The Power of the Vortex

The U-M is developing a nonpolluting electrical generator.

To explain how his invention works, naval engineering prof Michael Bernitsas shows grainy footage of the collapse of the Tacoma Narrows Bridge in Washington State in 1940. What does a suspension bridge bucking in the wind have to do with generating electricity from gentle river and ocean currents? Both, Bernitsas explains, depend on a phenomenon called "vortex-induced vibration," or VIV.

The arcane phenomenon was first described in 1504 by Leonardo da Vinci. Historically, however, VIV has been of interest to engineers only as a destructive force to be controlled. "That's why no one has thought of it [as a power source] in five hundred years," says Bernitsas.

Until now, that is. Bernitsas has installed a working prototype of his generator—a U-shaped apparatus about the size of an office chair—in a slightly leaky circular tank in West Hall. Dapper in a blue monogrammed shirt with gold cuff links, he stands next to the tank and slowly twists the Speed knob on the wall. A motor whines, a propeller spins, and the water starts flowing like a river past the generator.

The device is fixed in position, so the current can't push it sideways. Instead, as the water flows past, a gold-colored cylinder in the center begins to rhythmically bob up and down, like a pogo stick. "The flow excites the structure," explains Bernitsas. The same kind of vertical motions destroyed the Tacoma Narrows Bridge. Here, they're being harvested: the cylinder pulls a shaft that turns a rotary generator and, voilà, produces energy. Three bulbs attached to the generator blink off and on in rhythm with the bobbing gizmo.

Bernitsas can add fluorescent material to the water, illuminate it with lasers, and reveal the secret behind his invention: the current passing around the cylinder is actually made up of a string of curlicue shapes called vortices. The spinning vortices push the cylinder up and down.

"I definitely need to explain how the phenomenon works—even in my department," Bernitsas admits. "But the two colleagues in my department who understood vortex-induced vibrations were pretty thrilled."

In years past, Bernitsas has written extensively on how to dampen the destructive effects of VIV on marine objects such as fishing nets—so extensively, in fact, that he burned out on the subject. So when one of his Ph.D. students, Kamaldev Raghavan, proposed writing his dissertation on the subject two years ago, Bernitsas balked.

"I was writing on the whiteboard," Bernitsas recalls, "and said, 'Wait a minute. You want to work on VIV; I want renewable energy—why don't we combine the two and see if we can generate energy from VIV!' We did some calculations and it seemed viable, so I said, 'Don't talk to anybody!' "

Since then, Bernitsas has applied for a patent under the direction of U-M's Office of Technology Transfer (the rights belong to the U-M under his name and his students'), formed a company called Vortex Hydro Energy, and, along with a cadre of students, built the working prototype. According to his lab data, it can generate a kilowatt-hour of electricity in Michigan for 5.5¢, compared to 4¢ for coal and 48¢ for solar energy. Toni Newville from the Department of Energy says Bernitsas's device "appears to be extremely cost effective for a renewable energy source."

Bernitsas's next step is to build an oceangoing prototype. He's trying to raise $2.5 million to construct and install a device the size of a small house. Using tides and currents, it should generate enough energy to power up to fifty homes. Eventually, he envisions giant VIV generators powering desalinization plants to provide fresh water to parched coastal cities around the world.