

The 5th Stroke--Underwater Kicking

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A Philosophy That Guides My Coaching

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I would like to give you two important components in my philosophy of coaching that have affected my work on Underwater Kicking. Every coach, either consciously or unconsciously, relies on some very basic beliefs that they have developed through their experiences or study that determine much of the actions and teachings in their daily work with swimmers. Two major components of my coaching philosophy include a “commitment to specific techniques” and the importance of “change” to improve performance.

Coaches need to study, rationalize, use and then get committed to specific techniques. There are a lot of different variations to many of the skills in swimming. However, you as the coach need to eventually make a strong commitment to the best of breed “conceptual model” of a specific skill that you want to give to your swimmer. If you do not make this commitment, then you put your swimmer in quandary about how they are to think about a skill or how to pattern or execute the skill. This is a tremendous disadvantage to your swimmer and can lead to great frustration on their part. So many times I have heard swimmers say, “I do not understand what I am supposed to be doing or why I am doing this skill like this!” Commit to a conceptual model and then COACH IT!

When you commit to a conceptual model, you are not committing for the rest of your life? Often what we thought was really great and true in the past, is quite different from what we now believe in and practice with our swimmers. It is OK to change, modify, and question! You can even have different conceptual models of the same skill for different swimmers. Or if you have a swimmer who can handle it, you may have different conceptual models of the same skill for different situations and applications. Just remember, it is important to make the commitment to very specific conceptual models in skill development. Right for now, but wrong in future is much better than being vague and avoiding making the commitment to specific techniques.

Another important philosophic component is a passion for change. Not any change, just for the sake of change; but continually striving for the better. One of the worst situations that some coaches develop is a compliancy in what they are doing, by doing the same thing day after day, week after week, month after month, and even year after year. Some coaches and swimmers fear change, when they should be embracing it! If you remain the same, you will continue to perform at approximately the same level. This is why most swimmers improve very little after they reach

their adult height and weight/strength ratio. They keep swimming with the same tempo patterns (seconds per cycle) and distance per cycle (cycle counts), and as a result they swim the same times. If they do not change one of these variables, then they will never have significant improvements! Change is exactly the key necessary for coaches to get swimmers to swim faster—YOU MUST CHANGE!

Underwater Kicking—A Short History

Although I have been given some of the credit for taking underwater kicking to new heights in recent times, I certainly was not the first to explore the speed of underwater kicking and its tremendous influence upon swimming performances. Most of us will assign the real pioneer work of underwater kicking in the recent, modern period to the great backstroker, David Berkoff. In 1988, he broke the world backstroke record using approximately 35 meters (30-31 kicks) of underwater dolphin kicking on the start, and about 15 meters of kicking on the turn. He and his coach at Harvard, Joe Bernel, should be credited with this application and the success that it generated. The performances led the traditionalist of the sport to enact legislation for the 15 meter rule. This 15 meter rule ended the long extended breakouts that were spurring on the continuous assaults on the record books.

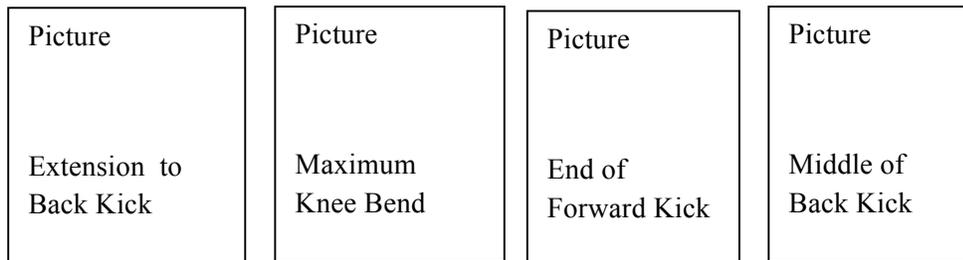
Many of us now have wondered why we did not immediately apply the lessons of underwater kicking on backstroke to butterfly. Maybe we thought that butterfly was so much faster than backstroke at that time, that we felt it would not be successful. For whatever the reason, the norm remained on butterfly to dive the start or push a turn and take two dolphin kicks into the full stroke.

