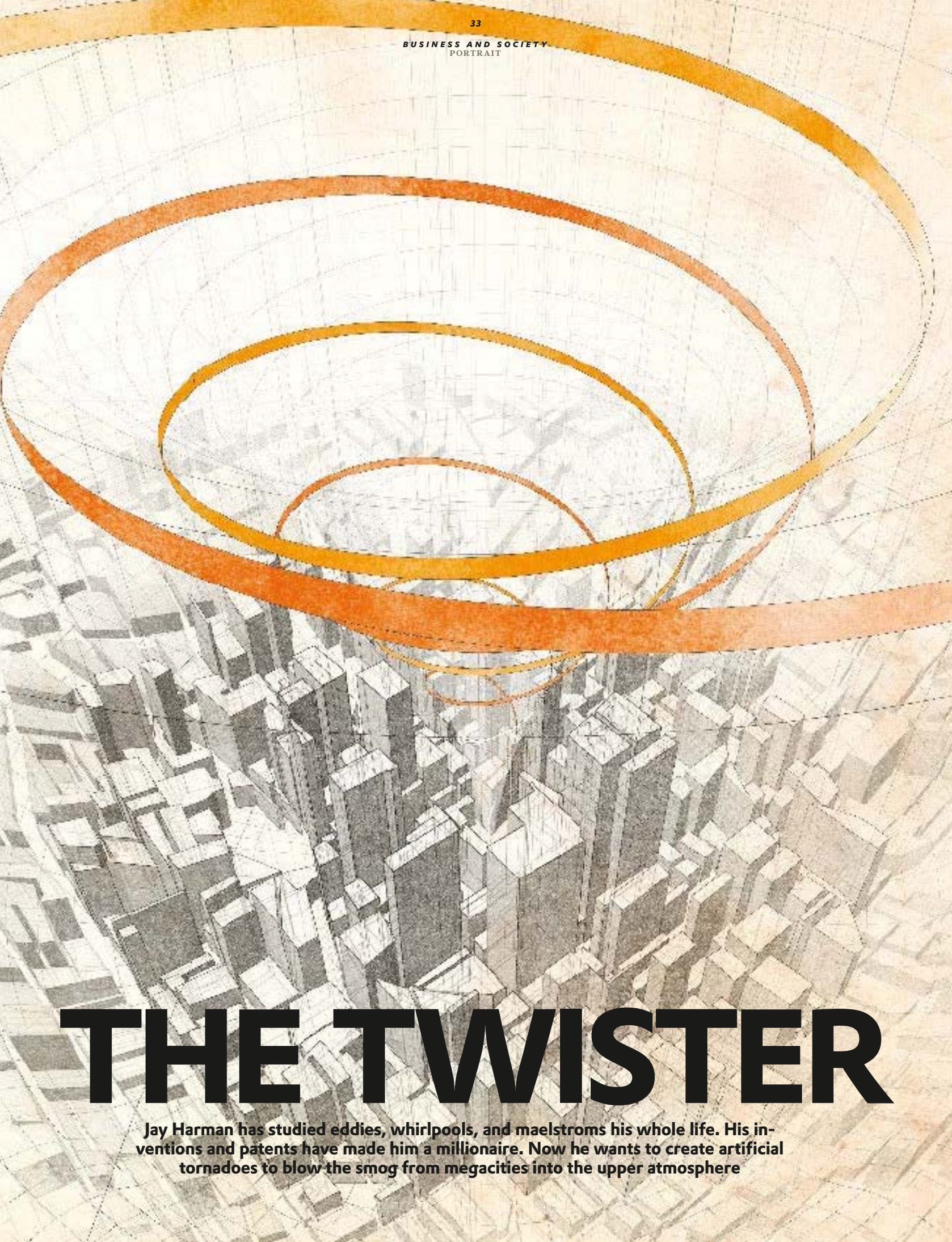
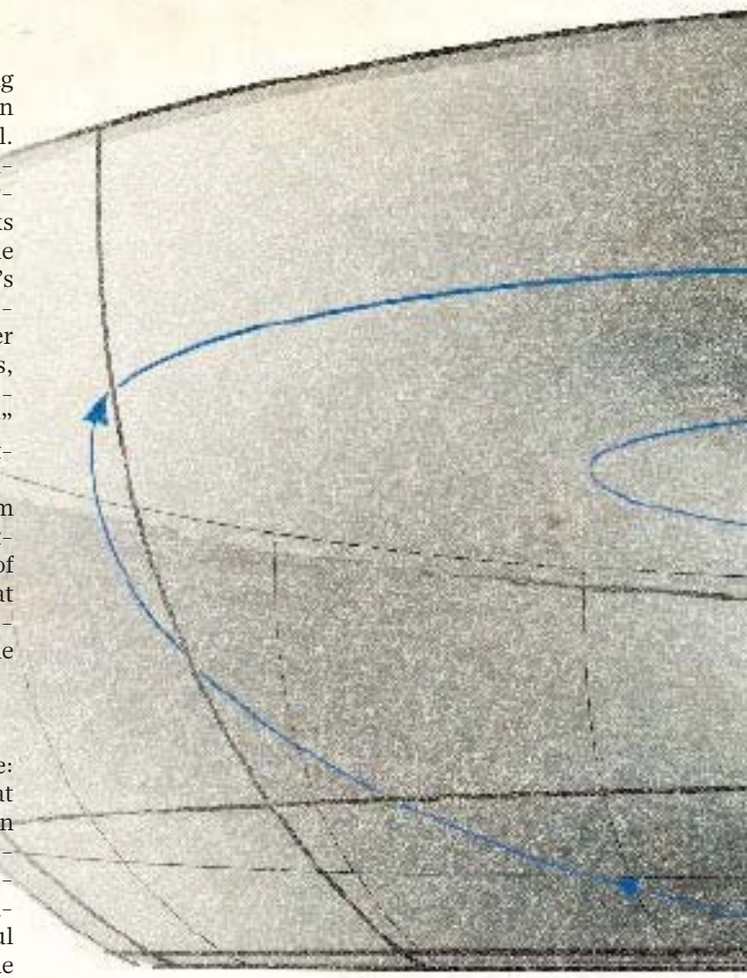
A tamed tornado: Biomimeticist Jay Harman plans to use high-powered nozzles to drive away smog from big cities

