



Helping cyclists train intelligently

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The Third Dimension to Training ***A Very Brief Introduction to Coaching with Power Meters***

Affordable heart rate monitors became widely available in the 1980's and we dinosaurs who rode back then rushed out to buy them. While it was interesting to know what your heart rate was, it wasn't very informative in the early days. It wasn't until the late 80's or early 90's that we learned how to turn heart rate data into *useful information* for training purposes. Today, we're on the brink of another revolution in training: training with power.

Power, measured in watts, is an instantaneous and objective measure of the rate of work produced by the cyclist and can be expressed as:

$$\text{Power} = \text{Pedal Force} \times \text{Angular Velocity (Cadence)}$$

The formula simply indicates that an athlete can increase power by exerting more force on the pedals at the same cadence (i.e., use a bigger gear), by increasing cadence while exerting the same pedal force, or by increasing both force and cadence.

Why is Power Useful?

There are only three variables to control in a training system: duration, intensity and frequency. Duration and frequency are easy to measure objectively. Intensity, on the other hand, is difficult to measure. Many of us have been using RPE (rating of perceived exertion) and/or heart rate with our athletes for years.

Heart rate is a fairly reliable way to devise a training plan during lower intensity (i.e. aerobic) training and a lot easier to govern than wattage. But as an athlete moves into more race specific training, heart rate becomes a less effective proxy for intensity. Besides being subject to certain variables (e.g. humidity, temperature, etc.), heart rate lags effort.

Power is an especially useful training device because it is both instantaneous and completely objective in measuring intensity: 300 watts is 300 watts, no matter how the athlete feels, how hot it is outside or what their heart rate is.

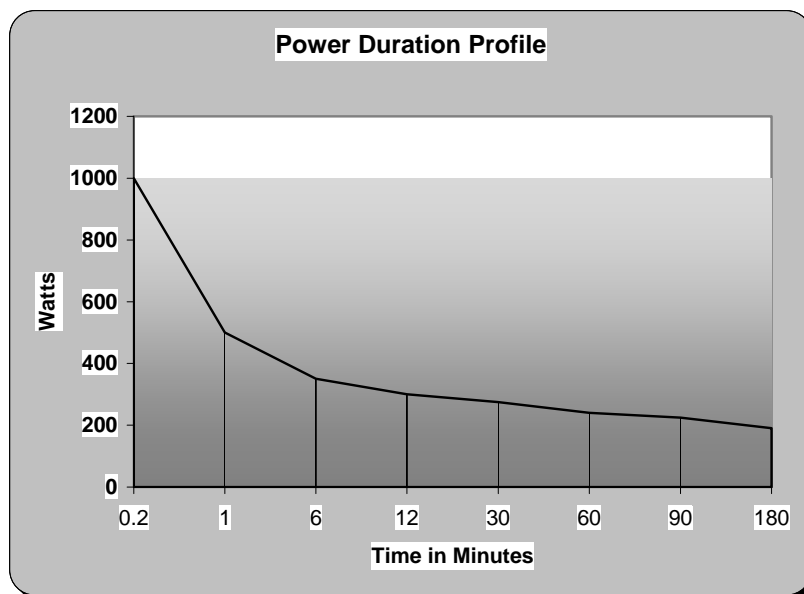




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As you can imagine, the average power you sustain for one minute is dramatically different from what you can average for thirty minutes. There is a non-linear relationship between power and duration (Figure 1), but the slope of the line becomes fairly constant as duration is increased beyond 12 minutes.



Joe Friel refers to the power duration relationship as critical power points.¹ The average power an athlete can sustain for six minutes thus becomes her CP6. Not all segments need to be test or monitored; that is, certain segments along this line become training zones when training with power. Which of these points to monitor will depend in part upon the athlete's event focus and where they are in their training program. Average power for 30-minutes is a reasonably good proxy for lactate threshold power, which is a key performance metric and is highly predictive of success in endurance cycling events.

The beautiful thing about using an entirely objective measure is the ability to periodically test an athlete to determine whether or not the training is paying dividends. For example,

¹ This is different from the concept of critical power presented by Monod & Scherrer in the 1960's and others in the scientific literature. In their definition, critical power is a level that can be sustained for "a very long time." While some scientists are disturbed that we use CPxx to describe our power duration levels, think of it simply as average power for any given duration.



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every four weeks during “Base” training you may test average power over 30 minutes, a reasonably good proxy for lactate threshold power), as this is where you would expect to see the most benefit. As you move into race-specific training (i.e. “Build” phases), you will focus the training and testing on the athlete’s race-specific limiters. For example, a criterium specialist might focus on CP0.2, CP1, and CP6 while a “roadie” focuses on CP6 and CP30.

As you track your athletes’ progress, keep in mind that in some cases it may be necessary to normalize the data, such as when there has been a significant change in body weight. Over time, you will gather data from multiple athletes as well as from other sources. It’s important to bear in mind that weight may not be the appropriate manner to normalize data across individuals. For example, when comparing two athletes’ abilities on anything other than sustained climbs, effective frontal area is the more significant factor that must be considered.

While some coaches use only power to prescribe workouts, I think disregarding RPE and HR is like seeing in less than 3-D. As an analogy, most people get their news and information from multiple types of media. The introduction of the radio did not render newspapers useless, nor did television result in the demise of radio. Each type of media has its inherent strengths and weaknesses and most of us draw on all three to gather news and information. It is the same with RPE, heart rate and power. Each “intensity indicator” has its place in structured training. Used together, they provide a three-dimensional approach to training.

INTENSITY INDICATORS BY WORKOUT TYPE

WORKOUT TYPE	PRESCRIPTIVE	POSTSCRIPTIVE
Neuromuscular (sprint power)	RPE	Power
Anaerobic-endurance (speed)	RPE	Power
Anaerobic-endurance (force)	Power	HR
Muscular endurance	Power/HR	HR
Aerobic endurance	HR	Power
Recovery	RPE	HR





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Basically, I think of intensity indicators as either “*prescriptive*” or “*postscriptive*.” That is, prescriptive intensity indicators govern the actual intensity whereas postscriptive indicators provide after-the-fact analytical power. While RPE is always prescriptive, heart rate and power can be either prescriptive or postscriptive.

Eddie Monnier focuses on helping cyclists and runners train intelligently through his coaching business, VeloFit™. Power-based training for cycling is one of his specialties, though he also coaches athletes by perceived exertion and heart rate (or better yet, all three). He is also an Expert level USA Cycling certified coach and a member of cyclingnews.com’s Form & Fitness Panel. He can be reached at edward_monnier@hotmail.com.

