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On the Cover

Two first time Head Olympic Coaches will lead the USA into the London Olympic Games. Gregg Troy, University of Florida, and Teri McKeever, Cal-Berkeley Women, will join the very small club of Olympic Head Coaches. Congratulations to both coaches on their appointment and GO TEAM USA!

John Leonard
Gregg Troy and Teri Mckeever Named 2012 U.S. Olympic Head Swimming Coaches

The Training and Development of Christine Magnuson by Coach Matt Kredich

Book Review: “Boys Adrift” by Leonard Sax, M.D., Ph.D

mmol/L to Velocity to Stroke Count: A Practical Approach for Monitoring Level of Effort During Training by Gary Leslie

Speed Training - Tips from Vern Gambetta by John Leonard

It is Time to Change the World by Coach George Block
COLORADO SPRINGS, Colorado, December 8. GREGG Troy and Teri McKeever were named head coaches of the USA men’s and women’s Olympic teams, respectively, today in a press conference held by USA Swimming.

USA Swimming Executive director Chuck Wielgus and Interim National Team Managing Director Jim Wood made the announcement, ending months of speculation over who would lead the American team to the London Olympics. Troy and McKeever were notified of their selection on Tuesday.

Both coaches led the U.S. team to a total of 51 medals at this summer’s Pan Pacific championships. McKeever’s appointment marks the first time a female coach has been at the helm of an American Olympic swimming team. It is believed to be the first time a female coach has led any Olympic swimming team in the world.

“It’s an incredible honor,” McKeever said. “I hope someday that a female on an Olympic staff isn’t as noteworthy as it is now.”

McKeever made history in 2004 when she was named as assistant Olympic coach for the women’s team, the first for an American female at the time. She was an assistant coach again at the 2008 Games. McKeever’s most prominent swimmer has been Natalie Coughlin, who helped give McKeever’s program at Cal-Berkeley more credibility while a student-athlete there from 2000 to 2004 and won 11 medals in the 2004 and 2008 Olympics. McKeever also coached Staciana Stitts to an Olympic berth (and gold medal in the 400 medley relay) in 2000 and Haley Cope to a silver medal in 2004. Since then, McKeever’s Bears won the 2009 NCAA national championship, and such swimmers as Dana Vollmer and Caitlin Leverenz have shone on the international scene.

Today’s announcement marks Troy’s third appointment to the U.S. Olympic coaching staff, but his first as head coach. He was the women’s assistant coach in 1996 and the men’s assistant coach in 2008. In a coaching career spanning more than 30 years, Troy has guided five U.S. swimmers to medals at the Olympics: Greg Burgess (1992, silver in 200 IM), Ashley Whitney and Trina Jackson (1996, gold in 800 free relay), Caroline Burckle (2008, bronze in 800 free relay) and Ryan Lochte (2004, gold in 800 free relay and silver in 200 IM; 2008, gold in 800 free relay and 200 back, bronze in 200 and 400 IM). He is also now the coach of 2008 Olympian Elizabeth Beisel. Troy has coached nearly 70 international athletes to spots on other countries’ Olympic rosters.

“It’s certainly a tremendous honor,” Troy said. “I’m not going to take it lightly and I look forward to the opportunity. We’d like to exceed or do better than ever before. But we know it’s more competitive around the world.”

The selection of the Olympic coaches was begun by an independent panel who reviewed the accomplishments of the applicants. The panel recommended McKeever and Troy, Wood said, and his staff at USA Swimming approved the selection.

The jobs of Olympic coaches weren’t the only open positions in USA Swimming. The organization is conducting a search for a new national team director in the wake of Mark Schubert’s termination last month. Wielgus said the process of finding Schubert’s replacement “had absolutely no impact” in selecting Troy and McKeever.

Though the Olympic Games are about 18 months away, Troy and McKeever said they will have plenty of work to do in their new roles. Though they stressed that their first priority is to their primary athletes, they said they will be in contact with coaches of veteran swimmers and rising stars who could find themselves on the Olympic team.

“I see my main goal and responsibility is to continue to be the best possible deck coach I can be and not only inspire my athletes,” McKeever said, “but look at the men and women who have proven themselves at the Olympic level and those aspiring to that, and put the best possible team together.”
The Training and Development of Christine Magnuson

By Coach Matt Kredich

Introduction
It is a pleasure for me to introduce our next speaker here this morning - someone that I could probably sit and talk to for days about swimming and the great thing is that he is so willing to share. Matt has been a successful coach for many, many years. My guess is that a lot of people are probably just starting to notice - just because being at more of a high profile school. I know for a fact when he was coaching at Richmond and we had some swimmers that we were trying to recruit that went to school there and he did an amazing job with some kids that were somewhat no- named that just developed and progressed beautifully and he has done that every stop along the way. Now, if any of you club coaches out there have swimmers that are looking at Tennessee and Northwestern I want you to kind of ignore all those things that I just said there a second ago. Matt has done an incredible job in probably one of the most demanding and competitive conferences in the country in the Southeastern Conference, as we all know, it is not easy to go in there and go up against some of those big dogs - no pun intended there with Georgia. It is a tough place to go in and make a name and make your team rise up and compete against the best in the country and he has done just that in a relatively short time. We all know about Christine Magnuson - the amazing progression that she has had over the last couple of years, so without further ado - it is my pleasure to present our next speaker, Coach Matt Kredich.

Coach Matt Kredich
Thanks. I am going to invite you to come closer because I know that some of the slides that I have are going to be difficult to see in the back. My understanding is that these slides will be available for download from the ASCA website at some point. It is great to see a lot of people here who are really familiar to me and I am going to go over some things that I expect to be challenged on at some point. I have a couple of people in the audience that have really influenced and mentored me in the past - specifically Dan Flack and Clive Rushton - it is great to be up here and have the chance to speak to them. This is fun for me because I am getting a chance to talk about a young woman who is just a wonderful person and a wonderful story. The amazing thing to me is - and you could say this with many Olympians, but her in particular - if you were to look back five or six years ago at Christine Magnuson it would be difficult to say there is a future Olympian, but the fact is - she always was - at every point along her career she was a future Olympian and that is the benefit of hindsight, but if you look at it that way then it should follow and some of the same things that I think you have heard this weekend - that you just never know how good a swimmer is going to be.

I think there were some real keys to her success at the Olympic Games. She certainly has some physical, emotional and mental talent. I believe that the way we structured her training season was ideally suited to her and that is that we really separated the training of capacity and power. She learned in the time that I knew her - how to master her fear and how to embrace competition and then she also was really good at paying attention to detail - both technical - in terms of stroke and tactical in terms of racing. First of all - her physical attributes - she is long and tall. She is 6’1” - about 150 - 160 pounds - depending on the time of the season and she adapts really quickly.

The first year that I coached her she was coming off mono. In her first workout back she lifted until she passed out and it concerned me a little bit so I asked her to back off and she didn’t back off one bit. The next day she was stronger. I also found that in any kind of a practice that I give her a high dose of stress - the very next time we do that type of practice she is better. Her body is a sponge for stress and she adapts really quickly.

If you look at her from the side she has no curvature to her lower spine and I think that is really
Water-Clogged Ears
Tips for avoiding this irritating condition.

Is swimming part of your regular exercise regimen? Do you spend countless hours in a pool each week providing instruction? Maybe you shower after an evening run or workout in addition to your regular morning shower. Situations like these can result in water-clogged ears, an uncomfortable condition that makes hearing difficult.

Preventive measures such as wearing earplugs while in water and having professional ear cleanings can be helpful in discouraging a buildup of water in the ear, but it's also a good idea to have an ear drying aid, such as Auro-Dri®, handy to dry up any water that becomes trapped. Auro-Dri® Ear Drying Aid is a fast-acting ear drop treatment specifically made to help dry and relieve water-clogged ears on contact.

Aaron Peirsol, 5-time Gold Medalist in swimming and Auro-Dri® spokesperson, explains: "Water-clogged ears can be painful, annoying and even make it hard to hear. Spending as much time as I do in the pool, I frequently count on Auro-Dri® to effectively remove any water that gets trapped in my ears."

Keeping your ears water-free should be a priority every time you swim or shower, so be sure to have an ear drying product on hand with you at the pool or gym, as well as in your medicine cabinet at home. With reasonable care you should be able to avoid further discomfort and inconvenience of water-clogged ears. Of course, if you should experience fever, pain or pressure in the ear, consult a physician right away — your hearing is too valuable to take any chance!

"I use Auro-Dri® regularly to protect my ears after I swim."

Aaron Peirsol
5-time Gold Medalist and World Record Holder
important in helping her ride high in the water - both in fly and freestyle and she has an extremely flexible neck. I would like to say that the idea to turn to side breathing in fly was mine and that that made all the difference in the world, but that is something that she kind of came on to naturally and she has the ability to turn her head more than 180 degrees. She is also very bright. She is focused and she is very motivated. She has won numerous post-graduate awards - both from the SEC and the NCAA. She has got incredible parents - just dream parents. She is an exceptionally motivated team swimmer. She will do anything for her team - whether it is USA or Tennessee. She has tremendous capacity to mentally engage in a practice. She doesn’t tolerate herself spacing out and when she is at her best she loves to compete.

This is kind of a graphic representation of her training evolution and the density of training that she has done over the years. She did not swim long seasons growing up, but she did play a lot of different sports. She played basketball, volleyball and swimming and did something all year around. The spheres here represent the seasons of swimming and so early on the seasons were short and not real stressful. When she got to high school they were still only three months, but more stressful and then when she got to college she started training year around. This is a progression of her times in the hundred fly from 2003 to 2008. The top line is meters and the bottom line is yards and you will find the same kind of progression for all of her events - the 50 through the 500 freestyle and the 100 and 200 butterfly.

I would like to talk to you a little bit about the evolution of her competitive mindset. When I first started coaching her - her very first season - she was really successful at SEC’s. She dropped from 1:49 to 1:45 in the 200 yard freestyle and when I talk about times I think if we can set our minds back to whenever the year that these times were done - then maybe they are a little more impressive. That 200 freestyle landed her the second seed at NCAA’s and this was her very first experience being at the top. She really struggled to adjust from being the hunter to being hunted. She was seeded second. She was a mess going into that race. She just felt like everybody was coming after her and she finished 12th with a great deal of relief that she actually scored. Kind of hidden in that meet she split a 53 low in the hundred fly on a relay and that to date really had not been much of an event for her so that was intriguing.

We went into the summer season with some high expectations. It was a selection summer and we felt like she could make a team in the 200 freestyle and she went out slow in that race and came back even slower. She really wilted under what she felt like were expectations from everybody - including her and once that was out of her system she had a really beautiful 100 fly and went 1:00.7 - that was a drop from 1:04 which had been her best time earlier in the season. Then we swam an 800 freestyle relay and at the time and this happens at a lot of meets - the announcer has world record splits from a relay and so with all those splits - I am not sure how useful that is, but when Christine flipped at the 50 - she was ahead of world record pace for the 800 free relay and that was kind of the sign that she was back because she really races best when she is aggressive. She was out two seconds faster than she was in the event and back slower, but it was fun and she learned a lot from contrasting those different events at that meet.

The next season - she came into the season with a big change in her self concept. I think she really started to enjoy thinking about winning. She put in a really good training season and won the 100 fly at SEC’s. It was a big step for her and for our program. She went 52.0 - was 3rd in the hundred free and 48.4 and went to NCAA’s and really enjoyed racing. She finished 4th. She was a little bit slower than SEC’s, but felt great about herself and got hungry for more. She got a taste of what it is like to race at the highest level and not get in your own way and she got hungry for more. The following summer - I will forever be grateful to Coach Schubert and USA Swimming for putting that Japan meet in place after 2006 when all these teams were picked - we had nothing to aim for in terms of International competition in 2007 so along came this Japan meet with a qualifying standard. You didn’t even have to be in the top X-number of people and that may never happen again, but having that standard in her mind be attainable I think was the right thing at the right time for her and it took some pressure off of her performances and just allowed her to swim for herself and again I think that time that was really important for her.

