Is it Time to Consider a Different Way of Swimming Backstroke?

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Abstract. For several years many of the world’s best backstroke swimmers, both male and female, have been performing this stroke in a unique style which may be superior to the traditional way that backstroke has been taught. This paper will describe the various ways this unique style of backstroke is being swum and its possible benefits.

Introduction.

The backstroke arm stroke has traditionally been taught with two propulsive phases, a pull and a push, or, as I prefer to call them, an upsweep and downsweep. The graph in figure 1 demonstrates the location of those propulsive phases during the underwater arm stroke as well as the transition periods between them. The graph is for Kristina Egerszegi, former World Record Holder and Olympic Champion in the backstroke events. It was constructed from data collected in competition at the 1991 World Swimming Championships where she won gold medals in both backstroke races.

Figure 1. A forward velocity graph for Kristina Egerszegi, multiple Olympic Gold Medalist and former World Record Holder in the 100 m and 200 m backstrokes. This graph was drawn from data collected at the 1991 World Championships. It shows her velocity during the left underwater arm stroke. It also identifies the location of two propulsive phases, the pull and push. Modified from: J. Cappaert and B.S. Rushall. (1994). Biomechanical Analyses of Champion Swimmers. San Diego: Sports Science Associates. P. 2.3
The forward velocity of her center of mass was calculated and plotted for her left arm stroke. The first propulsive phase, the pull, occurs as she flexes her arm and brings her arm up toward her body during the middle of her underwater arm stroke, and the second, the push, takes place as she extends her arm back, down and in toward her thigh.

Let describe the velocity pattern produced by her arm stroke in greater detail. The graph begins when her left arm enters the water. At that time, she has just completed the underwater arm stroke with her right arm. Consequently, the velocity peak observed at the time her left arm enters the water is the result of propulsion from her right arm stroke. Her forward velocity decelerates after her right arm releases the water and it will continue to decelerate until she reaches the catch position with her left arm. That occurs at about 0.2 secs. on the graph.

The catch marks the beginning of the two propulsive sweeps that take place during her underwater arm stroke. In the first of these, she sweeps her arm up and back. This phase of the arm stroke is referred to by most as the “pull”, although, as mentioned, I prefer to call it the upsweep.

After a slight transition period between 0.5 and 0.6 secs. on the graph during which she decelerates, she executes the second propulsive sweep by extending her arm back and down. Photos of her upsweep and downsweep are shown in figure 2.

\[ \text{Figure 2. Kristina Egerszegi's left arm stroke. The photo on the left shows her left arm when it is midway through the pull or upsweep, and the photo on the right shows her left arm starting the push or downsweep.} \]

In the next section, I will describe how many elite backstrokes are using three propulsive sweeps, rather than two, during their underwater arm strokes. The third propulsive sweep actually takes place after the downsweep, during a stroke phase that has generally been considered the beginning of a backstroker’s arm recovery.
The three-peak backstroke

A center of mass velocity graph for a three-peak backstroke is shown in figure 3. The swimmer is Martin Zubero, former World Record Holder and 1992 Olympic Gold Medalist in the 200 m backstroke. The graph begins when his right arm enters the water. His velocity at that point comes from the final propulsive phase of his left arm stroke. When his left arm releases the water, his velocity drops to approximately 1 m/sec during the following 0.17 secs. as he positions his right arm for its catch at point #1. Point #2 indicates his peak forward velocity during the first propulsive sweep of his right hand, the upsweep. From there he transitions into the next propulsive sweep, a downsweep, at point #3. His peak velocity during the downsweep, occurs at point #4, when he extends his arm down and back. The downsweep is followed by another transition at point #5, after which a third, and final, propulsive sweep takes place, at point #6. I have termed this final propulsive phase of the backstroke arm stroke a “final upsweep” although some also refer to it as an inward scull. The graph ends when his right hand leaves the water. His forward velocity decelerates at this time because he is recovering his arm.

The photos in figure 4 demonstrate how Zubero performs the final upsweep with his right arm. The yellow arrows extend to the point on his forward velocity graph represented by each photograph.

He has completed the downsweep in the photo on the left and is about to begin the final upsweep. Notice, in the middle photo, that he changed the direction his palm was facing from down to back so he could immediately begin pushing up and back.
against the resistance of water with his extended arm and hand, as he is shown doing in the middle photo. The final upsweep ends as his hand approaches his thigh, at which time, he releases pressure on the water, turns his palm in toward his thigh and recovers his hand and arm out of the water (see photo on extreme right of figure 4).

Figure 4. Martin Zubero’s final upsweep with his right arm.

