



Turning Technique: The Biomechanics of Age Group Turns by John Walker (1995)

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Today we're going to talk about turns. I became interested in turns at the ASCA World Clinic, I think in 1990. I had the opportunity to watch an excellent presentation by John Trembley and Eddie Reese with regards to starts and turns. I really picked up a few things and I picked up an interest in turns from

that. It's not that I didn't think turns were important, but from that talk, I guess I changed my outlook a little bit in that I started thinking of turns as a way to win a race, rather than just kind of continue on with a race or to stay in a race.

From that talk two things kind of struck me about the turns. First, and the one that intrigued me the most, is that I felt there was some really easy seconds hiding in the turns for a lot of my swimmers. Easy seconds in that just a little bit of attention to technique, a little bit of focus, and you can get the type of improvements that might take 100, 200, or 300 thousand yards of training to get the physiology results. The technique, that was something I really hadn't tapped into. Also it kind of struck me that how important the contact or the relationship with the swimmer and the wall is during the turn. It has to be, you don't want it to last an extended period of time but at the same time it's real important that you get something out of that interaction and you use it to the best of your abilities.

Everybody has a feel for that going back into your own swimming experience. Maybe it was at a High School or a U.S.S. meet, or even at practice where you were doing a 50 freestyle and you're having a great race of a lifetime. You're up on top of the water, go into a wall, come over, hit the wall, good leg snap, good streamline, you're a third of the way down the pool and you're up. Piece of cake. Maybe a week later in the same practice you're doing the same thing. Get up, start swimming, go into the turn, everything's the same, get that leg snap, and you miss the wall by about two feet. It's kind of like whiplash, you actually just stop there, and there's not a lot of things you can do. You can do a little sculling, you can do a little kicking, but you can't recover from that. That type of experience focuses how important the walls are or the interaction with the wall and the turns are for me.

My objective is to offer a different way of looking at turns — a different way of thinking about them, and looking at the time on the wall, and the contact with the wall. We'll talk about first what I'm not going to do today or what I won't be trying to do with this talk. I'm not going to be suggesting any drills or teaching progressions. I haven't had the opportunity to work with 8 & unders, or 10 & unders for a couple of years so my creative edge might be a little dull in comparison to a lot of you who are working with them everyday. So I'll leave that aspect up to you.

The second thing is, I'm not going to be offering scientific facts or statements of ICAR research. We'll get into how this is related to ICAR as we go along. But really what I'm doing today is a very anecdotal, case by case and a general look at this type of information. Some of this information will be published by ICAR, but these aren't conclusions from ICAR. We're just taking snap shots of what's happening and trying to get a better feel for what the swimmer is trying to do on the wall. I think the examples are good. They're consistent. I'm not just taking one particular example and pulling it out of a mass. I could come up with three or four or five other ones to support these. And when I talk about trends, they might not be statically significant but they are very strong trends. So, don't take this as the word of science.

I'm also not going to specifically address breakouts or the streamline off of the wall. That's becoming an extremely important part of the race. People are real innovative there and it's very important, it's probably another subject for another hour or two hour talk at some point. But today we're going to talk about probably what's the primary, primary not as in importance, but as the first thing you have to do. You have to get that momentum off the wall. You have to get that wall speed to be able to use it efficiently in a streamline. So

we are not going to discuss the breakouts. We will touch a little bit on approach strategy.

I'd like to discuss a little bit the history and importance of working on the turning technique. I'd like to describe how the information was gathered, and describe some of the forces involved in each competitive turn. So we'll go through each one and look at: what the swimmer is actually doing on the wall, identify some common errors in turning technique for age group swimmers and also their consequences in terms of time and force, and then compare the mechanics of those age group swimmers to world class athletes that we have information on. Then towards the end we'll try to identify some goals and principles from this information that you can take into developing your turning technique with your programs. I will also summarize some points and ideas that came from a lot of the conversations and the reading I did in working on this.

Briefly, I want to talk a little bit about the history of turns and the relative importance of turns. Turns have not been a exciting or a sexy topic for any swimming researcher to look at. In the past years they did a series of compilations of science work on aquatics for swimming, an annual swimming science book. In the last thirteen years there's been four studies that have dealt specifically with turns. At the same time there's been over twenty eight studies that have dealt with starts. Starts are definitely the most exciting thing to work on but I think that the turns are really where you really need to focus your time on getting some productivity out of the results.

