

## Inside this Issue

1	President's Letter <i>Gil Summy</i>
2	Crank Arm Length <i>Fred DeLaCerde PhD</i>
3	32nd Annual Joe Martin Stage Race 50+ Event - Fayetteville, AR May 9-10, 2009 <i>Gary Ziegler</i>
4	Master's Race Report From Cloudy Dallas and the Matrix Challenge Criteriums <i>Gary Ziegler</i>
4	Topeka Road Race Report <i>Peter Erdoes</i>
5	Rocky Mount Race Report <i>Tony LaSorsa</i>
5	Track Racing at the Superdome Frisco, TX Friday Night <i>Gary Ziegler</i>
6	Fire Hill Criterium 4/18/09 <i>Gary Ziegler</i>
6	Velotek Grand Prix <i>Bruce Tanner</i>
6	Tour of Hermann <i>Phil Harris</i>
7	Loctate Threshold and Functional Threshold Power FTP - Why it's Important and How to Determine it <i>Charles Howe</i>
9	Foot Pronation in Cyclists - From Diagnosis to Intervention Strategies <i>Michael J. Choate</i>
12	Our Sponsors

President: Gil Summy  
Vice President: Steve Schlegel  
Secretary: Bill Wylie  
Treasurer: Randy Kamp

*Off The Front published monthly with the exception of December. Articles and comments may be submitted to the Editor.*

OKC Velo Club  
P.O. Box 21465  
Oklahoma City, OK 73156

## President's Message

*By Gil Summy*

To start off this newsletter, I thought it would be worth noting that despite the challenging economic times, the Club and Oklahoma bicycle racing in general is having one of its best years ever. As I write this, the 4th Tulsa Tough has just wrapped up. This has become one of the top races in the country with both men and women NRC events and has really put Oklahoma on the Nation's bike racing calendar. OKC Velo had some excellent performances in this year's edition. Congrats to all who represented the club. In Oklahoma City, the April Central Oklahoma Race Series (CORS) on Wednesday evenings had an unprecedented number of riders. The time trial attracted almost seventy entries, while the circuit race and zoo criteriums each saw more than fifty racers show up. The June CORS is looking to be bigger and better than ever with a slightly different format. For the upcoming series there will be two crits at the Edmond fire training center (the popular "Fire Hill" circuit) and two time trials at Lake Draper (organized by CRRC and PG13). By request, we are also introducing a C category for category 4 women and cat 5 men. The final event in the Overholser Saturday TT series is also this month (June 13). Even though there has again been a record level of participation, there is still "money on the table" in some of the categories. This is particularly true for the teams (which only require one event for prize eligibility), so hopefully we will again see a large number of racers showing up. Lastly, we have our state championships in road race, criterium, and time trial coming up in the next two months. For this year the Bicycle Racing Association of Oklahoma has introduced new guidelines for how these events are run which should produce even higher quality championships. This can only help to build on the momentum that we have seen in the first half of the year.

See you at the races!



Off The Front is published by Performance Conditioning Cycling, a newsletter dedicated to improving the cyclist and the official publication of the USA Cycling Coaching Association.

[www.performancecondition.com/cycling](http://www.performancecondition.com/cycling)



# CRANK ARM LENGTH

*By Fred DeLaCerde, PhD  
OKC Velo Club Senior Member*

Needless to say, a proper bicycle-rider setup is required for optimal performance. Such a setup is not simple due to rider skeletal variables that must match the frame geometry of the bike plus the various components. For example, the height and fore-aft position of the saddle relative to the frame must take into consideration the anthropometric dimensions of the rider. In addition, rules of the cycling organization also impose certain dimensional parameters involved in the rider-bike setup.

In most cases the techniques for proper bike fit are relatively straightforward, except for the crank arm length. A simple technique for determining the optimal crank arm length for a given rider in a specific cycling event has not been identified. Attempts to measure physiological response to crank length has been unsuccessful in determining optimal lengths.

One commonly used method for determination of crank arm length is based on pants inseam. If the inseam is less than 31in, start with 170mm length; if 31-33in, use 172.5mm, longer than 33in, use 175mm crank. These sizes can be modified relative to the rider's race event. For track races, subtract 2.5mm or 5.0mm. Add 5.0mm for mountain bikers. Note, add no more than 2.5mm at a time, and, if knee problems exist or develop with length change, reduce length by 2.5mm. This method assumes leg length is the key factor in crank arm length.

Consensus biomechanical thought considers leg length to be the dictator of crank arm length, yet, others believe height is the key. One such scale illustrates this theory.

Less than 5'0: 160mm  
5'0 to 5'5": 165.0 to 167.5mm  
5'5" to 6'0: 170mm  
6'0 to 6'2": 172.5mm  
6'2" to 6'4": 175mm  
Taller than 6'4": 180 to 185mm

This method assumes body height as adequate to find crank length, but, like the inseam method, does not consider the relative lengths of the two major leg bones (femur and tibia) as a factor in determining crank arm length.

The relationship of crank length to other bike components is complex. Crank length determines the size of the pedal circle, the vertical distance from bottom to top stroke. As with most bike components, if one is adjusted a second, and possibly a third, must also be adjusted. A change in crank length requires an adjustment in seat height, possibly a saddle fore-aft movement and even a change in stem length.

Both biomechanists and cyclists have a long, continued interest in determining bike equipment adjustments required for optimal performance. Consequently, analytical studies of cycling have used mathematical models of pedaling to investigate various biomechanical parameters associated with cycling.

One such method is analytical optimization where dynamic equations of motion are used to derive mathematical models of pedaling. This technique allows systematic exploration of multivariate biomechanical parameters on cycling performance.

Two approaches to analytical optimization are used in cycling; inverse dynamic equations and forward dynamic equations of motion. Inverse modeling uses pedaling motion and forces to calculate net joint torques produced by the muscles. Forward modeling uses net joint torques to calculate pedaling motion.

To understand analytical optimization the concept of cost function is utilized. A cost function is a mathematical equation that rates the level of pedaling performance by assignment of a numerical value. Hence, a pedal motion that has a lower value of cost function is considered a more optimal performance than a higher value of cost. Note, this function does NOT indicate the actual cost, only a comparison of values for each variable.

For example, a multivariate optimization study of optimal crank arm length-cadence found a low cost for 170mm crank, with 100rpm, but, when the cadence deviated from 100rpm, a crank length of 170mm raised the cost function. When the size of the rider was considered in the variant the cost function was minimal for a tall rider using a longer crank length, lower cadence as compared to a short rider.