I first learned that some backstroke swimmers were using a final upsweep for propulsion when a group I was working with, filmed and analyzed the stroke of Jesse Vassallo, a member of the 1984 U.S. Olympic swim team in the 200 m backstroke. I was surprised to see that he swam with his arm extended for most of his underwater arm stroke. Initially, I thought this was a huge stroke error and marveled that he was able to qualify for the Olympic team in spite of it. That all changed when we developed a propulsion graph for him. That graph is shown in figure 5. The unit of measurement is propulsive force, not forward velocity, because that was the way we were measuring propulsion at that time. You can assume, however, that increases of propulsive force also indicate greater forward velocity.

The graph begins at point #1 where his right hand enters the water. He makes his catch at point #2. Notice that his propulsive force was negative between the time his hand entered the water and it reached the catch position. The negative propulsive force indicated that he was actually losing speed during the interval between the time he initiated the recovery with his left arm and made the catch with
his right arm. The catch with his right hand occurred after it had traveled down and out for a short period of time and was in position to accelerate his body forward.

His upsweep was very short and quick with very little upward motion (see the area between points #2 and #3 on his stroke pattern and propulsive force graph in figure 5). Nevertheless he was still able to increase propulsive force, and presumably forward velocity, with it. His downsweep, between points #3 and #4 on the graph in figure 5, was also very short because his arm was almost extended when it began and was completely extended shortly thereafter. As I mentioned earlier, from the surface he appeared to be stroking with a straight arm at all times, although videos showed a slight flexion and extension of his arm during the upsweep and downsweep respectively. He exerted less propulsive force during the downsweep than he had during the previous upsweep, therefore, his forward velocity probably decreased during that portion of his underwater arm stroke.

While completing the downsweep he positioned his extended arm so it faced back, similar to Zubero’s right arm, in photo #1 of figure 4. From there, he executed a long and very powerful final upsweep, pushing back, up and in against the water with the underside of his upper arm, forearm and the palm of his hand. That phase of his right arm stroke is designated by the dark blue area on his propulsive force graph and you can see that it is by far the longest and most propulsive phase of that

![Propulsive force graph for Jesse Vassallo, 1984 U.S. Olympian in the 200 m backstroke.](image)
arm stroke. So, although Vassallo executed only two sweeps that were propulsive, his arm stroke consisted of three sweeps, one of which, the downsweep, presumably resulted in a loss of forward velocity. The second propulsive sweep, and his third sweep overall, was achieved with a long, upward movement of his extended arm that was done similar to the way in which Zubero executed his final upsweep (see figure 4). Vassallo’s propulsive force graph indicated, to me, that backstroke swimmers should be capable of achieving three propulsive peaks during an underwater arm stroke; a notion, that was later confirmed by center of mass forward velocity analyses of Martin Zubero and Jeff Rouse (Cappaert & Rushall, 1994).

I included the graph in figure 5, as evidence that the final upsweep can be very propulsive. This may be because swimmers are able to make a large paddle with their hand and arm to push back against the water. It may also be that they are able to generate greater velocity with their hand, and thus, greater power, when their arm is extended instead of flexed. This is very likely because the hand would be further from the shoulder, which is the center of rotation for the arm.

Let me describe some other aspects of the three-peak backstroke that differ from the traditional two-peak stroke. This will be done using side and front views of Martin Zubero’s stroke pattern illustrated in figure 6.

The first item I want to discuss is the depth of the swimmer’s arm when he makes the catch. Not so very long ago, conventional wisdom was that backstrokers should sweep their hand down fairly deep in the water before making the catch. Swimmers were generally taught to turn their palms down toward the bottom of the pool during this motion (see photo on the left in figure 7). This type of catch was in vogue when we thought sculling was the preferred method of propulsion. The belief was,(1) that a deep catch would allow for a longer and more propulsive upsweep and, (2) that it encouraged backstrokers to roll from side to side and thus, travel through the water with less drag. Neither of these observations have proved to be
accurate over time. Most modern-day backstrokers, and in particular three-peak backstroke swimmers, are now making their catch much nearer the surface of the water, and they are rolling from side to side much less, only 20 to 30 degrees to each side (Mark, 2013). As a consequence, they are “catching” earlier and can start pushing back against the resistance of the water very quickly after their hand enters the water (see points #1 and #2 on the side and front view stroke patterns in figure 6).

