new biomimicry technologies. The military is also said to be interested. In fact, Pax has partnered with industry experts at Stanford University to apply its technology to aerospace.

Some companies are already selling products based on biomimicry. JDS Uniphase in Santa Rosa sells paint inspired by a peacock feather. Instead of using pigment for its color, the peacock feather has a surface layer of small crystals that catch light and reflect color back to the eye. The new paint is four times brighter than regular paint, never needs retouching and doesn't have the same problems with toxins that pigment has.

Students can even learn about biomimicry in school now. UC Berkeley has started the Center for Integrative Biomechanics in Education and Research, or CIBER, an educational facility devoted, in part, to biomimicry.

"Imagine discussing how the molecular function of bio-adhesives from sticky gecko feet can be applied to the design of the next type of easy peel bandage," CIBER's Web site (**http://ciber.berkeley.edu**) says. "Imagine doing it during class, in a small group, with a professor or graduate student acting as a mentor."

Biomimicry is a large element of the Bioneers Conference held at the Marin Center every October. Run by the Collective Heritage Institute in New Mexico, the conference is set in Marin in part because of all the innovations happening here.

"We hold the conference in Marin because there is so much activity going on in that area," says Kai Huschke, strategic-partnership manager for the Institute. "There is a lot of leading-edge progressive thinking and community building around the work. Jay Harman is definitely one of the leaders in that."

By proving that imitating nature can be profitable, Harman may have helped show where to look for answers for our human problems—answers that have always been there. Nature has conducted untold research and development already, and knows what works and what does not. After all, nature is energy efficient, recycles everything, fits form to function and encourages diversity. If nature solves one problem, it solves them all, beautifully and efficiently.

"Nature uses 50 to 75 percent less energy in its systems than humans use," says Harman. "And in a world running out of energy, it's good to know that nature has already solved the problem. We just have to figure out how to copy it." ✹