In addition, studies found cadence affects cost function the most, followed by crank arm length. However, the size of the rider produced marked changes in cost with optimal cost function being for a crank length when the cyclist rode at his or her preferred cadence.

The optimal performance for a given crank length depends on the preferred cadence of the cyclist. This preference in turn is dictated by the race requirements such as road race, crit, time trial, terrain features or track. Races with sharp cornering, particularly crits and track, surface clearance of the crank becomes important. Simply put, there is no single crank arm length for a given cyclist or a given event.

While analytical optimization develops mathematical models for study of biomechanical components, singularly and in combination, there are no absolute answers, and, until valid scientific methods are developed for determining optimal crank length, the following guidelines must be followed:

1. Crank lengths for general purpose increase with length (inseam); however, it is the femur length that has a greater effect on crank length than inseam. A long femur relative to the inseam dimension may do better with the next size crank arm.
2. Junior riders need shorter cranks and smaller gears to develop high cadence pedaling, physiological capacity, and strength foundation. Failure to do this creates the potential for overuse injuries, particularly for knees.
3. Long cranks provide higher mechanical advantage and are better for pushing larger gears. Time trial bikes and mountain bikes usually have longer cranks.
4. If a cyclist has experience with a single crank length, careful experimentation is required before changing to another length. It is possible that two cyclist may prefer different crank lengths because of individual physiological and muscle-skeletal differences. When crank length is changed, a time period of at least six weeks is needed for the human system to adjust to the new length. Never change more than 0.25mm at a time and never race without allowing at least a six week adjustment period. Return to the original length if medical issues develop, particularly with the knee joint.

An example illustrates this last point. A road race cyclist decided to change his crank length from the 170mm he had used for a number of years. So, believing the old myth, "If a little bit helps, more is better," he proceeded to install a 175mm. Without even trying this new length, he raced with it. For the first half of the race, things were going great, but, at the three quarter point he developed leg muscle cramps and knee pain so great he had to drop out.

---

## **32nd Annual Joe Martin Stage Race 50+ Event, Fayetteville AR May 9-10, 2009**

*by Gary Ziegler*

Bike racing, especially a stage race, is like a chess match with multiple opponents, or teams of opponents. Each piece, or rider, has strengths and weaknesses, as do I. My job is to play my strengths against their weaknesses, at just the right moment. This is probably what I like best about racing.

For the first time, I guess in forever, which is how long this race has been going on, they had the hill climb time trial (which I hate, by the way) BEFORE the road race on Saturday. This opened up the event for a strategic afternoon on the very rolling road race course. Teammate Bruce Tanner was in second after the TT, and I was in seventh. A lot of strong individual riders, a very strong three-man GeriAtrix team from southern Texas, and a scary-strong Chris Black from California, all traded attacks constantly during the 46 mile road race. No one could get away for long. I was hoping for an opportunity to go away with one of the two GeriAtrix riders whom I was ahead of from the TT. George Haggerty (GeriAtrix) was getting aggressive late in the race, and with ten miles to go we launched a hard two-man attack as the remaining ten-man leading field slowed after catching the um-teenth attack of the day. We quickly got 20 seconds or so, before the chase was organized. I realized that with my teammate Bruce and the two other GeriAtrix riders in the field not working, that left only five riders to power the chase. We extended our lead to over a minute, which since I was 45 seconds out of first, put me in the GC lead "on the road". As is usually the case, the field turned up the heat of the chase towards the last few miles, and we were in trouble. The prospect of getting caught after nine and one-half miles of all out work was alternately inspiring and discouraging. I was cheering George on, but with two miles to go he started soft-pedaling his turns at the front, not wanting to put me ahead of his teammate who was in third. I figured that with the time bonus for first or second, and the gap we still had on the field, I could possibly still go into the lead overall. But if I slowed and started playing cat-and-mouse to try and win the sprint, all would be lost. I pulled hard to the end, George beat me in the sprint, and the field came in thirty-five seconds later, giving me the overall by less than ten seconds!

Still holding onto a podium spot after initial road race results, Bruce had a spot of bad luck and received a twenty second penalty for a center-line violation during the road race, dropping him off the podium. In the very wet criterium stage on Sunday, we carefully guarded my overall lead, while Bruce schooled the field with his uphill sprinting technique and took all the primes. Ha! Criterium results: Sprint strongman Chris Black first, I was second, Bruce finished fourth. Overall results: I kept my first in GC, Bruce sixth. Yeah team! . . . I mean, ARRGGH! (Well, we DID race like pirates!)

(OKC Velo results in the 40+ race were very interesting and mostly dominating. Hopefully someone with an insider's view will enlighten us.)

# MASTER'S RACE REPORT FROM CLOUDY DALLAS AND THE MATRIX CHALLENGE CRITERIUMS

by Gary Ziegler

(When they asked where Peter, Paul and Les were, we responded that all we needed was the "B" squad for these races.)

Great venue. Super promotion. Fun weekend. The track races Friday night were canceled due to dangerously high winds at the velodrome, but I got plenty of sprint practice Saturday and Sunday. This is a fun figure "8" course in historic downtown Dallas. Eight corners per lap with a slight drop and climb. Windy both days.

Good size field in the 50+ on Saturday, especially with equal money between the 40's and 50's. I went for 2 of the 3 primes and got them, finding myself off the front after the last one, so I just stayed away the last 7 laps. Ouch! That hurt. But I held on for the win.

The 40+ was an hour later, and we had a good showing of pirates: Brad, Johnny, Crabby Ken, and I. Brad and I got a good starting position on the front row, which was great since they announced a \$100 prime on the first lap! So I said let's go for it, and indicated I wanted a lead-out. We got clipped in quickly and were 3rd and 4th through the first corner: perfect. Brad gave it a go but waited a little too late and we were beat to the critical last 2 corners. Good try, though. Watch out next time! A \$50 prime followed quickly, and I got that one. Back-to-back primes were the order of the day, with another \$50 prime following the next lap. I was at the front with Cat 1 rider Kevin Schaefer of Team Six and told him it was his turn. We then had a gap on the field and decided to go for it, even though we were only about a quarter into the race. Ouch, again. I asked if he had any teammates in the field and he said no. I told him I had a couple that were going to shut down the chase. So he was nice (and smart) enough not to try to drop me. He was doing the lion's share of the work and I was helping as much as I could. We got a 25 second gap and started to feel a little safer. He took the well deserved win and went on to ride the 1,2 event. I hung on for 2nd and went on to collapse at Knollie's. Brad finished 9th with Johnny close behind.

