Dancing Scientists Bring Fluid Mechanics to Life

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Yuna Hattori and I both grew up in ballet studios, hers in Japan and mine in America. Over time, we were both drawn to science, until eventually, our paths crossed at the Okinawa Institute of Science and Technology Graduate University (OIST). Though Yuna now studies fluid mechanics and I write about OIST's latest research, she and I bonded over our mutual love of dance. Inspired by our shared passion, we decided to enter this year's "Dance Your Ph.D." Contest.

For 11 years, the annual "Dance Your Ph.D." Contest has challenged scientists to communicate their research without the help of words. The contest began as a ploy to get scientists to dance at a party, spurred on by their competitive nature and slight inebriation. Dr. John Bohannon, a molecular biologist and science communicator, instigated the challenge, posted videos of the competition online, and sparked a movement - literally.

Elevated from its humble origins, "Dance Your Ph.D." is now sponsored by the American Association for the Advancement of Science and *Science* Magazine and attracts participants from around the globe. Bohannon still curates the contest each year. He believes dance can make complex concepts easier to understand, and has collaborated with professional dancers on projects of his own.

"Scientists and artists are close cousins. They're always looking for a way to work together," Bohannon wrote in an email to me. "I just created a convenient excuse."

I, too, am always looking for an excuse to merge science and dance. In college, I briefly debated whether I should major in neuroscience or dance. In the end, I chose to study both and graduated after receiving highest honors for my undergraduate thesis: an exploration of Locked-In-Syndrome, a rare neurological condition, presented through the lens of dance choreography.

I learned that dance relays information in a way that words cannot. Dance creates dynamic visuals, breathes life into metaphor, and triggers visceral empathy in its viewers. As a professional science communicator, I aim to keep putting science on stage. In the spirit of "Dance Your Ph.D.," I believe dance can offer an entry point into the intimidating world of science, and serve as a source of inspiration for scientists themselves.

"Doing this project has helped my research," said Yuna, who will complete her Ph.D. in 2020. "I've really had to think through the fundamental points of my work and visualize what's happening, physically." You can often find Yuna swimming in mathematical equations; the chance to communicate her research through dance steps and short captions came as a welcome challenge.

“I knew about ‘Dance Your Ph.D.’ before and vaguely thought my research would be fun to visualize through movement,” she said. Armed with her physics expertise, my background in science communication, and our mutual dedication to dance, we decided this year would be the perfect time to actually participate in the contest.

In the OIST Fluid Mechanics Unit, led by Prof. Pinaki Chakraborty, Yuna studies turbulence -- a state of chaotic rotation observable in most fluids in the universe. It’s rare for fluids to flow in a straight, orderly line, like the water from your sink faucet. You can witness turbulence on a grand scale when you look out over the roiling ocean, or up at clouds churning in the sky.

But turbulence also exists at small scales: picture water boiling in a kettle, or cream swirling in a coffee cup. Yuna studies turbulent flows swirling through films of soap, which she makes with a sudsy solution. Driven by gravity, the solution flows between two vertical wires and forms a thin film. The fluid collects in a bucket below and is then pumped back to the top of the system to flow again.

Yuna measures how energy travels through the flat soap film in spiraling eddies. Turbulent flows seem chaotic at first glance, but Yuna hopes to find order in the madness and someday be able to predict their movements. The work has broad applications in weather and climate research, as well as in engineering aircraft, industrial mixers, or pipelines -- any system containing turbulent fluids.

The tumbling eddies Yuna studies easily translate into dance choreography. I drew inspiration from images of crashing waves, flowing air currents and Jupiter’s famous Red Spot, the beet-colored storm that rages across the planet’s surface. The resulting dance captures these ideas through twisting arm movements, spiraling turns, and rotating jumps.

Yuna and I filmed a large portion of our dance on Tancha Beach, just down the hill from OIST campus in Onna Village. We twirled through the sand and waves with the ocean and distant horizon as our backdrop, dancing along with the turbulent flows of the sea and sky. But this was just one chapter in our story; to tell the rest, we needed more dancers.

Some scientists study turbulence by observing eddies -- swirling whirlpools spinning through a fluid. A turbulent system contains eddies of many different sizes, spinning at different speeds. In three-dimensional space, these eddies have room to stretch in the vertical direction. Much like a dancer pulling in her arms to perform a turn, an eddy spins faster when its stretches.

In two-dimensional space, however, eddies cannot stretch and turbulent flows behave very differently. In both 2D and 3D turbulence, large eddies break down into smaller eddies. But in 2D, small eddies can also combine to make large eddies. Turbulent flows on the surface of the ocean and in the atmosphere behave in this way, as do Yuna’s soap films.

To demonstrate how eddies behave in both 2D and 3D, we turned to our fellow OISTers. Our ensemble became our eddies, performing different turns at different speeds in our makeshift

turbulent system. Together, we embodied Yuna's thesis in a way no PowerPoint presentation ever could. And we caught it all on film.

Our final video is now live on YouTube and will be judged by a panel of scientists and dancers on its technical and artistic merit. Each year, the judges select a limited number of finalists to compete for the grand prize: $1000 and acclaim among the grooving science community. Submissions can also earn the top prize for their selected scientific discipline -- physics, chemistry, biology, or social sciences -- or the coveted people's choice award.

As for Yuna and I, whatever the outcome, we're just happy to be dancing.

"While completing my Ph.D., I want to continue combining art and science, and collaborating with people," said Yuna. "I just need [dance], for balance, and I think it helps my research, as well."