As far as teaching technique, ASCA and some of the coaches who are interested in the mechanics of swimming have done a much better job than

on the researcher end. Every year we've had a discussion here at the World Clinic at least including turns in the session. A lot of the manuals that are out to help coaches have at least a decent treatment in length of turns.

Most of the studies that are done on turns in swimming sciences are utilized to break down the races. So they break down a race into swimming time, starting time, finishing time. And they do this at major competitions. For this talk I tried to find one of the local B/C Open Meets for the age group turns. But nobody really wanted to break down a B/C meet so we have to deal with World Championships and Senior Nationals. So this is elite athletes that we're talking about. From those we found that in long course swimming two things are apparent. Well, actually two things were apparent as we go through races. The longer the race gets the more the turns contribute to or the more time is spent in the turns. And also, short course more than doubles the percentage of turns that you have or the amount of time that's spent turning.

Here are some quick numbers for freestyle: In the 200 meter freestyle turns contributes 8 to 10% of the race as far as time is concerned. And in the distance races, 1500, we're talking 11 – 12%. With breaststroke it's, and probably butterfly and backstroke are heading that way, it's a greater percentage spent underwater. You're looking at 20 – 38% of the breaststroke races are spent in turning or the under water pull. So it's a major percent and you can get a great deal of advantage using the turn.

I am going to go through a few slides to show you how this information was gathered. I was working on my graduate Exercise Science degree at Colorado Springs with the International Center for Aquatic Research. I was

working on this project for them so it was done at the Olympic Training Center. So we'll get to go through a quick review of the nice toys that we have there. If you haven't had the opportunity to go out, I would go and visit. This is the best science place and now the best training place in the world for aquatic athletes.

We used two things to analyze the turns. We used a filming analysis or digitizing process in two dimensions. And then we also use the force platform. The force platform is going to be what we're talking about most. This is the video equipment that we have to work with at the pool at the OTC. We used for this study three over water views and two under water views of each turn to break down different aspects of what the athletes are doing. The force platform is unique. I don't believe this is anywhere else in the world and it was an opportunity we couldn't pass up to work with. The force platform is water proof and you can slide it into the wall and mount it flush with the turning surface so it actually becomes part of the wall for the athlete. The force platform measures very accurately the force that is presented by the athlete. It samples every hundredth of a second so it takes a lot of samples during the course of the turn and it samples in three dimensions.

This is the first time that turns have really been looked at in three dimensions. It turns out that that is real important especially in butterfly and breaststroke turns.

As far as what the data I'm going to be talking about this is the only age group project that has been in U.S. Swimming Sport Science. This is the only age group project for ICAR since the change in management a couple of

years ago. We invited swimmers from five different top age group programs in Colorado to come in and perform turns. We got seventy three athletes to come down. They were all under fourteen and the average age was a little over twelve for both sexes. They performed two short course meter swims in each stroke with the turns at that wall at race pace. So we had 8 turns time 73 swimmers for a total of 584 turns we were looking at. We had a lot of information to go through. We also had the opportunity to use a lot of training camps at the Olympic Training Center.

We also asked some elite athletes when they were coming through for different training situations to do some turns for us. They typically only did their specialty for two course meter 50's.

What information did we get from all these nice little cameras and platforms? With the cameras, we were able to go back and use a system where we have to mark joint centers, frame by frame through a motion. From that, the information that we can obtain are velocities. We were interested in how fast swimmers come into the wall and how fast they leave right after push off. We can also look at joint angles. How much knee bend do they have? How much elbow bend do they have? What might be ideal? We can look at where the center of mass is. The center of mass, or center of gravity, is if you took all the mass in your body and lumped it into one point so it acted just like a projectile or ball, that would be the center of mass.