Sunday's events boasted more cash primes, including \$360 in the 50+ race. I decided that keeping the field together was best for prime hunting today, but the other riders didn't agree so the field was soon split into two medium sized groups. I tried to keep a low profile while snagging 5 of the 6 primes given to our group. After winning the next to the last prime I found myself off the front by about 20 meters as I passed the line and they rang the bell again for back-to-back primes: \$100 on the next lap. Sheesh! I stayed out again while 2 guys with fresh legs (they didn't race Saturday!) tried to bridge. Ouch, Ouch, Ouch!!! Nabbed the \$100, but now we had 4 laps to go. Arrghh! I jumped them on the back stretch and held the gap to win, thinking: "Do I really want to do the 40+ race today?"

40+ race. Lots of cash. More riders than yesterday. Brad got a prime and was active at the front. Johnny tried a next to last lap escape. I sat in until the finish and mustered up a 4th place. Brad upped it to 7th with Johnny close behind again.

Not a bad weekend for the "B" squad. Ha!

---

## Topeka Road Race Report

By Peter Erdoes

We had a slight change of course as instead of going to Shreveport to do the Rocky Mount Stage Race with Tony LaSorsa and Brad Fisk, 4 of us headed to Topeka to support the northern legion, Frank Jakofcich and Peter Grieg, in their battle at the 67 mile Auburn Road Race. The group included new addition to our team, Brady Schmmiedeberg, and up and coming Cat 3, and the legendary Jason Wadell, who'd just finished his first year of law school and was looking forward to test his legs on the back after only racing a handful of times since retiring from the pro ranks.

What we thought was going to be a typical pirate ship attack with multiple riders making the winning break, turned into an all-out street fight, as the officials announced just before the start that they were racing together, but scoring separately, the 1,2's with the 3's.

At the gun, Steve Tilford and his Children of the Corn team had the race strung out at 30mph+, trying to blow up the field. Numerous attacks and counters were made, until I realized we were just reacting to the Corn clan and decided to counter one of their moves to see if they'd let me go. They did.

A few miles later, Bill Stolte, Tilford's longtime right hand corn clan man, bridged up, and we hammered away for the next 40+ miles, only to have a local Cat 2, with a huge butt to draft off of (hooray) bridge up solo.

Without about 15 miles to go, Tilford bridged with Alex Battles-Welch, a really strong junior from Tulsa, and Peter Grieg. This was a perfect scenario for us as Peter and I were the only 3's in the break and hence had built up enough of a gap on the field that even though Tilford shelled us both in the last 10 miles, we both rode in for first and second well ahead of the field.

Much respect to Frank and Jason for marshalling the field after the break had gone up the road and hats off to Gil who had bad luck who flatted in the first 3 miles of the race and never got back on

# ROCKY MOUNT RACE REPORT

*By Tony LaSorsa*

The Black pearl sailed down the Red River to Shreveport with a reduced crew of Brad and I doing 45+ and Bob doing 55+. The RR was uneventful with very negative tactics. I had to attack myself twice just to get a counter attack going. After that I went to the back and waited for the finish, which is at the top of a fairly good hill. As we roll up to the hill both Brad and I are positioned at the front, but as soon as it started the guys on the front slowed and were dropping into their small chain-rings. I attacked and got a gap, but 4 were able to get to me at the top, 1 being Brad. I was not able to come around them at the end ( I need to work on my timing) Brad finished 4th with me 5th.

We had gapped everyone else and the field was strung out all over the hill, but do to their scoring system we all go the same time. After the TT I was still in 5th, but Brad had dropped to 10th or 12th, since he did the TT on his road bike. Sunday Morning it was 51 degrees and raining, after talking ours selves into and out of doing the race several times we started the damn thing anyway.

I swear the ref told use there was only going to 1 prime for time bonuses so when they rang the bell I went for it only to find out at the end of the race they added some primes and I won a box of Bonk Breakers instead of 7 seconds. Final result was Brad 1st me 2nd for the crit and I ended up 3rd in GC and Brad moved back up into 5th. Bob flatted Sat. on the first lap and had to chase the whole RR, unfortunately they did give him his time gap and he was out of contention.

---

## TRACK RACING AT THE SUPERDROME FRISCO, TX FRIDAY NIGHT

*By Gary Ziegler*

After a few minutes of warm-up on this track I remembered why I drive seven and a half hours, round trip, to race on the Superdrome. Imagine riding a thrilling roller coaster, but you have control of the speed and the direction . . . and all the other participants do, too. Swooping up and accelerating down the 44 degree banking in a ballet of speed, and sometimes terror, shoulder-to-shoulder and wheel-to-wheel. The control you have with the fixed gear allows a closeness not usually achieved on the road. Of the eight tracks I have raced in the US, the Frisco track is the best facility and the most fun to ride (and swoop).

The track opens at 6 PM for warm-up and sign-up. The Superdrome has an active junior development program that is usually in action when I arrive at this time. I unload my trainer and road bike, track bike, spare wheels, gears changes and tools, and water bottles in a small ice chest, through the tunnel to the infield. The facility has ample infield seating and shade for the riders, and plenty of stadium seating for spectators. With an impressive press box and "jumbo-tron", the venue is first-class. (It was built by EDS with the Olympics in mind.) The wooden track surface was recently replaced with an upgrade in material, so the track is smoother and quieter. The Superdrome will be hosting several national events this year.

After a thorough warm-up on the trainer and then on the track, racing begins and we rotate through the various classes, juniors, women, cat 4, etc. For tonight's program we are doing scratch races, with each class taking a turn on the track, then a rest while the other classes race. Then we rotate through again twice more, for three races total. I spend much of the time between races on my trainer to stay loose.

