A longer crank isn't necessarily better, experts say. Shorter cranks can recruit muscles for a contraction rate that better mimics run cadence.

The Crank Length Debate Comes Full Circle

By Mark Deterline // Photos by John Segesta

While building up a new TT bike recently, I asked famed aerodynamics and biomechanics guru John Cobb which crank lengths to use and which corresponding gear ratios he would recommend. I'm just over 6'2" tall and have always used 180 mm cranks on my TT and mountain bikes. I was thinking I might even need to go longer to optimize my power output or achieve maximum efficiency. But what Cobb said challenged that thinking, and forced me to consider the topic more broadly.

"I used to be a big believer in long crank arms, but now I'm going in a different direction," Cobb says. "I'm convinced that crank length and pedal rate (i.e. cadence) should be more directly related to one's natural running cadence and stride length than anything else. Every muscle has a natural contraction rate that will yield maximum efficiency. The game is to keep the muscle in its most efficient extension range and at its most efficient rate of rotation."

John McDaniel holds a PhD in exercise physiology and is an elite amateur road racer and triathlete. He is also a research associate of Dr. Jim Martin, whose exercise physiology lab at the University of Utah is well respected. McDaniel adds some insight to Cobb's observations.

"Every muscle does two things for which an athlete should strive to determine optimal performance parameters: One is the contraction-relaxation rate (the rate at which the muscle will contract, perform work, then relax), and shortening velocity (the speed at which the muscle contracts, or shortens)," McDaniel says. "These two tasks determine maximum power and maximum efficiency.

"By varying pedal rate and crank length we can adapt conditions to the muscular system so that it operates closer to its maximum efficiency or power. Our goal is to do both. It is interesting to note, however, that the parameters in which max power is produced are often not the same as those that produce max efficiency. This is obvious in cycling where max power is usually produced around 120 to 130 pedal rotations per minute, yet max efficiency is reached at around 60 to 70 rpm," McDaniel says.

When I brought up the issue of crank length with Ironman champ and "super-biker" Chris Lieto, he said that internationally renowned exercise physiologist and coach Max Testa suggested that he transition to shorter cranks to improve efficiency. But Lieto confided that he had been reluctant to make the switch since he was comfortable on 175s—what he has always used on his road bike—and hadn't wanted to mess with what he felt was "dialed in."

Cobb explains what got him moving in the new direction in the first place.

"My initial motivation for experimenting with shorter cranks was to get riders lower on their bikes by rotating them forward and down without their legs hitting their rib cage, and without restricting their breathing," Cobb says. "But first, I had to determine that shorter cranks and the lower seat heights they afforded, because of improved upper-body clearance, would not adversely affect power output or efficiency.

"That led me to Professor Jim Martin at the University of Utah. Martin conducted a study using 60 racers of all skill levels. He would vary crank length in 15 mm increments both longer and shorter. His findings showed that there was no power difference from one length to another but that oxygen uptake was always better with shorter cranks.

"I've worked with a rider who is 6'5" and has worked down to 165 mm cranks over the last three months; he's gained 65 watts of power," Cobb says.

"During one particular study, Martin and I recorded athletes' oxygen consumption while cycling on a stationary bike in the lab," McDaniel says. "We used crank lengths of 145, 170 and 195 mm, pedaling rates of 40, 60, 80 and 100 rpms, and intensity levels of 30 percent, 60 percent and 90 percent of lactate threshold.

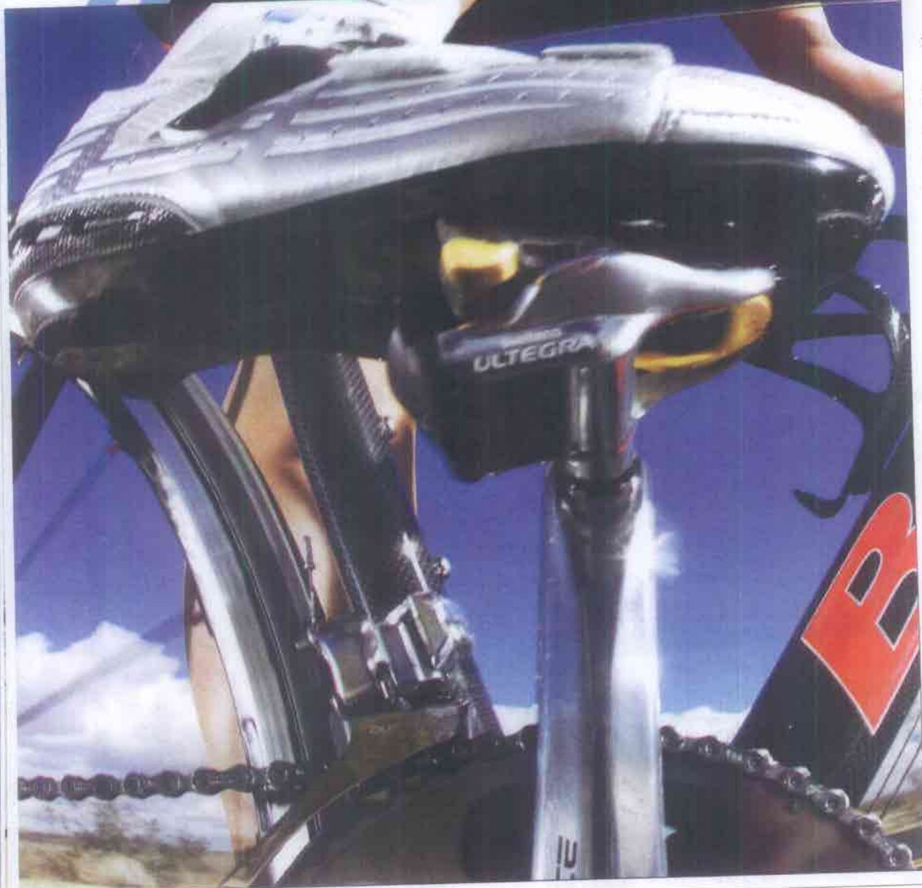
"We found that the power produced (i.e. force applied to move the pedals) during exertion accounted for 95 percent of oxygen consumption ($V0_2$). Changes in crank length and pedal rate had the capacity to alter oxygen consumption or efficiency by about 3 percent," McDaniel says.

