People Powered

The late aeronautics engineer Paul MacCready (MS '48, PhD '52) had already won a mile-long human-powered flight competition in 1977, claiming a $100,000 Kremer Prize (part of a series of challenges set by industrialist Henry Kremer in 1959), with his aircraft the *Gossamer Condor,* when two years later, he and his team completed a successful crossing of the English Channel to win a second Kremer Prize.

The aircraft that crossed the Channel was named *Gossamer Albatross* and was constructed from carbon fiber, polystyrene, and Mylar. It was designed to be powered like a bicycle, using pedals that drove a two-bladed propeller.

MacCready not only designed both aircraft but also selected the same man to pilot them: an amateur cyclist from Bakersfield named Bryan Allen, who, as MacCready explained in his 2004 Caltech Archives oral history, fit his list of requirements: "… somebody with light weight ... a good bike racer who could help build the plane, who had some experience in model airplane construction, and who was unemployed, so that he would be available."

A little after dawn on June 12, 1979, Allen powered up the *Albatross* to 75 revolutions per minute and took off from Folkestone, England. "We knew that he could put out enough power to stay aloft for two hours," MacCready said in his oral history interview, "and we were hoping that the wind would be nothing, or that there would even be a slight tail wind. But instead ... it became a headwind."

That two-hour flight turned into almost three. "When his left leg would cramp, he'd pedal mostly with his right. When his right leg would cramp, he'd pedal mostly with his left. Both legs cramped toward the end, and he somehow just struggled through." As the winds calmed again, Allen landed on the beach at Cape Gris-Nez in France, having completed the 22.2-mile crossing in two hours and 49 minutes, achieving a top speed of 18 miles per hour and an average altitude of 5 feet.

Allen would later set world records in distance and duration in a small pedal-powered blimp named *White Dwarf.* Today, he works at JPL, which Caltech manages for NASA, as a software engineer.

"Every glider pilot around the world knows about Paul MacCready," says Marshall. "He came up with the optimal speed-to-fly theory. There have been other people who have added little bits and pieces to it, but at the end of the day, the fundamental theory on optimal speed-to-fly is still MacCready's."

The MacCready Ring was originally a physical device, but the theory behind the MacCready Ring is now implemented in a glider's flight computer. Based on his speed-to-fly principle, it calculates the speed and altitude necessary to glide to a particular destination. The indications for when to speed up and slow down change depending on the rate of climb that is set; with higher climb rates, it is more optimal to fly faster, which consequently uses up more altitude when gliding between thermals.

MacCready's affiliation with Caltech was part of the reason Marshall wanted to come to the Institute, he says. "There's a lot of soaring, aviation, and aerospace history associated with Caltech, and MacCready played a large part in it. I hope to emulate some of his successes one day, in both soaring and aerospace."

MacCready, who died in 2007, achieved early gliding success in a Pasadena-made sailplane called the *Screaming Wiener.* He won national soaring championships in that glider, and its successors, in 1947, '48, '49, and '53. He also competed in England, Spain, and Sweden, winning the World Championship in France in 1956. "I quit soaring after that contest," said MacCready in a 2003 oral history conducted by the Caltech Archives. "It was a very extreme day. … The wind was, oh, 60 miles an hour or more, and you'd get a down-current behind the slope, maybe 100 feet a second down, mingled with currents of 100 feet per second up. And it was luck as to whether you made it there."

Although he achieved remarkable success in soaring, MacCready never saw himself as an instinctive pilot. Instead, he said, "I used my brain power in the important part of the flight. Those contests wouldn't be won by somebody who could do turns effortlessly but by somebody who knew where the next thermal was. I would concentrate very hard."

Marshall, too, says he is not necessarily a natural flyer. "I do think that good glider pilots usually fall into one of two categories: tactical pilots, who understand the fundamentals of soaring and how to apply them, and intuitive pilots, who are very good at reading the sky and sensing the air around them," he says. "I fall more into the former category, though I'm trying to get more over to the other side, too."

