Words and Images by: Kirk Willett

“Base” is defined by the American Heritage Dictionary as a fundamental principle or underlying concept of a system or theory. Cycling performance does indeed have such a base, though its popular definition in cycling circles has blurred the concept by focusing on large volumes of lower powered riding. The performance-rooted cycling definition of base is simply power at “threshold”. Power at “threshold” has many definitions, but I define it as 20 minute mean maximal power or 20MP.

The traditional definition of cycling base training seems to have evolved out of the general concept of periodization largely credited to Dr. Tudor O. Bompa. Periodization is a method of planned training cycles which ideally lead to peak performances. I believe periodization can be a valuable means of eliciting future performance in cycling, but I have a different perspective than many on how to go about it. Generally, periodization is intended to address the most basic aspects of performance, and then the finer details are built around that in order to achieve maximal performance. What is more basic to cycling performance than 20MP or power at “threshold”? Everything else is peripheral, including large volumes of low intensity riding.

As long as I have been involved in the sport of cycling (since 1984), base has not carried this definition. Base has almost always been defined as something to do with long, easier rides before higher intensity training or racing begins, and it has been suggested that this approach is a prerequisite for future performance. Some base traditionalists have been known to prescribe power or heart-rate ceilings in order to limit training intensity for many weeks or months during their base period. The rationale is that this builds “endurance” and enhances future higher intensity training. The issue with this more traditional approach is that endurance is primarily a function of 20MP, as 20MP influences nearly every power-duration relationship in cycling. The primary benefit of long, low intensity rides is that they train your body to sit on the bike for longer; however, these efforts have a limited impact on 20MP, and by definition, overall cycling performance.

How does 20MP dictate nearly all the power-duration relationships? There are two main parts, but they are both connected. First, intensities above 20MP cannot be sustained for very long and require recovery below that intensity to repeat the effort. Basically, every little bit harder than 20MP an effort is the shorter the duration that effort can be sustained. The power-duration relationships become curvilinear in that the duration drops exponentially as power rises above 20MP. Whether climbing in a mountain-bike race or road race, holding a wheel in a cross-wind, time-trialing, or positioning for a sprint, 20MP influences the intensities sustainable during these efforts and what capacity is available to launch above it before failure and necessary recovery. In other words, the higher the 20MP, the higher the absolute powers which are sustainable for durations shorter than 20 minutes up to the genetic limitations of fiber type and neuromuscular make-up.

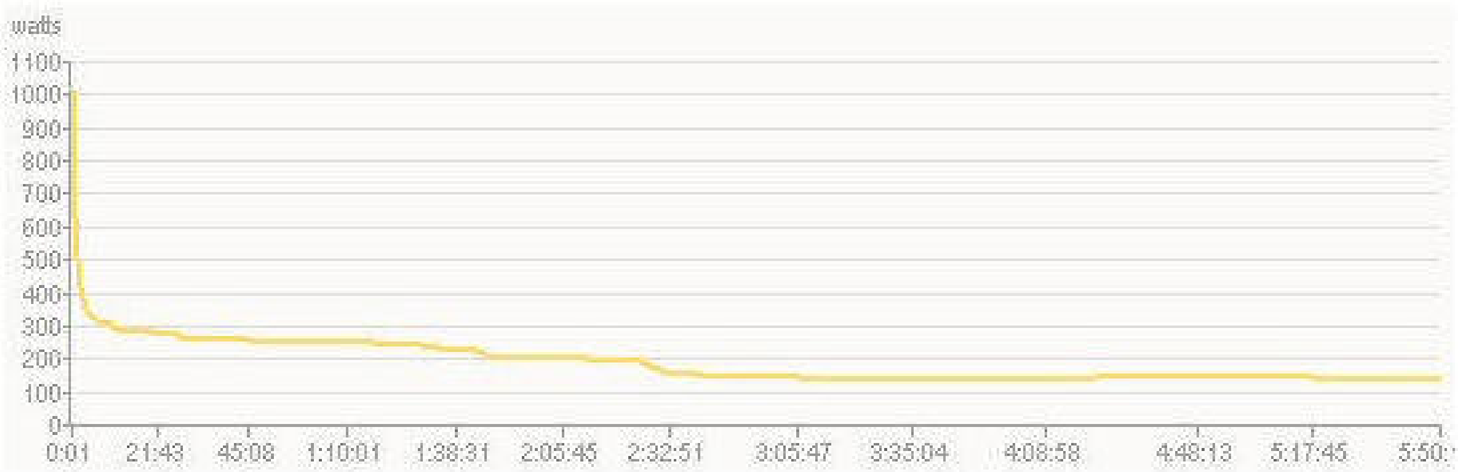

Figure 1. Sample of power-duration curve.

Second, the duration one can sustain a given power output below 20MP increases with decreasing intensity, and this relationship is rather linear with a shallow slope. In other words, small drops in power result in large increases in duration. This is primarily due to an energy source shift away from glycogen as intensities decrease below 20MP (as implied by Holloszy and Coyle, 1984; Coyle et al. 1988; Romijn et al. 1993). Generally, more fats are used to generate that energy and glycogen is spared. Put more simply, the higher the 20MP, the longer a lower absolute power can be sustained and the faster a power relative to 20MP will be. For example, my 20MP is about 290 watts right now. For every little bit easier I ride below 290w the duration I can hold that lower power increases. If I was to improve my 20MP to 310w, I suddenly would be able to ride at 290w for a lot longer than 20 minutes. I very well could ride at 290W for an hour. By increasing my 20MP, I increase the amount of time I can spend at every power level below it. Longer rides are not absolutely necessary for improvement in power-duration relationships – improve 20MP and everything else for longer durations will follow.