We had about ten days after Nationals before she was to leave for Japan and in that time we talked about what her goals were and what this would mean and she was real clear. She was more than just happy to be there. She
felt like it was another chance to race and I got the call from her dad - I didn’t know where to find results - I got the call from her dad and her best time in the hundred free was a 56 low and her dad told me that on the relay she had split a 54 high which kind of blew me away because I didn’t see any signs of that in the ten days that she trained before she left and then she swam the hundred fly and got in there and really mixed it up with people that had intimidated her before - the Australian women and Rachel Komisarz and they beat her. They beat her by just kicking her butt on the turn and that was cool too because she came back from that meet knowing that she could swim with the best people in the World, but she had some stuff to work on and she got really excited about that. Just that taste of International competition got her really excited about what might happen the next year.

So in 2007 - 2008 I was real sure that we needed to focus on the college season and with the ultimate goal being Christine was going to make the Olympic team, but she had to focus on the college season. She is - as I said before - a tremendous team swimmer and coming off that Japan experience I knew that she had some confidence that could fuel our team and in my mind there was never any question that we needed to get her ready for NCAA's and that that experience would help her Olympic chances more than anything else we could do. I felt like she needed the experience and she needed the confidence so she ended up having a dream season. SEC’s - she went 22 flat - 51 flat in the fly - 48.2 in the freestyle or that might have been 48 flat. She went 1:43 flat - which at the time made her the 3rd or 2nd fastest 200 freestyler ever and then she had a 22.3 fly split and she was out in 9.9 in that 50 fly with her relay start. She looked absolutely scary at that meet. She was so fast and strong that she just couldn’t control it and I didn’t know what to do because she was having so much fun, but it seemed like she was really out of touch with the water. It was like the water for her - she was so strong she couldn’t feel it and so her races were kind of rough. I sat back and watched because I had not seen anything like it before and it was a meet where I didn’t give her a whole lot of rest, but it doesn’t matter what I gave her because whatever it was - was just what she needed. I am not sure I have ever seen her that strong before. She won three individual events. She helped our relay win for the first time in a long time and she was named swimmer of the meet.

At NCAA's she went back to being the hunted and the big stuff was - she figured out how to love it. The great thing about the swims at SEC’s being messy - was that there were a lot of things that we could do to clean them up. When we got to NCAA's I actually do not think that she was as physically prepared to swim fast, but she was smarter and better prepared technically and better prepared tactically and she was also swimming better - just not faster. We started off that meet and she was a little bit more reserved. She qualified 9th in the 50 which was real frustrating for her and the next day was 100 fly. She was the top seed, but Dana Vollmer - who had won the year before with a faster time than Christine was seeded with was definitely on her mind. Instead of being the kind of free-flowing, fun-loving athlete she was at SEC’s, she was a little quiet. Right before her event she came up to me and said - talk to me please and I looked at her and she was smiling this kind of smile that says I am about to throw up. I just said, “listen - no one is trying to GET you and nobody is trying to take anything away from you. They are not going to come into your lane and they are not going to try to slow you down.” It is a cliché - that is just a string of clichés I just spat out, but it is what she needed to hear and she took a deep breath and said okay and she was seeded with a 51.00 and she ended up going a 50.99 because it was a much better race. Her turns were much better and the way she approached her stroke was much better and that is all she really needed.

Heading into finals - well, I will back up a little bit. We have a team with - it is a women’s team and they love to dance and love to sing and they love to kind of be allowed to be goofy. On our bus ride up to Columbus our massage therapist busted out in a Michael Jackson dance down the aisle of the bus and from that point on we were listening to Michael Jackson on the bus rides to and from - in their rooms and that sort of became a theme for that group. They were dancing in the stands - not me - it was them. They were having a great time and so when Christine walks out for finals the theme music was “Beat It” and our team went nuts and the cool part was that Christine was marching down the side of the pool and then marching towards us and she saw them dancing and she just got this huge grin on her face and she was gold - I mean - she went 50.7 and swam a technically excellent race and just had a blast doing it. So that was a huge step. She figured out how to be chased and how to be in that
situation.

In the summer of 2008 - again - mentally, now she is starting to think that she has got a good chance to make that team and we went to Charlotte and she went 58.5 in the hundred fly which is right on her best time and 2 minutes in the 200 free and that was at the end of some really intense training so that was a huge confidence boost. And again - just talking about her mental evolution - got to Trials and she was good and in prelims she swam a really good race and had a great mind set - she came out of prelims seeded 1st. In finals she didn’t have a great mind set and she didn’t swim a great race, but she happened to get her hand on the wall first. She went - the progression there was 57.7 - 57.5 and then 58.1 and I will go over those races a little bit later. She wasn’t afraid in that race, it was just unfamiliar. I think we saw a ton of that. We saw a lot of people swimming with a mix of fear, desperation and confusion in that setting that none of us had ever really been in before and certainly not Christine.

I feel really fortunate that the hundred fly was first. I actually believe if the 200 free had been first then she would have made the team in that too, but whatever was first - she wasn’t going to make what was second because we were not prepared for what happens when you make an Olympic team. This really makes me appreciate people like Jon Urbanchek and Bob Bowman and what Michael did and Gregg Troy and how he handled Ryan Lochte with multiple swims - keeping their focus through the entire program because I did not do a very good job of that and the following morning in prelims of the 200 free when I felt like Christine was ready to go 1:57 - she went 2 minutes and qualified 18th. There were a lot of things the night before that we could have done better, but she settled down in the 100 and 50 free and came back in those events with the mindset that she just wanted to compete. She wanted to race other people and she would decide how much pressure to put on herself. Those races were really key in helping set up where she ended up at the Olympic Games.

I have taken you up to this point with her mentally and emotionally. Now I want to talk about the training elements that I think are really important. A number of years ago Jan Olbrecht spoke at this clinic and it had a profound effect on me. His premise was that lactate testing - as it was being practiced - was flawed and based on flawed assumptions. He explained that he had this test and this algorithm that could provide a wealth of information on any swimmer’s training state at any given time.

So you take one sample and you know where that swimmer is in terms of their training structure and he was selling this book. I bought that book and I read it cover to cover and there is not one mention in that book of that algorithm and he never said it was in the book. He just said I have this algorithm and he still has it. I don’t know that he shared it with anybody - maybe, but I don’t think so. But, the book is fantastic and if anybody can get ahold of one you should. It is difficult to get in this country, but along the way - I just loved his paradigm for explaining how training worked.

I started incorporating his terminology and his training paradigm into the way I thought about training and it is really built well on some conversations that I had with Clive Rushton - who is sitting right here - in the past. Clive has actually helped since - clarify some of what Jan Olbrecht was talking about, but basically the premise is you are either training an energy system for capacity which is basically the size of the gas tank or for power which is the rate at which you can get the fuel out of the tank in a race. So it is either size or the rate that you can get that fuel out. He believes that you really can’t do both effectively simultaneously as training for one - capacity negatively affects the training for the other - power - or vice versa. So I took this information to heart in planning our season. You can see just in this kind of simple diagram that we will spend the first 2/3 of our season training to increase the capacity - both aerobic and anaerobic and the last part of the season is power training. I felt like since Olbrecht feels that capacity training involves changes in structure - the structure of the body and power training involves changes in function of things that are already in place and that excessive power training can lead to negative adaptations and he feels like aerobic power takes 3 - 7 weeks to fully optimize. Anaerobic power takes anywhere from 2 - 6 weeks to fully optimize and past that - you may risk going into negative adaptation. Then what we did is we left 7 weeks at the end of the season to train power. Everything else is building capacity.

One thing that he doesn’t talk about that I sort of brought in from some previous experience that I had is this concept of parametric training and that - like other words that I am going to use today - there
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are a lot of different definitions. I am going to try and explain to you what I think of when I talk about parametric training and this is sort of a system that was taught to me by Sergei Beliaev who works for Super Sport Systems. As coaches - we manipulate a lot of different parameters in training. We manipulate - and the idea of progressive overload to create adaptation means that you are going to overload some different things and if we are going to understand how this works then we need to control what we are progressing. We need to control what we are overloading and basically when you want to train capacity the main thing that you want to progress is either time of work - which is a measure of volume, or distance which is also a measure of volume. Your body doesn’t know how far you have gone - your body knows how many strokes you have taken.

In terms of power - we can change or progress effort. We can change or progress speed and we can change or progress velocity. One of the things that you will have available to download is this chart and don’t write it down - just try to understand a little bit and what I provided is kind of a base set and that is ten 200’s on 2:40 where the result is you are holding 215’s and your heart rate which is a measurement of the energy you are outputting is 175. So that is the base set and the question then is how do we take that set and make it progressive - how do we add to it? Well - one way to do that is to add distance or add repetition so you can keep constant the heart rate so now instead of going 10 and a heart rate of 175 we are going to be going 12 at a heart rate of 175 and what is variable there is velocity because you are just keeping - you are progressing definitely the distance and you are keeping the heart rate the same. The second thing you can progress is the speed and that is more towards power so we are going to go ten 200’s on 2:40 and this time we are going to aim to go faster and this time your heart rate is going to be higher. It costs more energy to do that, but you have gone the same distance and you have done it faster. The third thing you can change is the amount of rest and so you have less recovery and a little bit more stress on the body so you have gone - in this example - ten 200’s on 2:30 this time - you have gone 2:15’s and you have got a higher heart rate because you have had less chance to recover so you have progressed the stress there. Then the fourth way and this is what I am going to talk about in terms of increasing capacity is that we are going to add two more 200’s. We are going to go exactly the same time and the time is one of the definites that we are going to keep steady and the goal is to do it at a lower cost. The goal is to go to that speed at a lower cost and so then the next step might be to go 14 and squeeze the interval a little bit - so a little less rest and still hold 2:15 - does that make sense? And this type of progressions - keeping the speed the same and adding volume to it and then maybe even reducing the rest is what I will refer to as parametric training.

In the summer of 2006 when Christine started taking fly seriously - I felt like she needed to do some of this type of training in order to be confident in the fly. The way we set that up is we took 91% of what I felt like her top speed at the time was - which in a time trial was right around 1:05 and so we chose the speed of 1:11. Then the goal is to go your speed on a certain number of repetitions on as little rest as you possibly can - as you need - to do those reps. We started with four 100’s on 2:15 and she completely overshot the first one and by the last one she was limping, but she still went probably 1:12. You can see in progression by weeks - the first week it was 4 - the next week 5 and then up to 20 at the end of 8 weeks. The goal is to set up the set so that she could repeat 20 100’s holding 1:11’s. Even if this has no physiological benefit in itself - then there was a tremendous amount of psychological benefit that it gave her. She could do 20 100’s so instead of thinking about finishing 100 fly - which was a primary concern before this summer - she was able to take that step to start thinking about how she could do it well. This training - over the years that I have used it - has been incredibly effective in helping increase capacity by increasing efficiency. The adaptation goals that we are looking for with this type of training is basically - we are looking for a lower energy cost at a given velocity and that velocity has to be meaningful. If you can get better at swimming that speed at a lower energy cost - then there should be some carry-over into your top speed. We are also looking for a greater ability to deliver energy at a given velocity so it is not just costing less - it is being able to get energy to the muscles that need it more effectively.

