Putting the right spin on things

Some cycling skills come from judgment and experience, not technology or technique

BY CHARLES HOWE

Feedback is always welcome, but a recent comment came as something of a surprise: "Charles, your articles on training are great, but I need some help just shifting gears properly." Well, after all, this column *is* called "Shifting Gears," so this month, I'll focus on the skills side of things rather than training.

Practice makes perfect

Training regularly on an undulating or hilly circuit that you repeat several times during a workout lets you practice and perfect your shifting skill while getting in a good workout, too. As you become more familiar with the course each lap, you'll begin to anticipate the terrain ahead, refining your gear/cadence selection and modulating your level of effort with perceptual feedback from the previous lap(s). Did you get bogged down in too big of a gear, one that made your legs start to burn halfway up a particular climb? Or perhaps you were spun out in too small a gear going downhill? In each case, you can correct any deficiency and get things right the next lap.

In numerical terms, is there a particular cadence you should aim for? Both practical experience and controlled studies show that cyclists tend (without the aid of a cadence monitor) to self-select the pedaling rate that is *optimal* for them, i.e., between what is most efficient and what generates the most power; in nearly all cases this falls within a range of about 70-110 rpm. For me personally, it's 95-100 rpm during a 30-minute, flat time trial, and perhaps 85-90 rpm during a 2-hour training ride on flat terrain (not including coasting periods for stoplights and corners). When climbing, it's more like 75-80 rpm, depending on the steepness of the grade as well as the level of fatigue present. I emphasize, however, that these values were obtained largely out of curiosity, and often from the simple technique of counting the number of pushes by one leg over a 20-second period and tripling it (or doubling the number in 30 seconds). Again, perceptual feedback, course knowledge, anticipation, and judgment are what should determine gear selection and cadence – not a cadence monitor, which may even prove a distraction in certain situations.

Still, there is often a tendency, even among experienced cyclists, to stand up and push too big of a gear while climbing, which does generate more power and allows rapid accelerations, but at a much higher comparative energy cost than staying seated. Savvier riders therefore learn to keep their upper body relaxed while they "sit and spin" up hills in a lower gear, saving any out-of-the-saddle efforts for when they are truly needed. Indeed, if there is a fundamental rule to gear selection, it may be this: *try to never get caught in too large a gear*, and it applies to everyone from a tourist on a hilly century ride to a criterium racer who must respond instantaneously to the accelerations of other riders. The one exception to this is on descents, when power is applied to the pedals for control as much as speed, and being spun out in too small a gear has an adverse effect on bike handling.

The underlying pattern

So a cadence monitor may not be necessary, but you do need to understand how gearing is measured, and the particular ratios your own bicycle has. Consider a bicycle where the chain is on a 52-tooth chainring in front, and a 13-tooth cog in back. For every one turn of the pedals, the chain will wrap itself around the cog four times, and the wheel will make four revolutions. Multiplying this 4:1 ratio by the wheel diameter (for most road bikes, it's right around 26.3 inches or so) gives what's known as *gear inches*, so a 52 × 13 combination is a 108-inch gear – a fairly big ratio that would be used for sprinting and when descending hills.

Gear inches may be thought of as the effective wheel diameter; imagine an old 'penny farthing' or 'high-wheeler' with a 108" front wheel. (In Europe, the effective wheel diameter is more commonly multiplied by π, the result is expressed in meters, and is called a *development* – or how far you travel with one turn of the pedals – so a 108-inch gear would have a development of 8.62 meters). Gear inches can be expressed algebraically as

$$g_i = T/t \times d_w$$

where g_i = gear inches
T = chainring teeth
t = cog teeth
d_w = wheel diameter in inches