These two parts of basically the same principle illustrate how 20MP strongly influences power-duration performance. The higher your 20MP, the more power you can sustain for nearly every duration attempted (some extremely short sprint-like efforts may not be changed). This is one reason why 20MP is the base of cycling performance.

Traditional base often suggests that there are unique physiological adaptations which only occur during slower, longer rides. This is not the case with the exception of glycogen storage in the particular muscle fibers used during these lower power rides. Let's take a look at a summary of the primary components which come together to produce 20MP in order to illustrate how long, slower rides only have a limited and secondary role in performance.

20MP is primarily a product of two things: mitochondrial density or activity and oxygen delivery. There are other aspects which affect 20MP such as clearance of metabolic byproducts, acid tolerance, motor-unit recruitment patterns, a small "anaerobic" power component, and the like, but for purposes of comparison to lower intensity training (and traditional base definitions), mitochondrial density and O2 delivery are the most applicable.

Mitochondria are the energy factories of working muscle cells. Basically, the higher the mitochondrial density a muscle cell has the more power it can generate over time. Mitochondrial markers do not appear to increase under low intensity conditions very quickly. They appear to only increase when the rate of energy demand over time in an individual muscle fiber outstrips the cellular mitochondrion's ability to provide it. The maximum stimulus for mitochondrial development as a whole appears to exist at the edge of aerobic power production or 20MP (as suggested by Dudley, 1982 and subsequently Terjung, 1995). When you ride hard enough for long enough such that the muscle fiber overload is nearly maximized, it appears that the biochemical environment is primed for mitochondrial growth – and this is a good thing. Lower powered efforts predominantly only use muscle fiber profiles which have already mostly adapted to this stimulus in prior training. These muscle fiber-profiles are already equipped and respond much slower since as a whole, the biochemical stimulus for mitochondrial growth is minimal – one just isn't going hard enough to be very productive.

O2 delivery is similar. Vascularity only adapts if the rate of muscular oxygen demand increases. Gains in blood-vessel measures appear to respond similarly to mitochondrial measures in that it is the rate of oxygen demand which stimulates the greatest demands for vascular adaptation as mitochondrial improvements appear to parallel vascular improvements (Coggan et al. 1992; Poole, 1996; Charifi et al. 2004; McAllister et al. 2005). The heart responds in much the same way. If the heart is not forced to pump hard and fast, it is just pumping. Lower intensities do not provide the same stimulus for O2 delivery as 20MP focused training.

The biggest decision in training choice and prescription addresses the cost-benefit relationship between time and intensity. Hypothetically, if you trained at lower intensities for large amounts of time (per day/week for many weeks) and increased the training power a few watts every week, you might eventually reach your genetic limits for O2 delivery and mitochondrial density and therefore maximize your 20MP. The costs incurred with this approach are time and the large volume of overall fatigue caused by exposure to the weather and the mental and physical stress of all those endless hours on the bike. This fatigue can result in immune-system depression, psychological depression, depression of “good” hormone levels, and over-use injuries caused by such huge volumes of repetitive motion to name a few. These potential liabilities suggest that this approach may not be worth it, especially when you can accomplish the same adaptations in a small fraction of the time.

Why waste your time and incur these significant costs? Even professional riders do not have time to waste. Time is better spent riding harder, recovering sooner, and avoiding unnecessary fatigue when building your base. There is a proper application for those longer, easier rides which shift adaptations towards glycogen storage in lower powered muscle fiber profiles, but they are not the base of cycling performance. 20MP is this base.

The many variables which compose individual performance are often hard to learn how to manage. Proficient management of training variables requires the incorporation of the science of physiology, the advances provided in performance measurement offered by such items as power meters, and the experienced interpretation and application of both to performance. Experience can help direct efforts in the absence of expensive tools since improving performance is still all about identifying that which limits it. This is often the role of a good coach when combined with the understanding that the ultimate thing a coach can do is teach you how to be your own coach. There is no more powerful a tool than the super-computers we all have. We can all use a little more software, but generally, your super-computer already knows this:

“You have to train hard and rest hard to go your fastest.”

Happy training and have some fun out there! That’s really what sport is all about!

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About our Contributor:

Kirk Willett, is a twenty-year+ participant in the sport of cycling who has competed in 17 different countries on 5 different continents. Originally from Pullman, Washington, his racing career has ranged from his roots as a Pacific Northwest junior and amateur competitor to time with the U.S. National Team and then on to professional competition as a member of the Mercury Cycling Team including events such as the Tour of Switzerland. He was also a director with the Mercury Cycling Team and then directed the Prime Alliance professional team full-time from 2001 through 2003. He has also been a coach and advisor to members of both the Mercury and Prime Alliance professional teams in addition to other Pacific Northwest athletes.

Kirk is currently a medical student attending Oregon Health Sciences University building on his exercise science education from Washington State University. He resides in Portland, Oregon with his wife Tina and two sons. He is a strong advocate for clean, ethical sport and encourages all athletes to take the same pledge he did as a young amateur: “I will never participate in doping no matter what I stand to gain.