

## ***Getting it half right***

*Scott Thor did a good job accounting for energy intake during his recent series of century rides, but the distribution of energy output must be considered as well.*

**BY CHARLES HOWE**

I would like to commend Scott for his thoughtful [article](#) exploring the energetics of three long rides he completed in the Autumn of 2005. Although I will show that this analysis is incomplete, and question the conclusions that were reached, it is important to be aware of what, how much, and when you eat over the course of most any ride longer than ~40 minutes, and especially for the sort of 5-6 hour efforts that Scott undertook. As he was writing this article, I offered a few comments that I hoped would shed some light on the issues being considered, but I am not sure my remarks sank in, so I will try here once again to add some perspective.

In addition to being inventoried and totaled, as Scott did, energy intake on each ride needs to be assessed against the feeding guideline established for endurance cycling in studies published more than 15 years ago: during moderate-to-intense endurance cycling, 45-60 grams of carbohydrate (CHO), or 180-240 calories, in a 6-8% solution, should be ingested every hour, in 3-4 feedings. This works out to almost exactly one large (750 ml capacity) bottle, in 6-8 oz portions every 15-20 minutes. Despite perennial manufacturer claims of exclusive, patented, breakthrough formulas, there is no evidence that one CHO beverage works better than another, nor that the addition of protein, lactate buffers, etc., etc., etc., is advantageous; neither is there any support for claims that energy bars or gels are superior to liquid refreshment alone. Indeed, it is possible to train and compete on the following home-made mix without any compromise in performance:

<b>COST</b>	<b>QUANTITY &amp; INGREDIENT</b>
\$0.7200	3 packets (4.2 g) Kool-Aid or Wyler's unsweetened soft drink mix
\$0.1000	1¾ - 2 cups cane sugar
\$0.0063	1½ tsp (8,850 mg) table salt (yields 3,480 mg sodium)
\$0.0538	½ tsp (2,325 mg) Morton Salt Substitute (yields 1,220 mg potassium)
\$0.0321	½ Tums® Smoothies™ Extra Strength antacid tablet (yields 600 mg calcium)

Combine ingredients in a recycled Gatorade container and rotate/invert repeatedly until thoroughly mixed, then use the Gatorade scoop or a tablespoon to measure out enough powder for each 750 ml bottle (2¼ scoops, or 3 tbsp to a bottle). Since the mass of the sugar in each bottle is 50 g and the volume of the liquid is 750 ml, the concentration of the CHO is 6.7% (50 g/750 ml), while sodium is in a solution of 0.76%, both within recommended ranges of the [fluid replacement guidelines](#) published by the American College of Sports Medicine, furthermore, this solution provides the same essential ingredients as Gatorade Endurance Formula Energy Drink™, in the same proportions, at just 29.3¢ per half gallon – not even a tenth the cost of the liquid form, and less than half as much as powdered.

