Part II:

ROAD RACING DE-MYSTIFIED
Racing classes and categories

1. **Class** is determined by age and sex; riders 18 and under are referred to juniors, while those 30 and over called masters

   For instance, a 36-year-old male man can enter Masters Men 35+ races, and a 17-year-old girl can enter Junior Girls’ 17-18 races. All riders, regardless of age, can also race “in category” . . .

2. Racing **category** is designated by numeral, and depends solely on performance

   Cat. 1 – national-caliber riders (performance upgrade)
   Cat. 2 – state-caliber riders (performance upgrade)
   Cat. 3 – regional-caliber riders (performance upgrade)
   Cat. 4 – local-caliber riders (experience upgrade: 10 mass-start races)
   Cat. 5 – newly-licensed riders
Racing classes and categories

3. Eligibility for age groups is determined on the basis of racing age, which is how old you are on December 31.

4. Women may “ride down” a category and enter men’s races, e.g., a Cat. 2 woman may enter a race for Cat. 3/4 men (Cat. 1 women may ride down 2 categories)

Cat. 3/4 women may race with men up to 20 years greater in age. For example, a Cat. 4 woman aged 39 can enter a men’s 56-60 age category race.
Race category structure comparison

Typical sanctioned event

<table>
<thead>
<tr>
<th>RACE CATEGORY</th>
<th>DISTANCE</th>
<th>START TIME</th>
<th>PURSE/PLACES</th>
<th>FEE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cat. 5/Citizen Men</td>
<td>20 miles</td>
<td>8 AM</td>
<td>Awards/5</td>
<td>$20</td>
</tr>
<tr>
<td>Women</td>
<td>20 miles</td>
<td>8 AM</td>
<td>$150/4</td>
<td>$25</td>
</tr>
<tr>
<td>Cat. 4 Men</td>
<td>30 miles</td>
<td>9:30 AM</td>
<td>$250/5</td>
<td>$25</td>
</tr>
<tr>
<td>Masters Men 35+</td>
<td>30 miles</td>
<td>9:30 AM</td>
<td>$250/5</td>
<td>$25</td>
</tr>
<tr>
<td>Cat. 1-3 Men</td>
<td>40 miles</td>
<td>10:00 AM</td>
<td>$500/10</td>
<td>$30</td>
</tr>
</tbody>
</table>

- Conducted under racing rules determined by governing body and supervised by trained, licensed officials who are usually independent of promoting club

- Annual or one-day license required

- Separate fields; narrower ability range

- Cash prizes, but (generally) no t-shirts
Race category structure comparison

Typical citizen event

<table>
<thead>
<tr>
<th>RACE CATEGORY</th>
<th>DISTANCE</th>
<th>START TIME</th>
<th>PURSE/PLACES</th>
<th>FEE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Citizens</td>
<td>20 miles</td>
<td>9 AM</td>
<td>(Top 3 overall M/W; top 3 M/W &lt;20, 20-29, 30-39, 40-49, 50-59, 60+)</td>
<td>$15</td>
</tr>
<tr>
<td>Intermediate</td>
<td>20 miles</td>
<td>9:05 AM</td>
<td></td>
<td>$15</td>
</tr>
<tr>
<td>Experts</td>
<td>40 miles</td>
<td>9:10 AM</td>
<td></td>
<td>$15</td>
</tr>
</tbody>
</table>

- Event rules as determined and enforced by race promoter
- No license required
- Combined fields with separate scoring; wider range of abilities
- Usually includes t-shirt, door/raffle prizes; small cash prizes may be offered
Race types
(aka specialties, subdisciplines)

1. individual time trial (ITT, or CLM for contre-la-montre)
2. team time trial (TTT)
3. criterium ("crit")
4. circuit race (multiple laps)
5. road race (single lap or point-to-point), includes hillclimbs
6. stage race/omnium
7. cyclo-cross (CX)
Speed, power, and force

Speed is the quotient of power and the sum of all forces resisting the forward motion of the bicycle, or

$$ s = \frac{P}{\Sigma F} $$

Therefore, to maximize speed, power must increase and/or resistive forces must be decreased:

$$ s \uparrow = \frac{P \uparrow}{\Sigma F \downarrow} $$
Forces resisting forward motion of bicycle/rider system

1. aerodynamic drag – from body (including clothing & helmet), bike, and wheel rotation

2. tire rolling resistance – from energy lost due to ‘flexion’ (deformation) of tire casing and tube

3. direct resistance from weight (uphill terrain only)

4. “inertial” resistance from changes in kinetic energy, (i.e., accelerations)

5. mechanical friction – rolling (hub bearings) and drivetrain (chain wrap, derailleur pulleys, bottom bracket bearings, pedal bearings)
Power requirements of cycling

Expanded motion equation for cycling:

\[ s = \frac{P}{\Sigma F} \]

\[ = \frac{P}{(R_a + R_t + R_w + R_f + R_i)} \]

\[ = \frac{P}{[k_a v^2 + mg (k_t \cos \theta + \sin \theta + k_f s) + ma]} \]
Relative distribution of resistive forces on an 80 kg bicycle/rider at 300 W over varied terrain.