The force platform is what we're going to talk about a little bit more today. We're going to be talking about three different axis or dimensions. You can see the Z dimension goes into the platform. That's when the

swimmer is pulling on the wall or pushing into the wall. The X is side to side on the wall. That will show when a swimmer is pushing to the right or pushing to the left. And the Y is up and down and will show when they're pushing up on the wall or they're pushing down on the wall. I'm talking about what the swimmer does to the wall. You have to take a second and think about what that's going to do to the swimmer. It's going to be the opposite. The wall is going to push back. If I say a swimmer is pushing into the wall, that means that is the force that is going to send them to the other end of the pool, or the fast turn.

These are the graphs you want to see or the axis we're going to see. These are three little graphs. On the side of the graph is a force in newtons — or the force that the athlete produces. A newton is a metric measurement. 4.5 newtons is around one pound. When we talk about some numbers I'll try to change it into body weight.

If you see a curve in this zone the athlete is pushing to the right side. If you see a curve in this zone the athlete is pushing to the left side. If you see a curve here, they're pushing down on the platform. If you see it here, they're pushing up on the platform. This is probably the one we want to maximize which is pushing in so they're giving themselves momentum leaving the wall. Then pushing out. We're very rarely going to see that but it does happen, that an athlete is actually pushing or pulling the wall towards them. How can they pull the wall towards themselves? This happens in either a breaststroke or butterfly turn with of the younger swimmers where they will actually go here and pull in. Which as we go through and discuss the ideas regarding rotation we may find that it can probably help you. Whether you can get your hands and the rest of your body in the right position while you're doing that is a question that I would have. But that's the

point, usually they're going to be pulling themselves in that way. But we can come back to that after we talk about some of the rotation things.

Let's go in and describe what an average turn looks like. I've pulled some of the age group data, basically what an average age group swimmer is doing on the wall. But the first thing that we should know is we're going to talk about freestyle and backstroke turns. Freestyle and backstroke are the same turn. After they reach the last stroke they're trying to do the same thing on the wall and I'm going to treat them as being the exact same turn. That doesn't mean that the approach or leaving the wall is the same but it does mean that what they're trying to achieve by their push on the wall is the same.

To illustrate this we're going to consistently use an age group swimmer from my team, a thirteen year old named Dwayne Hedges. This is one of Dwayne's backstroke turns. We're going to take Dwayne's freestyle turn, put it right on top and see if there's much difference. So in the dimension that's important, pushing off the wall, this turn is basically the same. There's some minor differences on the other two dimensions, but note the scale, those are really minor pushes. We're talking a thousand on the bottom scale and on the top scale it's a hundred. So those are less than a tenth of the forces that are the focus of the push off here. So what do we have as far as a typical backstroke or freestyle turn? You're going to have a positive push off the wall in the "Z" dimension. But really there's not much happening in the other dimensions. Maybe consider it a one dimensional turn, in and out.

One thing we found is that if there are things happening in those other dimension, it is probably not a good turn. Less in those dimensions is

better. Here is what we can tell from these on this turn: We can tell that Dwayne is circling, he's circling to the right and also he's pushing upward. So he's coming in and pushing up towards the surface. Both of those are wasted motions in these turns.

Breaststroke and butterfly turns. Again, I'm going to argue that these two turns are the same turn per what we're trying to do on the wall. Back to Dwayne, this is Dwayne's butterfly turn. And we'll put another breaststroke turn right on top of it. Now the rotation speed is a little bit different here. You can see that the initial hand touches down here are at slightly different times. But the general, basically what he's trying to do

In a typical turn for breaststroke and butterfly we've identified three phrases. They're pretty common sense but they show up real well on these graphs. The phases are going to be the hand touch — what the swimmer's trying to do while the hand's in contact with the wall. And then we'll go into rotation phase, where the hand actually leaves the wall. Actually, everything leaves the wall, there's no part of the swimmer's body that's in contact with the wall. Then finally, the foot or the leg push phase.

So we've broken the turn down and we're trying to find some information regarding what the most important thing to do in each phase is. And what the time spent in each phase is. Two dimensions appear to be important in this turn. The "X" dimension, right and left, doesn't seem to be extremely important. The force is very small and the only thing we can really tell is which side they're turning to. But the "Y" and the "Z" force are extremely important. The "Z" force is important for getting the push off the wall and increasing the momentum off the wall. The "Y" force or the up and down

push of the athlete does two things, one in the breaststroke and butterfly turn, which was a surprising result and one that I didn't expect, we found that the hands have very little force into the wall. But every athlete that you see will have the greatest force with their hands pushing themselves up or their pushing down on the platform.