Coordination: if you get really, really good at swimming a speed then you are going to start to smooth things out. You are not going to be using muscles that you don’t need. All of these goals or adaptations - we are just talking about efficiency and this is a graphic representation of some 200’s that another swimmer did,
but I had it in a graph form and it is kind of beautiful. These were performed over a number of weeks and you can see there that the purple line is speed - velocity. It stays the same. The yellow line is heart rate and as the number of repetitions goes up - her average heart rate is falling and in fact this training goes through a number of different zones. It starts off in a zone that is pretty close to VO2 MAX and ends up being a speed that you are training at threshold pace and it is a distance where the stress is at threshold pace. And the end result is that you get really good at swimming that speed.

If you want to try this then I think it is really important to monitor it. I think you need to watch real carefully at the beginning and the first two practices where you do any set like this are designed to get used to that speed - to become familiar with the speed. I think you need to make sure that the effort that they are giving is a combination of really challenging, but also doable. They have to swim well. It is imperative that they swim well - otherwise - if you set the setup right - they won't be able to finish. They need to be swimming well from the very beginning. Then recovery - what this means is you don’t want them to recover a whole lot during this set. The goal of the set is by the end, that last effort - whether it is 4 or 20 - at the very end - whatever they have to give - they are giving. If you let them recover too much - if the rest is too much in the beginning then the stress isn’t enough to really make a change and then just be ready as a coach to make adjustments as necessary. This is a table of kind of projected growth of a set like this over a number of weeks - in 8 weeks - so if you start in week 1 with eight 25’s - at the end of the 8th week you should be able to do 40 at that same speed and that is a growth rate of about 20-25% a week and it is really effective at all distances. We have used this type of training for up to 250’s. I haven’t reached into the 400’s and 800’s yet.

So, back to the summer of 2006 she did a progression of these 100’s through the summer and it really helped her. It changed the way she viewed butterfly. Here is an example of volumes that we did in one particular capacity phase. This is actually their shortened season of Spring 2008 and it was six weeks of capacity training and we peaked at about 55,000 meters and so that is the sort of volumes that we were looking at that particular time and we knew going into 2008 that the majority of the capacity work that she had to do had to have been done in the fall and we hit it pretty hard so this six weeks was really kind of getting back up to speed and this is a sample week. I tried to come up with a couple of highlights here again - if you want to download this you can. I am not sure there are too many secrets in here.

Monday morning we were doing parametric 150’s and those progressed through the time period from 5-11 and her time that she had to hold was 1:40 for meters and we did those on 2:10. On Thursday afternoons we did parametric 50’s fly. Her time she had to hold was 30.4 and progressed from 6 to 17 of those, but a typical capacity workout on let’s say Saturday - when the total meters were 7,000. It was about 2,400 meters at a heart rate of 150 - 175 - some race pace work at the end and a volume of consistent, thoughtful - both freestyle and butterfly to make up the rest of that workout. This is an example - we were not able to get a whole lot of heart rate data on Christine because she gets mad at the instrument that takes the data which is a strap that goes around her chest and that strap is evil in her mind and she throws it and she curses it because it makes it difficult for her to breathe and she tried to actually take it off where you see the dip there and I wouldn’t let her - I wanted that data this time and she bought herself an extra few seconds - you can kind of see, but that is her heart rate as it progressed through a set of seventeen 50’s fly and the first 12 were on 1:15 and then she got mad and I think started falling apart a little bit - the last 5 were on 1:30 and she averaged 30.4’s and the stroke count part was really important and I will get to that in a little bit, but we felt like her second 50 needed to be 23 strokes. That is where she was going to swim best and that was the final set that we did. Here is an example of that Saturday morning workout which involves about 2,000 of warm-up and technique work at various aerobic speeds, twelve 25’s - those were a combination of fly and free and that was for efficiency. That was about 92% of her top speed. We did those over in a short course pool and that was just really neuromuscular practice. It wasn’t particularly stressful, but it was a chance for her to practice a stroke count and a speed. Then we went into a typical aerobic set for her fly which is 250’s - keeping her a low stroke count - 100 - where her goal was to build the last 50 and that is real stressful for her - to go 200 in a row fly and then a hundred freestyle easy on 1:50, but that is how we got some of her aerobic fly work in and her capacity work.
Then we moved to freestyle and the goal was - given heart rate - heart rate 127 for her which is about 40 beats below her max. Her goal was to go as fast as possible with a heart rate no higher than that so again - we are promoting efficiency and at the end we did a little race pace work - working on back end speed and back to sort of that parametric pace where she is going 50’s fly and there are 4 rounds of basically three fast 50’s fly with some swimming in between - that is what I think you would call active rest.

So, our power training: when we moved into the second phase of that season, our aerobic power training - the goal was to maximize the way you can use your VO2 MAX. Your VO2 MAX is potential and your power is your ability to use that potential. So, an example of a set that we use to drive aerobic power is three rounds of all out with a lot of recovery in between rounds. One hundred from a dive - really fast - 100 from a push - really fast and then two 50’s from a push. What Christine is really good at is if she understands why we are doing a set then she will execute it beautifully. This summer she was able to go 56.8 on the first one and then come back on the second one and go 59. When we first started that type of training she might go 58 on the first one and 1:04 or 1:05 on the second one so clearly there are some lactate tolerance issues here. We are also - we are blasting - we are trying to get everything that we can out of your aerobic ability so we are overshooting it, but we are asking your body not only to produce as much energy as it can aerobically, but to do it quickly. She is somebody that is very adaptable so we do this once - you can see a result the next week that is dramatically different and so if we do this set 4 times during a power phase then each one is going to be faster than the one before. We also do one that is a little bit less intense and that might be 2 to 3 rounds of eight 100’s - best average. It is very difficult. It is not as high speed. It is a little more steady state and it is an easier set I think mentally to manage. Those are examples of some power training for aerobic power.

Anaerobic power, the goal is to go as fast as you can for as long as you can and we are trying to again - get the most out of your ability to produce energy anaerobically and this is again the lactic system. An example that we did with Christine would be three rounds - everything is as fast as you can go - a 50 from a dive and then it may not be a minute - just however long it takes her to get out to 10 meters and then four 25’s timed from a turn and those areas fast as you can go and she will cross the 25 and then head back to the 10 meter mark and then do it again. It is maintaining race pace and race speed under what we hope are progressively challenging conditions. I think it is real important though - real important to have multiple swims in a set like this and that gives the athlete a chance to reset - to get some feedback and then really home in on the last repetitions with full concentration on how they are swimming. Another example would be six 25’s on :30 - the odd ones dive - the even ones push and again - those are all top speed and then other types of power training that we actually do all through the year - because I don’t believe that these are counter-productive to capacity development or alactic power. We are working on strength. We use Power-Ex. We sprint against tubing. We do 15 meter sprints or sprints lasting 15 seconds. We do a lot of resistive swimming - both slow and fast and I feel like both of those can help anaerobic power and we do a lot of explosive land work.

Back to that short season of spring 2008. We went to Colorado Springs for a few days at the end of the capacity phase of training and this was to help Christine remind herself that she was a National Team Member - she is special and it was kind of a way to give her a break before we headed into what I think of as really dense and intense power training. We didn’t have six weeks for power training - I think we had more like four before it was time to really rest so in Colorado Russell Mark spent some time with us filming and reviewing her stroke. A man named Gordon Wood - who really worked some miracles with her with active release - put her shoulder back into place where I guess that it had been displaced for a little while. She really reset her mind before we came back into this cycle. We decided - since we had a short period of time - that we were going to go 5 day cycles so we are going to go three weeks of 5 day cycles and this would let us do a whole lot of aerobic and anaerobic power work, but since she had a day off every 5 days - there was more of a chance for recovery also. In the very last cycle involved the Ultra Swim Meet in Charlotte so here is an example of the pattern that we designed for the 5 days. On days 1 & 4 we are working on aerobic power in different ways in the morning and anaerobic power in the afternoon and like I said - that is dense training - it is intense training. Day 2 is regeneration - some skill work - some video taping - aerobic capacity maintenance and then Day 3 is a little bit of speed work - stationary work - feeling her
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stroke and then basically a chance to be ready for the next day so we went through essentially three training cycles like that and then the 4th cycle was the Ultra Swim Meet.

I am going to kind of go back to the beginning and talk about - just kind of give you a summary of her training evolution. So - in her age group years she had multiple coaches - a new one every 1-2 years and this is all from her. She said she learned to be independent and to question and she learned it really well because she is real independent and she knows how to question. In her high school years she moved to three month seasons and her coach then was Donna Driscoll. She spent summers with her dad as a coach and with less coordination and then had 10 days we also worked on strength and conditioning and then had 10 days taper. You will have a slide available for download with some of the stuff that we did at the camp. One of the sets that was most impressive to me was 18 days out - we did three broken 100’s where the goal was always the second 50 was going to be 29.5 or better with 23 strokes and she was going to descend the first 50 from a dive and on those she was 27.9. This is the first 50 - 27.9, 27.3, 26.9 and those are always 20 strokes which was the plan and the second 50’s were 29.5 on the first one - 29.1 on the second one and then 28.1 on the last one and she asked for extra rest and I told her - I will give you extra rest and then I sent her - that was 11 seconds - she got 11 instead of 10 and still went 28.1.

Christine’s technical development - we basically worked on three elements of her fly. In the front end of the stroke we felt like she needed the recovery to be forward instead of down and she needed to be patient in the front because she has got such a long vessel and she has long arms that generate a lot of momentum coming forward and so I felt it was important for her to use that and to ride that. In the back of the strokes she tended to rush and retract her hands up towards her belly so we worked a lot on keeping that stroke deeper in the back, she is strong enough to do it. Then at the end of a race she would tend to tighten up - lean back a little bit, but she made those corrections really easily. To tell you the truth - the stroke changes that we really made with her in the last two years were always subtle and they are always fine tuning - except the back of the stroke and I am still not even sure she has that.

This is a video Genadijus used his black box on her that May when we went out to Colorado Springs and this is her swimming fly. I feel like at that point she collapses her elbows and she was retracting her hands up into her belly and losing speed. It just felt like she was exhausted at that point in her training and that was the part of the stroke that gave way and if you come to my talk later this afternoon I will tell you some ways that we have addressed it that I think are pretty cool so I felt like she was missing some good water in the back of the stroke so some of the ways that we worked on this were by doing fly at near race pace with a low stroke count, but also by doing freestyle and trying to get real deep at the end of the stroke in freestyle. This was just a week later and actually no - this was still in Colorado and it was a substantial change from what she had been doing with freestyle.
earlier. Keep your hand deeper at the end instead of pulling it up into her belly. Then her stroke at - I don’t know if I am allowed to show this so do not tell NBC or whoever videotaped this that we are using it, but this is some underwater footage of her at the games and man - she was swimming well at the Games. I felt like she was - she had it and I feel like her hands - she was able to keep her hands deeper for longer and she is able to keep a good angle on the water with her forearm. She is still collapsing a little bit, but there is always room for improvement and if you are going to go 54 you have got to make some changes.