Tonight they combined the better masters and the P,1,2,3 fields, and scored them separately. Some of us had entered both categories, so we got scored for both events. The first race for us was 16 laps (4 km) and ended in a bunch sprint, where I got 3rd. The second race for us was 32 laps (8 km) and had a lot of action, including an unsuccessful attempt by the winner of the first race and myself to lap the field. The race ended with an exciting bunch sprint where I got boxed in at the bottom of the track for a 6th place (bad habit of mine). The third race for us was 60 laps (15 km) and was very active, with riders attacking repeatedly both solo and in small groups, trying to gain a lap. I snuck off the front late in the race to bridge to another rider who was just hanging out there. He was pretty gassed by the time I caught him, but gave me a couple of laps of rest, then wished me the best and dropped back to and through the field. With about 10 laps of hard TT effort I made contact with the back of the field, one lap later got the bell, and thus garnered the win without having to test my sprint in the last race of the night. Pack it all up and head back to Tulsa. Home by a little after 2 AM. But I won more than enough to cover the gas, and had a great time, too. I'll be back the Friday before the Dallas Memorial Day races, for more fun on the track.

For anyone wanting to try racing on the track, the Superdrome has a certification program that is required before entering any races. Check it out at: <http://www.superdrome.com/>

# Fire Hill Criterium 4/18/09

By Gary Ziegler

*"It's said you only have so many matches to burn during a race. I definitely burned all mine today." - oldest rider in the 1,2,3 event.*

Ten of us rode the 35+ race today, and most of us also raced an additional event. The top heavy prize list attracted Steve Tilford and teammate (Stolte) from the Toyota United team. They warmed up by hammering us mere mortals beginning on the first climb. Les and Phillip were with Tilford from the start. Stolte soon bridged, and the added horsepower punched Phillip's ticket after a valiant four laps. Les could not be shaken by the dynamic duo, however, and handily placed third in the final sprint, after agreeing not to blow them away with his now patented explosive sprint, in exchange for them not tagteam attacking him into smithereens. Gary won the field sprint for 4th, followed in by Paul, Phillip and Gil, in one order or another, depending on which lap we were supposed to be scored on. (Got lapped at the end by the god-like, well, he is pretty old, Tilford and crew.) Looked pretty cool with 3rd thru 7th, and only the Pro's beat us.

In the 1,2,3 race the field was as top-heavy as the prize list, with the likes of Tulsa Cat 1 riders Ankney, Cagle and Welch of Team Texas Tough, some Team Mercy riders, a strong contingent of Tulsa Wheelmen, the Tilford duo, and a bunch of strong local riders. Les, Paul, Phillip, Gil and Gary faced off with the best from the region, and considering it was their second race of the day, faired pretty well. We were all active at or near the front, and Les pulled off an impressive solo breakaway to capture one of the \$100 primes! Paul soloed off the front late in the race and almost stayed away for 3rd. Final placings: Paul 8th, Gil 9th, Gary 11th, . . . and Les the highest paid!

---

## Velotek Grand Prix

By Bruce Tanner

Another good showing by OKC Velo at this year's Velotek Grand Prix. The Pirates had only 4 guys in the Cat 3 race, unlike the 10 that showed up last year. But, we prevailed and though we didn't get the top spot in GC individual, we did the next best thing with Bruce taking 2nd. Gil was 5th and Frank came in 12th. Pete Greig was covering all the moves at the back of the field. We also took 2nd and 3rd in the Masters competition and 1st in Team GC.

The prologue was again a tight race due to the short distance of this event. The top 20 guys were separated by not much more than 15 seconds and Pirates had 3 in this group.

The crit played out about like last year with no breaks able to get away because everyone wanted to show off their Cavendish sprinting skills going for the 2 bonus sprints and finale sprint which with time bonuses can help more in the GC than a good prologue.

At the start of the road race, the results from the previous days races were screwed up, and we weren't really sure of our actual placing, but it looked like Bruce was 7th, Frank 18th and Gil 19th. We decided to race aggressively and try to make the race work in our favor. About 20 miles into the race Bruce was able to get away with Jay Hawkins (sitting in top 3 GC) and another rider. Shortly after, Gil bridged across with Trey Harrison (also top 3 GC) and 2 others. With 7 we had a good number to deal with the wind and terrain and stay away. OKC Velo was the only team with 2 in the break with definitely worked in our favor for the team GC. The break was able to put 3 & 1/2 minutes on the next group. Jay cramped going across the dam just before the finish and lost about 40 seconds which ruined his GC standing. Trey took the sprint for the RR win (and GC win). Bruce took 3rd in the road race, Gil was 4th. Frank won the sprint from the chase group, and though his group came across the line splintered, they all got the same time which affected his overall time.

---

## TOUR OF HERMANN

By Phil Harris

Three Pirates ventured into the soggy bottoms of Hermann Mo. Bruce Tanner was a picture of total domination as he won all three 50+ events for 1st overall in omnium! What impressed me most is Bruce beating Evan Wykes at the line in RR as Evan celebrated too early. The dude is a known wheel suck but Bruce was not going to be denied! Great job Bruce!!!

In 40+ it was Frank and Phil Harris. In TT, Phil was 5th and Frank 6th. 1st place was Mark Schwartzndruper who got a 2nd at national TT. He and a teammate, David Stone, were machines! In crit, both of us made a 6 man break. The race was a hilltop finish. Frank took 2nd and I was 6th. I crashed at the line as my seat post came apart on the hill from vibration on rough course. Crazy!

Sitting 4th (Frank) and 5th (Phil) on GC, the RR was rainy misery, but both of us were in a 6 man break that didn't include Schwartz... As Frank and Phil hooked wheels with Schwartz....getting the worst of the deal (tip - ksyrium spokes are stronger than Sapim!) with approx. 5 miles left, our luck turned south as Frank let me know he was riding now with a front flat. At the KOM point, we knew I needed to stay with Frank to preserve omnium points with him finishing in front of me. The real pisser was that a dude 4 points behind Phil wound up winning the RR. So, he went ahead of Phil, but Frank finishing ahead of Phil, put Frank 1 point ahead of him. Thus, we finished 5th and 7th overall, money going 10 places. Great race, lots of hills and rain, and the Pirates were definitely a force to be reckoned with!!

