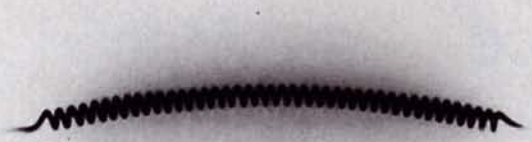
THE 13TH ANNUAL DISCOVER MAGAZINE AWARDS

FOR INNOVATION IN SCIENCE AND TECHNOLOGY

FIVE REVOLUTIONARIES WHO CHANGED THE WORLD | PHOTOGRAPHY BY ALYSON ALIANO



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THE WUNDERKIND IS A ROMANTIC FIGURE IN SCIENCE, A young hotshot who skateboards into a discipline, turns everyone's idea of reality upside down, and reveals the stodginess of conventional thinking. Gifted young researchers truly are a driving energy in science, and we like to give them their due. But geniuses are geniuses and innovators are innovators, regardless of age. This year the five scientists chosen to receive the 13th Annual Discover Magazine Awards for Innovation are not wunderkinds, but they are revolutionaries, people of vision who have changed their fields irrevocably. The youngest is 47. The oldest, a 76-year-old aeronautics engineer, is planning to requalify for his pilot's license. None of them ever stops dreaming. They are not satisfied with the newest and the most extraordinary. Imagination, not youth, powers them. Experience, not adrenaline, fires their neurons. They are contradictions in a society that places such high value on being forever young. These days, when a worker hits 50, it's not unusual for an employer to start nudging him toward the door, often escorting out the very brainpower that keeps the enterprise competitive. Today you couldn't do cutting-edge science without the innovations these guys thought up, and that's why we think they're keepers.

LIGHTBULB PHOTOGRAPHS BY AMANDA MEANS

Aerospace | Paul MacCready

DESIGNER OF THE FIRST HUMAN-POWERED AIRCRAFT | BY JOSEPH D'AGNESE

PAUL MACCREADY HAD TWO OLDER SISTERS, BUT THEY WERE SO MUCH older that he always felt like an only child. Socially awkward, dyslexic, the smallest kid in class, he might have suffered through childhood. But even as a boy, he knew exactly what made him happy. During summers at his parents' cottage, he collected butterflies and moths, marveling at their ability to fly on such delicate wings. There were lots of birds to watch, too, their aerobatics accomplished by such effortless, slight movements. A child with the soul of a poet might have written about that. Another child might have sketched these wonders. MacCready set himself a very different path: How, he began to wonder, could I build a butterfly, or a bird?

Almost 70 years later, it can be said quite simply that MacCready has succeeded: He has built machines that soar through the air with the effortless precision and grace of a butterfly or a bird. There was, just for starters, the *Gossamer Condor,* the first successful human-powered aircraft. The *Condor* was quickly followed by the *Gossamer Albatross,* which was pedaled through the air and across the English Channel from Folkestone, England, to Cap Gris-Nez, France, in 1979. A few years later MacCready's company built the world's first solar airplane, the *Gossamer Penguin,* and then a more powerful one, the *Solar Challenger,* which flew from Paris, reaching an altitude of 11,000 feet, and landed at an air force base in England with energy to spare. In 1987 he and his team built a bizarre-looking solar-powered car called the *Sunraycer,* which won a 1,867-mile race across Australia against 22 other solar-powered cars. Three years later they introduced the prototype for the battery-powered Saturn Impact, which is still leased in Arizona and California. And when the producers of an IMAX film on the history of flight were casting about for a pterodactyl, MacCready built them an 18-foot working replica of the largest flying creature the world has ever seen. But it is always the superlights we remember, aircraft that seem so delicate, so light, so impossible, yet prove to be as strong and durable as a monarch butterfly migrating from Mexico to Maine. His company built three of them for NASA. All have flown effortlessly, quietly, on solar power, into the stratosphere. The latest, *Helios,* reached 96,863 feet last summer, two miles higher than any other non-rocket-powered aircraft had flown. It is powered by 14 electric motors that turn props. It will be able to stay aloft for months at a time. The Smithsonian Institution understands this genius. It has collected two planes flown by Charles Lindbergh, three built by the Wright brothers, and five of MacCready's creations.

As a boy he built model aircraft—gliders, ornithopters, helicopters, and autogiros; by the age of 16 he was through with miniatures, opting instead to fly the real thing. At 20, bored by powered flight, he chose to master gliders. A glider pilot who wants to stay aloft longer than 20 minutes at a time must search for thermals, as hawks do, exploiting a free ride from nature. By age 31 he had won four soaring contests in the United States and Europe. Now, at 76, MacCready still dreams about carving out time from his perpetually busy schedule to return to his first love, promising himself: "This year I'm going to get my license and get back into gliding."

Understanding how a light aircraft flies like a bird came in handy when MacCready, the father of three young children and head of a fledgling engineering start-up, co-signed a $100,000 business loan for a friend, who then defaulted. Looking for a way to pay off the note, MacCready began to think about a cash prize offered by British industrialist Henry Kremer to anyone who could fly a human-powered airplane over a one-mile-long, figure-eight circuit. The money—about $95,000—had gone unclaimed for almost two decades. To get it, all MacCready had to do was make a man fly.