It was quite by accident that we found the beginning of a “new technique” while I was working with one of my very young butterflyers, Misty Hyman in March, 1994. Misty was very bad at the speed of her starts throughout her age group career. She had finally gotten to the beginning level of Jr. National swimming by barely making the cut times in 100 and 200 yard butterfly events. Shortly before the 1994 SC Jr. Nationals in Long Beach, CA, I arranged a dive practice session with her, with the objective of doing something about her really difficult time with the starts. I timed her for a 25 yard dive sprint fly at 12.4—which even during those days was going to put her way behind on the start. We talked about trying to “exaggerate” the streamline. As usual Misty was 110% into whatever you asked! She exaggerated the streamline, and in the process extended the breakout with extra kicks as she strived for a better streamline position. I told her, “You will have to go back and do it again, I missed timed it: 11.8.” She got back up and did it again: 11.7. Now we got excited and really went at it! I said, “Add a couple of kicks and let’s

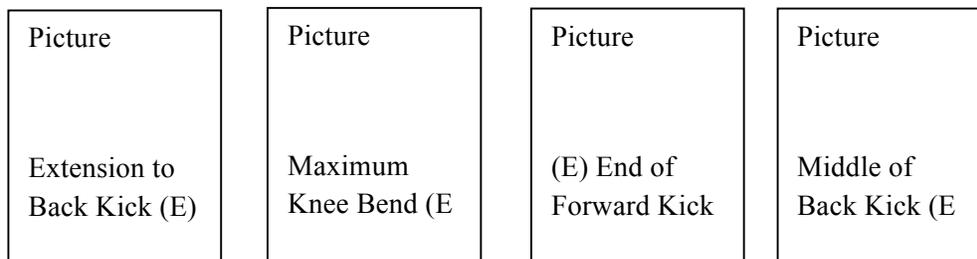
see what it is.” When 11.5 came up on the stopwatch, we were off on the beginning of a very exciting adventure in Underwater Kicking!

The “Foil” Movement

The “foil” movement is the term we use for this undulating, fish/dolphin type movement that results in forward motion in the water. As the legs move back, the knee joint is kept in a fully extended position until the desired maximum range of motion in the backwards direction is reached. At this point of full backward extension, the knees push forward and flex to an angle range of 110 to 90 degrees of bend. At this time the feet are accelerated forward resulting in an arc as the knee joints between the upper and lower legs are extended to complete forward extension. I put special emphasis upon a very extreme and precise extension on the knees and feet at the ends of each kick’s directional move. I do not want the kick to stop at the body mid-line or even within the body profile.



The above pictures are of Cindy Tran (52.55 100 back) during a training session at the OTC. Her tempo in this series of pictures was at her race pace of .45 seconds per kick.



The above pictures are Cindy Tran, working on distance per kick with a very slow, and exaggerated magnitude of movements.

Dolphin Kick, Fish Kick and Slant Kick

I had been working with Misty Hyman on extended breakouts since March, 1994. In March, 1995, while walking in the airport before Nationals in Minnesota, Coach Don Watkins stopped me and gave me a magazine and said, “. . . you take this because it seems to be related to your work on underwater kicking.” It was Scientific American, March 1995, which had a cover article, “An Efficient Swimming Machine” by two fluid dynamics scientist, Michael and George Triantafylou. Their study was primarily about how fish use the flaps of their tails to produce counter rotating vortices that interact to provide thrust for forward movement. In “coaching terms” for our use, the kick in one direction sets up a rotating vortices, followed by another kick in the other direction that sets up a counter rotating vortices. The interaction between these vortices is what determines the efficiency of the kicking. After reading the article, I was not sure how it might help with getting improvement out of my swimmers. I did keep going back to it, trying to grasp an understanding of the Strouhal numbers, which has to do with frequency (tempo) and spacing of the counter rotating vortices, angle of attack of the kick, and the idea of smaller rotating vortices on the back kick and larger ones on front kick.

The article had pictures of the vortices, by using dye in the water. In November, 1995, I decided that I wanted to see the vortices of a swimmer. I took Misty and taped a plastic tube down the side of her body, while she held the end in her hand. She lay on the deck and I filled the tube with dark blue cake coloring from a quart bottle. I told her to go under water, push off and turn on her side, where I could see the dye as she kicked. I was astonished to see that the arc of the vortices was huge, with a diameter of about 10 feet! That is when I rationalized that if we were kicking in the vertical plane (dolphin kick) in pools with only 4 to 7 feet of depth, then we were destroying the vortices as they hit the top of the water and bottom of the pool. To keep the advantage of the vortices’ counter rotating interaction, we would need to turn on our side and use the water of the next lanes. This is why we named this position as fish kicking; mammals kick in the vertical plane and fish kick in the horizontal plane. I videotaped our work and sent it to the authors. I asked them to take a look at it and see if I was making the correct interpretations. Dr. Triantafylou wrote back that he thought I was making the correct interpretation; and that he was amazed at Misty because he, “. . . did not know that humans could do that!” Of course I enjoyed that comment!!