The photographs in figure 7 show the difference between the “deep” catch and the modern-day “shallow” catch. The first two photos illustrate the difference in depth between the deep and shallow catches. The swimmer in the photo on the left is using a deep catch and the swimmer in the middle photo is catching much earlier with his hand and arm closer to the surface, and out to the side more. The final photograph on the right shows an excellent top view of Missy Franklin, 2012 World Record Holder and Olympic Champion in both the 100 m and 200 m backstrokes, just after making her catch. Notice that her arm has moved out to the side considerably after entry and that it is flexed and close to the surface of the water.

As mentioned, most elite backstroke swimmers no longer sweep their extended arm down deep into the water to make the catch as the swimmer in the left hand photo of figure 7 is doing. Instead, they make the catch very quickly after their hand enters the water by flexing their hand at the wrist and their arm at the elbow. At the catch, their hand and arm should be facing back, with fingertips pointing to the side like the swimmers in the middle and right hand photos in figure 7, and, their arm should also be flexed at the elbow. Additionally, the swimmer should not roll to the side any more than necessary to facilitate this “shallow” catch.
Many backstroke swimmers try to apply propulsive force immediately after their hand enters the water. However, forward velocity graphs show that elite backstroke swimmers wait until their arm is in a backward-facing position before doing so (see middle and right hand photos in figure 7).

The propulsive force graph in figure 1 indicates that Kristina Egerszegi did not begin to apply force immediately after her hand entered the water, and the velocity graphs in figures 3 and 4 demonstrated that Martin Zubero’s body did not begin to accelerate forward until after his arm was flexed. Likewise, the propulsive force graph for Jesse Vassallo show that the force he applied did not become propulsive until some time after his right arm entered the water. This suggests that backstroke swimmers take the time to flex their arm and position it so they can push back against the resistance of the water with the palm of their hand, and the undersides of their forearm and upper arm when they make the catch and execute the upsweep that follows.

This method of making the catch is demonstrated in the photos and accompanying forward velocity graph of Martin Zubero in figure 8. The two photos show him, at the time his left arm enters the water and at the point where he makes his catch. It usually takes 0.1 to 0.2 seconds after entry, for swimmer’s to position their arms for the catch, or, to put it another way, about 1/4 of the way through their underwater arm stroke. A shallow catch, as shown in the right hand photo in figure 8, should be employed, by backstrokers whether they are swimming with a two-peak or three-peak propulsive stroke because it reduces the time they will decelerate between the end of the propulsive phase with one arm and the point where they initiate propulsion with the other.

Figure 8. *The backstroke catch for Martin Zubero’s left arm stroke.*
The Upsweep. The upsweep begins at the catch. It is the first propulsive sweep of the arm stroke. As mentioned earlier, it is more commonly referred as the “pull”. At one time it was taught as a long upward and inward sweep of the hand and arm, which started with the swimmer’s arm fully extended and ended with the arm flexed nearly 90° when it approached the surface of the water near the ribs.

Many of today’s world-class backstrokers are using a much shorter upsweep. With an emphasis on pushing back against the water with their hand instead of sculling up with it. Following the shallow catch, they direct their hand back against the water (see point #2 in the side view stroke pattern in figure 8). They also do not flex their elbow to any great extent during this motion. Instead, they flex their arm at the elbow while making the catch, (see right hand photo of Zubero in figure 8) and it does not flex very much more during the upsweep.

The upsweep in backstroke is an example of the same shoulder adducting movement I described in an earlier paper for the breaststroke, butterfly and front crawl arm strokes. Backstroke swimmers direct their arm almost horizontally back against the water with the hand traveling up only a small amount due to rotation of the arm at the shoulder joint. This is probably because stroking back more enables backstroke swimmers to exert propulsive force against the water with both their upper and lower arms, as well as the palm of their hand during the upsweep. The photos in figure 9 show the upsweep of Martin Zubero’s left arm.

There is one important difference between the shoulder-adducting upsweep in backstroke and the corresponding sweeps in the other three competitive strokes. Viewed from overhead, the direction of the upsweep is almost directly backward with minimal out and in motion. Most modern-day backstrokers make the catch with their arm out to the side more and they have eliminated the inward portion of the shoulder adducting movement. Because of this, they do not bring their arm in close to their side before they transition to the downsweep. Although the upsweep will be shorter when done this way, there should not be any significant loss of propulsion because they have retained the most propulsive part of the movement.

The right hand photo in figure 9 shows Zubero near the point in his upsweep where he begins to transition to the next propulsive phase, the push or downsweep.
Figure 9. The upsweep for Martin Zubero’s left arm stroke.

The Downsweep. Photos of Martin Zubero’s push or downsweep with his left arm are shown in figure 10, together with a velocity graph that demonstrates its effect on his forward propulsion. As he completes the upsweep, he turns his palm so it faces back and pushes against the water by extending his arm in a backward and downward direction. The front view stroke pattern in figure 6 shows that he sweeps his hand almost directly back for most of the distance, not back and in as is traditionally taught.