The last thing I will do is I will just kind of take you through how we use some race analysis and how her technique and how her technique and her race tactics developed. I hope you can see that, but the top is her race in Japan and this race analysis is very helpful, but in fact it is wrong. In a lot of cases and thank God we can go back to the video for confirmation because even though it says that at Trials she was 20 strokes - she was actually 21, but this is her first race at Trials and see - she was getting great distance per stroke - low tempo - really under control and that second 50 was faster than she had been in Japan - both parts were faster. We felt great about where she was at that point. That was prelims at Olympic trials. Her start and turn in that race were absolutely abysmal. 6.7 on the start and look at that turn time - 1.24 - I don’t even know how you can go that slow. Her semi-final swim at Trials was really good and in fact that was 21 strokes again and her turn was better. The start was still slow and so she was 21 and 24 strokes and at night - that is when the nerves hit and the wheels came off. She was 23 strokes going out and that 23rd stroke was long it should have been 24. She was spinning and look at that tempo - .97 and I talked about earlier - we wanted her to be patient out in front and she just wanted to get to the next stroke and she didn’t go fast and she used a lot more energy so all that efficiency training that we did - you can see - it helped in the semifinals - didn’t help so much in finals. Then that 25 strokes coming back is accurate and nearly gave me a heart attack, but she finished really tough and that gave her a lot of confidence.

Then at the Olympic training camp she did a whole lot of work on her start with Jonty Skinner and you can see - that really paid off. She actually had some of the best starts at the Games and was at 6.4. She also did a lot of underwater work with Natalie Coughlin and Natalie just took her under her wing and helped her and Teri McKeever helped her a ton too. So at the games her starts were .23 seconds faster and I think a lot of that had to do with the work that Jonty did with her, but also the work that she did underwater with Natalie. The goal was 20 and 23 strokes and in semis she was actually 21 - again - and that was a short stroke - the 21st stroke was short and in finals she was actually 20, but it was a long stroke and it was heading into the turn where these two Australian women just again - kind of destroyed her. This is my favorite race that she has ever swum because of what you will see when she comes off the wall because she kind of knew she had gone long into the wall. She kind of knew she had made a mistake, but instead of panicking she got excited. She actually believed - for whatever reason - that she could run anybody down because nobody caught her at Trials. She has run people down before and she had that belief in her mind that she could run anybody down and I think that is all you need.

This is her final race. I don’t have sound and there is a lot of footage here of the winner as there should be, but Christine is on the other side of her and for warm-up at this meet - I was up in the stands and I watched her do warm-up and it was the best fly I have ever seen - still to this day - from her - she was so ready to go and the first 50 I think was beautiful. She just drifted into this wall here - with 20 strokes which was what we were aiming for, but came off a little behind and here she goes and she is patient. She is not panicking. One of the negatives - the side breathing - is that if you are in lane 5 and your competitor is in lane 4 and you breathe to your right you are not going to see her, but it works well the other way too so that is what you get. But in this last 25 you can see her gaining on Jessica Schipper and finally passing her and I believe if she had had another 5 yards she was going fast enough to have run down Libby Trickett. I just love that race - I love her mindset - I loved the way she finished. There were two people in that building that were a little bit pissed off that she had a silver medal and that was me and her and that is what makes her great.

Thanks for your attention - that is kind of the story of Christine and I hope you cheer for her in the future because she is worth cheering for.
Book Review:

“Boys Adrift” by Leonard Sax, M.D., Ph.D

I am continually fascinated by the changes in males over the past few decades. In particular, Coaching Boys has become a radically different proposition than it was in the “old days” of the 70’s or even the 80’s. I am always looking for both reasons and solutions.

I found a good bit of both in “Boys Adrift” by Leonard Sax. Written in plain language, it outlines Four Factors that are causing issues and problems.

First, Changes at School, Second, Video Games, Third, Medications and ADHD and Fourth, Endocrine Disruptors.

He calls the end product, “Failure to Launch”. Well said. There is also a brilliant final chapter called “The Revenge of the Forsaken Gods”, that I’d like to publish in whole if I could….it’s that good.

If you coach boys and want to do a good job, I recommend reading this book. It’s the best thing I’ve read so far this year.

All the Best, John Leonard
Introduction

The anaerobic threshold is often used to identify a specific level of effort by the swimmer during training. Perhaps the most common test to help determine the anaerobic threshold is the blood lactate test which determines the swimming velocity (level of effort by the swimmer) at which the anaerobic threshold occurs. Knowing the anaerobic threshold velocity allows the swimmer to increase or decrease level of effort (velocity) depending on the coach’s desire to train above or below the anaerobic threshold. Regardless of how level of effort is referred (e.g., anaerobic threshold, time, velocity, heart rate, etc.), the major problem with using scientifically quantifiable metrics is that the swimmer has difficulty determining level of effort during the training exercise (i.e., while swimming) and must wait until after the training exercise is complete and then receive feedback from the pace clock and/or coach.

While application of scientific methods to athletic training have contributed to helping swimmers achieve performance levels previously thought unattainable, research is primarily limited to laboratory environments. A common holdback of applying science during training is that the scientific method relies on formal protocols and test equipment of varying levels of complexity and size, often making an already crowded pool deck even more cumbersome to navigate. Additionally, test equipment often interferes with the flow of the training session desired by the coach.

Perhaps the biggest limitation to applying scientific training methods to swimming is that data collection protocols are not easily performed with a large number of subjects (e.g., an entire swim team). It is true that portable lactate analyzers are available, however obtaining the large quantity of blood samples necessary to determine the anaerobic threshold for an entire training session of 30 senior level swimmers (i.e., high school, college, post graduate) is cumbersome, and could lead to mistakes in data recording that could produce erroneous anaerobic thresholds for one or more swimmers. The question becomes, how does the swimming coach help a large number of swimmers better estimate level of effort throughout a training session with common everyday equipment found on the pool deck?

The discussion that follows illustrates how stroke count can be used as an alternative way for the swimmer and coach to accurately estimate the swimmer’s velocity at the aerobic and anaerobic thresholds (i.e., level of effort). Establishing the aerobic and anaerobic threshold velocities using stroke count provides the swimmer with real-time level of effort feedback that will help the swimmer train longer at the desired level of effort thereby improving the effectiveness of the training exercise and the cumulative effect of the training session. Given the ability to more accurately monitor level of effort during training exercises will enable the swimmer to sustain the necessary athletic performance improvement required to achieve personal and team goals.

The following sections provide the reasoning which links the level of effort measured by the velocity at which the aerobic and anaerobic thresholds occur to the level of effort measured by the velocity a swimmer is able to achieve for a specific stroke count. However, before proceeding, a review of training terminology used within the following sections is in order.

Review of Training Terminology

As swimming coaches we use a set of training terms in our daily lives, and through familiarity or context of use, sometimes overlook the true meaning of a training term. Therefore, to improve communication of the logic used in the following paragraphs, a review of training terms that may have more than one meaning within the swim community is presented in Table 1.

Having established a common reference for training terms in Table 1, the next step is to relate
the terms to the training categories used in swimming. While there are several versions of training categories or training zones in use today, this discussion uses the six training categories found in the three book Swimming Faster series by Dr. Ernest W. Maglischo (EN1, EN2, EN3, SP1, SP2, and SP3). Table 2 associates each of the six training categories with the definitions of aerobic and anaerobic threshold found in Table 1. Readers interested in additional information on training categories are referred to the vast quantities of swimming literature pertaining to the purpose and effects of each training category.

**mmol/L to Velocity**

Blood lactate monitoring has many uses within athletics including the identification of swimmer’s peak lactate level, determining performance potential and determining muscular endurance/anaerobic capacity. The discussion that follows will be limited to using blood lactate monitoring to determine the velocity at which the swimmer’s aerobic and anaerobic thresholds occur and the application of swimming velocity to achieve the desired level of effort from the six training categories listed in Table 2.

Training literature indicates that using blood lactate levels to determine the aerobic and anaerobic thresholds provides an accurate estimate of the velocity at which optimal endurance training occurs. Training literature also indicates that training above the anaerobic threshold velocity is necessary to provide overload endurance training (EN3), improve lactate tolerance (SP1), improve lactate production (SP2) and to provide power training (SP3).

**Protocol for Blood Lactate Testing**

There are many swimming test protocols used during blood lactate monitoring. A typical test protocol and sample test set commonly found in swimming literature is listed in Table 3.

<table>
<thead>
<tr>
<th>Table 1 – Training Terminology Review</th>
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<tbody>
<tr>
<td><strong>Training Term</strong></td>
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<tr>
<td>mmol/L</td>
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<tr>
<td>• In training, the metric measurement for liquid (liter) refers to a liter of blood.</td>
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<tr>
<td>• Mole – is a molecular measure of weight, in this case the molecular weight of lactic acid in grams</td>
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<tr>
<td>Lactic Acid, Blood Lactate</td>
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<tr>
<td>• The accumulation of lactic acid in the muscles contributes to muscle fatigue.</td>
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<tr>
<td>• Excessive accumulation of lactic acid in the muscle cell causes the pH of the muscle cell to become acidic resulting in a condition referred to as acidosis (lactic acid produces lactate and hydrogen atoms – the increase in hydrogen atoms results in the muscle pH becoming more acidic and the excess lactate enters the circulatory system to become blood lactate).</td>
</tr>
<tr>
<td>• As more lactic acid is produced by the muscle cell more lactate is produced and enters the blood.</td>
</tr>
<tr>
<td>• Blood tests measure the increase or decrease in blood lactate which in turn represents and increase or decrease of lactic acid production by the muscle cells; as a result lactic acid and blood lactate are used synonymously but in actuality are two uniquely distinct entities.</td>
</tr>
<tr>
<td>• For additional information on lactic acid and blood lactate the reader should research one or more of the following topics; ATP-PC System, Lactic Acid System, Oxygen System, Glycolysis, and the Krebs Cycle.</td>
</tr>
<tr>
<td>Aerobic Threshold</td>
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<tr>
<td>• a.k.a.: the first breakpoint</td>
</tr>
<tr>
<td>• Represents an approximation of the minimal velocity (speed) needed to improve aerobic endurance.</td>
</tr>
<tr>
<td>Anaerobic Threshold</td>
</tr>
<tr>
<td>• a.k.a.: Onset of Blood Lactate Accumulation (OBLA), lactate threshold, lactate breakpoint, Maximum Lactate Steady State (MAXLASS), lactate turnpoint, the second breakpoint.</td>
</tr>
<tr>
<td>• Often expressed as a percentage of VO2max</td>
</tr>
<tr>
<td>• Above the Anaerobic Threshold, blood lactate levels (mmol/L) increase rapidly</td>
</tr>
<tr>
<td>Lactate-Velocity Curve</td>
</tr>
<tr>
<td>• The first breakpoint on the curve equals the Aerobic Threshold velocity (swimming speed)</td>
</tr>
<tr>
<td>• The second breakpoint on the curve equals the Anaerobic Threshold velocity (swimming speed)</td>
</tr>
<tr>
<td>• Endurance training occurs at swimming velocities between the aerobic and anaerobic thresholds.</td>
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</tbody>
</table>
In other words, to obtain valid test results, the selected distance must allow lactic acid to accumulate and the swimmer must complete the test distance before buffering starts reducing accumulated lactic acid. Normally, repeat distances of 300 to 500 yds are used with the total set distance of 1,500 to 3,000 yds. As with any testing protocol, the test must be repeated throughout the season to adjust training velocities in order to optimize training. The frequency of testing is up to the coach with a minimum of three to four weeks between tests.

