3 Questions: Anette Hosoi on engineering and the Olympics

August 2 2012

How do engineers watch sports? Pretty much like the rest of us, but with a little more time spent scrutinizing the mechanics of athletes and the technologies they use. With the Olympics under way, Anette Hosoi, an associate professor in MIT's Department of Mechanical Engineering and a wide-ranging sports fan, talked to MIT News about the mechanics of sports.

Q. Many people were startled by the record-breaking performances of sprinter Usain Bolt in 2008. What is the key to his speed, as you see it?

A. Two things that influence how fast you go are your stride frequency and your stride length. Speed is the product of those two things. It turns out that all sprinters' frequencies are roughly the same; if you look at all the top runners, they're basically moving their legs at the same frequency. But the amazing thing about Usain Bolt, the thing that sets him apart, is his stride length, which is almost 10 feet. I was so impressed by that, that I went to the track to measure my own stride length, which is more like five feet. To get a feel for how large a 10-foot stride is, I recommend that readers measure their own stride length for comparison.

The problem with being a tall sprinter is that the more mass you have, the harder you have to work to accelerate. So, in addition to running skills such as form and timing, it's a matter of having the strength to propel that much mass forward. People overlook how much strength sprinters need to have. Bolt has a unique combination of both the strength and the long stride.

It's the same with cycling [a sport with both sprint specialists, who are best on flat terrain, and riders who excel at climbing mountains]. I'm a cyclist and I was just watching the Tour de France; if you look at the peloton [main group of riders], you can pick out the sprinters, who are bigger, compared to the climbers, who are lighter.

Q. Where else in the Olympics do you see engineering problems? What about swimming as it relates to your own specialty, fluid mechanics?

Athletes like to swim in a "fast pool." But what does that mean? Whenever you move your body in the water, you create waves. You put energy into a system and create waves. As a swimmer, you would like to prevent those waves from coming back and hitting you. Engineers have made pool gutters absorb waves so they don't bounce back into the center of the pool. Instead the wave goes into the gutter and then dissipates. Olympic pools also have lane markers that spin, so that when a wave hits the lane marker, instead of propagating to the next lane, the energy is absorbed by the lane marker.

With swimsuits, the issues are a bit subtle. Swimmers were allowed to use bodysuits, sometimes called "shark suits," to reduce drag [from about 2000 until they were banned in 2010]. It's a little contentious how much the suits actually reduce drag. However, they were definitely providing buoyancy. And if you get extra buoyancy, then you can use more of your energy to go forward rather than keeping yourself afloat. So now there are regulations on buoyancy. It matters because when you're talking about these top athletes, the thing that is separating them is tenths or hundredths of a second. So if there's some technology that lets them shave off a hundredth of a second, they're going to want to use it.

Q. What kind of sports-related engineering work is being done, or could be done, at MIT?

A. People are very passionate about sports, which are intimately connected with engineering. There are people at MIT Sloan doing sports analytics, and there are people doing biomechanics such as Hugh Herr [of MIT's Media Lab].

We would like to move forward on a project about Sports, Technology, and Education at MIT (STE@M). It's something students can get really excited about. If you talk to someone about statistics in general terms, their eyes glaze over, but if you talk to them about baseball, suddenly they know everything about statistics. Or materials: If you talk about strength of materials abstractly, you lose people in five minutes, but if it's a cyclist, they will talk for an hour about the difference between steel and carbon fiber. Sports put fundamental engineering challenges in a context people enjoy.

We would like STE@M to encompass research and education, because at MIT the line between them is blurred. UROP [Undergraduate Research Opportunities Program] projects are a good way to start. … A great UROP project would be to put a sensor in a football, so you know exactly where the ball is when it's under a pile of players, and test it with a football team. Or, in cyclo-cross, we could have a [student] build a little testing center, and see which tires have the least rolling resistance.

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Provided by Massachusetts Institute of Technology