“The Physics of the Fastest Swim Strokes” Excerpt Transcript

Excerpt from ([August 5, 2016](#)) episode of Science Friday.

IRA FLATOW	This is "Science Friday." I'm Ira Flatow. Tonight, the summer Olympics kicks off with the opening ceremony in Rio. And the swimmers are the first ones up, and they take to the pool this weekend. There's some debate about what is the fastest swimming stroke, and it's not what you might think. It's not the crawl. It's definitely not the breaststroke. The speediest swimming style may be a version of the dolphin kick known as the fish kick, a difficult stroke to master, performed entirely while the swimmer is submerged. And whether it's the fastest stroke, it's still up for debate between coaches and swimmers. But my next guest is here to tell us about the science of swimming. Rick Madge is a research engineer. He's also head coach of the Mighty Tritons Aquatic Club in Milton, Ontario in Canada. Welcome to "Science Friday."
RICK MADGE	Thank you, Ira.
FLATOW	Let's talk a bit about just the basics of physics of swimming. The idea is you push the water back and you go forward, action and reaction?
MADGE	It's pretty much that simple. The big key there is that as you try to push through water you have resistance, or drag. And then as you push water behind you, you use that drag to your advantage.
FLATOW	Let's talk about this new dolphin kick, the one you swimmers dive in and they transition off the wall. We know about that. We've seen that. But there's this thing called the fish kick that's different.
MADGE	Fish kick is usually what they call dolphin kick on the side. And this is called that because it's more like what fish do, as opposed to the up and down motion that we've been watching for the last 20 or 30 years in underwater swimming.
FLATOW	But do you think that it might be tried more in this Olympics?
MADGE	Not at this point, no. The strokes are pretty much locked in. There's another type of fish kick where they refer to as really the dolphin kick, but on the side. And that has some definite benefits to it, and a few drawbacks as well. But it is something that you're going to see some of the swimmers push off

	on their side and kick on their side for a little while, and then transition to the back or the stomach, depending on the stroke.
FLATOW	And that that's only though, you say, for the first 15 meters?
MADGE	15 at the most. The head has to emerge at that point, other than breaststroke.
FLATOW	Why would that stroke be better than, let's say, that standard dolphin stroke?
MADGE	Well, it gets down to why does underwater kick work? And the reality is that when you push off the wall or you dive in, you're going faster than you can possibly swim.
FLATOW	So you're a little missile at point coming on.
MADGE	Very much. In fact, if you can push off the wall and maintain that speed, you'll do the length of the pool in as little as 15 or 16 seconds. Now of course you can't, because water's fairly thick. So the whole purpose of the dolphin kick is to maintain your speed for as long as possible. So you're not trying to generate speed. You're just trying to maintain it. And to do that, we have to get into fluid dynamics. Specifically, you don't want to interrupt the laminar flow of water over your body.
FLATOW	You mean the smooth flow? The water is smoothly flowing over your body.
MADGE	Yes.
FLATOW	You don't want to interrupt that and make turbulence.
MADGE	Yes. So if you've seen car commercials on TV where they show the car in a wind tunnel, and they always have some colored streams that are being fed into the airflow. If you see that smooth color flowing over the car, then it is streamlined. Now the thing about cars is they don't kick. So it complicates it tremendously when you take the body that pushes off, and then you add undulations at the lower half. You have to keep those undulations more or less within the bounds of that laminar flow, or else you create turbulence.
FLATOW	And so by doing that, the fish kick, you're basically undulating your body instead of disturbing the water with your feet kicking it, and that keeps the flow smoother.

MADGE	It allows you to have some propulsion that offsets some of the resistance, but it doesn't disturb the laminar flow that's keeping you streamlined and relatively fast.
FLATOW	I know from submarine technology, we all know that a submarine can go faster on the surface than it can underwater. Why do you swim underwater faster than you could on the surface this way?
MADGE	It's really surface tension. There is a lot of surface tension in the water. And if you have to continually break that surface tension, then you're going to be spending a lot of effort on that. But not only that, from the point of view of the kick, if you've seen little kids kick, a lot of times you can see their feet come out of the water, and they slap down. They're spending a lot of energy kicking air. And if you can imagine, kicking air doesn't send you very far. You want to kick water to the point where you actually want to be at least half a meter underwater, preferably more, so that your dolphin kicks don't cause the water to swirl on the top, meaning that you're moving air. The deeper you can get, the more propulsion that you are getting out of the kick.
FLATOW	Do you envision if it's faster to use and it becomes more popular, we might change the rules to allow this to be used in competition?
MADGE	Well, the dolphin kick or the fish kick, if you consider those as just variations in the body position, the body orientation, they put a limit on 15 meters, as I said, in the late '80s simply because the 1988 Olympic 100 meter backstroke had people swimming underwater most of the time. And as a spectator sport, that's not very good. You have people popping up anywhere between 5 meters and roughly 40 meters down the pool.
FLATOW	Let me ask you one more question, because I was reading all the papers on this. And I came across some paperwork about how to hold your hands the right way. I mean, when I was swimming, I made a scoop out of my hands. But reading the paper, says that's the wrong thing to do.
MADGE	That's about the only wrong thing you can do with your hands is to kind of scoop the water. Hands are interesting, because you basically have a certain surface area of your hands if you hold your hand out flat. So if you were to press your hand down on a desk, you would have a certain surface area. And that surface area stays the same, whether the hands are fairly close together or if they're spread wide apart. And that's the dominant reason why you move forward, and the dominant mechanism for moving water.

	If you push, squeeze your fingers together or if you scoop, you're actually reducing the surface area. And by doing that, you're making your hand less effective.
FLATOW	Now, do we want to keep our fingers together? I was reading in some of the papers where people were arguing with each other how many fingers apart? Should we keep them together? What's the fluid dynamics of that?
MADGE	Yeah, the fluid dynamics on this is probably a little more simple than a dolphin kick underwater. It has to do with the boundary layer. And that, I call it the dust on the fan effect. If you can imagine if you've got ceiling fans, and you have to clean them, one of the questions that will come up is, why am I cleaning something that moves through the air all the time? How can dust stay on the fan? And the answer is that there's a very thin boundary layer that is attached to the fan's surface where the molecules of air immediately above in that boundary layer don't move. That's the reason why dust can settle on the fan. And then the air moving across the fan because the fan's moving doesn't actually disturb that dust. We can use that to our advantage when you're pulling. So if you use that boundary layer, and you have, and it turns out to be roughly a third of an inch, or eight millimeters spacing between your fingers, no water is going through your fingers because of that boundary layer effect. So you've basically increased the size of your hand slightly with no detriment.
FLATOW	Fascinating, Rick. Thank you very much for taking the time to be with us. And how are the Mighty Tritons doing?
MADGE	Oh, we're having fun as always.
FLATOW	All right. You'll be watching this weekend, I'm sure. Rick Madge, research engineer, head coach of the Mighty Tritons Aquatic Club in Milton Ontario.