There was one other thought that came from the article that caught my attention. The scientists presented the idea that fish can capture energy from encountered vortices. Again after a couple of months I begin to think about the idea that it may not be so bad if vortices were created by the hands undulating over head due to an increase magnitude of upper body movement. As the

vortices slide down the body into the kicking zone, could energy be captured with the foil movement of the legs to increase the distance per kick? We were thinking about letting the upper body go with more press of hands to transfer energy down the body into the kicking motion; using the core body strength to a greater extent. This was avoided in the beginning in the name of streamlining! However, we wanted more distance per kick and maybe the increased power of a more dynamic upper body press, coupled with captured energy from the resulting vortices was worth considering. This is an interest note: many years later, while attending a National Coaches Clinic at the Olympic Training Center in Colorado, we had a presentation by a couple of scientists brought in to present their works on the computational fluid dynamics of swimming. I ate lunch with one of the scientist, and found that he had studied under Dr. Triantafyllou. I asked him if my interpretation could be correct; that there was a high probability of capturing energy from the vortices created by the hands and upper body movements could be correct. He said he thought it was entirely possible but did not know.

So, I think underwater fish kicking, WITH THE DEPTH OF WATER THAT WE ENCOUNTER IN COMPETITIVE SWIMMING, is more efficient than dolphin kick. There is another degree of this skill that we call “slant kicking”, which is just in between the total vertical of dolphin and the horizontal of fish kicking, say 45 degrees. Slant kick takes on some of the advantages of keeping the vortices of the kick from slamming into the bottom of the pool and beginning destroyed by the surface of the pool.

Most swimmers feel uncomfortable when they first start doing the totally horizontal kicking of fish kick. They often say, “It seems harder to do and it makes me tired.” Unfortunately, all but the most conscientious and disciplined swimmers will give up on the mastery of the skills involved before they become comfortable and proficient at the skills. But, then that is why we have Champions! I think this uncomfortable feeling is primarily due to a change in the pressure in the thoracic cavity. The pressure is a sideward push, rather than a front-back push. As with many skills, it will feel perfectly normal after the skills are mastered. As I like to say, “. . . you won’t have any problems with this, after a few 1000 repeats on it!” One time a newspaper reporter asked Misty, “Why do you kick on your side?” Her answer was great, “Because it is faster!”

Distance per Kick, Tempo and Interaction of Fish Kicking

Traditionally, most coaches have followed the belief that dolphin/fish kick movements should stay within the body profile for a more streamlined result. Traditionally, the upper body has been kept very straight and in alignment with the thought of reducing resistance. With this technique, the body is limited in movement and the kick is done with a smaller range of motion and high tempo.

I am presenting you with a much different technique approach of a more dynamic body movement as well as a increased magnitude of leg movement. When Misty Hyman and I really started to explore the dynamics of the fish kick in late 1995 and early 1996 before the Olympic Trials, we were faced with the quandary of, “Do we emphasis streamlining and smaller kicks with fast tempo, or bigger kicks with a slower tempo?” We committed to the traditional streamlining, smaller kicks and fast tempo! The Olympic Trials were in March and of course we wanted to have our new application of fish kicking ready to go. In January, 1996, we went with the fish kick for the first time in competition in a Grand Prix meet in Seattle. We had to make sure it would be judged legal and not get disqualified. Misty did a great job in winning the 100 Meter Butterfly against a great field. We stayed with the commitment to execute with the straight, stretched, streamlined body position, and reduced range of motion, fast kick on all the breakouts. As a young 16 year old, Misty barely missed making the USA Olympic Team by placing third.