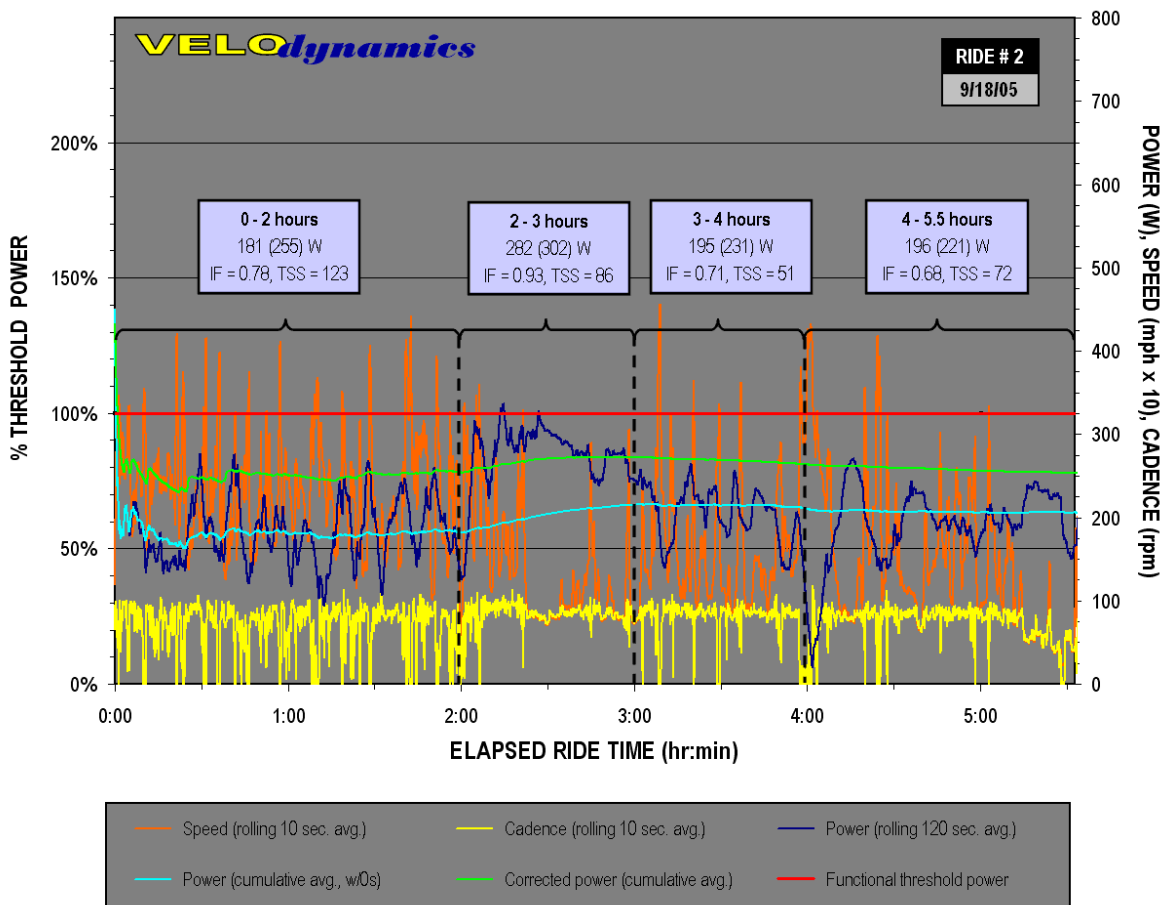
On long rides in locations where only water is available, or during tours where refreshments are of unknown concentration, this powdered mixture can be conveniently carried in 2 oz containers, such as travel-size bottles of shampoo, which hold just enough for a 750 ml bottle. Be sure to plan your ride around several stops for water refill, and try using transparent bottles, which allow consumption to be easily monitored.

The fundamental point to be made here, however, and the one that Scott neglected to consider, is that how well you sustain energy output (how “strong” you are) towards the end of a long ride is a function not only of the composition (CHO, fat, and protein), total energy (caloric) value, and timing of what you take in, but of how evenly you distribute energy *expenditure* – i.e., how well you pace or “dose” your effort

throughout the ride, with particular respect to intensity expressed as [normalized power](#) (NP), in relation to functional threshold power (FTP), which is defined as average power for a 60 minute, flat time trial. Consider: assuming you were fit enough not to exceed FTP and “blow up” in the first several hours of the race, could you hang with the main pack in something like Paris-Roubaix simply by eating enough? Of course not, and the reason is that you will be riding at a higher percentage of your lactate threshold than the other riders, and will therefore more quickly exhaust limited energy (glycogen) stores, which are drawn on more heavily as exercise duration wears on and/or intensity increases, no matter how much you eat. Lowering the intensity would allow you to derive more energy from fat stores, which are essentially unlimited, while bringing CHO metabolism and supplementation into a more optimal balance.

Similarly, the loss of power which Scott experienced in the latter stages of the Bridge-to-Bridge Century was almost certainly due not just to how much and what he ate, but also the pace maintained by the group he rode with from the start, although the group alone cannot be blamed, since his energy output on Ride #1, where pace was self-selected (ridden solo?) was about as badly imbalanced as in Bridge-to-Bridge.

A graphic of Ride #2 (Bridge-to-Bridge) gives a visual appreciation of the unevenness of Scott’s effort:



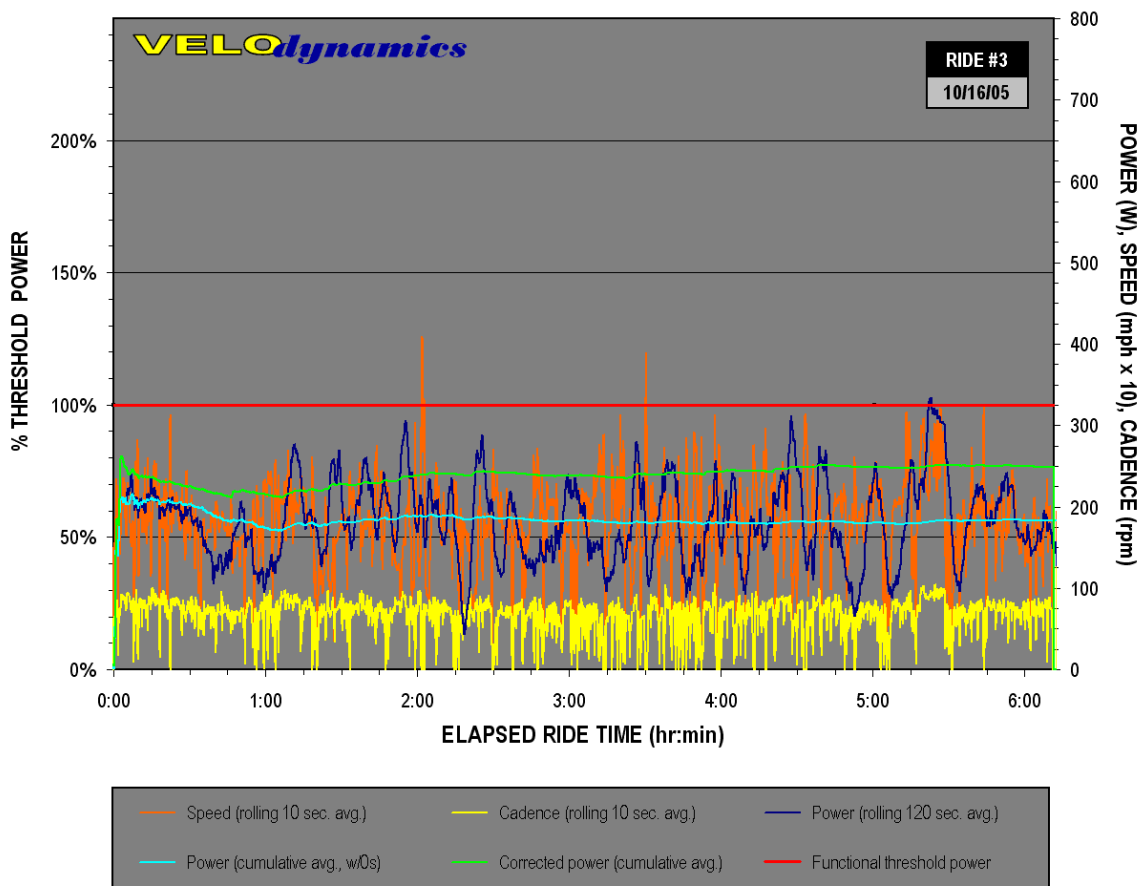
Cumulative average NP (the green line) topped out at 272 Watts just past 3 hours into the ride, then began an inexorable fade (this is actually where the “lights started to go out”) to end up at 253 W, or a decrease of 7%, but the fact that cumulative average is progressively weighted – the longer you go, the more samples it is based on, and the more slowly it changes – hides the extent of the decline; comparing the average NP for the first 3 hours against the remainder of the ride shows a drop of 18%:

WORKOUT	DISTRIBUTION of STRESS LOAD			POWER (normalized Watts)			CHO INTAKE (grams/hour)
	0-2 hr.	2-4 hr.	4-6* hr.	0-3 hr.	Remainder	Change	
Ride #1 (9/10/05)	36%	39%	25%	265	236	-11%	61
Ride #2, Bridge-to-Bridge Century (9/18/05)	34%	38%	28%	273	225	-18%	60
Ride #3 (10/16/05)	31%	34%	35%	241	260	+8%	71

\*Projected by extrapolation for the incomplete 6th hour of Rides #1 & #2, and back-interpolated to 6 hr. for Ride #3. TSS was chosen over kiloJoules to express stress load since it more accurately reflects 1) efforts that exceed lactate threshold, and 2) perceived exertion.

Clearly, Scott's unfamiliarity with rides lasting 5-6 hours (Ride #1 was only his second century) kept him from recognizing that he was putting out too much effort, too early; indeed, the intensity factor (NP/FTP) for the first 3 hours of Bridge-to-Bridge was 0.85, just what he would typically manage for a hard 3 hour race or ride – without continuing for another 2.5 - 3 hours! On the other hand, his overall CHO intake appears to have been adequate, although there is no indication of its distribution, i.e., when he ate what, and it is possible that fat content of the peanut butter sandwich interfered with CHO absorption.