We feel that the rotation the hip, getting the legs to the wall and head back rotation about your hips, the short axis of your body is the most important part of these turns. So another little hint here: the largest force exerted by the hands in the breaststroke and butterfly turn is directed down, downward on the wall to gain rotation. You want to achieve the fastest rotation possible. In breaststroke and butterfly it appears that there's more focus on how deep you are coming off the wall.

[Question] In the upper right graph, the first section outlined by the red lines is the hand touch. The person is touching down with the palms of their hands to rotate the hips. The head going down, and the hips coming up. Then it's peaking the other way because when they're pushing off they tend to push down a little bit because they're going to do a pull out or kick sufficiently deep to dolphin kick. Is that part similar for breast and dolphin or is that a lot bigger for breaststroke because you're going to go down and do a pull out?

[Answer] It's actually very similar, very similar. It's a good question, the second part of the why it's important is the depth factor. This person is trying to get down, and we find that butterflyers also try to get down in general. It depends on their foot placement. Sometimes they don't rotate fast enough to get to the wall. They want to go down.

We find the better freestylers and backstrokers tend to go straight off. The average on the elite freestylers that we have for a vertical velocity, up and down is -.001 meters per second, so they're basically pushing straight off.

[Question] Are the elite backstrokers pressing down a lot more when they push off the wall with their legs?

[Answer] Yes.

[Question] With their legs pushing off to kick on their back, do you find the ones going 15 meters underwater pushing off deeper?

[Answer] No, because the depth that they're going isn't much greater than the average backstroker. They're just leveling out and going into their kick.

Now, going back to the hands. The hands' time is actually the largest time factor in the turn for breaststroke and butterfly. So your hands are on the wall longer than you rotate. Your hands are on the wall longer than you push. That leads us to believe it's a very important phase in the stroke. They're there for a reason. Sometimes I still get on my swimmers to get their hands off the wall quickly. After looking at this I don't really encourage that anymore. It's, there's a fine line between being on long

enough to get some good force or some good rotation and to get your hands off the wall and not stay on the wall.

[Question] You're talking about the time of the hands on the wall. Is this a flat wall or gutter?

[Answer] This will happen either place. We have both turns, where we asked all the elites to do a flat wall turn and had to touch a little lower than they're used to but they still had to do the flat wall. With the age groupers, we just let them do what they wanted. And it showed up in both with the gutter and without approaching for a flat wall. Actually it's greater with a flat wall.

The concept is that we're looking to increase the idea of torque. Torque is basically a force applied a certain distance from an axis to gain or to start a rotation. Again, we're talking about rotating around a short axis of the body, the hips here. So I'm trying to get my head down and my feet to the wall as fast as possible. It turns out that we spend a lot of time thinking about what the swimmer is doing with this hand to get the rotation started. It's really the hand on the wall or the touch with the wall that's most important with getting that rotation going. That was evident in how much time people were spending leaving their hands on the wall — how much force they were producing. The idea is the torque or the amount of torque that you produce is dependent on how far away it's applied from the axis that you're rotating on, at a perpendicular distance. The best example that I can think of is a door going into a kitchen or a swinging door. If you're standing in front of that door and you push on the outside edge of that door it's going to slide open after a certain point. If you move your hand in and push right next to the

hinge of the door it's much harder to push in. That's kind of the concept that we're working with here.

Now how does that apply and why are the swimmers pushing up on the wall? I kind of stole these the other day from Maglischo's book. Basically we're looking at two different forces — the forces that we're looking at if you're pushing straight back and try to get a rotation. The swimmers are basically going to rotate very close to their hips, very close to the center of gravity. We're not sure exactly where it is but when they're flat on the water when they initiate the turn if they have force going back this way you can see that the distance away from the rotation point is very small. So you're not going to get very much torque to initiate that spin. But if you're going up you can see how far a distance or how great a distance you have to apply that force. Actually you're going to have greater torque generated by the same force applying it upward at that point. Apply torque around this area to increase rotation then you would have it go straight back. So that's why athletes are pushing up on the wall. And that's something that you should probably be encouraging.