The sport, adds Marshall, tends to appeal to mathematicians, scientists, and engineers, and while his graduate research on the dynamics and control of flexible spacecraft has no direct correlation with soaring, he feels sure that he benefits from his analytical background. "I have a reasonably good understanding of how things fly. Just being an aerospace engineer is beneficial. The challenges in engineering and research are similar to the challenges in soaring: they're both difficult problems that you tackle with a set of fundamental principles and judgment formed from experience. It's just that the consequences if something goes wrong in soaring are often higher than the consequences in research."

Preparing for competition means researching the local terrain as well as the likely weather conditions. For instance, he says, flying on the West Coast is not great practice for flying in Europe, since European thermals are slower and the highest a glider pilot is likely to reach is around 5,000 feet, while on an average day in the western United States, a sailplane might reach an altitude of 15,000 feet. And, with fewer mountains in some parts of Europe, features like lakes, forests, and even roads can have a significant effect on gliding conditions.

It also helps to know who else is in the race. "You want to know who the really good pilots are," says Marshall. Equally important, he says, is knowing the pilots who have historically made bad decisions and then both literally and metaphorically steering clear of them.

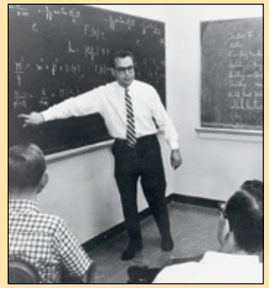
Even with careful planning and smart strategy, every flight holds some surprises. One day in Florida, Marshall recalls, he found himself sharing a thermal with a bald eagle. Another day, during a competition in central Utah, he says, "We were flying down a ridge that was maybe 70 miles long, and it ended up being a pack of gliders all basically hugging the top of the ridge, cruising at like 80 to 90 miles an hour just a couple hundred feet above the ground. We were basically in formation flying down the ridge, a flock of gliders. So that was unexpected but pretty exciting."

When Marshall tells people he's a glider pilot, they often muse about how peaceful it must be up in the skies without any engine noise. "But it's not as quiet as people think," he admits. "You have instruments beeping at you. And then there's the wind noise. It looks peaceful, but sometimes it can be a lot more like a roller coaster."

There is nowhere he would rather be, though, on a day away from his research on campus. "There are a lot of puzzle pieces that need to be put together to do well," he says of his intellectually challenging sport. "I have some of the pieces but not all of them. I don't think you can ever really get all of them."

In Memoriam

Read more about their lives at **magazine.caltech.edu/post/in-memoriam**



Murray Gell-Mann
1929–2019

Murray Gell-Mann, who was Caltech's Robert Andrews Millikan Professor of Theoretical Physics, Emeritus, and a winner of the 1969 Nobel Prize in Physics, passed away on May 24. He was 89 years old.

Gell-Mann helped bring order to the field of particle physics in the 1950s and 1960s. He devised a new method for sorting the particles into simple groups of eight, based on their electric charge, spin, and other characteristics. He is perhaps best known for developing the theory of "quarks," indivisible components of matter that make up protons, neutrons, and various other subatomic particles.

Manuel Soriaga
1950–2019

Manuel "Manny" Soriaga, a research professor of applied physics and materials science, died on July 17. He was 69.

As a principal investigator in Caltech's Joint Center for Artificial Photosynthesis (JCAP), Soriaga studied electrochemical reactions that make artificial photosynthesis possible. His research focused in particular on the discovery and development of the catalysts required to perform those reactions.

Allen Robert Gross
1944–2019

Allen Robert Gross, longtime director of the Caltech Orchestra who retired in May after 36 years at the Institute, died on August 20. He was 75.

During his time at Caltech, Gross also served as music director and conductor of the Santa Monica Symphony Orchestra and of Orchestra Santa Monica, and he led tours of the Santa Monica Chamber Philharmonia. In addition, he worked at Occidental College until 2014, when he retired as emeritus professor of music.