Illustration: KircherBurkhardt Infographic



THE TWISTER

Jay Harman has studied eddies, whirlpools, and maelstroms his whole life. His inventions and patents have made him a millionaire. Now he wants to create artificial tornadoes to blow the smog from megacities into the upper atmosphere



It's not surprising that people who are trying to save the world aren't easy to get hold of on the phone. They have other concerns, after all. Moreover, the person we're trying to reach lives in Hawaii, which has a 12-hour time difference from Germany—the most possible. As a result, it takes weeks before a crackling noise can be heard on the telephone line. After a slight time delay, we hear Jay Harman's grating voice. Harman, 65, is an inventor, an entrepreneur, and a specialist for all kinds of air and water flows. From bathtub drains to destructive tornadoes, Harman knows how vortexes work. The scientific discipline that Harman practices is called "biomimicry" (→box) and seeks to solve today's problems by imitating nature.

Harman holds 30 biomimetic patents, ranging from refrigerator fans and drinking water mixers to "atmospheric mixers" designed to free Chinese cities of smog. Harman has also founded eight companies that market his inventions. He lives in California and Honolulu, where, despite his work, he still finds the time to carve wooden statues and cultivate fruit trees.

The spiral pattern of life

Born on Australia's west coast, young Jay (full name: Jayden Harman) was sent to a Catholic orphanage at the age of eight. Every time Jay was about to be beaten by one of the orphanage's strict Jesuit priests, he escaped by running down to the beach. In the surf between the rocks, he made his first life-changing nature observations. He was fascinated by the graceful and efficient movements of the fish as well as by marine plants. He wanted to know why he could easily tear off kelp even though it was able to withstand strong currents and mighty waves. "After long observation, I noticed that the shape of kelp is adapted in such a way that it presents as little resistance to the water as possible," says Harman. "This means that kelp doesn't move in a chaotic fashion, but always pursues a certain spiraling path."