<table>
<thead>
<tr>
<th>Training Term</th>
<th>Definition/Additional Information</th>
</tr>
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| VO2max        | **Definition:** The maximal oxygen uptake or the Maximum volume of oxygen that can be utilized by an individual in one minute during maximal or exhaustive exercise.  
**Measurement:** milliliters of oxygen used in one minute per kilogram of body weight.  
- Determination of VO2max requires strict laboratory protocols and requires the individual to endure exhaustive exercise to determine the individuals true VO2max (other methods are available to estimate VO2max but are not as accurate as strict laboratory protocols). As exertion increases so does oxygen consumption up to a point where oxygen consumption plateaus. The plateau represents VO2max.  
- Considered to be the best indicator of cardiovascular fitness and aerobic capacity  
- Many training protocols are represented as a percentage of VO2max.  
- Improving VO2max requires an increase in both training volume and intensity.  
- Research indicates that as the athlete’s fitness level increases the harder it becomes to increase the athlete’s VO2max.  
- Readers interested in an alternative VO2max testing protocol should research the Bruce Treadmill Test Protocol (a.k.a. stress test). |
| Buffering     | The ability of the human body to remove lactic acid before it leads to muscle fatigue, either by use within the muscle fiber for additional energy, or transferring the lactic acid to other areas of the body for use as energy, allowing the athlete to perform longer at intensities above the anaerobic threshold (i.e., transfer from a concentrated source to a less concentrated source). For readers who want additional information about buffering, research the topic ‘lactate shuttle’. |
| Race Pace Training | A training protocol where the velocity of a training exercise is performed at or above the swimming velocity necessary for performance improvement during competition (i.e., goal event splits). While race pace will vary by event (stroke) and distance, Race Pace Training will almost always, if not always, occur at velocities above the anaerobic threshold, therefore care must be taken to follow the guidelines for the frequency of training in the EN3 and SP1 training categories (see Table 2) in order to prevent overtraining. During Race Pace Training the swimmer and coach also need to insure proper technique is maintained. Race Pace Training is a combination of level of effort (velocity) and technique efficiency. |
| Stroke Cycle  | One complete stroke as defined below.  
- Long Axis Strokes (Freestyle and Backstroke) – 2 arm strokes or hand hits of the water, one with the right hand and one with the left (e.g. – right hand hits water to right hand hits water again).  
- Short Axis Strokes (Breaststroke and Butterfly) – 1 complete stroke often measured from full extension to full extension (i.e. – point just before arms start to move horizontally to start arm pull of a new stroke). Note – in Butterfly hand hits can also be used. |
| Stroke Count  | See the section of this text titled “Defining Stroke Rate and Stroke Count”. |
| Stroke Rate   | See the section of this text titled “Defining Stroke Rate and Stroke Count”. |

<table>
<thead>
<tr>
<th>Training Category</th>
<th>Relationship/Additional Information</th>
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| Endurance 1 (EN1)  
(Basic Endurance)   |  
- Swimming velocities faster than aerobic threshold but slower than anaerobic threshold.  
- The swimming velocities found on the lower half of the Lactate-Velocity Curve (Figure 1) between the aerobic and anaerobic thresholds. |
| Endurance 2 (EN2)  
(Threshold Endurance) |  
- Swimming velocities around the anaerobic threshold.  
- The swimming velocities found on the upper half of the Lactate-Velocity Curve (Figure 1) between the aerobic and anaerobic thresholds.  
- It is allowable for the swimming velocity to be slightly above or below the anaerobic threshold. |

When selecting a test distance care must be taken to insure the distance is long enough so that the swimmer can not sprint the entire distance yet short enough that the swimmer can maintain a consistent velocity over the testing distance. In other words, to obtain valid test results, the selected distance must allow lactic acid to accumulate and the swimmer must complete the test distance before buffering starts reducing accumulated lactic acid. Normally, repeat distances of 300 to 500 yds are used with the total set distance of 1,500 to 3,000 yds. As with any testing protocol, the test must be repeated throughout the season to adjust training velocities in order to optimize training. The frequency of testing is up to the coach with a minimum of three to four weeks between tests.
Interpreting Results of Blood Lactate Testing

Training Category | Relationship/Additional Information
--- | ---
Endurance 3 (EN3) (Overload Endurance) | • Swimming velocities above the anaerobic threshold.
• The swimming velocity and duration of the velocity should not cause severe acidosis (swimmer experiences light to moderate discomfort from acidosis).

Sprint 1 (SP1) (Lactate Tolerance) | • Swimming velocities above the anaerobic threshold.
• The swimming velocity and duration of the velocity should cause severe acidosis (swimmer experiences severe discomfort from acidosis).

Sprint 2 (SP2) (Lactate Production) | • Swimming velocities that are above the anaerobic threshold that engage anaerobic metabolism but do not cause acidosis.
• Sustained swimming velocities that allow anaerobic metabolism to produce large amounts of lactic acid with the duration of the velocity ending prior to or just as the discomfort of acidosis begins, approximately 20 to 40 seconds of work.

Sprint 3 (SP3) (Power Training) | • Maximum or near maximum swimming velocities (i.e., above anaerobic threshold velocity) with the duration of the velocity ending before the pH of the muscle fiber changes.
• Maximum muscle contraction for duration of 4 to 6 seconds of work or 4 to 8 stroke cycles.
• Goal is to limit the muscle cell to using Creatine Phosphate stored in the muscle and end the activity before the onset of anaerobic metabolism.

### Table 3 – Example Blood Lactate Testing Protocol

1. Determine resting blood lactate level before testing.
2. Swim a series of repeats at the test distance at progressively faster times (velocity).
3. Obtain blood sample after each swim (usually from earlobe or finger tip).
4. Use a blood lactate analyzer to determine the amount of lactate acid in the blood sample. Note – most of today’s portable lactate analyzers can produce pool side results in about a minute.
5. Record swim time and blood lactate level.

Common Test Set Found in Swimming Literature
- Swim 5 x 200 with 1 minute rest between each swim
  - 1 = easy
  - 2 – 4 = each faster than one before (goal 5 – 10 seconds faster)
  - 5 = maximum effort
- Convert TIME to VELOCITY by solving for Rate (velocity) (See Table 6, Basic Algebra Distance Formula).
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Interpreting Results of Blood Lactate Testing

Lactate-Velocity Graph as illustrated in Figure 1. Swimming velocity to complete the test a minimum of three to four weeks between tests. Training velocities in order to optimize training. The frequency of testing is up to the coach with are used with the total set distance of 1,500 to 3,000 yds. Buffering starts reducing accumulated lactic acid. Normally, repeat distances of 300 to 500 yds allow lactate acid to accumulate and the swimmer must complete the test distance before completing the distance at a velocity of 1.66 yds/sec (300 yd/180 sec). To calculate the goal training pace for a given distance, use the distance formula to solve for time (see Table 6, Basic Algebra Distance formula). Velocity in swimming is expressed in yds/sec or m/sec by converting the time to complete the test distance from the standard minutes and seconds format into seconds (e.g., 1:30 minutes = 180 sec) indicates the swimmer completing 300 yds in 3 minutes (3 1.30 becomes 90 seconds). For example, 1.40 seconds format into seconds (e.g., 1:30 becomes 1 minute before point B represents the anaerobic threshold (second breakpoint). Note that the slope of the line between A and B indicates a gradual increase in blood lactate as the amount of accumulating blood lactate is ‘easily’ removed by the body. Above point B the anaerobic thresholds occur is beyond the scope of this discussion.

To identify the aerobic and anaerobic thresholds the blood lactate test results are plotted on a Velocity graph curve (figure 1) helps the coach determine swimming velocities for the six Training categories found in Table 2. Below the aerobic threshold small quantities of lactic acid are produced and easily removed from the body. As a result, training recovery swims are often performed at velocities below the aerobic threshold to help remove lactic acid accumulated during training. Endurance training would primarily occur at velocities between the aerobic and anaerobic thresholds, with EN1 training velocities in the lower part of the curve and EN2 training velocities in the upper half of the curve between points A and B in Figure 1. Overload Endurance training (EN3) and all Sprint training swimmers are different, perhaps, in order to determining an appropriate anaerobic threshold velocity, a shorter distance test protocol should be used for sprinting and a longer distance test protocol should be used for distance swimmers.

Due to the characteristics and the physiological requirements of each stroke, it is logical to conclude that the observed anaerobic threshold will be accurate only for the stroke and distance tested. Unless additional testing is performed at other distances (ex. 100, 300, 500) with other strokes, the anaerobic threshold velocity obtained during testing will need to be manually adjusted (estimated) for other training distances and strokes. Logically, in order to approximate the anaerobic threshold, training distances shorter than the test distance will require faster swim times and training distances longer than the test distance will require slower swim times. For example, if a 200 yd test distance was used, then a training distance of 100 yds would require a faster training time to achieve the anaerobic threshold velocity and a training distance of 500 yds would require a slower training pace in order that the swimmer not exceed the anaerobic threshold; estimation methods are beyond the scope of this discussion.

As the velocity at the anaerobic threshold may be faster than that which the swimmer can maintain during training, especially when short test distances are used, it is recommended that the anaerobic threshold velocity be verified before using the velocity to design training sets. If the anaerobic threshold velocity is too fast the swimmer may start the training set at the anaerobic threshold (EN2) but due to over exertion may not be able to maintain the EN2 velocity and approach EN1 velocities by the end of the training set thereby reducing the desired training affect.

When completed, the Lactate-Velocity Graph curve (Figure 1) helps the coach determine swimming velocities for the six Training categories found in Table 2. Below the aerobic threshold small quantities of lactic acid are produced and easily removed from the body. As a result, training recovery swims are often performed at velocities below the aerobic threshold to help remove lactic acid accumulated during training. Endurance training would primarily occur at velocities between the aerobic and anaerobic thresholds, with EN1 training velocities in the lower part of the curve and EN2 training velocities in the upper half of the curve between points A and B in Figure 1. Overload Endurance training (EN3) and all Sprint training
(SP1, SP2, and SP3) would occur at velocities above the anaerobic threshold (Point B in Figure 1). Common sense would dictate that EN3 velocities would occur closer to the anaerobic threshold and sprint velocities would occur further up the Lactate-Velocity Graph curve. Obviously, when determine training velocities, the usefulness of the Lactate-Velocity Graph improves as the number of samples above and below the anaerobic threshold increases.

**Limitations of Blood Lactate Testing to Determine Anaerobic Threshold Velocity**

Knowing that the human body starts to recover immediately after the removal of stress (e.g., swim test), it is important that the blood sample is taken as quickly as possible upon completion of each test swim. As precise data is important during testing, the number of swimmers in a test group must not exceed the ability to accurately collect blood samples during the recovery period between test swims. As it is assumed there will be a limited number of assistants obtaining blood samples, it may require several test groups over two or more days to test an entire team or training group.

Extra planning on the coach’s part is required when testing several groups during a training session. While testing one group the remainder of the team scheduled for testing during the training session will need to be engaged in activities that will not affect blood lactate testing. For example, care must be taken not to raise blood lactate prior to an individuals test as the extra blood lactate from prior activity plus the lactate produced during testing may result in a slower swimming velocity when the anaerobic threshold is achieved. The coach will also need to plan activities for swimmers who will not be tested during the training session in accordance with the yearly training plan.

Prudent managers will also consider the two costs associated with blood lactate testing. As illustrated above, each time blood lactate testing is conducted the normal training routine is disrupted producing a cost in training time. The second cost associated with blood lactate testing is the monetary cost of equipment and supplies each time testing is conducted.

The primary monetary cost associated with blood lactate testing is the portable blood lactate monitor, about $250 per unit. Other cost items that quickly come to mind include the lancets used to produce a minor wound capable of producing the required blood sample after each test swim, and rubber gloves to protect the individual obtaining the sample from blood borne diseases. Information on the internet indicates the estimated cost of supplies for blood lactate testing is between $1.14 and $1.60 per test. For a test set like the one illustrated in Table 3, the estimated cost per swimmer would be between $5.70 and $8.00, and for a training group of 30 swimmers the estimated cost for blood lactate testing would be between $171 and $240. Table 4 summarizes the previously identified costs associated with blood lactate testing.