The downsweep ends when his arm is completely extended below his body and away from his side (see stroke pattern in figure 6 and the right hand photo in figure 10). Extending the arm back and down should allow backstroke swimmers to use their forearm to push water back for a longer period of time during the downsweep, whereas, pushing the arm in toward the side at this time, as is traditionally taught, would eliminate the forearm as a propulsive surface almost immediately. Swimmers would be pushing water in toward their leg. Perhaps even more importantly, it enables them to finish the downsweep with their hand and arm below their body and away from their side. This will position their arm for a longer and more propulsive final upsweep (see figure 11). The swimmer’s palm should be facing back and his fingertips should remain facing, away from his or her body and toward the side of the pool throughout the upsweep and downsweep.
Figure 10. Martin Zubero's downsweep during his left arm stroke. These photos are not in sequence with the left arm photos in figures 8, 9 and 10. The photos in this figure are of his left arm stroke when he is traveling in the opposite direction. This was done because it is easier to see what he is doing with his left arm and hand during the final upsweep from this angle.

Please notice, on his velocity graph, in figure 10, that Zubero’s downsweep is very short, and, that his body accelerates only slightly during it’s execution. This is probably an attempt on his part to get his arm in position for a long and propulsive final upsweep, which, as you can see, he certainly achieves.

The Final upsweep.

The final upsweep is the third propulsive phase of the underwater arm stroke. Most three-peak backstroke swimmers have learned to do this sweep intuitively. In fact, they may not even be aware it is propulsive, thinking instead, that they are recovering their arm to the surface. Photos of the final upsweep of Zubero’s left arm in figure 11 show otherwise.

I can’t stress too much that swimmers should rotate their palm to a fingers-down position as they complete the downward portion of the preceding downsweep so they can transition smoothly and quickly into the final upsweep (see the left hand photo in figure 11). From there they should sweep their extended arm up and in toward their thigh, using their palm and the underside of their forearm to push back against the resistance of the water as they do so.

As you can see, these photos are not in sequence with the photos of his left arm stroke in figures 8, 9 and 10. This is because Zubero is traveling in the opposite
direction in figure 11. In figures 8, 9 and 10 he is swimming the first 50 m of the 100 m backstroke. He is swimming the second 50 of that race in figure 11. The sequence in figure 11 was chosen because the propulsive motions he executes during the final upsweep can be seen more clearly from this view. He is in the first portion of the final upsweep in the photo on the left in figure 11.

**Figure 11.** Martin Zubero’s final upsweep during his left arm stroke. These photos are not in sequence with the left arm photos in figures 8, 9 and 10. They are photos of his left arm stroke when he is traveling in the opposite direction. This was done because it is easier to see what he is doing with his left arm and hand during the final upsweep from this angle.

The final upsweep ends, and his arm recovery begins, as his left hand approaches his thigh (see the photo on the right in figure 11). At that time, he should turn his palm in and release backward pressure on the water. This should be done before his hand passes his thigh on its way out of the water so it (his hand) can exit the water on edge, with thumb leading. This will reduce water resistance as his hand and arm leave the water.

Backstrokers should not carry the final upsweep to the surface of the water because this will push their body down rather than propel it forward. Thus, they should release pressure and start their recovery before their forearm and hand begin pushing up excessively against the water as Zubero has done in the right hand photo in figure 11. A telltale indication that they are pushing up against the water is that the upward motion of their arm will push the shoulder of their stroking arm underwater. Accordingly, as a teaching point, they should be cautioned to terminate the final upsweep and begin their arm recovery before that happens.
In the past, many coaches have noted that elite backstrokers are often able to hyperextend their arms at the elbow. This was considered an advantage for performing the recovery correctly. It may be, however, that the ability to hyperextend the arm at the elbow joint allows for a more effective final upsweep. Three-peak backstroke swimmers who can hyperextend their arms at the elbows should be able to start the final upsweep earlier and push back against the water with the underside of their forearm and the palm of their hand for a longer time (see the photos of Martin Zubero right and left arm strokes in figures 4 and 11).