He later encountered this kind of spiraling pattern in all kinds of objects: in seashells that he gathered at the beach, in hurricanes and eddies, and even in the crozier of the archbishop who once attended mass at Jay's school. But even as a young man, Harman didn't know what he should do with this insight. Instead, he began studying electrical engineering. He soon left college, however, to work for the Department of Fisheries and Wildlife.

In 1982 Harman achieved his first success practically out of the blue when the Energy Research Group (ERG), a company he had founded, developed electronic displays and smartcards for public transportation systems. When the company's share price skyrocketed after a few years, the restless entrepreneur decided to sell his stocks and sail around the world.

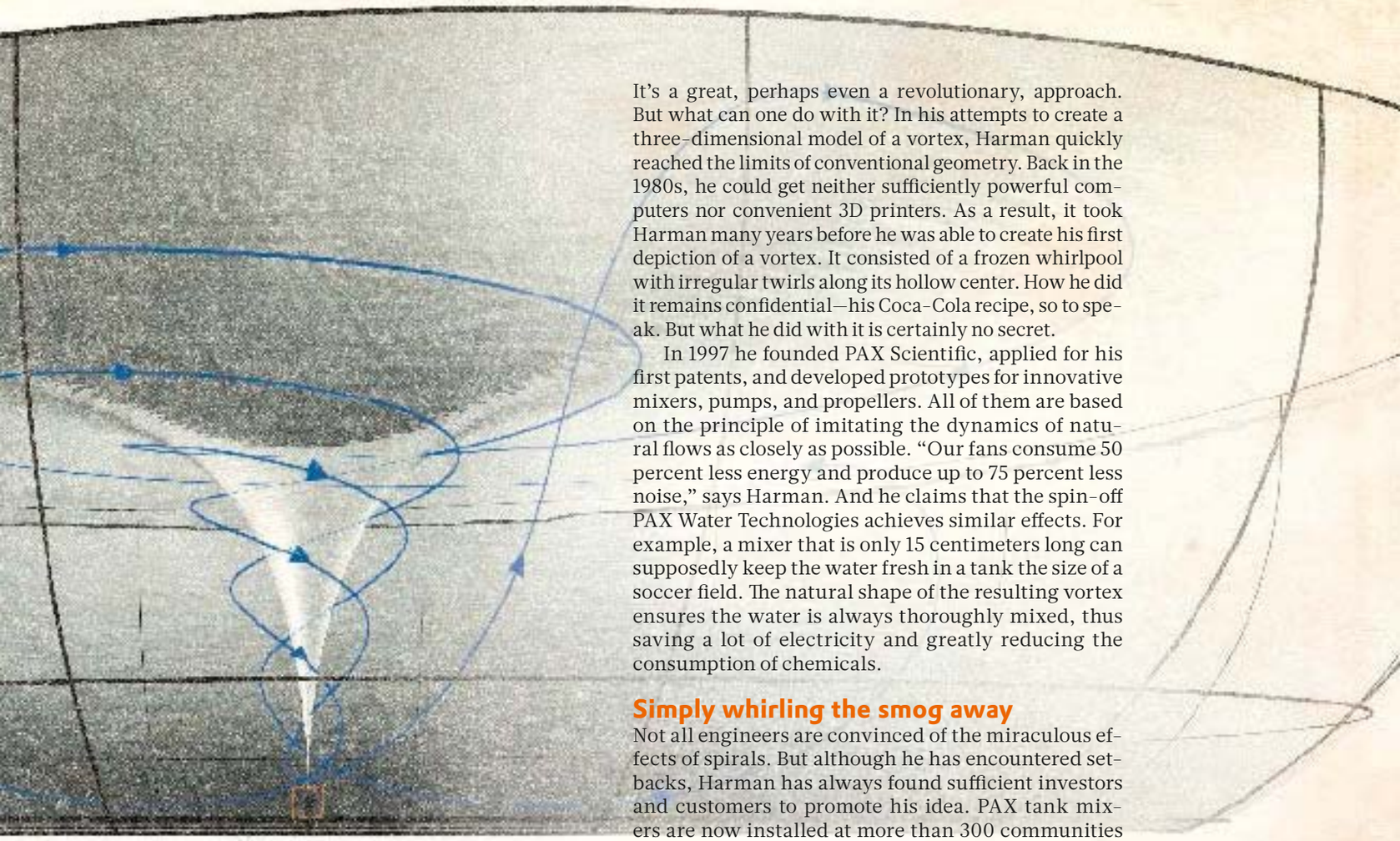
During this voyage he once came to a beach where he picked up the broken shell of a marine snail. It brought back memories of the spiral pattern of life that he had encountered before. Harman decided to get to the bottom of this phenomenon. "All I had to do was to continue to study the perfected shapes that appear everywhere in nature and to adapt them to arrive at product designs," he says. The spiral pattern was especially intriguing. Harman asked himself whether it could be transferred to industries and products that involve liquids, gases or heat flows—i.e. to practically every industry and product in the world.