Within the swimming community, the T3000 swim test is often used as an inexpensive substitute for blood lactate testing to estimate velocity at the anaerobic threshold. However, there are several assumptions that limit the validity of the T3000 or 30 Minute Continuous Swim Test. The primary assumption is that the swimmer swims at a maximal sustainable effort at an evenly paced velocity for the entire distance. Personal experience has indicated very few age group or senior swimmers posses the motivation, let alone the desire, to swim 3,000 yards/m for time or any other reason. Therefore, the velocity indicated by the T3000 test is often well below the anaerobic threshold and negatively impacts training and goal achievement. Additionally, others will argue that an improvement in T3000 time (velocity) indicates an improvement in conditioning. Measuring improvement in conditioning solely based upon an improved test swim time is an over simplification of the effects of training on the human body. For example, with younger swimmers, as one grows...

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**Table 4 – Estimated Monetary Cost of Blood Lactate Testing**

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<tr>
<td>Cost of Supplies Per Test</td>
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</tr>
<tr>
<td>Supply Cost Per Swimmer for Test Set (Table 3)</td>
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</tr>
<tr>
<td>Supply Cost Per 30 Swimmers</td>
<td>$170 - $240 per team testing</td>
</tr>
<tr>
<td>Supply Cost Assuming 3 Team Tests Per Year</td>
<td>$510 - $720 annually</td>
</tr>
</tbody>
</table>

Source: various internet vendor and independent sites.
older you would expect the T3000 swim time to improve as the swimmer naturally gets stronger. With mature swimmers you would expect the improvement from T3000 to T3000 to decrease as the swimmer approaches biological maturity, approaches his potential as a swimmer, and as the swimmer adjusts his training to match a specific event. Additionally, like blood lactate testing, the results of the T3000 are only valid for the stroke swum during testing. For example, while a T3000 using freestyle (front crawl) will identify an anaerobic threshold velocity, additional testing is necessary to determine if the freestyle anaerobic threshold velocity also applies to backstroke, butterfly and breaststroke.

Finally, the major limiting factor in using blood lactate testing to determine anaerobic threshold is the fact that the swimmer must have reached a point in biological development that enables the production of lactic acid in quantities that will make training above the anaerobic threshold beneficial to the swimmer’s development (i.e., the swimmer must be post puberty). As a majority of most age group teams are pre-puberty, the monetary cost for blood lactate testing of a smaller population of the post puberty swimmers may not produce a cost benefit for the team.

**Velocity to Stroke Count**

Before continuing, it should be explicitly stated that velocity is the common denominator used to measure level of effort during training and competition. Technically speaking, velocity measures a rate of change in position along a straight line in a given time and is commonly expressed in miles per hour (mph) or in swimming as yards or meters per second (yds/sec, m/sec). While velocity could be used to determine the fastest swimmer or indicate a specific level of effort, the term velocity is seldom used when the coach and swimmer discuss training intervals and event goal times.

Within the swimming community, time is most often associated with determining a swimmers level of effort during training and competition. Time is easily understood by the swimmer because time is used in the swimmer’s daily life, and time is displayed on pace clocks and other devices on the pool deck, and time is used to communicate departure intervals during training. It is also interesting to note that qualification standards, pool records, meet results are displayed in time format, not velocity. Time is an acceptable substitute for velocity as time is a component of the algebraic formula \( R = \frac{D}{T} \) used to calculate velocity (see Table 6, Basic Algebra Distance Formula). It is interesting to note that while swimmers, coaches and spectators know the swimmer with the fastest time wins the event, it is really the swimmer with the fastest sustained velocity over the event distance who gets the fastest time; \( T = \frac{D}{R} \) (see Table 6, Basic Algebra Distance Formula).

Whether the coach and swimmer use time or velocity as the metric to determine level of effort necessary for athletic performance improvement, neither metric does the swimmer any good if the swimmer can not monitor the metric while swimming, after all, swimming is not like driving a car with a built in speedometer on the dashboard. The question then becomes how can a swimmer, within reason, monitor swimming velocity (level of effort) while swimming and be reasonably sure he is training at the level of effort desired by the coach? More simply stated, what is the swimmer’s equivalent to the car’s speedometer? The simple answer, stroke counting.

Before proceeding it is important to understand that the information in this section, and the sections that follow, is considered an alternate application of the research and procedures found in the article titled “Training Using the Stroke Frequency-Velocity Relationship to Combine Biomechanical and Metabolic Paradigms”, by Budd Termin, M.S., and David R. Pendergast, Ed.D., in the Journal of Swimming Research (JSR), vol 14, Fall 2000, pp 9 - 17, and should not be considered original work.

Analysis of the JSR article indicates the general rules of periodization were followed with the stroke rate and velocity determined during initial stroke count testing as the baseline for monitoring biomechanical efficiency (i.e., technique, specifically stroke length), and aerobic and anaerobic development. Analysis of the JSR article also implied the swimmers received feedback from the coach pertaining to stroke rate and velocity upon completion to the training exercise.

The four training phases identified in the JSR article were directly influential in developing the concept of using stroke count to estimate the aerobic and anaerobic thresholds, using stroke counting by the swimmer to provide real-time level of effort monitoring during training exercises, and the association of stroke counting to traditional training models based upon the six Training categories.
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identified in Table 2. References in the JSR article to use stroke counting for the development of biomechanical efficiency (technique and improved stroke length) during Phase 1 of training directly influenced the idea of using stroke counting to help younger swimmers develop stroke technique, and the continued importance of using stroke counting to maintain and improve biomechanical efficiency for older swimmers.

**Defining Stroke Rate and Stroke Count**

While stroke rate and stroke count are often used interchangeably in swimming literature, they are two separate items. Therefore it is important to establish the contribution of stroke rate and stroke count when it comes to determining the aerobic and anaerobic thresholds and their application to monitoring a swimmer’s level of effort during training.

Stroke rate is calculated by determining the time it takes a swimmer to complete a predetermined number of stroke cycles and expressed as cycles/minute, seconds/cycle, or cycles/sec, and most commonly expressed in cycles/minute. Obviously, the swimmer can not calculate stroke rate during a training exercise, thereby eliminating stroke rate as an effective way for the swimmer to monitor level of effort during training. Stroke rate is more commonly used in a swimmer’s event racing plan where the desired stroke rate to achieve a goal time is defined.

Stroke count is simply the number of strokes it takes the swimmer to complete one lap of the pool short course or long course. As stroke count is easily obtained while swimming, stroke counting is well suited for helping the swimmer monitor level of effort (i.e., is the swimmer maintaining velocity) throughout a training exercise by periodically counting strokes per lap.

Stroke counting as a means to estimate swimming velocity (level of effort) is supported by the following formula widely used in swimming literature, \( V = S \times R \times L \) (see Table 6, Swimming Velocity Formula). The preceding formula illustrates that the key to maximum swimming velocity is finding the proper combination of stroke rate (SR) and stroke length (SL). As will be illustrated in the following sections, an increase in stroke count represents a corresponding increase in stroke rate which, to a point, produces a corresponding increase in swimming velocity. As stroke count is directly dependant on stroke rate, the stroke count can be substituted for stroke rate (SR) in the Swimming Velocity Formula to monitor level of effort during training.

In order for stroke counting to be an effective training aid the swimmer and coach must be consistent in how stroke count is determined. In breaststroke and butterfly it is common to count one stroke from full extension to full extension (i.e. - point just before arms start to move horizontally to initiate the arm pull of a new stroke) but one stroke may also be counted from head surface to head surface, and in butterfly hand hits (each time the hand enters the water) could also be used. For freestyle and backstroke, experience has shown that it is easier for the swimmer to increase the stroke count by one each time a hand hits or enters the water (i.e., right hand hit + left hand hit = a stroke count of 2) rather than counting stroke cycles. Additionally as each lap starts with a stroke count of zero, and the first stroke is often associated with the transition from underwater swimming to surface swimming, the swimmer and coach must decide if the initial stroke of each lap counts as a zero or one.

For the remainder of this discussion stroke rate will refer to the mathematical calculation expressed in cycles/minute and the term stroke count will refer to the physical/mental act of counting strokes or hand hits by the swimmer or coach. For example, the swimmer completed the lap at a stroke rate of 44 cycles/minute with a lap stroke count of 16 strokes/hand hits.

**Protocol for Determining Stroke Count**

The test protocol used to determine lap stroke count was taken from the previously identified JSR article. It should be noted that the JSR article used a test length of 22 meters and college age swimmers while the data presented in the following paragraphs was collected using a test length of 25 yds and high school age swimmers who had qualified for USA Swimming’s Speedo Championship Series (a.k.a. Sectionals) and planned to swim in college.

The test protocol from the JSR article is summarized in Table 5. While the swimmers are asked to gradually increase their stroke count throughout the test, the test is essentially divided into two parts; the first part emphasizing stroke length and the second part emphasizing speed (stroke rate) without regard to stroke length. The dividing point between the test’s two parts is the highest stroke
count at which the swimmer can focus on stroke length to increase velocity (speed).

To perform the test a group of six swimmers with similar background, as indicated above, were placed in one lane. Each swimmer swam his lap individually in turn. Rest between test laps was equal to the time it took for the remaining 5 swimmers to complete their test lap and to record data.

The first time the test protocol was used it took longer than expected (about 1 hour and 10 minutes) as the swimmers often repeated the same stroke count and achieved two or three different lap times. To prepare for the first test it is recommended that the coach include several training sets based upon the test protocol in order to decrease the learning curve during the test. Experience has shown that it is important for the coach to become familiar with the lap routine necessary to collect test data. Therefore, it is also recommended that the coach practice using the stopwatch as he will use it during the test in order to establish a consistent rhythmic process to collect lap test data (especially important if the coach will be using two stopwatches).

By the third time the test protocol was used testing time was taking between 30 to 45 minutes for one lane of 6 swimmers. The time required for testing was reduced as swimmers learned to use stroke counting in training to control velocity.

During the test the coach collects the following information for each lap:

- Stroke Count - as provided by the swimmer,
- Lap Time - as obtained by the coach’s stopwatch,
- Time to complete 3 stroke cycles - as obtain by coach’s stopwatch.

From the data collected the coach is able to determine the following for each lap:

- Stroke Rate (cycles/minute) (see Table 6, Formula Number 3),
- The Stroke Count associated with each Stroke Rate,
- Distance Per Stroke (see Table 6, Formula Number 6),
- Velocity (see Table 6, Formula Number 1)

During the test, it is recommended that the coach instruct the swimmers to increase their stroke count by one or two strokes/hand hits per lap in order to more accurately determine stroke counts associated with various velocities and stroke rates.

**Interpreting Results of Stroke Count Test Protocol - Defining Training Categories**

In his book Swimming Fastest (page 420); Dr. Ernest Maglischo indicates it is only necessary to train at a velocity that approximates the anaerobic threshold to benefit from Threshold Endurance Training (EN2). As

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**Table 5 – Stroke Counting Test Protocol**

**INSTRUCTIONS TO SWIMMER**

**Every Lap**

- Push off side of pool and swim 1 lap (25yd, 25m, or 50m)
  - Maintain consistent underwater work
  - Maintain constant stroke rate and velocity
- Count strokes (hand hits) each lap and provide when requested at the end of each lap

**First Lap** – use minimal number of strokes to complete one lap to achieve maximum distance per stroke.

**Subsequent Laps – Distance Per Stroke**

- With each lap – increase stroke rate (hand hits) while maintaining maximum distance per stroke.
- Continue until swimmer feels maximum velocity (lap time) achieved (i.e., the point at which the swimmer feels that in order to go faster it will be necessary to rely on a higher stroke rate rather than maintaining distance per stroke).