After the Olympic Trials we decided, as always, to make an effort at some changes and think outside the box. We decided to challenge the traditional belief that we had to stay in such a tight streamline and keep the kicking motion inside the body alignment. Misty had been taking about 27 kicks on the start of the 100 Meter Butterfly. Our objective was to reduce the number of kicks and give up as little as possible on the tempo. For part of March, April, and May, we focused our underwater kicking on bigger ranges of motion, and increasing the magnitude of the kick—more range to the front and back of the movement pattern and more knee bend. We let the upper body go and allow for a much larger range of motion of the extend arms. Misty was able to increase her distance down the pool, with about a 2 kick reduction at the same tempo. We got really excited about such an improvement. By May, 1996, Misty was much faster on that first 50 out split. The change to the bigger range of motion was a huge boost to her career. Change is good!

Why Underwater Kick is Faster

Most of us associated with top level swimming know that extended breakouts on starts and turns are faster for most swimmers than doing a short breakout and just start swimming. Many swimmers and coaches do not understand the “why” of the causal effect of the technique. I think that once swimmers and coaches understand exactly what they are working on and have quantified it, the practice for perfect execution will be much more precise. This will result in faster improvement and higher levels of achievement.

YOU HAVE TO UNDERSTAND THIS!! The reason races are faster with extended breakouts on starts and turns is due to reduced cycle counts and the interaction with tempo. For example, in the past we would dive in and do two dolphin kicks and then start our stroking. For example, a swimmer would do two kicks, and take 10 cycles at 1:10 tempo. We determined that if we could complete two kicks in about .90 seconds (.45 kick tempo); and if we could go just as far with those two kicks as we do with one cycle; then we would be ahead in the swim by about .2 of a second. If we did it again we would be another .2 ahead; and again, and again . . .!!!! In this example if we replace three cycles at 1.10 with 6 additional underwater kicks at .45, then we would be .6 second faster and take 7 cycles. Do this on four lengths and we have a 2.4 second drop in time. This is WHY IT WORKS!!!!

The best is yet to come! I believe that after the swimmers gets to the very advanced stages of these skills that they can actually develop distance per kick that will allow them a little more distance with two kicks that with one stroke. As this is applied over many kicks, enough distance will be gained that allows for one less cycle, with only one additional kick. Now we are in for some excitement! In our example, if the swimmer can take one additional kick at .45 and can reduce the cycle count by one more cycle then they will save an additional .55 seconds. So now we have $.2 + .2 + .2 + .55 = 1.15$ seconds on each length!

This magnitude is increased even more in backstroke! The reason is that backstroke tempo is generally slower than butterfly. For example, if a swimmer is swimming at a 1.30 tempo and is able to replace 3 cycles with 6 dolphin/fish kicks at .45 each, then the results are a time savings of $.4 + .4 + .4 = 1.2$ seconds on each length. If the swimmer gets to the level of mastery that result in one more cycle reduction with only one additional kick, now we are looking at an additional .85 seconds for a whopping 2.05 seconds. This is the reason for the historical change between backstroke and butterfly times; for example, the greater improvement in backstroke compared to butterfly in NCAA short course swimming.

Many swimmers can increase their performance levels in freestyle events by using underwater kicking in extended breakouts on starts and turns. If for example, a swimmer is swimming an intermediate split of 28.0, with three dolphin kicks on the turn breakout, a better performance could result if the swimmer extend the number of kicks to five fish/dolphin kicks and replace one

cycle. If it resulted in a trade off of .90 for the addition 2 kicks and 1.40 for 1 cycle, the result would be an improvement of .5 per length. If the series of five kicks on the turn breakouts on this swimmer could be maximized, then it could even be possible to subtract out 2 cycles per length. How fast could our top males be going in the 500 yard freestyle by using a 5 or even 7 kick breakouts on each length? Even without a perfect correlation of efficiency, we could have a sub-4:00 performances from more than one of our current great freestylers by using more kicks on extended breakouts. I hope this discussion will help motivate and challenge some more top swimmers to maximize this skill.

Odd Number of Kicks on Breakouts

In a previous section I discussed the concept of reducing cycle counts, by substituting 2 dolphin/fish kicks for each cycle. In relation to this, I have presented the technique of adding only one more kick to a series in order to take off an addition cycle, a trade off of 1 for 1. This is accomplished by getting very good at the foil movement; meaning developing more distance per kick. The pattern of movement, magnitude of the knee bend and the increased utilization of the core body strength with the magnitude of body undulation are very important to this goal.