# Lactate Threshold and Functional Threshold Power FTP

## Why it's Important and How to Determine it

Charles Howe

Charles Howe has been involved in the sport of cycling since 1973 in numerous capacities. An early proponent of power-based training, a member of the Wattage Forum since 2001, he has written an FAQ on power-based training, as well as numerous articles and a free on-line training guide. More recently, he developed *trainwithpower.net*, an informational web site for power-based training. After advising riders informally for several years, Howe founded *Velodynamics* in 2006 to meet increased requests for technical assistance



Charles Howe

Imagine yourself on the starting line of an auto race. All cars have identical aerodynamic characteristics (i.e., the same body), so you're wondering what each one has "under the hood." Now, suppose your own engine is the most powerful in the race the – it can reach 500 horsepower – but there's just one problem: when you try to sustain more than 80% of those 500 horses for a few minutes, a sort of governor kicks in that makes it cut back until various engine conditions return to a particular operating range. Your principal opponent, on the other hand, has an engine that can only reach 475 hp maximum – 5% less than yours – but his governor kicks in at 90% of that, or 428 hp – a full 7% more than you can maintain on a prolonged basis.

The horsepower-governor analogy helps illustrate the relationship between the central and peripheral determinants of human endurance exercise performance, namely maximal oxygen uptake ( $VO_{2max}$ ), and oxygen uptake at lactate threshold ( $VO_{2LT}$ , or simply LT), respectively:

1.  $VO_{2max}$  sets maximum rate of ATP (adenosine triphosphate, the sole source energy used directly for muscular contraction) production via aerobic metabolism, and is determined primarily by cardiac output (Q), the ability of the heart to pump oxygen-carrying blood to the working muscles; Q in turn depends on cardiac stroke volume (SV) and the rate of cardiac contraction (HR):  $Q = SV \times HR$  (the Fick equation)
2. LT determines the percentage of  $VO_{2max}$  that can be utilized for an extended period (3 minutes or longer), and correlates with the density of mitochondria (the locus of aerobic ATP production) within the working muscles, as well as the extent of capillarization present, two adaptations that depend largely on years of specific endurance training at an adequate intensity

$VO_{2max}$  is determined in a lab by analyzing expired gasses during a "ramped" test on a calibrated ergometer cycle, wherein increasing work loads are imposed in a specific protocol until exhaustion is reached. LT is determined prior to exhaustion through analysis of blood samples, with the ratio of expired  $CO_2$  to inspired  $O_2$  (known as respiratory exchange ratio, or RER) serving as a check. On a practical level, LT is important for numerous reasons, such as setting training levels, as well as gauging pace during interval workouts and time trials, however, it need not be determined in a lab; average power over a 40-60 minute test TT, or "functional threshold power" (FTP), serves well as a "proxy" since it correlates very closely with LT (although power at LT, as determined in the lab, will be somewhat lower than FTP). Such a test gives a "bottom line" measure that integrates all physiological determinants of endurance performance ( $VO_{2max}$ , LT, and efficiency), and so is an excellent practical alternative to a ramped lab test.

The drawback to functional field testing is that it is self-administered, rather than

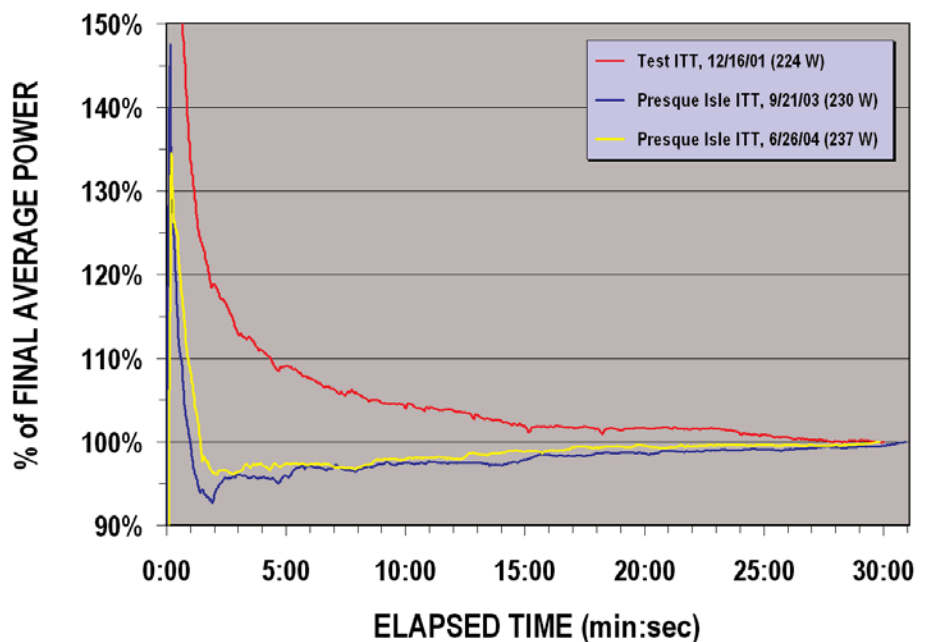


Figure 1. Running average power as a percentage of final average in three flat-terrain time trials.

carried out under the watchful eye of a coach or exercise physiologist in a lab or other controlled setting, and can therefore be affected by environmental conditions, the motivation and concentration of the test subject, as well as (to a lesser extent) his or her judgment and skill in pacing correctly. For consistent and reliable test results, make sure you are adequately rested, with no illness or infection present, while avoiding extremes of temperature (especially heat) and wind. Flat terrain is recommended, but a steady, continuous uphill grade can also be used, and even a rolling to hilly course will do if the same one is used each time; average power in such conditions (or if it is variably windy) may be somewhat less than for a windless, constant-grade test of similar duration. It may take a few attempts to get the pacing just right and the wattage “dialed in” (Figure 1), but once it is, average power achieved in any carefully executed FTP test should be highly repeatable from day-to-day.

Wide and rapid variation in the energy demands of road cycling has led some, such as to conceive of it as an anaerobic sport, but this is contradicted by what is already known:

1. Most energy for any single, maximal effort over 70 seconds, starting from a rested state, comes from aerobic sources (Figure 2).

2. In four 30 second bouts of exercise, each separated by complete recovery, most of the energy utilized by the third bout comes from aerobic sources (Figure 3), and the predominance of aerobic metabolism becomes even more pronounced during longer exercise bouts (Figure 4), not to mention continuous exercise, such as any road race, where intensity is lower, and recovery is not nearly as complete.