**Subsequent Laps – Stroke Rate**

- Continue to increase stroke rate (hand hits) and not concentrate on distance per stroke.
- Continue swimming with increased stroke rate (stroke count/hand hits) until no further increase in lap speed (lap time) – indication will be a slower lap time with an increase in stroke rate or some swimmers may not be able to increase their stroke rate any further.

**COACH’S TASKS FOR EACH LAP**

- Record lap time
- Record time to swim three stroke cycles (may use stopwatch that determines stroke rate).
- Record stroke count (hand hits) from swimmer.
- Record stroke count where swimmer feels must rely on increasing stroke rate rather than maintaining stroke length to get faster lap times.
all data necessary to determine stroke count and stroke rate are gathered together during testing, stroke counting by the swimmer can be used to approximate the anaerobic threshold and swimming velocity for EN2 and the other training categories identified in Table 2. Knowing the stroke count for each of the training categories is the swimmer’s equivalent to the speedometer on the car’s dashboard; thereby enabling the swimmer to monitor swimming velocity (level of effort) during training sets which contributes to improved quality of training and improved athletic performance. How to estimate the stroke count equivalent for the desired training velocity is explained later in this section.

While coaches of pre-puberty swimmers will primarily use stroke counting to improve stroke technique and to help swimmers understand the relationship illustrated in the formula \( V = SR \times SL \) (see Table 6, Swimming Velocity Formula), this section is most applicable to coaches who work with serious post puberty swimmers that require training in the six training categories identified in Table 2. Figures 2 and 3 will be used to illustrate how the raw data collected during testing can be changed to useful information that can improve the swimmer’s ability to monitor level of effort during training and select the best stroke count necessary to achieve competitive performance goals. Figure 4 illustrates the improvement obtained by the same male high school age swimmer over 1.5 years. Improvement in this case is defined as an increase in velocity for the same stroke rate (stroke count) and the results are consistent with the improvement observed in the previously identified JSR article.

The shaded rows in Figures 2 and 3 identify the data collected by the coach during pool testing. The next four rows in Figures 2 and 3 are calculated values based upon the collected data. The formulas used to calculate velocity, cycles per second (a.k.a. Stroke Rate), cycles per minute (a.k.a. Stroke Rate), and distance per stroke (a.k.a. Stroke Length) are listed in Table 6. For ease in calculating and plotting the values in a graph, it is recommended that the coach use a spreadsheet application capable of doing both; Figures 2, 3, and 4 in this discussion were generated using Microsoft Excel.

The Stroke Rate Velocity Curve (Figures 2 and 3) illustrates the velocity achieved for each stroke count. By applying the definition for aerobic and anaerobic threshold the estimated velocity for each can be identified in Figures 2 and 3. You will note that the structure of the Stroke Rate Velocity Curve in Figures 2 and 3 is similar to the previously introduced

   Lactate-Velocity Curve (Figure 1). As velocity is common between the Lactate-Velocity Curve and Stroke Rate Velocity Curve, the Stroke Count Test Protocol and Blood Lactate Test Protocol can be compared for accuracy if desired.

   Identifying the Training categories from the stroke count and calculated values in Figures 2 and 3 is a combination of science (applying definition of terms) and common sense (applying knowledge). For example, recalling that velocity is being used as the quantifiable component of level of effort, when assigning stroke counts to a specific training category, it is important to insure that the stroke counts within a training category have similar velocities.

### Table 6 – Formulas

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<tr>
<td>1</td>
<td>Basic Algebra Distance Formula</td>
<td>( D = R \times T )</td>
<td>The algebraic formula used to calculate Distance, Rate (velocity), and Time.</td>
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<td></td>
<td></td>
<td>Other Forms</td>
<td>Formula Acronyms</td>
</tr>
<tr>
<td></td>
<td></td>
<td>( R = D/T )</td>
<td>D - Distance swum in yards (yds) or meters (m)</td>
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<tr>
<td></td>
<td></td>
<td>( T = D/R )</td>
<td>R - Rate or velocity expressed as yds per sec (yds/sec) or m per sec (m/sec)</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>T - Time in seconds</td>
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<tr>
<td>2</td>
<td>Swimming Velocity Formula</td>
<td>( V = SR \times SL )</td>
<td>Commonly used swimming formula used to illustrate the influence that stroke rate and stroke length have in determining swimming velocity.</td>
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<tr>
<td></td>
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<td></td>
<td>Formula Acronyms</td>
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<tr>
<td></td>
<td></td>
<td>( V ) - Velocity or rate expressed in yds/sec or m/sec</td>
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<tr>
<td></td>
<td></td>
<td>( SR ) - Stroke Rate (a.k.a. Turn Over Rate) expressed in cycles per second (CPS) (see Formula Number 4)</td>
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<td></td>
<td></td>
<td>( SL ) - Stroke Length (a.k.a. Distance Per Stroke Cycle or Distance</td>
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</tr>
</tbody>
</table>
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The swimmer’s ability to gradually increase stroke count also helps in the identification of training categories. Note that the stroke counts in Figure 2, the swimmers first use of the test protocol, are not as consistent as the stroke counts in Figure 3. As a result, more interpretation of the data was required in determining the training categories in Figure 2 when compared to Figure 3.

The first step in identifying Training categories in Figures 2 and 3 is to identify the aerobic and anaerobic thresholds. The aerobic threshold, or first breakpoint, is easily identified. The anaerobic threshold, or second breakpoint, is a little trickier as you will note what can be interpreted as two breakpoints between the aerobic and anaerobic thresholds in Figures 2 and 3. Recalling that the stroke count test protocol includes the swimmer indicating the stroke count that marked the point from focusing on stroke length to stroke rate in order to increase velocity, the transition point from stroke length focus to stroke rate focus was interpreted as being approximate to the anaerobic threshold. While not quantifiably verified, the transition point in the stroke count test protocol would appear to be consistent with the T3000 swim test to identify the maximum sustainable pace (anaerobic threshold).

What then is the significance of the spike observed at a stroke count of 14 between the aerobic and anaerobic thresholds in Figures 2 and 3? Earlier in this discussion it was stated that EN2 training occurred at velocities closer to the anaerobic threshold while EN1 training occurred at velocities closer to the aerobic threshold. Therefore, the spike occurring between the aerobic and anaerobic thresholds was interpreted as the approximate boundary between EN1 and EN2 training.

While training literature is heavily focused on the anaerobic threshold, little, if any, information could be found on observable conditions that would mark a boundary between EN3 and sprint training. As a result, defining a boundary between EN3 and sprint
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<table>
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- Swimmer America Leadership Conference: Thursday, 9/7, 8 AM - 5 PM - Led by Julie Nitti/Lori Klatt $50.00
- Certified Stroke Technician Course: Wednesday, 9/7 - 5 PM - Lori Klatt $50.00
- Masters Certification School Level 1: Thursday, 9/8 - 1 - 5 PM - Scott Bay $70.00
- Masters Certification School Level 2: Friday, 9/9 - 1 - 5 PM - Susan Ingraham $70.00
- Leadership for Athlete Development: Saturday, 9/10, 8 - 11 AM - Tim Welsh $50.00
- Swimming America Program Director Training: Sunday, 9/11 - 8 AM - 1 PM. Separate fee, contact Julie - 1-800-356-2722.
- Coaching Novice Swim Teams: Sunday, 9/11 - 8 AM - 3 PM - John Leonard $70.00
- Planning Your High School Season: Sunday, 9/11 - 8 AM - 12 Noon - Guy Edson $50.00
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training relied heavily upon common sense (applying knowledge) and observation. Additionally, the three sprint categories SP1, SP2, and SP3 were combined and are referred to as ‘Sprint’ in Figures 2 and 3.

The boundary stroke counts between EN3 and sprint training were determined by the anaerobic threshold at the low end and the point where the slope in velocity improvement decreased from the previous sample on the high end (i.e., between stroke count of 20 and 21 in Figure 2 and a stroke count of 18 and 19 in Figure 3). Stroke counts for sprint training were bounded by the maximum EN3 velocity on the low end and the point where any further increase in stroke count resulted in a decreased velocity on the high end (i.e., stroke count of 22 in Figure 2 and stroke count of 21 in Figure 3). After determining the stroke count that represented the six training categories, the swimmer was asked to train at the identified stroke count for the respective training category. During training the swimmer was also provided guidance as to the goal time for the training exercise and to maintain both the stroke count and goal time during training. It should be noted that in the previously identified JSR article the stroke count was the emphasis during training.

Based on the Stroke Rate Velocity Curve competitive stroke rates were also selected. To select the event stroke rate, first a goal time was established; then using basic algebra the velocity needed to achieve the goal time was determined (see Table 6, Basic Algebra Distance Formula). Finally, using the data from the stroke count test protocol the stroke count matching the goal velocity was identified.

---

**Figure 2 – Actual Stroke Count Data and Graph #1 (Short Course Yards)**

<table>
<thead>
<tr>
<th>Sample</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stroke Count</td>
<td>11</td>
<td>13</td>
<td>14</td>
<td>15</td>
<td>16</td>
<td>19</td>
<td>20</td>
<td>21</td>
<td>22</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td>Complete 3 Cycles</td>
<td>7.06</td>
<td>6.25</td>
<td>5.39</td>
<td>5.37</td>
<td>4.77</td>
<td>4.11</td>
<td>3.57</td>
<td>3.35</td>
<td>3.14</td>
<td>2.93</td>
<td></td>
</tr>
<tr>
<td>Cycles/Sec</td>
<td>1.30</td>
<td>1.43</td>
<td>1.55</td>
<td>1.56</td>
<td>1.59</td>
<td>1.67</td>
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<td>1.83</td>
<td>1.96</td>
<td>1.79</td>
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</tr>
<tr>
<td>Cycles/Min</td>
<td>25.50</td>
<td>28.80</td>
<td>33.40</td>
<td>33.52</td>
<td>37.74</td>
<td>43.80</td>
<td>50.42</td>
<td>53.73</td>
<td>57.32</td>
<td>61.43</td>
<td></td>
</tr>
<tr>
<td>Sample Date: 4/1/06 Pool Size: 25 Yds Sec/min: 60</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

**Figure 3 – Actual Stroke Count Data and Graph #2 (Short Course Yards)**

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<tr>
<th>Sample</th>
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<td>15</td>
<td>16</td>
<td>17</td>
<td>18</td>
<td>19</td>
<td>20</td>
<td>21</td>
</tr>
<tr>
<td>Complete 3 Cycles</td>
<td>7.42</td>
<td>5.53</td>
<td>5.77</td>
<td>4.79</td>
<td>4.82</td>
<td>4.21</td>
<td>3.76</td>
<td>3.47</td>
<td>3.12</td>
<td>3.06</td>
<td>3.01</td>
</tr>
<tr>
<td>Lap Time (Yds/Sec)</td>
<td>17.92</td>
<td>15.41</td>
<td>15.20</td>
<td>14.12</td>
<td>14.10</td>
<td>13.61</td>
<td>12.94</td>
<td>12.36</td>
<td>12.18</td>
<td>12.07</td>
<td>12.27</td>
</tr>
<tr>
<td>Cycles/Sec</td>
<td>1.42</td>
<td>1.62</td>
<td>1.64</td>
<td>1.77</td>
<td>1.77</td>
<td>1.84</td>
<td>1.86</td>
<td>2.02</td>
<td>2.05</td>
<td>2.07</td>
<td>2.05</td>
</tr>
<tr>
<td>Cycles/Min</td>
<td>24.26</td>
<td>32.55</td>
<td>31.20</td>
<td>37.58</td>
<td>37.34</td>
<td>42.76</td>
<td>47.87</td>
<td>51.87</td>
<td>57.69</td>
<td>58.82</td>
<td>59.80</td>
</tr>
<tr>
<td>Sample Date: 4/9/05 Pool Size: 25 Yds Sec/min: 60</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

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American Swimming

Volume 2011 — Issue 3
“PUSHING YOURSELF TO THE LIMIT IS THE ONLY WAY TO KNOW WHO YOU ARE.”