With underwater kicking we are faced with the same problem of balancing distance per cycle and tempo, as with the full stroke. The INTERACTION between distance per cycle and tempo is what I humorously reference to as: THE ESSENCES OF LIFE! IT IS THE ESSENCES OF SWIMMING!! If you put total focus on distance per cycle, doing a slow but very precise movement patterns, most swimmers can really generate long strokes, resulting in very low cycle counts. However, the velocities of swimming will remain low. If you put total focus on tempo, moving your arms as fast as you can, you will have very high tempo but your distance per cycle will be short, resulting in a high cycle count. THE ESSENCES OF SWIMMING is to adjust each of these two variables and achieve the balance that will result in the highest velocities and get your best performance. It is exactly the same for underwater kicking, you must maximize your distance per kick and your ability to generate tempo, but within the context of INTERACTION!

Referring to the concept of adding one dolphin/fish kick to the breakouts, with the goal of getting a 1 more cycle off with only one more kick—rather than two more kicks. I have always felt like the pursuit of this goal would have a higher probability if my swimmers always used an odd number of kicks in the breakouts. Therefore, I have the progression of 3-5-7-9-11 or 13 kicks in

my program. Using this approach it is hoped that it will speed up the developmental process. So, in my program, little swimmers to elite swimmers are instructed to use an odd number of kicks for breakouts.

The Plus Two Rule

Another important workout procedure is what I call the PLUS TWO RULE. In 1994-96 in my early work with Misty, we realized we had a huge problem with deceleration at the end of long extended breakouts. After working hard on this, I realized that if we would practice with 2 additional kicks on the breakouts to what we were planning for in meets, it had a great positive effect to minimize this deceleration. So we now ask all of our swimmers to do much of their practice using 2 additional kicks to their planned number in competition. For example, if a swimmer is planning to do 7 kicks on their turns in meets, then they need to do 9 kicks in most of their practice sets.

The Depth of Underwater Kicking on Breakouts

I am of the opinion that it is better to be too deep, rather than too shallow on underwater kickouts; especially when dolphin kick is beginning used, instead of fish kick or slant kick. On dolphin kick, the reason is that the vortices of the kicks are disrupted significantly when up directional vortices crash into the top of the water (you can easily see this trailing a shallow kickout by a swimmer) and down (forward kicking) vortices compress against the bottom of the pool. The interactions of the next kicks will not be as effective. If you are swimming in a seven foot deep pool, and you set up the majority of the kicks at three and a half feet, on dolphin kick you will have about 24 inches between the end of your kick and the top of the water or bottom of the pool! This situation can be reduced with slant or fish kick.

Breakout Trajectory Of Extended Underwater Breakouts

Breakout trajectory of extended underwater breakouts is very important. How many times have you seen developing swimmers try to keep kicking too shallow on a breakout and have their feet start breaking the water too soon? Their velocity just falls off the cliff! I try to get the swimmer to stay away from the surface of the water for as many kicks as possible, and then do a slightly sharper angle up into the “surge stroke” of the breakout. For example, on a nine kick fish kick breakout on butterfly, I would have the swimmer on the side for eight kick, and then make the

transition to the front on the one last kick before the surge stroke. They would ascend during the last three kicks. On backstroke, I would have the swimmer do ALL nine kicks on the side and then initiate the bottom arm breakout with flutter kick—ascending the last three cycles.

Counting Kicks

It is absolutely essential that swimmers count their kicks on extended breakouts. It is the only way to get totally consistent with high level performances that challenge the fifteen meter mark, which is presently the limiting rule for underwater kicking distance. A few years ago, I was associated with a coach who had a swimmer in our program that was swimming very fast on backstroke. I ask the coach how many kicks his swimmer was doing on the start and the coach replied, “. . . I don't know, he doesn't count but he has perfect feel on this and does a great job every time.” You guessed it; in the preliminary of the 200 backstroke at Jr. Nationals, he was at least 4 yards past the mark on the start and was disqualified! Later in the meet, he went 47.63, in the 100 Yard Backstroke. He left a great 200 Yard Backstroke time on the table for that season!

For top level swimmers at this time the variance is not much, but it can make a big difference **BECAUSE EVERY HUNDREDTH OF A SECOND COUNTS IN THIS SPORT!** Also, this will change over time, but most top swimmers are now taking between 9 and 11 kicks to cover the 15 meter breakout distance, with a kick tempo of approximately .40-.50. This is meant to give you some starting points for your evaluations and work on underwater kicking.