This relationship can be used to construct a gearing table, such as for a crankset with a 53/39 tooth chainring combination paired with a 12-26 tooth cogset (Table 1). The resulting pattern, as indicated by the gray line, can guide your gear selection and identify the point at which you need to cross over from one chainring to another, as well as how many cogs you need to simultaneously shift the chain in back to acquire the next gear, but don't follow the sequence slavishly; for instance, you might find yourself in the 39 × 15 after topping a hill, with a false flat section ahead, followed by another climb. Instead of shifting to the 53 × 19, you could simply go up to the 39 × 14 and stay in it until you downshift when the road turns more steeply upward. On the other hand, if a sharp downhill immediately follows the crest of the climb, you'll want to slam the chain on to the big 'ring and pop the rear derailleur over a couple spots on to the 21-tooth cog at the same time. The 39 × 12 and 53 × 26 combinations (known as 'cross-chaining') should never be used, since they place excessive stress on the chain and accelerate wear to it and to the respective cogs.

Clearly then, it is very important to be ever-aware of what gear you are in, and while a cadence monitor is not necessary, a handlebar-mounted computer that indicates chain position on the rear cluster can be very helpful, especially since today's narrow 9 and 10-cog clusters make it difficult to monitor this visually.

The myth of technique

A specious and all-too-often recurring claim is that pedaling drills "correct muscular imbalances" and "even out the pedal stroke," making it more "efficient" – always without a valid definition of the term, nor any objective means of measuring it. This contradicts what is known about pedaling dynamics, namely that applying force more evenly throughout 360° (i.e., more "smoothly") does not generate more power, rather, it is simply a matter of exerting more net "downstroke force" each revolution. In a study conducted at the University of Texas-Austin, nine "national class" and six "state class" riders each completed a 60-minute test on a calibrated ergometer with instrumented force pedals. The result? Elite riders generated higher average power for the test by creating higher average and peak torque loads between "top dead center" (0°) and "bottom dead center" (180°) – the "power phase" of each turn of the pedals (Figure 1). This more than compensated for the fact that they exerted *less* net torque during the upstroke, or "recovery phase." Put simply, to produce more power, you need to push down harder with each foot, which is not a matter of increasing strength, but of consistent, long-term, aerobic training in sufficient volume. This basic "stomping" pattern of force application is just as should be expected, since it is what has been developed through millions of years of evolution.

Because movement while cycling is constrained (as contrasted with running or speed skating), it turns out that cycling efficiency (assessed as power output in relation to oxygen uptake) is a function not of technique or a smooth pedal stroke, but of muscle physiology, being directly determined by the percentage of Type I (slow-twitch) muscle fibers present in the working musculature. Gains in efficiency are quite small and take place slowly, once again as a result of – you guessed it – consistent, long-term, aerobic training in sufficient volume.

A final word

If you frequently struggle and have to climb hills out-of-the-saddle in your lowest gear, even when your fitness is good, it's not a technique problem, it's a mismatch of terrain with the lower range of your gears. Consider retrofitting your bike with a compact crankset that has a 50/34 chainring combination, or a triple crank with a "granny" gear. In my own experience, there are several hills locally that tax me with a 39 × 26 low: Ira, Martin, Oak Hill, and West Boston Mills Rds. coming out the west side of the Cuyahoga Valley, plus Cady Rd. in North Royalton and Center Rd. (S.R. 303) west of Hinckley between State and Medina Line Rds. I simply avoid these climbs, but if I lived in an area where I had to ride such steep grades regularly, I'd switch to a compact crankset.

REFERENCES

Coyle, E.F., et al. Physiological and biomechanical factors associated with elite endurance cycling performance. *Medicine and Science in Sports and Exercise* 23(1):93-107, January 1991.

Coyle, E.F., L.S. Sidossis, J.F. Horowitz, and J.D. Beltz. Cycling efficiency is related to percentage of Type I muscle fibers. *Medicine and Science in Sports and Exercise* 24(7):782-88, July 1992.

Hagberg, J.M., J.P. Mullin, M.D. Giese, and E. Spitznagel. Effect of pedaling rate on submaximal exercise responses of competitive cyclists. *Journal of Applied Physiology* 1(2):447-51, August 1981.

