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Dance works

Valerie Lawson

Of course ballet is art, but since when has it been science? Valerie Lawson looks at the leaps in technique that would have caught Margot Fonteyn on the hop.

TWENTY-FOUR years ago, the world of Professor Ken Laws flipped inside out. The professor of physics at a college in Pennsylvania took his two young children to ballet school. But instead of collecting Virginia, 5, and Kevin, 7, after class, like most dutiful parents, Laws never really left the studio.

Well, he did, but only to buy some tights, a dance belt and ballet shoes. At the age of 40, Laws enrolled for a beginners' ballet class himself. Until then, his only exercise was playing baseball and, he says, "jitterbugging in a ballroom" when he was a young man.

Rather than becoming a figure of fun, even an object of ridicule to giggling fellow students, Laws applied his own knowledge of physics to the art of dance to become a respected teacher and author of books on ballet technique. He's given more than 300 talks on the physics of dance, most recently this year to a conference in Atlanta, Georgia, of 11,000 physicists.

"It's been a source of joy for me," he says. "I started working backstage, and became the chief curtain puller for the Central Pennsylvania Youth Ballet," which sounds small time but is, in fact, a good company producing some principal dancers for leading US companies.

"I was overwhelmed by the art form. I would stand backstage with tears streaming down my face." His tears, though, did not blind his intellect. Laws's 24-year journey has helped him find meaning in life, to marry science and art, and to come up with a bridge to help physicists see how dancers' bodies move, and dancers see how to apply physics to help their technique.

The knowledge is increasingly useful to teachers and dancers as technique powers ahead, sometimes ahead of artistry. As the Kirov Ballet principal Igor Zelensky recently said, each new decade sees astounding advances in technique. The lovely dancer

of four decades ago, Margot Fonteyn, would struggle to reach soloist level in today's companies led by long-legged, extremely flexible ballerinas with so-called 6 o'clock extensions, such as Sylvie Guillem and Darcey Bussell.

Newton's three laws of motion, including the third law - for every action there is an equal and opposite reaction - have been Ken Laws's companions on his own journey of discovery, allowing him to understand enough to teach partnering classes to a high level.

"There's little I would rather be doing in life than teaching pas de deux. That's the epitome of life for me," says Laws, who teaches at both Central Pennsylvania Youth Ballet and Dickinson College in Carlisle, Pennsylvania.

The most difficult yet exhilarating time for Laws himself was at the start of the journey when he took two or three classes a week. With limited turn-out of the legs in the hip joint (which classical ballet dancers develop from the age of eight or so when their muscles, joints and tendons are still flexible), he "ached every day".

"Going into class in tights had its own embarrassment, too. The teacher accepted me as unusual but I really worked hard and wanted to learn. The kids stared at me and thought, 'What is this old guy doing here?' I could understand it at an intellectual level. I got up to intermediate level and they developed a respect for me and would joke around and call me Ken."

By the time he was 50, he was taking eight to 10 classes a week and had written his first book, The Physics of Dance, which 21 publishers rejected before it was accepted by a division of Macmillan and sold 10,000 copies. It is now out of print. In 1994, he wrote his second book, co-authored by the former American Ballet Theatre principal Cynthia Harvey. Called Physics, Dance and the Pas de Deux, it too is out of print but he is planning a new edition of his first book as well as two more, one on music, the other on meteorology.

The only reason Laws doesn't dance so much now is because of a recent appendicectomy and shoulder surgery, but he plans to return in a limited way, limited being the only way most people over 40 can even attempt classical ballet.

Dancers may look as if they simply raise their arms, rise up on their toes and twirl around like dolls in a music box. But such sugary images hide the truth. From about the age of eight, ballet dancers begin a rigorous eight- to 10-year training period, as tough as any athlete's, to develop enough strength and control to jump, turn and balance, as well as to lift or support one another in partnering work,
while looking as though it is as simple as a walk through a park in spring. Unlike athletes, who might grimace and grunt, dancers aim to show no effort in their arms, hands and face. Their firepower comes from their strong muscles and controlled breathing but the actual movements are all based on physics, as of course are the movements of athletes such as high jumpers or ice skaters.

Laws is especially interested in two types of movement, turns and jumps. He has analysed in detail a turning jump called a grand jete en tournant. The series of photos of the Australian Ballet's senior artist, Kirsty Martin, shows the sequence.

The dancer must turn in the air but once she is in the air, she has nothing to push against, so the turning movement should come as she starts to leave the floor. This is called applying a torque, or twisting force. Once the dancer is in the air, she should bring her legs close together as her arms also rise above her head. The legs and arms, therefore, are close to the axis of rotation.