I have my age group coaches run a progression of kickouts for our age group program. We start with 5 for drop pushes and 3 for turns with the little swimmers. The intermediate competitive swimmers are coached to go 7 on drop pushes and 5 on turns; and the advanced age groupers are coached to go 9 from drop pushes and 7 on turns. A popular combination for Jr. Elite Swimmers is 11 and 9. For the Jr. Elite Swimmer (18 and under, Jr. National and above swimmer), I would like to see the 15 meter mark challenged on starts with 9 and challenged with 11 on ALL turns (this has not happened for me yet, but it will happen in the future!).

Best of Breed: Fish Kick, Slant Kick or Dolphin Kick or ???

You should now know the “why” of my order of preference on the type of underwater kicking. I believe the order of maximum potential is fish kick, slant kick, and then dolphin kick. I know that some associated with swimming have stated that there is no or little advantage in doing fish kick as compared to dolphin kick. I have no research to defend my position, which is where the

PRACTICING swimming coaches often find themselves on such issues. However, with my work with several top swimmers over the past 15 years on these skills, I have developed enough “practical experience and coach’s feel” that I believe I have a good grasp in the evaluation of the different kicks. I believe that I have a reasonable probability of not being wrong; but if I am, the negative consequences of being wrong are few to none!

I feel the efficiency differential between fish kick and dolphin kick in the competitive situation can be expressed in the following: approximately the distance achieved on 9 or 11 fish kicks at .45 tempo, will be the same as for 10 or 12 dolphin kicks at .45 tempo. Most individuals would say the difference between 11 and 12 is not very much! However, at .45 seconds per kick it is very significant number! I believe the quantified difference is one kick!

All this being said I want you to know that the TYPE of kick is not really the most important variable in underwater kicking EFFECTIVENESS. THE MOST IMPORTANT VARIABLE IS THE NUMBER OF KICKS. I am amazed at how few of swimmers are actually challenging the 15 meter mark on starts and turns in today swimming world. I am aware that all swimmers cannot be successful with this skill. However, a large number of swimmers would be much better than they now are, if they would focus and develop and use better underwater kick techniques.

Measuring Kick Tempo

Measuring kick tempo on underwater kicking is very simple. Start the stopwatch at the end of a forward kick and count the kick, zero, one, two . . . I then split after 3 or 5 or 10 kicks. The more kicks you use in the calculation, the more valid the measurement will be. For examples, 5 kicks at 2.25 would be .45 tempo; 10 kicks at 4.50 would be .45 tempo; 3 kicks at 1.35 would be .45 tempo. After you do it a few 1000 times, you just know at a glance—works for coaches too;)

Workout Sets and Tips to Make You Better

I would like to share some methods of coaching that I have used over the years to get swimmers to have a great start at underwater kicking. Start with very short distances with fins, 10-15 meters. Practice fish kick, slant kick and dolphin kick. Ask the swimmers to count their kicks. Immediately introduce the two concepts of “distance per kick” and “tempo” into the kicking. It is important to do both—I like to alternate doing three on DPK and then three repeats on Tempo. Insist on very precise movements on the DPK repeats. Emphasis kicking with maximum speed of movement on the tempo repeats. If you wish to skew the number of repeats, the general procedure should be to emphasis precise, big range of motion, and big magnitude of movement. Do lots of kick counting—“the fewer the better!”

Use flex-lane bulkheads to set up 15 meter lanes. Do massive numbers of quick repeats. For example: 6(10 x 15 meters @ :20) :20 rest between sub-sets. If you have a movable bulkhead, set the bulkhead at 15 meter for an underwater day—fish, slant, dolphin, fins, no fins, DPK, tempo, underwater races, games of elimination by heats, relays, times, records, etc.

With all age groups, I like to dive a lot of repeats with fish kicks, based on distance in relation to number of kicks. An example for Jr. Elite girls could be: “Dive, do 11 kicks and try to hit the 15 meter mark right on the button—10 kicks on your side and then 1 kick in transition; then take 5 cycles on butterfly to the 25 yard wall. Then swim back easy in the next lane.” I refer to this set as Fish/Flops. 10 x 50 @ 1:00 Fish/Flops. Some days it will be on DPK. Some days it will be to focus on Tempo. Some days it will be 3 on DPK, alternated with 3 on Tempo. Often we will use 13 kicks (the Plus Two Rule) going past the 15 meter mark and take 3-4 cycles. Many, many different combinations of fish/flops will improve underwater kicking!