The photos in figure 12 show several present and former World Record Holding backstroke swimmers who appear to be using a final upsweep. Notice how similar the position of the arm is to that of Zubero at this same point in his arm stroke. The fact that their arms are extended and quite deep at the end of the downsweep with their wrists hyperextended and palms facing back suggests they are positioning their arm to apply propulsive force as it travels up and back toward the surface. You would expect that swimmers with their skill would not extend their arm completely so early and so deep in the water at the end of the downsweep if they were not going to do something propulsive with it. It would be more efficient to finish the downsweep later, with their arm at their leg to reduce the time and effort required to bring it out of the water for the recovery if they were merely recovering their arm at this time. It is too bad we do not have forward velocity graphs for these swimmers so we would know how they apply propulsive force during their arm strokes.
Elite backstroke swimmers who may be using a three-peak arm stroke

Missy Franklin  Matt Grevers

Ryan Lochte  Aaron Piersol

Figure 12 Photos of present day elite swimmers who appear to be using a final upsweep.

Other Three-Peak Backstroke Styles.

Three-peak backstroke swimmers can be observed using several different styles, with none of these, as yet, emerging as clearly superior to the others. In fact, some swimmers appear to use different three-peak styles during their right and left arm strokes. This should not come as a surprise. Great swimmers probably “feel” themselves decelerating between the end of the downsweep with one arm and the catch with the other. Therefore, they have found ways to fill that period with something propulsive. This probably takes place intuitively with the swimmers unaware they have adjusted their strokes to partially fill this gap with something propulsive.

My observations indicate that modern-day backstrokers, (and many from the past), are swimming the three-peak stroke in at least three different ways. The first of these was described earlier and illustrated in figure 11 with photos and a forward velocity graph of Martin Zubero. In this method the upsweep and final upsweep are the major propulsive phases of the underwater arm stroke and the downsweep is abbreviated to allow more time for a substantial final upsweep.
In the second method, swimmers execute an upsweep and downsweep which are similar in length and propulsion to the traditional two-peak stroke. Then they sweep their hand up, in and back for a short distance during the final upsweep. When the final upsweep is done in this way, it is probably best communicated to swimmers as an “inward scull” because of the brevity of its inward and upward motions. In the few forward velocity graphs available, this method of executing the final upsweep/inward scull delivers a short but very powerful acceleration of forward velocity.

Former U.S. Olympic backstroke swimmer, Lea Loveless Maurer, is shown completing the downsweep and positioning her right arm for a short final upsweep/inward scull in figure 13. Notice that her right arm is extended and away from her body, rather than close to her thigh at the end of her downsweep. From there, she will execute the final upsweep/inward scull by directing her extended arm in, up, and back while pushing back against the resistance of the water with the palm of her hand, and for a very short time, the under side of her forearm.

**Figure 13.** Lea Loveless Maurer finishing the downsweep in backstroke with her left hand and transitioning to the final upsweep (inward scull) with it. Lea was a member of the 1992 U.S. Olympic swim team, winning a good medal in the 4 x 100 medley relay and a bronze medal in the 100 m backstroke.

A probable stroke pattern for swimmers who use a short final upsweep or inward scull is illustrated in figure 14. The pattern begins with a short down and out sweep of the arm before making the catch. This is followed by a reasonably substantial upsweep and a substantial and propulsive downsweep, before finishing with a short final upsweep/inward scull. Notice that the swimmer’s hand is moving back, as well as up and in, during the final upsweep/inward scull. This backward component of motion is a prerequisite for generating propulsion during this phase of the underwater arm stroke.
Figure 14. *The probable stroke pattern for a backstroke swimmer who uses a short final upsweep or inward scull.*

My best guess as to the forward velocity graph this style might produce is shown in figure 15. Swimmers who use this style will probably exhibit patterns of forward propulsion during the upsweep and downsweep that are very similar to those of swimmers who use a two-peak style of backstroke. After that, however, they will add a short, and very propulsive third sweep, the final upsweep/inward scull, before releasing pressure on the water and recovering their arm to the surface.

Figure 15. *A hypothetical center of mass forward velocity graph for a swimmer who uses an inward scull during the final upsweep.*

Hours of observing video of elite backstroke swimmers during competition suggests to me that the majority who use a three-peak backstroke, appear to be performing the final upsweep/inward scull in the manner just described and not in the way it was performed by Martin Zubero, (see figures 4 and 11). That is understandable considering, as mentioned earlier, they have probably added the final upsweep/inward scull intuitively and unknowingly after they were taught to swim backstroke with a traditional two-peak stroke.
The third method that some backstrokers appear to use to propel themselves through the water with a three-peak stroke, is through eliminating or abbreviating the first upsweep and executing a long downsweep and long final upsweep. The hypothetical stroke pattern and forward velocity graph in figure 16, illustrate my best guess as to how backstroke swimmers might propel their bodies through the water with this method.