"The crucial thing is to get the body aligned along a nice straight line," says Laws. "It's like a turning ice-skating effect. You bring your legs together, close to the action and the rate of turning speeds up."

"He's right," says Noelle Shader, ballet mistress for the Australian Ballet. "The last step before the take-off is the most important. That's where the largest amount of force has to be. Your body is already turning as you work through the air, so at the highest point your body has already completed the rotation. Your arms bring the centre of gravity to a tighter position. Then the arms and legs open to sustain the landing, like a bird."

Physics explains how some dancers seem to hang in the air, an ability shared by certain stars such as Rudolf Nureyev, Mikhail Baryshnikov and Cynthia Harvey. It's known as "hang time", which gives the illusion of floating. This can be seen in a movement known as a grand jete, not a turning step, but simply a jump going straight ahead or to the side, like an arrow, with one leg leading and the other following, both opened below the torso at the height of the jump. As Laws says, when the dancer takes off, his or her "centre of gravity is going to follow a parabolic curved trajectory".

In the book Dance Imagery, the author Eric Franklin goes on to explain: "To increase your hang time ... you need to manipulate the location of the centre of gravity within your body while in midair. The parabolic trajectory of your centre of gravity during a travelling leap is a given; you cannot change it. If you throw a rock, it will never create the illusion of floating or gliding because it does not have arms or legs to shift its centre of gravity within its body. In the grand jete, the dancer splits his legs, bringing them to their highest point at the peak of the leap. The arms move up at the same time. The centre of gravity is high in the body at this point. The centre of gravity begins to descend along its parabolic path, but the downward motion of the legs and arms briefly lower the body mass to allow the torso and head to 'float' horizontally for a moment."

Says Shader: "I tell them to hold on to the absolute last moment so their hips are at the highest point, then to explode their legs. Unless you take your centre of gravity over to where it needs to be, you will not get that hang time."

In contrast, the centre of gravity of a high jumper is much lower, never rising above the bar in the newer technique called the Fosbury flop in which the back just curls over the bar and the legs hang.

In turns, the closer the legs are to the axis of rotation, the faster the spin, as you can see when an ice skater's body winds into a blur, arms above the head and ankles close. A classical ballet dancer, says Shader, should "spiral her energy towards the centre of the body. Their supporting leg is pushing all the energy down into the floor while it is lifting up out of the hip. That's the base. The working leg is a bit like a fan, working against it."
Another analogy is a revolving door, with pressure applied on push-off in the direction of the motion at the furthest lateral point from the axis. As the writer Anna Paskevska explains, in her book Both Sides of the Mirror, "The instant between the initial push-off, which is also the moment when torque is created, and the beginning of the spin is referred to by Dr Laws as the moment of inertia."

One night, the physics of another kind of turn came to Ken Laws in much the same way as Archimedes realised why the water got higher as he climbed into the bath. It was the fouette turn, in which a dancer continu-ally turns on one leg while using the other to whip around by taking it to the front, then to the side, then into a position called retire, or an angle to the supporting leg. As the dancer faces the front each time, she comes down off pointe (that is her stiffened pointe shoe which allows her to rise onto her toes) and her arms open to the side as if to say, here I am.

Says Laws: "What came to me was, why waste all that effort getting the leg from front to side, then I realised of course, you are storing the momentum." The dancer saves momentum from one turn to the next by keeping the leg in rotation. As the science writer Robert Kunzig explains, in a recent article about Laws in Discover magazine, "To store momentum in the leg, she kicks it straight out, far from her spin axis, as she faces the audience; to transfer momentum back to her body, she
tucks the leg back in as she faces away. The whole thing is fluid and physically sensible, beautiful and economical."
That's the whole point of what Laws is about, of course. To explain the imagery of ballet and the mechanics of what makes it possible. As he says, his marriage of science and ballet "opens a door, it's a bridge. We can see so much more."
It's not as if Laws was the first to marry science and dance. The technique of ballet was codified early last century by a mathema-tician, Carlo Blasis, and in a recent BBC Radio documentary the leading choreographer Wil-liam Forsythe explained his work in terms of geometry, of the drawing of lines between

points, of problem solving, the undoing of mathematical knots, of how movement develops from one moment to the next.

His work underlines the idea once expressed by Havelock Ellis that dancing and building are united, "the two primary and essential arts. The art of dancing stands at the source of all the arts that express themselves first in the human person. The art of building, or architecture, is the beginning of all the arts that lie outside the person; and in the end, they unite."