3. The extent to which limited anaerobic energy sources (primarily glycogen) are taxed (and blood lactate is produced) for a given set of race demands is determined by how much and often FTP is exceeded, therefore, the higher it is, the less frequently and less deeply glycogen reserves are drawn upon and ultimately depleted. Furthermore, within the context of any road (i.e., endurance) event, how quickly one recovers from short, hard “jumps” is actually more reflective of aerobic, not anaerobic fitness, since 1) fatigue during intense exercise is related to changes in high-energy phosphate (ATP) levels, 2) 100% of ATP resynthesis within working muscle occurs via aerobic metabolism, and 3) the rate of ATP resynthesis is correlated with mitochondrial respiratory (i.e., aerobic) capacity.

4. Racing categories and time trial performance both correlate much more highly with sustainable threshold power than with anaerobic capacity or sprinting power.

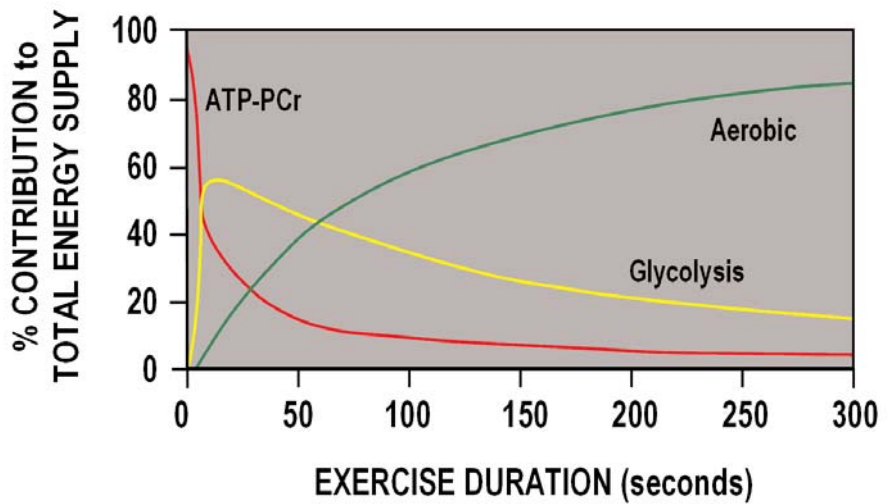


Figure 2. Relative contribution of three energy systems to exercise (Gastin, 2001).

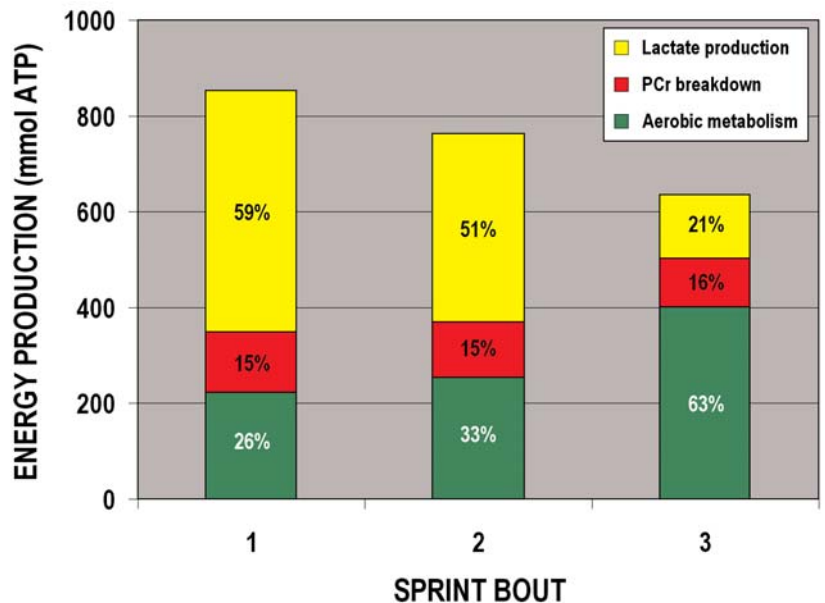


Figure 3. Contribution of three energy systems to three 30-second maximal exercise bouts separated by 4 minutes complete rest (Putman, 1995).

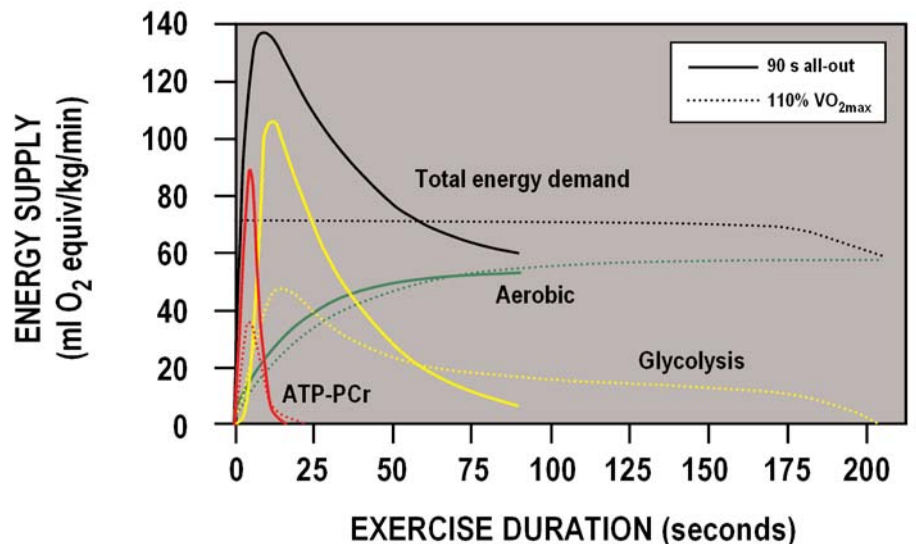


Figure 4. Contribution of three energy systems at two exercise intensities (Gastin, 2001.)