According to Harman, mankind could save huge amounts of energy if it dispensed with straight lines. "Most of our consumption of fossil fuels is utilized to overcome friction, resistance, and gravity," he says. However, all objects, from pistons to airplanes, move either through the air or through liquids. So why not simply look at the way nature deals with such resistance and conserves energy? "There are no straight lines in nature," Harman states. That pertains to our DNA and the pores of our skin as well as to the shape of our heart muscles and our earlobes. It also holds true for whirlpools and magnetic fields as well as for weather phenomena and even the shape of galaxies. "Nature never moves energy, liquids or objects along straight lines but always in accordance with the same spirals that we see in the vortex of a bathtub drain" he adds.

"It was easy. I only had to adapt shapes from nature to get product designs"

Jay Harman
Legend has it that the spiral pattern of a snail shell that Harman picked up on a beach gave the Australian inventor the topic of his life

Illustration: KircherBurkhardt Infographic



It's a great, perhaps even a revolutionary, approach. But what can one do with it? In his attempts to create a three-dimensional model of a vortex, Harman quickly reached the limits of conventional geometry. Back in the 1980s, he could get neither sufficiently powerful computers nor convenient 3D printers. As a result, it took Harman many years before he was able to create his first depiction of a vortex. It consisted of a frozen whirlpool with irregular twirls along its hollow center. How he did it remains confidential—his Coca-Cola recipe, so to speak. But what he did with it is certainly no secret.