As mentioned, the upsweep in the middle of the underwater arm stroke may be missing or greatly abbreviated so that the first major propulsive peak would be a long downsweep that starts at or shortly after the catch and ends when the swimmer’s arm is extended below and wide of his/her hip. In the absence of a velocity graph, the telltale indication that a swimmer is using a two-peak stroke with no upsweep will be that his/her palm will not rotate up after the catch. Instead, the palm will remain facing back, and down somewhat, from the catch through the downsweep that follows. Of course, when they eliminate the upsweep swimmers will actually be using a two-peak arm stroke (see figure 16), albeit, one that is different from the traditional two-peak style that was described earlier in this paper (see figure 1).

![Figure 16](image_url)

**Figure 16.** The probable stroke pattern and velocity graph for a backstroke swimmer who has combined the upsweep and downsweep into one long downsweep, that is followed by a long final upsweep.

A swimmer who abbreviates the upsweep but does not eliminate it completely, before starting the downsweep, will exhibit a three-peak stroke, although the upsweep will have little propulsion associated with it. That swimmer would rotate his/her palm up for a very short time following the catch, before quickly turning it down again, during the downsweep.

The advantage of swimming with an abbreviated or missing upsweep is that a longer propulsive downsweep can be completed earlier during the underwater arm stroke, leaving time for a longer and more substantial final upsweep like the one
used by Zubero. The downsweep will end and the final upsweep will begin approximately when the swimmer’s arm is passing his/her chest. (See photos of Zubero in figure 8). As the arm nears full extension during the downsweep, he/she will rotate the palm from down to back, after which the upper arm and palm will be used to push back against the resistance of the water in a long final upsweep.

It would be nice to know which of these methods will generate the greatest forward velocity. However, there is not enough quantitative data available to make that determination at the present time. Until such time, as more stroke patterns and forward velocity graphs are available for swimmers who use these various non-traditional styles, for swimming a three-peak backstroke, the exact methods, they employ to apply propulsive force and the relative effectiveness of those methods will remain unresolved.

**Some thoughts on the three-peak backstroke.**

I think a backstroke that is swum with three-peaks could be superior to a two-peak style for several reasons. These involve the propulsive force that can be generated during the final upsweep or inward scull as well as the way it encourages a different and better timing for the arm stroke. Nevertheless, the average velocity per arm stroke and the distance traveled are the key components of fast swimming. Any method, whether it be the addition of a third propulsive peak, an increase in the velocity of one or both of the two traditional propulsive peaks, or an increase in the length of one or both of those propulsive peaks should improve a swimmer’s performance markedly. That said, it seems probable that greater stroke length and average velocity per stroke are more likely to be achieved through the addition of a third propulsive peak, especially one that has the potential to increase forward velocity to a greater extent than the traditional upsweep and downsweep. Let me describe the potential advantages of the three-peak backstroke in greater detail.

**The unique style of the final upsweep may increase velocity more than the traditional upsweep and downsweep.** All of the forward velocity graphs that are available for three-peak world-class backstrokers during competition demonstrate that they achieve a greater forward velocity during the final upsweep than they do during the preceding upsweep or downsweep (Cappaert & Rushall, 1994). For example, Jeff Rouse achieved a forward velocity in excess of 2 m/sec during the final upsweep/inward scull of his right arm stroke but never reached a velocity greater than 1.9 m/sec during any other propulsive phase of with either arm. Martin Zubero’s peak velocity was approximately 2.4 m/sec during the final upsweep/inward scull but did not exceed 1.8 m/sec. at any other time.

Although data from only two subjects is far from compelling, they suggest the possibility that pushing against the water with an extended arm during the final upsweep or inward scull (see figure 11) may be more effective for increasing forward velocity than the upsweep or downsweep of the traditional two-peak backstroke. This may be, as mentioned earlier, because the swimmer can apply
more force with his entire arm when it is extended and/or because his hand can achieve a higher velocity at the end of his extended arm.

**Because of what was just said, a three-peak backstroke with a long final upsweep may be preferable to a shorter, inward scull, type of sweep.** As mentioned earlier, there are a greater number of world-class backstroke swimmers who use a short final upsweep in the manner of an inward scull than those using a longer more substantial final upsweep similar to the one depicted for Martin Zubero in figures 4, 8, 10, and 11. Regardless, this observation should not be considered evidence that a short inward scull is the most effective way to swim a three-peak backstroke.

In my opinion, the fact that a smaller number of swimmers are using a long final upsweep, like the one Martin Zubero uses does not disqualify his style as potentially the most effective way to swim a three-peak backstroke. It is very likely that the traditional two-peak style that most backstrokers are taught at a young age has discouraged many from developing a longer final upsweep and, consequently, a higher average velocity per stroke cycle. Nevertheless, what was just said is entirely speculation on my part and not proof that a long final upsweep should be adopted without a period of trial and error.