You can see that torque is going to continue to be substantial all the way through, probably past the point where your hips are under, or your feet are under your hips. That's what we still have at this point, the athlete's coming through. But we still have a very long distance of application to increase the torque. So the contact time or a long contact time is probably very important.

We're going to look at Eric Wunderlich's turn. He's a breaststroker for Michigan. He's a very, very fast turner for someone his size. He's the second

fastest turner that we've tested in breaststroke. He's got the fastest rotation time. And he's also got the greatest velocity coming out of the wall. So we're going to look at some video of Eric's turn with a couple of things I want to focus on. We get three turns, one in semi-slow motion, because the equipment I had to make the tape with was a little difficult. The things we want to focus on are: how long are the hands in contact, and where are the feet.

He waits until the hand releases and then he sculls up with the hand that comes through. He does that better than anybody I've seen. And you can see that you're actually getting another torque if you think about pushing the opposite way to get the same rotation principle and to add to that. So he's applying the torque all the way through. In this one you want to watch how long the contact time is. He really doesn't let go until a couple of frames after this point, so his feet are past being under his hips. You can watch the real scull up with his hand below. This is one of the fastest turns that we saw for the elite male breaststrokers. The six elite males that we looked at had an average lifetime best of 1:02.7 so it's a pretty good group.

So looking at Eric's turn you can see some of the principles there. After the first hand releases he is going to give you most of the rotation around but after that point there's a couple of things you can use. You can use the hand like you saw Eric used there to scull upwards. You can also use the head, throwing the head back is going to give some torque around that rotation axis.

The next thing I want to talk about is, if you've heard some of Bill Boomer's work, he really focuses on the other end of fast rotation. I'm talking about the

generating torque aspect of fast rotation. But another way to rotate quickly is to get as small a ball as possible. The longer you are the slower you're going to rotate around that axis. But the tighter you are the faster you're going to rotate. And when he's talking about doing back somersaults in the middle of the pool, he's talking about making it very easy to rotate. So you can just do a scull and get enough torque to come around. Getting people to be as tight as they can possibly be, and Eric, for somebody who's 6'2", 220 pounds is doing a pretty good job of getting tight.

Let's look quickly at some common errors of age group swimmers. The first common error we're going to look at is when an athlete in a freestyle or backstroke turn is too far away from the wall. They miss the turn basically. The result of this is a high peak force. Actually they're going to generate a lot more force, it's going to be for a very short period of time. So they're going to come in and they contact the wall, it will be a very high spike. And I'll show you a graph on that but it's going to be for very short period of time. You can run the video to show an example. That's what it looks like in the pool. This is the turn that he missed. On the turn, he again, has a very high peak force. That was one of our twelve year olds, a very large twelve year old. But his peak force was the second highest peak force we've measured, and that's including the elites. So he really nailed it for an instant, but after that he kind of died out.

This is the second turn that he hit right on. Here we're going to get an idea of why. You can see that it lasted longer and the peak stayed generally higher through out. That first spike he missed out, but he had more force applied over a greater amount of time. And force applied over time is what we call impulse. And so he had a greater impulse. Impulse is more important than peak force or how hard you can push initially. You need to have the contact time on the wall. If you saw the movie Apollo 13 this is a good example of the

concept of impulse and how time is important and very similar to being in the water. You have only the force of the wall applied. They're out trying to get back to earth and they have to get a certain burn time. It's not just how much thrust the rockets can give them, but for how long. Basically, with that if you have a small impulse you're going to have a small velocity out. You're not going to have that wall speed to maintain during your normal turns.

Over rotating, that was the next example you get to see. Here is the first turn of the individual over rotating. That's a very common problem for the swimmers. Going in, they're going to have their feet too high or too low and they're going to have to adjust with their legs. Now that does two things: one it puts them in a difficult push off angle so they'll have problem streamlining, but also with the forces they're actually going to end up taking force away from that momentum giving in and out push and have a less effective push out because they have to adjust on the wall.