Thus, it often goes unrecognized that greater aerobic ability (in particular, a high mitochondrial mass within muscle) enhances the ability to sprint or attack in almost all race situations. The reason is that short-term power production is reduced when the effort is initiated from prior exercise (as opposed to from rest), and this reduction is in direct proportion to high-energy phosphate levels within the muscle. In other words, the really “strong” riders seem to be able to attack repeatedly, or when the pace is already very high, and then recover more quickly than others, largely because their muscles are more aerobically fit, not because they have markedly greater “lactate tolerance,” and despite the seeming importance of sprinting ability in determining race outcome, it is more the case that the sprinter with the highest threshold power wins. Cycling coach Adam Myerson, a pro/elite-level field sprinter himself, summed things up nicely by noting that sprinting ability may be what helps you win the game (race), but having a high enough threshold power is what lets you play the game in the first place, and influences how well you can play at the end. Another insightful comment was offered by Andy Birko at Wattage Forum:

*“When rested, I’ve got a pretty decent sprint (for a Cat. 4) at around 1100 Watts or so. When I hide, suck wheel, etc., in a long race, I can produce about 800 Watts or so in the final sprint. When I’m pulling, chasing etc., I’m lucky if I can hit 650 Watts by the end. There’s another guy in my club whose sprint speed is about the same as mine (I don’t know his power), and when we do sprint drills, the result is split about 50/50. When we do our monthly time trial, he goes about 10 seconds faster on his road bike than I do on my TT bike. Guess who beats whom more often when we do our training races.*

*Anaerobic capacity is like a bank – every time you go over LT, you’re drawing from the bank, and again, the further and longer you go above LT, the quicker you’re withdrawing. You can only replenish the bank when below LT, so recovery from anaerobic efforts is directly related to how often and how much you go above LT, as well as long you stay there, so the higher your LT, the stronger your anaerobic efforts can be without draining the bank as much.”*

This interpretation is spot-on, and is essentially the same as what was presented in a recent study in the Journal of Applied Physiology. It explains why “genetic sprinters” need to be careful to “conserve their sprint” throughout most any road race; as Jim Martin (masters national match sprint champion, but only a Cat. 3 on the road) describes it:

*“I often to spend the whole race sitting in and suffering, waiting for the 1 km to go sign.”*

Further, world and Olympic match sprint champion Marty Nothstein is generally unable to contest for the win once the ‘smack’ really starts to go down in national-level points races and Madisons on the track, as well as road criteriums; despite his world-class sprint ability, and even though he has greatly improved his aerobic ability (threshold power), as evidenced by his win at the 2003 New York City Championship (a 100 km criterium), it still apparently was not enough to handle the repeated surges thrown at him by riders such as Colby Pearce, Jame Carney, etc. Even for a points racer, most training time should be spent working on threshold power, although the rule change awarding 20 points – but no other benefit – for lapping the field tends to tip the balance a bit more towards those who can sprint well.

#### **Acknowledgement:**

*Special thanks to Andrew Coggan, Ph.D, for his contributions to this article.*

**More Information Please!** Contact Charles at [trainwithpower.net](http://trainwithpower.net) For a copy of the Bibliography email us at [condpress@aol.com](mailto:condpress@aol.com) and ask for Lactate Threshold-Charles Howe

---

# Foot Pronation in Cyclists - From Diagnosis to Intervention Strategies

*Michael J. Choate, M.S., P.T., USA Cycling Level 2 Coach*

*Michael received his physical therapy degree from Duke University in 1992. He is a physical therapist and owner of North Lake Physical Therapy in Lake Oswego, Oregon. He is also a Senior Level Coach for Colorado Premier Training and USA Cycling Level 2 coach. He specializes in sports medicine and orthopedics and works extensively with cyclists and endurance athletes of all ages and abilities.*

*Michael has long held a passion for cycling. He continues to race competitively in road and mountain bike events. He is also an accomplished adventure racer and continues to race for a sponsored team.*

In the process of bike fitting and the analysis of cycling mechanics, it is important to begin with scrutiny of the foot and ankle. This isn’t simply a matter of establishing cleat position. In fact, before this is done, it is necessary to assess the cyclist barefooted and in a standing position. While there are numerous presentations that may be observed, one of the most common is to find some degree of pronation in the foot and ankle. Of course, the extent of pronation can vary greatly. It is often mistakenly accepted that these issues don’t manifest themselves on the bike because cycling isn’t a typical closed kinetic chain activity. However, we do know that there is nearly constant downward pressure on the pedals throughout the pedaling cycle and thus



Michael J. Choate

these forces and associated problems certainly do come into play. Therefore, it is important to understand the mechanics of the ankle and foot...especially as this relates to “pronation” and the associated biomechanical tendencies throughout the lower extremity.

Consider the function of the foot and ankle. It is designed to accommodate to uneven surfaces in order to establish a reliable and balanced platform. This means the foot and ankle must be adaptable and very mobile. Some degree of pronation can be a good thing during this process. The term “pronation” is actually a bit misleading. It is typically used to describe a flattening of the longitudinal arch (a.k.a. flat footed Figure 1). Not counting the joints in the toes, there are 17 joints in the ankle, hindfoot, midfoot and forefoot. As a person’s foot goes into “pronation,” all of these joints are involved (See Figure 2). The talus, which is the bone in the mortise of the ankle joint, moves into plantarflexion (downward) while the calcaneus (heel bone) drifts into a valgus position (inward tilt). The midfoot depresses or drops and the forefoot abducts (moves laterally or to the outside). Along the way, the tibia is dragged into internal (inward) rotation. Correspondingly, this will create a valgus moment at the knee and relative internal rotation of the femur. This process doesn’t stop just because a person is wearing a shoe. As a bike fitter, this cannot be ignored.

On the bike, the pronating cyclist may demonstrate significant medial (inward) tracking of the knee on the downstroke. An issue that appears subtle at higher cadence and under lower loads can become markedly apparent under higher loads and at a lower cadence. It is crucial that both pedaling situations are observed. This can also create an elliptical or diagonal tracking pattern during which the knee then tracks laterally at the top of the stroke. Marked side-to-side movement of the knee during the pedaling cycle may be appreciated. This can’t be addressed simply by altering cleat position or with the use of a wedge. Especially given the stiffness of cycling shoes, wedging can change the angle of the contact surface. Wedges are often used in an attempt to “push” the knee laterally or to the outside. However, it doesn’t limit or alter the degree of pronation occurring inside the shoe. To truly limit pronation, it is often necessary to provide some correction for the foot and ankle.

Correction does come in degrees and most would probably agree that a minimalist approach is typically best: use what is needed to achieve the desired result but no more. A mild pronator may get away with mild correction. This might be a set of off-the-shelf shoe inserts or possibly custom inserts. However, more severe issues may necessitate more involved correction. Arch supports or inserts simply limit the amount of midfoot depression. Remember that this problem involves multiple joints and multiple planes of motion. Therefore, correction can require multiple planes of control. In more pronounced situations, this may involve an orthotic that also corrects the position of the calcaneus (heel) as well as the forefoot. On occasion, you may find that one foot demonstrates appreciably more pronation than the other. This may result in an apparent leg length discrepancy when the cyclist is evaluated in standing. If this is simply addressed with a shim, the problem hasn’t truly been rectified. Again, correction may be warranted. As the foot and ankle position improves and proper alignment is restored, the apparent discrepancy will often be resolved.