If you wish to attempt swimming a three-peak backstroke with a long final upsweep, there appear to be two general ways it can be done. The first method, as displayed in Zubero’s and Vassallo’s forward velocity graphs, (see figures 5 and 8) is to sacrifice propulsion during the downsweep by abbreviating that sweep in favor of a longer final upsweep. The second method, that some appear to be using, is to abbreviate or eliminate the upsweep in favor of a longer downsweep and a longer final upsweep. Both of these methods were described earlier.

Of course, the flip side to this argument would be that a swimmer who executes the first two sweeps reasonably well, while using a short, highly propulsive inward scull during the third propulsive phase of the underwater arm stroke might be more likely to achieve greater stroke length and greater average velocity per stroke than one who abbreviates the upsweep or downsweep in order to gain a longer final upsweep. The only way to determine which style might be more successful for a particular swimmer is through testing and trial and error.

**The use of a final upsweep or inward scull may allow swimmers to use a higher stroke rate in races.** The final upsweep/inward scull is executed with a straight arm, therefore, as indicated earlier, greater hand velocity can be attained during that portion of the arm stroke, This should, in turn, result in a faster stroke rate and, greater forward velocity. There is some anecdotal evidence to support this observation.
The stroke rates used by modern-day backstrokers have increased more than those of any other competitive stroke in recent years (see Table 1). Could that be because more backstroke swimmers are now using three-peak strokes?

Craig and Pendergast (1979) were among the first persons to measure stroke rates. They did so for swimmers at the 1976 U.S. Olympic Trials. Stroke rates for female backstroke participants averaged 46 stroke cycles/minute (range = 46 to 47) in the 100 m event and 42 stroke cycles/minute (range = 41 to 42) in the 200 m event. The stroke rates for males averaged 46 stroke cycles/minute (range = 45-47) and 39 cycle/min. (range = 39-40) respectively in the shorter and longer backstroke events.

Craig and others (1985) then repeated this study for male and female backstroke swimmers at the 1984 U.S. Olympic trials. Their data showed that the average stroke rates for U.S. backstrokers were similar to those they calculated in 1976. Stroke rates were usually within one to two stroke cycles of the 1976 averages for both events and for both sexes. Apparently, not much had changed about the backstroke in the intervening decade. Something did change in the next decade, however.

An analysis, by the author, of swimmer’s stroke rates and stroke lengths at the 1996 Olympic Games and the 1998 World Swimming Championships showed, that the range of stroke rates for female backstrokers had increased to between 48 and 56 stroke cycles/minute in the 100 m event. The stroke rates for female 200 m backstroke did not demonstrate the same upward trend, however. The range for that event was 42 to 44 stroke cycles/minute.

The stroke rates for male backstroke competitors demonstrated a similar pattern. They increased to between 48 and 53 stroke cycles/minute in the 100 m event but remained at 42 to 44 stroke cycles/minute in the 200 m event during the period between 1985 and 1998 (Maglischo, 2003).

The average stroke rates for participants at the 1976 and 1984 U.S. Olympic Trials (Craig and Pendergast, 1979, and Craig, et al., 1985) and the range of stroke rates for participants at the 1996 Olympic Games and 1998 World Championships are shown in Table 1. The rates for male and female backstrokers are in bold print. The average stroke rates and range of stroke rates for swimmers in other events are also listed for comparison purposes.
Table 1. Stroke rates for Elite swimmers in 100m and 200 m events of each stroke in 1976, 1984, and 1998.