% of TOTAL RESISTANCE

ROAD GRADE %
Forces resisting rectilinear motion of a 185 lb rider/bicycle at 25 mph (242 W) on flat terrain with no wind. Arrow length reflects relative magnitude (font size not to scale).

\[ R_t = 0.37 \text{ lb (7.6\%)} \]
\[ R_a = 4.08 \text{ lb (84\%)} \]
\[ \Sigma F = 4.85 \text{ lb} \]
Air resistance (drag)

1. air resistance $R_a = k_a v^2$, $k_a = \frac{1}{2} C_D A \rho 0.359 P_B / T$

2. effective frontal area $C_D A$ of the bicycle/rider is the product of aerodynamic drag coefficient $C_D$, and frontal area $A$

3. frontal area $A$ is the size of the surface that the bicycle/rider system pushes through the air they move forward. $C_D$ is a measure of how ‘streamlined’ the system is, i.e., how smoothly air flows around it without swirling behind, and modifies $A$ to give effective frontal area.
Air resistance (drag)

4. $C_D A$ is most accurately determined in a wind tunnel, but can be measured with a power meter, on a flat course in calm air, but most improvement can be made simply through visual inspection. Frontal area only can be measured using digital photography, a reference diagram, and a pixel-counting program.

5. As a rule of thumb, at 30 mph, a reduction of 0.005 m$^2$ in $C_D A = 0.5$ seconds/kilometer = 0.1 lbs. drag = 7 W
Individual time trial (ITT)

1. riders start separately, at regular intervals (e.g., 0:15, 0:20, 0:30, or 1:00)

2. usually takes place on open roads; terrain may be flat, uphill, or a mixture of both (the last is more typically European)

3. 40 km out-and-back on flat terrain is the (neglected) U.S. national standard

4. “taking pace” (drafting) is prohibited and is defined under USA Cycling Rules as riding within 25 m (80 ft.) behind another rider; once you come within 80 ft. of the rider ahead, you must overtake within 500 meters, otherwise it is considered a failed pass attempt and you must drop back to 80 meters and try again

5. has become pervaded by specialized equipment and advanced technology
Time trialing tips

1. Fitness and skill should take priority over equipment and technology; the highly variable energetics of road/criterium racing are not the best training for flat TTs, so a period of specific workouts on the TT bike is necessary for peak TT performance.

2. Flat-terrain speed is determined by threshold power-to-frontal area ratio, uphill speed by threshold power-to-mass ratio, but . . .

3. The benefit of aerodynamic equipment can be compromised by bad positioning; wind-tunnel testing is the best way to refine position, but is expensive, and visual guidelines can correct most flaws.

4. Pacing (optimal energy distribution) maximizes work output and minimizes elapsed time.

5. Attention to detail pays off, as small things add up.
Time trialing form (good)
TT form (good)
TT form (good)
TT form (so-so)
Time trialing form (bad)
Time trialing form (bad)
Pacing with a power-measuring system
Individual time trial
(local event)

Presque Isle ITT
Erie, PA
12.5 miles

Sun.  4/27
Sun.  6/15
Sun.  9/14
Cyclist symbol
(overhead view)
Team time trial
(9-man paceline rotation pattern)
Team time trial (TTT)

1. Contested at U.S. collegiate championships, but no longer part of World Championship or Olympic programs; occasionally included in major stage races (e.g., Tour de France)

2. Takes place on generally flat terrain; emphasizes smooth, precise, rotating paceline riding at high speed (“working together”), which is the basis for effective breakaways during road races

3. Finishing time usually taken on incomplete team (e.g., 4th of 6 riders)

4. Requires team members to be relatively equal in ability; role of ‘weaker’ riders may be to take longer “pulls” at the front in the early going, then be “jettisoned” before the finish
Drafting a single rider at 32 km/h reduced VO\textsubscript{2} by 18 ±11%, and by 27 ±8% at 40 km/h (n = 92); the benefit was the same when drafting 2 and 4 riders.

Riding at the back of a pack of 8 riders at 40 km/h reduced VO\textsubscript{2} by 39 ±6%.

Team time trial (TTT)

In a 4-man paceline traveling at 57-60 km/h, the power requirement for the second rider was reduced by 29%, and by 36% for the third and fourth riders.