Horowitz, J.F., et al. High efficiency of type I muscle fibers improves performance. *International Journal of Sports Medicine* 15(3):152-7, April 1994.

Lucia, A., et al. In professional road cyclists, low pedaling cadences are less efficient. *Medicine and Science in Sports and Exercise* 36(6):1048-54, June 2004.

Table 1. Gear inches for a typical gearing configuration.

COG TEETH	CHAINRING TEETH 39	CHAINRING TEETH 53
12	n/a	116.2
13	78.9	107.2
14	73.3	99.6
15	68.4	92.9
17	60.3	82.0
19	54.0	73.4
21	48.8	66.4
23	44.6	60.6
26	39.5	n/a

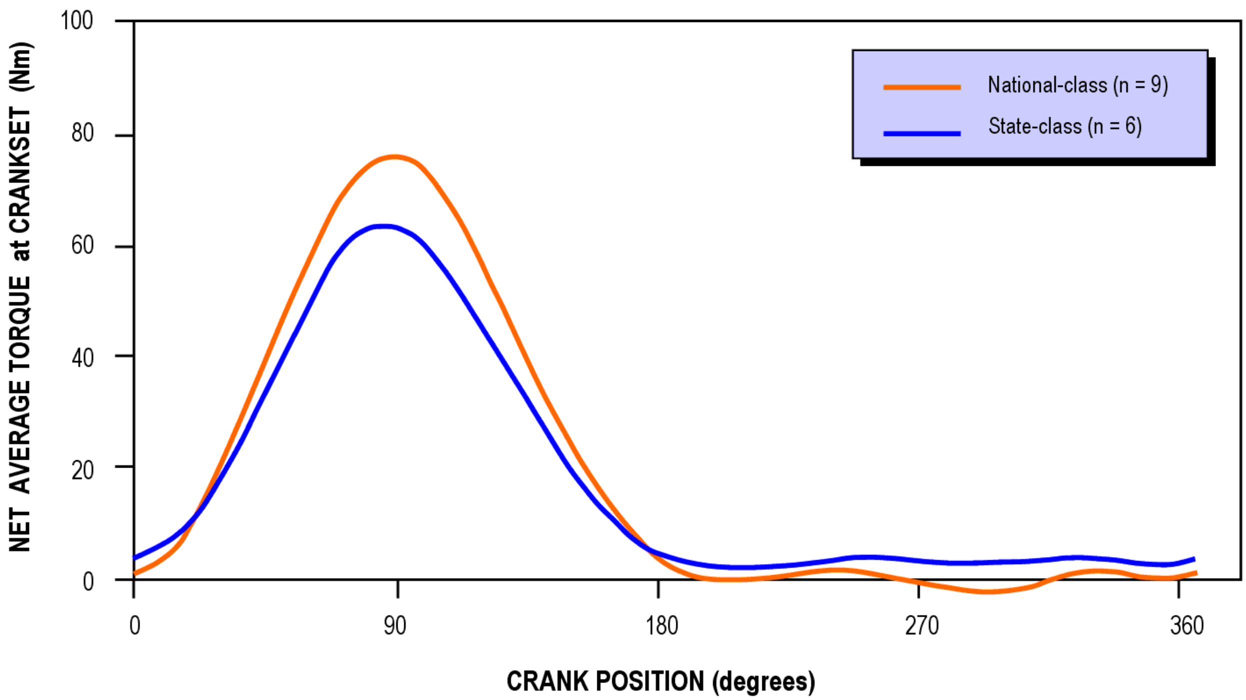

Figure 1. Torque profiles for two classes of competitive cyclists (in: Coyle, E.F. et al. Physiological and biomechanical factors associated with elite endurance cycling performance. *Medicine and Science in Sports and Exercise* 23(1):93-107, January 1991).