"Furthermore, this study demonstrated that the body requires more oxygen as pedal speed (speed of the pedal along its axis of travel—not cadence) increases. So, for any given pedal rate (cadence), pedal speed will therefore be slower with shorter cranks, resulting in a decreased oxygen requirement."

McDaniel emphasizes, however, that they determined modest changes in oxygen consumption across the large variations in crank length (145 to 190 mm) they implemented.

"So switching from 175 to 172.5 mm would likely have little measurable or even undetectable benefit," he says.

"The main point is that you would be safe switching to shorter cranks for aerodynamic reasons without the fear of decreasing efficiency. In fact, research implies your efficiency



would increase somewhat."

Since I'm about 6'2" with a common proportional inseam for North Americans, Cobb suggested that to start I shouldn't go longer than 170 mm and that I may want to try 165s. Then Cobb introduced what—at first—seemed a contradiction.

"My own continued research and experience supported Martin and his associates' findings," Cobb says. "But there was a recurring theme I was noting in my work with athletes. In order for shorter cranks to feel right to my riders, they had to start turning bigger gears."

I'm predominantly a roadie who has been using a 53-tooth chainring with 175 to180 mm crank arms, so Cobb suggested I might want to mount a 54- or 55-tooth chainring if I moved to shorter cranks.

This didn't make sense to me—or McDaniel—initially, as it seemed to contradict the whole leverage discussion. A shorter crank implies a shorter lever, which would imply that a rider needed to exert more force to turn the same gear.

However, Martin and his colleagues' findings implied that longer cranks didn't yield more power and that shorter cranks yielded more efficiency in the form of less oxygen uptake. This means that factoring in all aspects of biomechanics and physiology, with pedal speed perhaps being the most significant, the issue of leverage was no longer

A shorter crank can mean a lower seat, more aero profiles and allow for a lower more forward position.

a primary consideration. That's the change in paradigm.

For example, let's say a rider determines she is efficient (and has likely become comfortable) turning a certain gear size with 180 mm cranks at a given pedal rate, yielding a particular pedal speed. Now she switches to 165 mm cranks and settles back into her comfortable pedal rate. But after several rides she feels something is amiss. We know that her pedal speed has decreased, because she's now turning shorter cranks at the same pedal rate as before, so we —like Cobb—make an educated guess that what feels different can likely be attributed to the fact that her oxygen uptake is reduced. In other words, there is now less metabolic cost (i.e. she is not working as hard) to turn the same gears.

Applying these principles represents an additional advantage to time trialists and triathletes, according to Cobb. Not only can you become a more efficient human machine but shorter cranks will help improve your aerodynamics with a lower, more forward position.

"Martin has determined that shorter cranks can allow a rider to decrease saddle height by 50 to 70 mm with a comparable lowering of the front end—lower overall rider position—since the more contained pedaling action was less inhibitive with regard to leg movement and breathing," Cobb explains.

He contnues, "Subsequently I conducted a wind-tunnel test with one triathlete in which the change to shorter cranks and a correspondingly more compact position yielded a 30 percent reduction in drag. That means a theoretical reduction in time of 25 minutes over the Ironman bike distance!"

A final consideration is the "dead spot," generally established to occur between the 10 and two o'clock positions in the complete rotation of a crank arm. Lieto points out that over the course of an Ironman bike segment (112 miles) it becomes increasingly difficult to stay smooth through the dead spot, and he says that it could be easier to maintain efficiency by using shorter cranks. Lieto also hints that an athlete might potentially head into the run segment (26.2 miles) less fatigued, because an athlete might be able to stay within more natural movements with shorter cranks, causing less stress and strain on muscles and joints.

You've probably heard, "First learn to spin a small gear. Then get strong enough to turn a big gear. *Then* get fit enough to spin a big gear." Cobb's inference has similar performance implications, this time leveraging biomechanics: Use shorter cranks so that you can turn a bigger gear without working any harder. ▲