We looked a little closer at different approach philosophies or approach ideas in breaststroke and butterfly turns. There are three types of approach strategies you can have. One is the strategy that you want to be on stroke when you hit the wall. That's an on turn. A short turn is where you don't complete the stroke by the time you hit the wall. And the third would be where you glide or take an extra kick before you get to the wall. The thing that we found is that the velocity in tends to be related to the rotation speed. So the faster you're coming in the faster you're going to be able to rotate. And we know one thing, the slower velocity coming in the longer it's going to take you to rotate. So that's probably not a good version to use. But the "on" seems to be very solid. The surprising one is that the "short" seems to be as fast or faster than the "on" turn. The reason for that is probably that they can touch higher. Again, applying that force farther away from the point of rotation.

Here's an example of an age group swimmer doing several turns. You can see a few differences from turn to turn. You can see that there are minor differences throughout. No turn will be the same. But, we could highlight Eric Wunderlich's turns and you can see that Eric does basically exactly the same thing each time he hits the wall. Control is a very important thing. It's a funny thing to me that even though these swimmers were told that they were going to be taped from every angle possible and have all the force platform data and everything, six percent of the breaststroke and butterfly turns were illegal for some type of touch problem. Being able to focus and being ready for your turn, coming into your turn, I think, is a skill.

It is also interesting to note that about thirty percent of the elite breaststroke turns and butterfly turns were illegal or would have been disqualified because they are leaving the wall not on their breast. Many are leaving the wall generally on their back. What it says in the rule book and what happens practice is sometimes a little bit different.

In comparing the elite and age group swimmers, the averages for the hand time and the leg time are very similar. In fact they're within about two hundredths of a second per average. But the rotation time where there's no contact on the wall is much shorter in the elite swimmer — almost twelve hundredths of a second shorter for the elite swimmer. They're maintaining that contact and not having a lot of the dead spin time that some of the age groupers are having. That was a pretty substantial aspect.

To summarize quickly, for freestyle and backstroke turns you want to maximize the impulse into the wall or the push off. Just to increase the momentum and come off as quickly as possible you want to reduce the forces in the other dimensions or the other directions. For breaststroke and butterfly you want to generate as much torque as possible around the short axis of the hips. Use hand contact to start and probably complete about seventy five percent of that rotation with the contact on the wall. And the wall is the place where you can get the most force to help you with those movements. Then after that probably just use a scull and head movements to help you rotate.

That's it from the picture end and a different view of turns.

I had an opportunity to talk to a lot of great coaches and some great athletes. Some of the ideas I borrowed from Mike Doane, Jon Urbanchek, Alex Braunfeld, Jack Bower, Jack Nelson, Skip Runkle, Bill Boomer, and just about anybody who came and visited the training center in the last year. I had that opportunity and each time I talked to them there were some common things that came up when we were talking about turns. One thing they said that was important is that you teach turn skills young. They felt, this is coming from college coaches, it's difficult to change habits from years of sloppy unsupervised practice. Sounds a little lazy but it's probably actually the best thing for the athlete. Consistently make time for turns and focus on turn technique work in each practice. Do turn work early in practice when they're mentally and physically fresh. They said to make turns an important part of your races. Also, take pride in your turning skills and really attack the turns.

[Question] From your data, if you were to start working on breaststroke and butterfly turns with age group swimmers which would you prefer your kids to use, touching flat on the wall or grabbing in the gutter? Which would you prefer or would you let them make a choice?

[Answer] That's difficult. I'm a Senior coach right now so I like to go with flat wall. But I think it's probably easier to apply the force downward on the wall in the gutter. So I would say grab the gutter. You can use that as an advantage. I don't think it's a bad thing to use that. Then as they progress into Senior swimming, try to stay with the flat. You might try and see if somebody's having a problem keeping their hand on the wall. You might have them do a week of flat wall starts. Again they are going to have to automatically get that faster downward push and a greater downward push with a flat wall. Then switch them back and see if that helps get them off the gutter and maybe rotate faster.

[Question] I'm not sure if this a question as much as a comment but when you spoke a minute ago on speed, you said a short stroke approach turn can actually be faster or as fast as an "on" turn — when in doubt take another stroke. I think that's a little bit misleading because if you take a short stroke you have a really good grip on the wall because of that short stroke and a lot of force against the wall. The actual turn maybe faster but I think that it would leave out other factors like the time it took to take another stroke. I think if you watch a high level age group meet, like Zones, Regionals, or Jr. Nationals, and you have a dead even race going on, you see somebody really good in butterfly, really good at streamlining, kicking into the wall when they're long as opposed to the other guy taking another stroke, the person who doesn't take the other stroke, the one that's kicking it in is going to beat him every time.