Being a physical therapist, I must address the topic of corrective exercise as well. Orthotic correction should always be coupled with an appropriate exercise program. Those cyclists that demonstrate fairly mild issues may be able to deal with the problem with exercise alone. However, as the problem progresses, the ligaments and connective tissues of the foot and ankle become stretched. As these are non-contractile tissues, it is a change that typically will not be reversed. Unfortunately, gravity usually wins and no matter how much strengthening you do, you won’t change the fact that the supporting tissues have been altered. Therefore, in these cases, orthotic correction is often warranted in combination with the exercise program.

A pronator with internal rotation tendencies in the lower extremities will demonstrate tightness or decreased flexibility of the gastroc/soleus complex, hamstrings, hip adductors, hip internal rotators and hip flexors. Stretching these muscle groups can be very helpful and is often crucial. It can also be beneficial to strengthen ankle inverters, hip abductors, hip extensors and hip external rotators. Single-leg balance and proprioceptive exercises can also be very helpful to enhance motor control and stamina. These exercises, in combination with proper correction and improved alignment, will lead to greater comfort on the bike, improved performance and decrease the risk of future injury.

**More Information Please!** Contact Michael at [mjchoate6@msn.com](mailto:mjchoate6@msn.com) or North Lake Physical Therapy [www.northlakephysicaltherapy.com](http://www.northlakephysicaltherapy.com)



**Figure 1:** This is an excellent example of a moderate pronator. Notice the valgus or inward tilt of the calcaneus. From the front view, you can appreciate the depression of the midfoot as well as the abduction (outward drift) of the forefoot.



**Figure 2**



OKC Velo

The Blue Canyon USAC STATE TIME TRAIL CHAMPIONSHIPS Oklahoma

\$2025.00 PRIZE LIST

SUNDAY, July 12th 2009, 10:00 AM

Lawton, OK (NEW LOCATION!)

SPONSORED BY THE Oklahoma City VELO CLUB

USCF Permit: 2009-xxxx

STATE CHAMPION JERSEYS AND PRIZES will be awarded in the following categories:

	FIRST	SECOND	THIRD
MEN 1/2	\$100	\$75	\$50
MEN 3	\$100	\$75	\$50
MEN 4	\$100	\$75	\$50
WOMEN 1/2/3	\$100	\$75	\$50
WOMEN 4	\$100	\$75	\$50
MASTERS MEN 40-49	\$100	\$75	\$50
MASTERS MEN 50-59	\$100	\$75	\$50
MASTERS MEN 60+	\$100	\$75	\$50
WOMEN 35+	\$100	\$75	\$50
JUNIOR MEN/WOMEN (10-14)	Medal	Medal	Medal
JUNIOR MEN/WOMEN (15-16)	Medal	Medal	Medal
JUNIOR MEN/WOMEN (17-18)	Medal	Medal	Medal

THE FOLLOWING CATEGORIES WILL RECEIVE MEDALS ONLY:

TANDEM	Medal	Medal	Medal
Citizen CAT 5	Medal	Medal	Medal
MEN/WOMEN 70+	Medal	Medal	Medal

**DIRECTIONS TO LAWTON:** Take I-44 south to Medicine Park exit; go west on Highway 49 approximately five miles to Highway 58. Turn North on Highway 58 and go one mile to start area. You will see the signs.

**ENTRIES:** All licensed racers from any state are eligible. Oklahoma racers only are eligible for medals and Oklahoma State Championship jerseys. No advanced registration available. The fee will be \$20 for the first entry and \$15 for additional entries. Make checks payable to OKC Velo Club. Riders may enter any category for which they are eligible but each rider must pay entry fee for every category entered. Additional fee for one-day license (\$10) for non-USAC licensed riders, and such entrants are limited to Men's Cat 5 or Women's Cat 4 events with no payouts or State championship jerseys. Tandems are \$20 for the captain and \$15 for the stoker.

**MORE INFORMATION:** www.okcvelo.org or email William.Wylie@gmail.com or johnsheri@xanadoo.com. The new course has some hills, goes north and south, new pavement and wide shoulder. The course will take you over Stumbling Bear Pass, and by the historic Kimball Ranch and up to the Blue Canyon wind farm. A map will be on the OKCVELO website.

**RACE DAY REGISTRATION:** Available from 8:30 AM to 9:45 AM at the parking lot. Start order will be in order of sign up. Start time is 10:00 AM for the 20K with riders going off at 1 minute intervals.

**CLASSES:**

All junior women and men race 20K, Start times begin at 10:00 AM, subsequent riders at 1:00 intervals.  
All 55+ master women and 65+ men race 20K, start times begin at 10:00 AM, subsequent riders at 1:00 intervals.  
All other riders including tandems will race 40K, start time at about 10:25 AM, depending on the amount of 20K racers, subsequent riders at 1:00 intervals. Tandems will start after all individual riders.

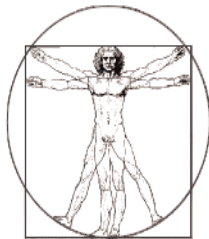
**CASH BONUS:** \$50.00 cash bonus paid to the individual rider who posts an official time under the Oklahoma State TT record of 52:44 for Men or the TT record of 59:30 for Women for the 40K. Tandems are not eligible for this prize. No one-day license entries are eligible for this award.

**RULES:** All USAC 2009 rules are in effect, including the requirement of the wearing of a helmet; reporting to the starting line at least 3 minutes prior to a person's designated start; on an out and back course one must stay on their side of the road centerline; maintaining a drafting spread of 80 feet behind a rider or else moving 7 feet off to the side; and all other Section 3E requirements. Race to be held rain or shine, except for lightning delay. Only USAC regulation bicycles will be permitted. Juniors will need to report by 7:00 AM on race day to have their gearing inspected for USAC compliance. If a junior does not know the details of this requirement, contact William.Wylie@gmail.com as many days before the race as possible.



## Our Sponsors

**Peter A. Erdoes, P.C.  
Robert & Cara Barnes  
Allan Devore Law Firm  
Bill Wylie**



**Anthony La Sorsa  
Physical Therapy, P.C.**