REBECCA SONI
Olympic Champion 200m Breaststroke
World Champion 100m Breaststroke

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Figure 4 illustrates the improvement, indicated by a faster velocity for a given stroke count, of the same male swimmer over 1.5 years. The stroke counts used in Figure 4 are the stroke counts that were common in all five tests illustrated in Figure 4 (e.g., if in one test the swimmer had stroke counts of 11, 12, 13, 14, and 15 and the second test the swimmer had stroke counts of 11, 13, and 15 only the stroke counts of 11, 13, and 15 were plotted). You will note that the 4/1/2006 test in Figure 4 only has five test points compared to the six test points in the other tests. The reason for one less test point on 4/1/2006 is because the swimmer could not get his stroke count above 21 during pool testing.

Training Implications - Applying Results of Stroke Count Testing During Training

The primary advantage of stroke counting is that it can be used by the entire team regardless of age, skill level, or pool size (Short Course Yards, Short Course Meters, or Long Course) in a variety of ways to help swimmers understand the expression $V = SR \times SL$ (see Table 6, Swimming Velocity Formula). Younger swimmers can focus on improving stroke efficiency by reducing stroke count, thereby improving stroke length. As younger swimmers become more proficient they will learn that there is a point where any further increase in stroke count will result in a decreased velocity resulting in slower event times. Older swimmers can use stroke counting to verify they are training at the velocity (level of effort) necessary to benefit from each of the six Training categories in Table 2. When swimmers are ready to develop event race plans, the stroke rate for the desired goal time can be converted into an equivalent stroke count enabling the swimmer to more accurately gage race pace during race pace training sets. During competition warm up, swimmers can use stroke counting to verify race pace on those occasions when the coach is working with another swimmer.

Coaches and swimmers will find that stroke counting is a technique oriented approach to training. To fully take advantage of stroke counting the swimmer can not just do ‘mindless laps’ of swimming. Mindless laps lead to poor technique, and even mindless laps will lead to minimal improvement as young swimmers naturally grow stronger and older swimmers use resistance training to improve strength. By emphasizing the improvement of stroke length, the swimmer consistently focuses on technique thereby enabling the swimmer to take full advantage of improved strength as the swimmer matures.

In the long term, stroke counting’s technique orientation provides the swimmer with what Sports Psychologists call a ‘controllable’. A controllable is something over which the swimmer has direct control. For example, the swimmer can not control time as there will always be 60 seconds in one minute. However, the swimmer can learn the level of effort in the form of a stroke count necessary to cover 50 yds/m in a specific time (pace or velocity). Each time the coach assigns a focus point or task during training, that task represents a controllable necessary to improve or maintain biomechanical efficiency which in turn should help reduce swimming related injuries. Additionally, all swimmers will find that the emphasis on technique during training will enable them to hold technique and the desired stroke rate longer during competition, thereby maintaining the desired velocity longer resulting in faster event times.

Limitations of Stroke Count Testing to Determine Anaerobic Threshold Velocity

As expected there is a trade off between blood lactate testing and stroke count testing protocols in determining velocity at the anaerobic threshold. While both test protocols are based on scientific methodology, it would appear that Lactate Blood Testing, with enough samples, will come closer to accurately defining an individual swimmer’s velocity at the anaerobic threshold. However, as previously stated, it has also been indicated that it is only necessary to accurately estimate an individual’s velocity at the anaerobic threshold for effective Threshold Endurance Training (EN2) to produce the desired training affect. Therefore, while stroke counting may not precisely quantify velocity at the anaerobic threshold, stroke counting can accurately estimate a range of stroke counts that will produce the desired training affect at, above, and below the individual’s anaerobic threshold. Determining the accuracy of estimating the individual’s anaerobic threshold using stroke count can only be accomplished with additional research where blood lactate and stroke counting test protocols occur simultaneously.

Like blood lactate testing, the cost of training time remains a limitation of the stroke count testing protocol. However as stroke counting does not require any
additional specialized equipment, it can be assumed that a greater proportion of the swim team can be tested at one time thereby reducing the impact on training time.

Obviously, short course stroke counts and velocities will not apply in long course pools. Therefore, stroke count testing will need to be conducted for each of the three competitive pool sizes (short course yards, short course meters and long course).

**Summary**

Stroke counting promotes sustained athletic performance improvement throughout the swimmer’s career. During training the stroke count represents the estimated velocity of the aerobic and anaerobic thresholds from which appropriate training velocities for all six categories can be estimated. When developing event racing plans, the stroke count represents the stroke rate necessary to maintain the velocity that is needed to achieve performance improvement goals.

Regardless of age or skill level, the ability of the swimmer to maintain the desired velocity over the event distance directly determines the standard by which performance improvement is measured, the event time. One of the factors restricting performance improvement is the limited options available to the swimmer and coach to monitor level of effort (velocity) and stroke efficiency during the training exercise (i.e., while swimming). During training, stroke counting enables the swimmer to continuously monitor level of effort real-time throughout the training exercise and take greater responsibility for his/her training in the following ways.

- For younger (pre-puberty) and older (post-puberty) swimmers, stroke counting promotes a technique oriented focus as the swimmer strives to improve or maintain stroke technique and efficiency which is essential to achieve athletic performance goals during training and competition throughout the swimmer’s career.

- For older swimmers, stroke counting provides the swimmer with the equivalent of a car’s speedometer that enables the swimmer to be more proactive in evaluating and adjusting level of effort while swimming rather than being reactive to the customary post exercise feedback obtained form the coach, pace clock or heart rate. As a result, stroke counting enables the swimmer to adjust level of effort during the training exercise and train longer at the velocity associated with each of the six Training categories (Table 2) thereby improving the effectiveness of training.

Coaches will find using stroke count to estimate the swimmers’ aerobic and anaerobic thresholds and to monitor the swimmers’ level of effort during training provides the following advantages in a team environment:

- Stroke counting can be used in short course (yards and meters) and long course pools,
- When compared to other scientific protocols, stroke counts are easily determined by the coach and swimmer,
- Non-invasive - stroke count enables estimating the
aerobic and anaerobic thresholds without a blood sample,
- Determining stroke count does not require specialized equipment,
- Stroke count can easily be monitored while swimming providing real-time level of effort feedback to the swimmer,
- Stroke counting can be used by the entire training group,
- Stroke counting is applicable to a wide range of ages, and skill levels,
  - For younger (pre-puberty) and older (post-puberty) swimmers stroke counting promotes technical efficiency
  (i.e., fewer strokes per lap yields longer stroke length and more efficient strokes),
- Older swimmers can use stroke counting to monitor and maintain level of effort during training while swimming (i.e., training within desired Training categories, or training at race pace),
- Applies Sports Psychology by providing a controllable task (the stroke count) upon which the swimmer can focus during training, competition warm-up, and competition,
- Allows the swimmer to practice event Race Plan strategies during training sets (i.e., stroke count necessary to produce a goal event time).

Arguably, the only difference between blood lactate testing and stroke count testing to determine velocity at the aerobic and anaerobic thresholds is the improved quantifiable accuracy provided with blood lactate testing as the number of test samples increases. As always, coaches are left to decide which method of determining the aerobic and anaerobic threshold best suites their team goals. Hopefully the preceding discussion has provided meaningful input to the decision making process used by coaches when evaluating methods to monitor level of effort during training.

---

**Speed Training – Tips from Vern Gambetta**

**BY JOHN LEONARD**

While in South Africa recently, listening to a Track Coach who was quoting Vern Gambetta on developing speed in land based sports, I made a few notes that relate directly to swim training as well. Thanks to Vern for these ideas/reminders.

1. Eliminate distance running (swimming) it reduces explosiveness that compromises speed. Train specifically for your events. (while we know this is not TOTALLY true in swimming, the point is still well-made and valid.....

2. When do you focus on speed development? It has to be at a time when your body is in a non-fatigued state. Plan your true “speed” development at the start of a training session, after a warmup.

3. For the very young (below age 10) speed development should be playful and game-like.

4. Maximal Strength and acceleration ability are closely related. Spend time developing maximum strength. (production of force.)

5. Don’t do drills for the sake of doing drills. A drill must LEAD somewhere.

6. Maximum speed is a combination of stroke length and stroke rate. Train both.

7. Starting skills is about extending ankle/knee/hip.

8. The 10% rule. IF the resistance you add changes the velocity (slows it down) more than 10%, it will change the dynamics of the movement. It will negate speed development.

9. 6-8 reps is the optimum number for speed development work.

10. In your training session, develop SPEED before SPEED ENDURANCE. (micro and meso-cycles).

11. In strength development, remember that CORE work provides the postural strength necessary to improve speed. Strength to stabilize the trunk of the body is essential.

Thanks to Vern Gambetta for these great reminders.

John Leonard
Fellow coaches, we have come to a place where we must decide if we should put great efforts into continuous, incremental change within FINA, or risk and achieve much more and Change the World.

This is a very difficult place for all of us. Many of us are intimately involved within our own federations. Most of us frequently coach athletes on the world stage. Changing the World requires risking both these relationships.

By their very nature, our federations must maintain close and positive relationships with FINA. Actively opposing FINA will place our relationships inside our federations at risk. By our very natures, we want to coach and compete on the largest stage. Actively opposing those who run that stage will make us persona non grata on that stage. When we have to resist the most, it may require asking our athletes or federations to sit out the very competitions by which we all define ourselves. Although we are all willing to do that ourselves, none of us wants to ask that of our athletes, but it may come to that - soon.

We have developed a mindset of fighting over table scraps from the FINA table and being quite happy when one falls our way. We have not stopped to realize that the banquet is being stocked by our labors and the fruits of those labors. This is the great irony. If we leave the FINA table, those at the table starve and we - coaches and athletes - will keep the fruits of our labors.

When dealing with an old, large bureaucracy, it is easier to blow it up and start over, than it is to significantly change it. We are inspired every day by seeing that happen in North Africa. Those citizens finally got tired of hoping for table scraps and decided to turn over the tables and Change their World. Many hundreds of them have given their lives. Can we sacrifice a swim meet? Is our legacy going to be merely titles won, or will it be changing the competitive landscape for generations of coaches and athletes to come?

Many of you will reasonably ask, “Can’t we do both?” Can’t we work for incremental change within FINA, while working outside to start a new organization? Can’t we preserve our options? What if FINA changes?

What do we tell our athletes when they bring the same questions to us? Can they preserve the security of their social lives while risking everything to be the best they can be? Can they commit half way?

We can hope FINA changes, knowing it can just as quickly change back. We can hope that the people of good will inside FINA can affect some changes that will last until changed back by those without that good will. However hoping is all we should do. We should not expend emotion, intellect, effort, or commitment to improve FINA. All of our emotion, intellect, effort and commitment should put to blowing it up and starting over.

We must have a World Swimming Association Championship in place by 2014, so that our federations and athletes can sit out the FINA Championships in the next quadrennium. We must stop putting our food on their table, then begging them for scraps. Our labors put food on that table. It is time that we Change the World and set our own table. •
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