Mono fins are a great tool for developing the correct foil movement involved in fish/slant/dolphin kick. First, I think development works best with a mono fin, rather than with just using two individual foot fins! It has to do with a movement educational type principle—keep the feet together while on the side, readying for the drop push, maneuvering to get out of the way of another swimmer, and the like. Become at one with the fin:) The mono fin should first be selected for teaching the foil movement and training second. It should not be a fin with the characteristic that are associated with performance fins. The mono fin should be of the proper size for swimmer to handle. It should be made of safe material! It should be the right shape and have the right flexibility. I believe that small (cut off) fins are not good for young developing swimmers. They do not promote that fin like range of motion and emphasis at the end of each foil movement. The scientists in fish hydrodynamics say that the end, or flip, at the end of foil movement is extremely important; and hard, short, inflexible fins do not develop this skill as well as flexible, longer, and pliable fins.

Summary

- Your Coaching Philosophy is important.
- Acquire and Commit to a Conceptual Model of stroke and skill movements.
- Have a Passion for Change in your coaching.
- Always Question and Evaluated.
- The effective Foil Movement in underwater kicking is a result of a coordinated movement pattern of ankle and knee extensions and flexions, and not just an undulating movement of the body. The end of the forward kick is a very important focus point. Range of motion (magnitude of kick) is important. Magnitude of knee flexion is in the approximate range of 110 to 90 degrees.
- Upper body movement is important in the transfer of energy, developed by the core body strength, into the power of the leg kick. More distance per kick can be generated by significant movements in the upper body and pressing of the hands.
- Underwater kicking can be divided into three or more plane positions: dolphin kick (vertical), fish kick (horizontal), and slant kick (an angled body position).
- The effectiveness of underwater kicking with these three kicks has a multivariate dependency. Some of the variables presented were: distance of the kicks from the bottom of the pool, distance of the kicks from the top of the water, frequency of kicks, magnitude of kicks, range of motion of the upper body movements, replaced cycles tempo, and the swimmer's experience, conditioning level, and tenacity.
- The number of kicks used in underwater kicking on the starts and turns is more important than the plane of kicking.
- With many swimmers underwater kicking is faster than swimming, because of the reduction in cycle counts, by replacing cycles with kicks. A simple reminder is: if you replace one cycle at 1.10, with two kicks at .45, then a .2 seconds improvement will occur.
- The ESSENCE OF SWIMMING: CYCLE, TEMPO, INTERACTION is the same for extended underwater kicking as it is for swimming on top of the water!
- Use odd numbers of kicks on breakouts to develop a higher probability of a one cycle reduction for an additional one kick in extended breakouts.
- Plus Two Rule: use two additional kicks on extended breakouts in workouts. This will help you minimize velocity reduction, a major problem, at the end of the extended breakouts.
- It is better to be a little too deep than too shallow on extended breakouts. This is due to the interaction of the water surface and pool bottom with the foil movement vortices.
- Approaching the surface too soon in an extended kick out will drastically reduce the effectiveness of distance per kick. On butterfly, using fish or slant kick, stay on your side for all kick, before using the last one kick to transition to the front for the surge stroke.

On backstroke and freestyle, do all fish/slant kicks on the side and then execute the breakout with the bottom arm using flutter kick.

- Always count your kicks on extended breakouts. It will help you attack the breakout without reservations of being disqualified for going passed the 15 meter mark. It will also help you maximize the number of kicks by not starting the breakout of the arms too soon. Kick counting allows for total consistence in performance—takes the guess work out of it!
- Best of Breed: the effectiveness of the fish kick in relation to dolphin kick is theoretically superior. With the years of empirical evaluation and performance observation, I think that the increased effectiveness in the competitive environment has the magnitude of 9:10 to 11:13. Is this really worth the effort? If .45 second on each length of the pool is important to you, YES!
- For a quick start in underwater kick: use it from the beginning with all age groups; fins are good—mono fins are better; balance practice between DPK, tempo and interaction with a skew to DPK; teach fish, slant and dolphin kick from the start; kick count over short distances; and do a lot of FISH/FLOP sets.