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<tbody>
<tr>
<td>100 m Fr.</td>
<td>58</td>
<td>57</td>
<td>53-56</td>
<td>50</td>
<td>54</td>
<td>50-56</td>
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<tr>
<td>200 m Fr.</td>
<td>55</td>
<td>46</td>
<td>48-54</td>
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<td>43-51</td>
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<tr>
<td>100 m Fly</td>
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<tr>
<td>200 m Fly</td>
<td>53</td>
<td>51</td>
<td>45-54</td>
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<tr>
<td>100 m Br</td>
<td>61</td>
<td>61</td>
<td>47-53</td>
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<td>52-55</td>
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<tr>
<td>200 m Br</td>
<td>51</td>
<td>47</td>
<td>34-45</td>
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<td>38-42</td>
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<tr>
<td>100 m Ba</td>
<td>46</td>
<td>46</td>
<td>50-56</td>
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<td>48-53</td>
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<tr>
<td>200 m Ba</td>
<td>42</td>
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<td>42-44</td>
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You can see that, from 1976 to 1998, stroke rates increased noticeably in only the 100 m backstroke events while in all other events they tended to stay the same or even decrease slightly. It is also of interest to note that female backstrokers were able to increase their stroke rates with no noticeable decrease in stroke length in the 100 m backstroke event while the stroke length for male backstroke swimmers tended to decrease in the 100 m event. Average stroke lengths for women were 1.94 m/stroke cycle (range = 1.91 to 1.97) in the 100 m event in 1976 while the range of stroke lengths for females in the 1996 Olympic Games and the 1998 World Championships was 1.75 to 2.03 m/stroke cycle in that same event. For men, competing at the 1976 U.S. Olympic Swim Trials, the average stroke length in the 100 m backstroke was 2.24 m/stroke cycles (range = 2.21 to 2.27). The range of stroke lengths for male backstrokers competing at the 1996 Olympic Games and the 1998 World Championships was 2.05 to 2.20 m/stroke cycle in the 100 m event.

Of course, it could be argued that today's world-class 100 m backstroke swimmers are stroking faster because they catch earlier and do not sweep their hand up very much during the upsweep, and, because they spend more time kicking underwater and less time swimming on the surface. These technique changes probably do account for the fact that backstrokers have been able to increase their stroke rates with no significant loss of stroke length. Nevertheless, the higher strokes rates of modern-day swimmers could also be a result, at least in part, of greater hand velocities because more are using a three-peak stroke. What cannot be explained is why the same trend toward increased stroke rates was not found for 200 m backstroke swimmers.
The three-peak backstroke may be more continuous than the two-peak style.

Another possible advantage in favor of a three-peak backstroke may be that swimmers decelerate less between arm strokes. In the traditional two-peak backstroke, the hand of the swimmer’s recovering arm usually enters the water when the other hand is finishing its downswing. After that it requires approximately 0.25 secs. until the swimmer makes the catch with the overhead arm and begins to accelerate his/her body forward. The other arm will be recovering up to the surface during most of this period and, with only the kick for propulsion, the swimmer’s body will decelerate rapidly so that the loss of velocity may be in excess of 0.6 to 0.8 m/sec during the “lag” period between the end of propulsion with one arm and the beginning of same with the other.

Videos suggest that both the length of time spent decelerating and the loss of velocity between strokes can be shortened considerably by using a three-peak backstroke. Swimmers who utilize a third propulsive phase in their backstrokes will be accelerating their bodies forward with a final upsweep or inward scull during a sizable portion of the time their hand is traveling up through the water in what otherwise would have been a recovery movement. Consequently, the addition of a propulsive final upsweep should shorten the time swimmers decelerate between arm strokes. In the traditional two-peak backstroke their forward velocity would be decelerating from the time their stroking arm was fully extended at the end of the downswing until the recovering arm reached its catch position to begin the propulsive phase of the next underwater arm stroke. Whereas, three-peak backstrokers would continue to accelerate their bodies forward during a portion of the time their stroking arm was traveling to the surface.

The, small amount of data available, only 3 subjects, indicates that the period of deceleration between the propulsive peak from the final upsweep or inward scull of the other arm and the catch of the stroking arm was in a range between 0.10 and 0.15 secs. for the three-peak backstrokers that have been analyzed (Cappaert and Rushall, 1994). On the other hand, the period of deceleration is usually greater than 0.2 secs. for traditional two-peak backstroke swimmers. This suggests that a competent three-peak backstroke swimmer should be able to maintain a faster stroke rate and a higher average velocity per stroke due to the combination of, (1) a higher ending forward velocity for each stroke occasioned by a third propulsive phase that takes place during the time a traditional two-peak backstroke swimmer would normally be decelerating, and (2) a shorter period of deceleration between that stroke phase and the catch of the other arm. A definitive analysis of this possibility would make an excellent research project. I hope that students of swimming who are reading this paper will be motivated to design studies to investigate this and some of the other possibilities I have described with regard to the three-peak backstroke.

To finish this paper, I have included a YouTube video of Martin Zubero swimming a three-peak backstroke. This video shows him competing in the 100 m backstroke at
the 1992 Olympic games. Click on the screen and you will be taken to the video so that you may observe his unique three-peak backstroke in real-time and slow motion.

Figure 17. A YouTube video of Olympic Gold Medalist, Martin Zubero swimming the 100 m backstroke at the 1992 Olympic Games.

REFERENCES:

Whereas, a three-peak backstroker would continue to accelerate their body during a portion of the time their stroking arm was traveling to the surface.