British engineers had tried in vain, and MacCready's preliminary calculations showed that a conventional design wouldn't work. He worried that figuring out a radical approach

Opposite: Aircraft design has long been a tradition in Paul MacCready's family. The famed designer of *Helios* and the *Gossamer Condor* ultralight aircraft holds a toy glider that his son Tyler began designing 27 years ago, when he was 13 years old. It has been sold as the Air Surfer.

would take too much time and be too costly, so he tried to forget about it. Then, on a cross-country trip with his family in 1976, he and his sons marveled at the flight of large birds overhead, watching hawks and vultures remain aloft for hours without ever flapping their wings. "I think it was the day after the tour of Kitty Hawk when I realized that you could win the prize with a different approach," MacCready says. "The plane would have to be larger and lighter. After that I knew just what to do. There was only one unknown. The wings would be so large they'd need exterior wire bracing, and I didn't know if that wire would have too much drag. So I couldn't wait to get back to the books to figure that out."

Back in California he and a cadre of 20 friends and employees worked weekends perfecting the 70-pound *Gossamer Condor*. The design was unprecedented: The plane had a wingspan of 96 feet, covered in Mylar sixteen-thousandths of an inch thick. Enclosed in a plastic cockpit, the pilot pedaled to get the bird airborne. The prize was theirs. But no sooner had they won it than Kremer offered another—$200,000 for crossing the English Channel under human power, a distance of 22 miles. "He thought it would take another 20 years to do," MacCready says dryly. "But we realized we could clean up the *Condor*'s design, up the efficiency by 20 percent, and the pilot could make it across the Channel."

He has always known that his machines are, at best, facsimiles of organisms that nature got right the first time around

Besides, he needed the money. He'd sunk so much into building the *Condor* that he'd been able to wipe out only a third of his original debt. So the team headed to England in June 1979 to launch Bryan Allen, a 137-pound cyclist, in a new plane, the *Gossamer Albatross*. A flotilla of media boats watched as the weather, which had seemed perfect early in the morning, deteriorated quickly. Two hours into the flight, drinking water gone, legs cramping badly, Allen signaled for a tow. But when he maneuvered the craft a few feet higher so that rescuers could hook a line to the *Albatross*, he found calmer air and waved them off. He pedaled another 49 minutes—sometimes with one leg, sometimes only inches above the waves—and touched down in France. "He did a truly phenomenal job," says MacCready, who was nursing a broken foot and watching from the deck of the lead boat.

By now MacCready was in the grip of an obsession—squeezing every bit of efficiency from aircraft, pushing engineering to new limits. He rarely paused in his work long enough to consider why he cared so much about such things. But then, in 1982, he had to make a speech in acceptance of the Lindbergh Award. In his research for the talk, he stumbled upon a story that spoke to his heart. "Few people know that in the last 20 years of his life, Lindbergh dedicated himself to the environment," MacCready says. "In Kenya, Africa, he found himself looking at a hawk, and he had to ask himself which would make him sadder—if there were no birds or no airplanes. And he chose birds, even though he was an aviator. And that helped him resolve to work on environmental things."

MacCready reflected that his own work was an expression of his lifelong fascination with wild creatures. The realization helped him clarify the goals of his company, AeroVironment, which now focuses on developing alternative energy sources. They manufacture batteries and chargers for short-range gasoline-free vehicles such as motorized airport carts and forklifts. They crank out half-ounce robotic planes that are used for reconnaissance by the Department of Defense. And they are perfecting solar power and hydrogen fuel-cell technology to keep NASA's *Helios* aloft indefinitely, carrying atmospheric monitoring equipment. The team also finds time to tinker with one of MacCready's pet projects: a human exoskeleton whose robotic legs would give wearers the lifting and climbing power of a Titan.

All of these ambitious endeavors dovetail neatly with MacCready's credo: Do more with less. What worries him these days is that the rest of us seem hell-bent on doing more with more. "I'm basically pessimistic about the future," he says. "There were 1.7 billion people on the earth when I was born, and now there's 6.2 billion. Almost four times as many. If you look at all the vertebrate creatures on sea, land, and air, humans and their livestock and pets occupy 80 percent of the mass of vertebrates. That's an overwhelming percentage. Natural animals account for the rest. I'm very dismayed that we are heading into a period where we may not have wild animals around. I show curves when I give talks to get people thinking about this: Humans, livestock, and pets keep going up, and all wild nature is going down. I think the two crossed about 80 years ago."

For MacCready, doing more with less means weaning ourselves from fossil fuels. It means investing in technologies that harvest sunbeams and wind and charging the batteries in home appliances with power drawn from these sources. It means building cars that guzzle hydrogen and expel harmless water vapor. And it means pursuing those technologies today—so that we're not rudely awakened when nature pulls the plug on fossil fuels. He is appalled that such planet-altering issues are a low priority on the national agenda. "It's got to get so bad that the politicians respond," he says. "It's a devastating problem for the United States to have key officials—the president, the vice president—associated with the oil industry. There are lots of people working on good, all-natural energy sources. Unfortunately, the politicians believe what only 1 percent of the scientists believe."

If MacCready sounds exasperated, it's because he cannot bear to lose what inspired him as a child. He has always known that his machines are, at best, facsimiles of organisms that nature got right the first time around. Every bird, bee, and butterfly in the kingdom of life flits at the edge of what is aerodynamically possible, but still succeeds. MacCready has lived a life playing on that edge, and he wishes the rest of us would join him there.