It seems easy when hummingbirds do it. The little birds don’t flap their wings straight up and down. Instead, they rotate them in a fast, tight oval. By changing the angle — or “pitch” — of its wings, the hummingbird can rest motionlessly in the air while it sips nectar with its beak, or it can dart away, flying too fast for larger birds to harm it. The hummingbird’s speed is limited only by the strength of its muscles.

So if the helicopter is mankind’s version of a hummingbird, increasing a helicopter’s speed should be easy. Just use stronger, lighter materials to make more powerful engines. But the helicopter speed record of 216 knots, or about 249 miles per hour, was set in 1986, and fast attack helicopters like the military’s Sikorsky Blackhawk, only cruise at about 155 miles per hour. Why?

“Helicopters have ‘retreating blade stall,’ and getting through it is the equivalent of breaking the sound barrier for helicopters,” explains Steven D. Weiner, director of Engineering Sciences for Sikorsky Aircraft Corporation. Weiner was chief engineer of Sikorsky’s X2 Technology Demonstrator, a helicopter that set an unofficial speed record of almost 288 miles per hour in 2010. But making this record-breaking aircraft required solving some tough engineering problems.

With helicopters, which both hover like a hummingbird and move swiftly in any direction, the difficulty lies in the way the two rotors of the aircraft work together. Both the main rotor in the center of the helicopter and the second, counterbalancing rotor in the rear appear to be fixed. But, in fact, each has a range of pitches and speeds that the pilot adjusts as needed to hover, lift up or fly forward.

“One rotor blade is moving in the same direction of flight, and one (is moving) in the opposite direction,” says Weiner. If you want the same amount of lift from both rotors, then the “retreating” rotor — the one that is moving away from the direction of flight — has to operate at a higher angle than the other, “advancing” one.

Eventually, you have to tilt the retreating blade so much that it stalls. “No matter how much power you put in there, you won’t go any faster,” Weiner explains.

The problem went to Sikorsky’s Advanced Concepts Group, whose 20 members look at advances in technology to find new ways to tackle old problems.

“Back in the 1970s,” says Weiner, “we came up with the XH-59, an advanced blade concept where we put one rotor on top of the other and had them rotate in two different directions.”

But the vibrations from the XH-59’s three blades were too ferocious for the electronics to work and the body to hold together. Forty years later, however, the technology has changed.

“We came up with an active vibration system that uses force generators,” explains Weiner. “…The computer will tell each one how fast and how much force to produce so the overall vibration is lowered.”

The Advanced Concepts Group began exploring design ideas and got the company’s approval to build a helicopter that could go twice as fast as current craft. Then Weiner put together a team of 30 old and young engineers to produce the X2. The X2 was finally assembled and connected to a computer, where the company’s test pilot put it through hours of simulated flight. Only after it completed this test did the pilot take the 6,000-pound craft and a test engineer into the air and show that it could, indeed, run at 250 knots, or 288 miles per hour.

At that point, the X2 retired, making way for the 10,000-pound, six-passenger production model F2 helicopter, which will be the workhorse of the future.