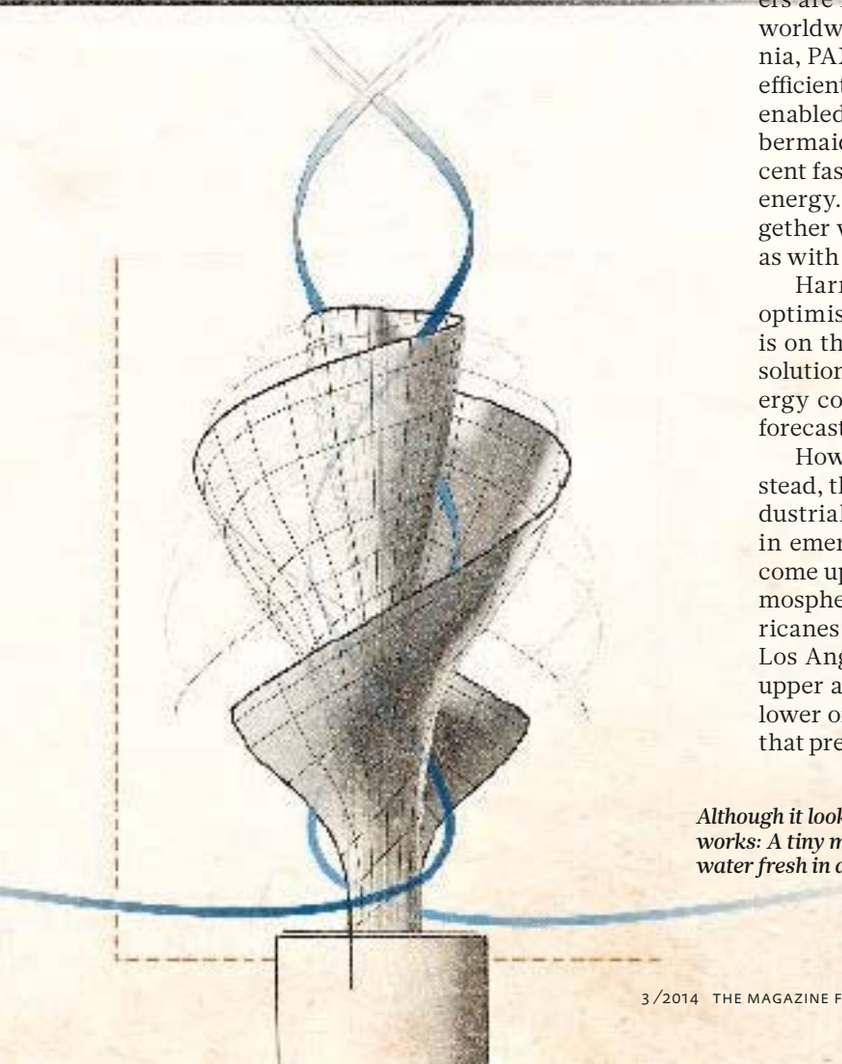
In 1997 he founded PAX Scientific, applied for his first patents, and developed prototypes for innovative mixers, pumps, and propellers. All of them are based on the principle of imitating the dynamics of natural flows as closely as possible. "Our fans consume 50 percent less energy and produce up to 75 percent less noise," says Harman. And he claims that the spin-off PAX Water Technologies achieves similar effects. For example, a mixer that is only 15 centimeters long can supposedly keep the water fresh in a tank the size of a soccer field. The natural shape of the resulting vortex ensures the water is always thoroughly mixed, thus saving a lot of electricity and greatly reducing the consumption of chemicals.

Simply whirling the smog away

Not all engineers are convinced of the miraculous effects of spirals. But although he has encountered setbacks, Harman has always found sufficient investors and customers to promote his idea. PAX tank mixers are now installed at more than 300 communities worldwide, from Melbourne to Barcelona. In California, PAX has commissioned the development of more efficient fans for server farms. The technology has also enabled the electrical appliance manufacturer Rubbermaid to develop a dryer that dries surfaces 33 percent faster than before, but without consuming more energy. Moreover, PAX subsidiaries are working together with the French energy company Suez as well as with Microsoft, NASA, and the US military.

Harman, who pronounces himself an incurable optimist, believes that a golden age of biomimicry is on the horizon. "If we develop green, biomimetic solutions on a broad scale, mankind could cut its energy consumption at least in half in the future," he forecasts.

However, this era won't begin any time soon. Instead, the number of conventionally built cars and industrial facilities will rise dramatically, particularly in emerging markets. Fortunately, the inventor has come up with an idea that might help stop it: the "atmospheric mixer, which could create miniature hurricanes that liberate large cities from smog. In Beijing, Los Angeles, and other cities that lie in valleys, the upper atmospheric layers are often warmer than the lower ones. This creates a kind of barrier or air dome that prevents wind from carrying pollutants out of →



Although it looks bizarre, it works: A tiny mixer keeps the water fresh in a huge tank

Biomimicry
Copycat, Copycat

Archimedes' inventions were inspired by nature, as were those of Leonardo da Vinci and George de Mestral, the creator of Velcro. For millions of years, the world's oldest research and development department has been changing, refining, and improving its products in a never-ending process of trial and error. It's likely that human beings have always engaged in "biomimicry"—the imitation of nature. Archimedes' corkscrew pump is similar to a snail shell, and Leonardo designed flying machines inspired by birds' wings.