In Ride #3, Scott did a **much** better job of moderating his pace from the beginning, which allowed him to be far “stronger” until the end:



Looking at cumulative average NP again, Scott reached 240 Watts at 2 hours, 243 W at 2:25, and 249 W at 4:30, where it more or less remained until the end – a value very nearly equal to his overall average NP at Bridge-to-Bridge. Thus, Scott’s improved performance and perception of reduced fatigue on Ride #3 was due to more even pacing, rather than his increased CHO consumption (and accompanying decrease in protein/fat intake); he would still have bonked in Rides #1 and #2, even with additional CHO intake, it just would have happened a little later, and the ensuing loss of power would have been attenuated somewhat. Unfortunately, Scott seems think that he needs CHO in excess of 70 g per hour, but since he did only one ride with good pacing, his test did not control for this variable. Had he done a fourth ride on the same course, with the same pacing and intensity as Ride #3, but ingested only 60 grams CHO per hour, there might be some basis for his conclusion. Furthermore, peer-review research indicates that CHO ingested in excess of 1 gram per minute does not necessarily result in any performance improvement, in part because limitations in the digestive system serve to hinder it from reaching the working musculature.

The ‘trick,’ therefore, is to balance intensity and energy intake such that you are able to maintain or increase cumulative average power throughout the ride, and begin to ‘bonk’ right at the end, if at all. This is accomplished not by any on-the-fly dietary analysis or energy balance calculations, but simply by ingesting CHO at the rate recommended above, while modulating effort by a sense of pace that becomes ‘calibrated,’ with the help of a powermeter, over the course of a sufficient number of rides of appropriate duration. In other words, try to keep increasing power gradually but steadily throughout the ride while holding something in reserve, then ramp up the power in the last 30-60 minutes and carefully expend whatever you’ve got left, so that you reach exhaustion right at the finish. This was a practice pioneered by Fausto Coppi, the immortal *Campionissimo* of the 1940s and ’50s, and it is still useful today.

All of this said, even pacing is not **necessarily** the best strategy for a long road race. An early breakaway might succeed if it gets a big enough margin and is organized well enough, even if it means that energy output is less evenly distributed, and power output declines somewhat late in the race. Still, where there is a fairly narrow range of abilities in a field of riders, most early breakaways fail, and most winning moves occur in the last third or quarter of the race. Put another way, the goal of training is to maximize the work performed, whereas in competition, it is to minimize time taken to finish, and Scott was not necessarily wrong to try to stay at the front of things from the start of Bridge-to-Bridge; I suspect he wanted to test himself against the best riders there, and the shelter they provided may well have gotten him to the finish line faster than if he had ridden more conservatively, notwithstanding his considerable fade. Scott’s approach was similar to the one I fell into when I competed – er, participated – in this “it’s not a race” event, way back in . . . 1990!

A final point I feel I must address regarding Variability Index, since I am the one who conceived ‘VI’: it is true, as Scott points out, that VI for a flat-to-slightly-rolling ride will be around 1.0 - 1.05, while hilly rides are typically >1.15, but it is a misinterpretation to call VI “a measure of your pacing during a ride” ([others](#) have made this mistake, too.) Consider, for instance, a flat, 40 minute time trial where you start off very smoothly, then very gradually ramp the power output up to slightly (~5%) above what you can sustain for the entire race, and as a result, power fades gradually but significantly over the last half or third of the entire duration. Clearly, pacing is worse than a ride of equal intensity and VI, but where you stayed slightly under threshold pace and got stronger over the latter portions of the race.

On the other hand, a ride may be hilly, have a high VI, and yet be better paced than a comparably hilly ride of similar duration with a lower VI. Scott’s Ride #3 is a perfect illustration of this, since it had the highest VI of all three, yet it is clear his effort was distributed much more evenly. Thus, VI simply indicates the *moment-to-moment variability* of power output (a “moment” being ~30 seconds), more so than it describes pacing; the latter should be evaluated over longer periods of time, and in relation to average power for the full ride.

## **FURTHER READING**

Coyle, E.F. Fluid and fuel intake during exercise. Review. *Journal of Sport Science* [22\(1\):39-55](#), January 2004.

## **ABOUT THE AUTHOR**

*Charles Howe has been involved in the sport of cycling since 1973 in numerous capacities, including tour director, race promoter, official (road, Cat. 2), club officer, and even (gasp!) recreational/ competitive rider. A strong proponent of power-based training, his interest in cycling power output dates to the early 1990s, when he wrote a brief article for the now-defunct Cycling Science magazine which modeled the effect of weight reductions on bicycle performance. A frequent contributor to the [Wattage Forum](#), he has written an [FAQ on power-based training](#) as well as numerous articles and a free on-line training guide, and 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.*