Motion-capture cameras, computer software assist skaters with jumps

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A simulation developed at the University of Delaware may help Olympic skaters nail those triple axels and quadruple toe loops in Sochi.

According to a recent poll, almost a fourth of Americans say figure skating is their favorite Olympic sport.

But while most of us just sit back and enjoy the show in all its grace, beauty, and athleticism, Jim Richards zeroes in on the skaters' "air position."

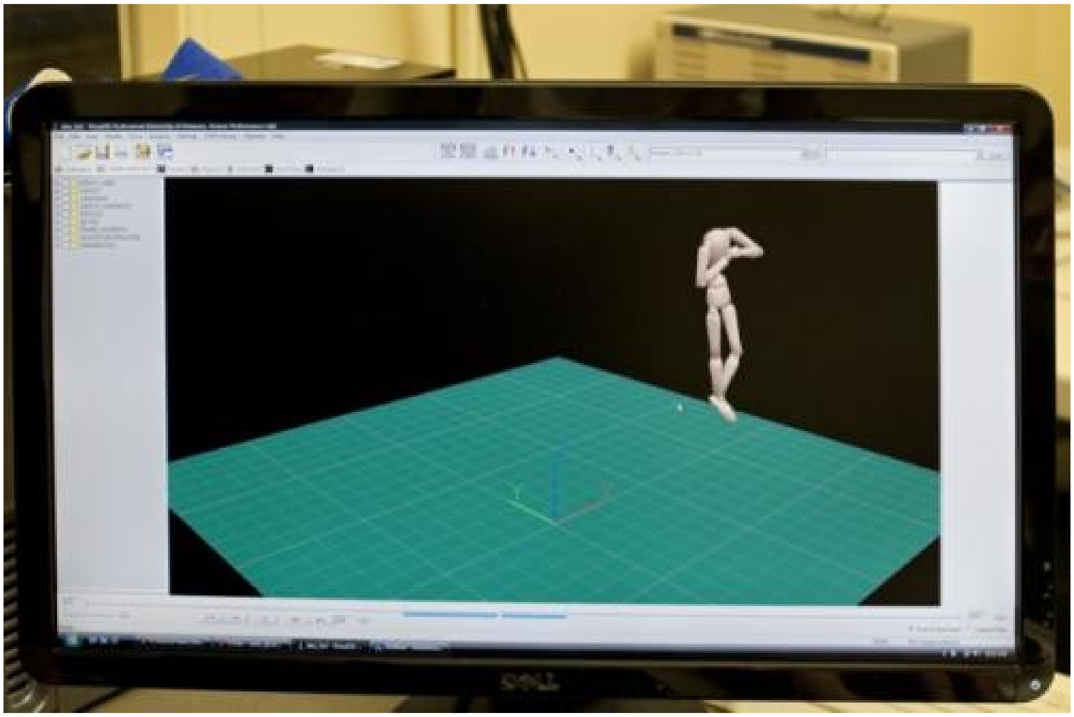
From his decades of skating research, Richards, Distinguished Professor of Kinesiology and Applied Physiology at the University of Delaware, knows that proper air position is critical to successful jumps.

A computer simulation developed by Richards's team at UD in collaboration with Maryland-based C-Motion Inc. enables skaters and their coaches to observe an athlete's actual movements on a computer screen and then see how those movements can be manipulated to improve jumping technique.

"The best part is that within just a few minutes, we can show them how making a small but specific change can effect a big change in terms of their ability to land their jumps and avoid repeated falls," Richards says.

The system looks almost ridiculously simple on the computer screen: two little mannequins, one representing the actual skater and the other a mathematical model of that individual.

"After years of fine-tuning the motion capture system, collecting data, and writing software, the end result was almost anticlimactic," Richards says. "All that work went into producing those two little figures."



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But Richards learned the hard way that simplicity was what the figure skating world needed. "Initially, we used a lot of tables and graphs and charts to describe recommended performance changes, but these ended up having little value to the skaters or their coaches," he says. "We couldn't translate numbers and graphs into useful information for them—we needed something that was more visual."

Over the past several years, some 80 elite figure skaters have turned to the simulation for valuable feedback on how they can turn doubles into triples and triples into quadruples. This group includes four of the five U.S. Olympic singles skaters competing this month in Sochi—Jeremy Abbott, Jason Brown, Gracie Gold, and Ashley Wagner. More than a dozen of the skaters who have used the system have already won medals at national competitions.

While physics may pave the path to better skating, Richards quickly discovered that the simulation alone wasn't enough. While the program's advice was physiologically sound, it wasn't psychologically realistic. Richards recalls that only one skater in the dozens he has worked with was actually able to see the simulation and nail the suggested change on the first try.

"What we found was that the skaters had a spinning comfort zone of about 330 RPM (revolutions per minute), and we were trying to get them to at least 400 and even to 430 or 440 for a quad," he says. "Their bodies were telling them it wasn't safe, so we realized we needed to strategize with them about how to accomplish more rapid spinning. It wasn't enough to just tell them what to do—we also had to tell them how to do it."

Richards has been called a sports researcher, but that's not totally accurate. Like many defense technologies that have transitioned into the civilian world, his simulation has applications far beyond the realm of elite skating.

A couple of years ago, he began working with clinicians at Shriners Hospital for Children in Philadelphia to explore the use of the technology in treating a condition called brachial plexus birth palsy (BPBP).

Occurring in about four out of every 1,000 births, BPBP affects nerve roots in the cervical spine, impacting muscle function in the shoulder and the arm. Most children recover on their own, but about 30 percent are left with lifelong deficits in arm function that require therapy or surgery. The problem with treatment is that movement of the scapula, commonly known as the shoulder blade, is incredibly difficult to measure.

But as it turns out, another simulation under development by Richards and his team shows promise for helping doctors determine what will happen if they move a tendon from one point to another in an individual patient.

Jim Richards (left) has developed a simulation that may help Olympic skaters nail those triple axels and quadruple toe loops in Sochi.

Although Richards reluctantly accepts his few weeks of fame every four years when the skaters who have visited his lab at the ice arena on the UD campus vault into the limelight, he's gratified that his work is finding new applications in the medical field.

He also believes that the technology could be applied to a broad range of other sports, but to the best of his knowledge this hasn't happened yet.

"Two aspects of this system are unique," he says. "The first is that we're taking a mechanical analysis of human motion and immediately using it to impact performance. The second is that the simulation confers the ability to mimic an activity and see what will happen if you make a change."

Simulations have been widely used to improve athletic equipment. For example, the bobsleds, luge sleds, and skeleton sleds used by Olympians have all been modernized and optimized by engineers using motion capture technology, 3D modeling, and wind-tunnel testing.

But it's the human element that takes center ice for Richards.

"I think our kids are in good shape for Sochi," he says. "Their air position is good."

Provided by University of Delaware