After the Industrial Revolution caused people to lose much of their interest in nature, bio-based innovations are now experiencing a renaissance, due in part to the availability of increasingly powerful computers. Biomimicry researchers model the behavior of swarms of insects in order to optimize traffic and energy flows; scientists create biomaterials modeled on spider webs or shark skins. There is a smooth transition to bionics, of course. In bionics, engineers try to recreate solutions from nature. The results range from the winglets found at the ends of aircraft wings to hydraulic, spider-shaped robots for hazardous assignments. Another advantage of biomimicry is that natural systems such as forests are inherently sustainable. They use local materials, don't waste resources, and produce only nontoxic waste.

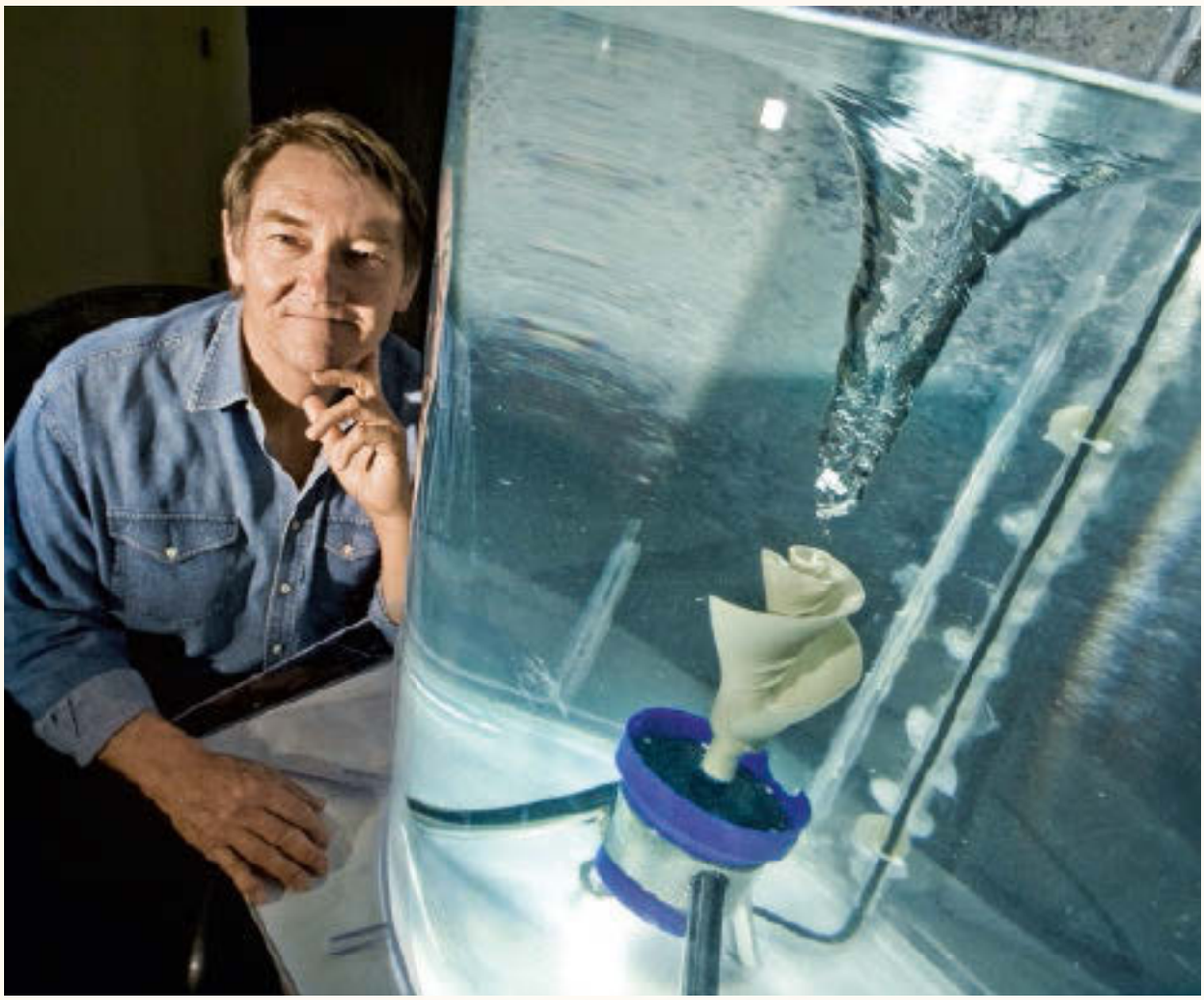
The diverse field of biomimicry has been an independent discipline since at least 1997, when the US author Jane Benyus coined the term in her book *Biomimicry—Innovation Inspired by Nature.*