The same is true in breaststroke. The breaststroker that instead of taking the time to take that other stroke lets his momentum carry him that foot — my experience has been that it's a real mistake to take another stroke for that little bit.

[Answer] There's a couple of things. One thing that I didn't say, a lot of coaches, and it's showing up in some of those profiles, is you want to make sure you touch high, you're always touching high on the wall. So you can again increase that distance that you rotate. That's important, if you're coming short and you touch high I think you're going to get more spin out of it. At least that's what we're seeing. You've got more speed and you are using that momentum coming into the wall to transfer to come back out. I may have seen some of the same things you did but I also think that part of what I've learned from this when I go into coaching is we talk a lot about contingencies because they're not always going to be perfect. What you do in each situation? I think if you take a short stroke and you touch as high as possible on the wall you're going to be better off than going in long. At least that's what I'm seeing here. I know what you're saying and I've seen that but usually the kid's trying to touch a little lower.

[Question] Do you look into head speed as far as initiating rotation and so on?"

[Answer] No, but that is a good point. We didn't digitize the neck as a joint but we could look at that. It would probably be a good thing to look at. I would say from my observations that for butterfly and breaststroke it seems

like the head starts down and comes back and stops in line with the shoulders. It doesn't go as far back, that's what most people are doing, or what I've seen. I don't really have a feel for what they're doing on freestyle.

[Question] For a teaching tool, especially younger ages, how are you getting them to feel the rotation and throwing their head back harder to help them get a start and does that continue on at a Senior level?

[Answer] That's good to point out to them, that you can aid your rotation by throwing it back. Actually even at the elite level you're going to see those guys, they're going to have their head start forward and they're going to move it back quickly and so they're using it at that level too. So I don't necessarily think it's a bad practice at all to keep doing that. Even if you're over exaggerating it, it's still going to be a learned skill where they can get that rotation faster.

[Question] For your timed axis, was that started from the first force against the wall or was it started from some arbitrary point that the person?

[Answer] The force platform is set up that you can trigger it at a threshold level or you can trigger it manually. And we couldn't trigger it at a threshold level because there's a lot of noise with the waves so that's why I had to move the graphs around a little bit. We just had a three second spot when the swimmer got close you hit it to start.

[Question] Okay, so then the time that he pushed into the wall might not be a real accurate measurement.

[Answer] We didn't take it from the start, from zero. But you get the data in like a spread sheet, and you can cut out points where you know they're not on the wall or the turn isn't taking place. We used the cameras and then a real low threshold value or a pattern value looking at the curves. So yea, that's a good question, but we didn't start it from zero.

[Question] Then I just wanted a quick results question, you mentioned that breaststroke and butterfly turns have a different rotation time from age groupers to elite — a different time for their feet to be forced into the wall. Did you find any differences between age group swimmers and elite swimmers on their freestyle and backstroke turn between the time from the wall to their peak impulse into the wall, peak force into the wall?

[Answer] I don't, off the top of my head, you're asking the first contact with the wall to the highest point? I would say it was probably faster just because they didn't go as high as the elites. No, I can't answer that question, we didn't really look at that. I can tell you that the contact time was very similar. The age groupers were slightly less, three hundredths seconds less than the elites.

[Question] This is more of a comment. It seems a real easy and empirical way to solve the question of which is better, being short to the wall or long. Time the swimmer in full speed race pace from the flags to the flags, in and out.

[Answer] Well, in looking at it I'm not sure. You know the person who talks a lot about coming in short, doing all their turns short, is Michigan. Jon Urbanchek is the person who was talking about that the most. He thinks it's faster. And the data had some strong trends but not significant that it was faster to be short. That's kind of where that comment came from.

[Question] That's a pretty high level athlete."

[Answer] That's very true. It's hard to go to the age group level from there. But hopefully, at least looking at it this way you get some different ideas on how you approach your teaching progressions.