The potential seems to be huge. For example, biomimetics professor Julian Vincent from the University of Bath (UK) estimates that "at present there is only a 12 percent overlap between biology and technology in terms of the mechanisms used." In his book *The Shark's Paintbrush,* Jay Harman cites studies that document the biomimicry boom in the USA. They show that the number of scientific articles concerned with biomimicry has increased fivefold in ten years and that the number of patents utilizing biomimetic ideas has risen 14-fold.

Economists at Point Loma Nazarene University in San Diego, California, forecast that biomimetic solutions will influence a large number of sectors by 2025, including 15 percent of chemical production and waste management as well as 10 percent of architecture, machine production, textile manufacturing, and transportation. Harman estimates that biomimetic solutions have a global market potential of "over $100 billion." The bio-visionary is convinced that biomimicry can reduce global energy costs by more than half and that it is the fundamental business of the 21st century.

"Biomimicry could enable mankind to cut its energy consumption by more than half"

Jay Harman
Until now, a lot of energy had to be consumed to overcome friction and resistance



Small cause, big vortex: The Australian biomimeticist Jay Harman bases his inventions on nature

→ the cities. Harman wants to penetrate this dome. "We can circulate the air in such a way that the smog is carried to a height at which the dominant winds can sweep it away," he claims. All he needs to do is to mount one of his vortex mixers on top of a vertical jet engine. "Our computer models and lab tests show that a 50,000 hp device measuring only three meters across would suffice to pump the air from an area with an 80-kilometer radius to an altitude of 7,000 meters."

Tempest in a teacup

Harman considers his idea so effective that he also wants to use it to save the global climate. "If we set up and coordinate 20 such turbines, the air turbulence will be 20 times stronger," he says. Several such clusters at the poles and on high mountains could continuously blow warm air from the troposphere near the earth's surface to the much colder ionosphere 80 kilometers higher up. "That's precisely what a tornado does," says Harman. "It equalizes air pressure by transporting warm air to cold heights." So why shouldn't we create a controlled tornado? "It's still only conjecture," admits Harman. Governments would first have to finance large-scale computer simulations and localized experiments. "But we think it's doable—it would be a natural extension of our previous activities."

Is this just harmless nonsense or rather a dangerous case of geoengineering? Some researchers think that intentionally tampering with the climate would be a sensible way of stopping negative developments such as global warming. Critics accuse such people of megalomania and fear that such manipulations would have dire consequences because the associated risks and side effects cannot be assessed in advance.

However, this seems to be a secondary consideration in Beijing, which is plagued by smog. In a key scene of the documentary film *Elemental*, Harman has a smile on his face as he looks through his big glasses. He watches a strange corkscrew-shaped fan begin to turn behind a window in his test lab. Next to Harman is an emissary from China, who calmly states that his current mission is to search for groundbreaking technologies that the Chinese could implement somewhat faster than would be possible in America or Europe. Gas clouds begin to form behind the curved window, creating a sort of tempest in a teacup. "We're not doing anything that nature hasn't already been doing for ages," Harman tells the investor. The contract for the atmospheric mixer is already lying on the table.

At the end of the scene, the Chinese emissary and the Australian inventor shake hands. "It will be great to work with you," the emissary says. "I will transfer the money if you give me your bank details. Let's get something going!"

Harman grins. "Yes, definitely," he replies. "Definitely." ●

"We aren't doing anything that Nature hasn't been doing for ages"

Jay Harman
The inventor wants to use 20 turbines to blow warm air into the cold ionosphere. In the best-case scenario, this would stop global warming

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