Team time trial
Criterium

1. takes place on a **closed** course between 800m and 5,000m (½ – 3 miles), with generally flat terrain; tolerates more robust physiques
2. often held in/around downtown square, therefore is conducive to spectators, compatible with festivals, attractive to sponsors, accessible to media
3. often run in minutes + laps format (e.g., 60 min + 10 laps)
4. places premium on racing skill, teamwork, sprinting ability
5. free lap rule/wheel pit
6. lapped riders
7. primes
Power, speed, and cadence data (flat criterium)

![Graph showing power, speed, and cadence data](image)

### RIDE SUMMARY

<table>
<thead>
<tr>
<th>Metric</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rider:</td>
<td>AWG</td>
</tr>
<tr>
<td>Event:</td>
<td>Firecracker CT</td>
</tr>
<tr>
<td>Level - conditions:</td>
<td>4 FV</td>
</tr>
<tr>
<td>Body mass:</td>
<td>72 kg</td>
</tr>
<tr>
<td>Threshold power:</td>
<td>325 W</td>
</tr>
<tr>
<td>Weight (kg):</td>
<td>4.45 W/kg</td>
</tr>
<tr>
<td>Energy (W/kg):</td>
<td>19.94 W/kg</td>
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<tr>
<td>Recording interval:</td>
<td>2.52 sec</td>
</tr>
<tr>
<td>Ride time:</td>
<td>0.89:28 hours</td>
</tr>
<tr>
<td>Pedaling time:</td>
<td>0:46:40 hours</td>
</tr>
<tr>
<td>Distance:</td>
<td>27.5 mi</td>
</tr>
<tr>
<td>Avg. speed:</td>
<td>27.7 mph</td>
</tr>
<tr>
<td>Avg. cadence:</td>
<td>68 rpm</td>
</tr>
<tr>
<td>Pedaling %:</td>
<td>78%</td>
</tr>
<tr>
<td>Avg. power (w/resting):</td>
<td>259 W</td>
</tr>
<tr>
<td>Avg. pedaling power:</td>
<td>330 W</td>
</tr>
<tr>
<td>Avg. adjusted power:</td>
<td>312 W</td>
</tr>
<tr>
<td>Max. 1 min power:</td>
<td>289 W</td>
</tr>
<tr>
<td>Max. 5 min. power:</td>
<td>307 W</td>
</tr>
<tr>
<td>Max. 20 min. adjusted power:</td>
<td>324 W</td>
</tr>
<tr>
<td>% overload:</td>
<td>83%</td>
</tr>
<tr>
<td>Intensity factor:</td>
<td>0.96</td>
</tr>
<tr>
<td>% of threshold:</td>
<td>86%</td>
</tr>
<tr>
<td>Training stress score:</td>
<td>91</td>
</tr>
</tbody>
</table>

### NOTES:
- Won the race!
Power, speed, and cadence data (flat TT)
Free laps/service pit

1. unless stated otherwise, a “free lap” may be allowed for a crash or recognized mishap (flat tire, broken chain, etc.)
2. two consecutive free laps may be granted on shorter courses; there is no limit to the total number of free laps
3. free laps not granted for being delayed by (as opposed to involved in) a crash
4. you may cut the course, or dismount and walk (but not ride) backwards to the service pit (aka wheel pit)
5. free laps end with 5 mi (8 km) to go
6. pit may be “wheels-in wheels out” or “neutral”
7. after repairs are complete and the free lap has been granted, you are returned to the race at the rear of the group you were with, and you are ineligible for primes on that lap
Criterium course
(4-corner)
Criterium course
(4-corner)
Criterium course
(6-corner)
Criterium course

(6-corner)
Criterium course

(8-corner)
Criterium course
(8-corner)
Criterium course detail
(8-corner)
Criterium course
(local event)

Races at the Lake Munroe Falls, OH
Saturdays, April 20 – May 3

1 lap = 1.2 mi.

Presented by SUMMIT
Mill Creek Criterium
Youngstown, OH
Sunday, June 8

Presented by
Mahoning Valley
Cycling Team

Criterium course
(local event)

1 lap = 0.97 miles
Criterium course
(local event)

Mill Creek Criterium
Youngstown, OH

Sunday, June 8

COURSE PROFILE
(Vertical exaggeration = 9:1)

117 climbing feet per lap

ELEVATION (feet)

DISTANCE (miles)

900 950 1000 1050

0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9

928' 983'
Racing line through corner

Hay bale
Correct racing line
Correct racing line
Correct racing line
“Accordion effect”
Bike-handling skill drills

1. “slow races” on grass
2. track-standing
3. bumping
4. small circles/figure-8’s
5. bunny-hops (use garden hose or sponge)
6. slalom (use sponges)
7. no-handed riding
Cornering form

- Achieve proper speed for intended line through corner before initiating turn

- Eyes sighting intended line and beyond

- Rear end back on saddle, hips rotated forward, torso nearly horizontal, arms bent but not tense, hands on handlebar “drops”

- Inner pedal up, weight on outer pedal
Cornering form
Cornering form
Criterium tips

1. stay near the front without leading
   a. helps avoid crashes
   b. allows you to choose better line
   c. aids in initiating/responding to attacks (“accordion effect”)

2. race your strengths
   a. if your forte is aerobic power, attack frequently to keep the pace unrelentingly high, opening gaps and making the others chase so as to take away the sprint of those with greater anaerobic power
   b. if sprinting is your strength, spend less time attacking, stay out of the wind, and conserve anaerobic reserves
   c. position and timing determine results of the final sprint as much as ability; riders with a big “jump” (high neuromuscular power) should “hide” as long as possible and “go late,” while those with high anaerobic capacity should go from farther out
2006 U.S. National Criterium Championships
Downers Grove, IL

Tina Pic, 4-time champion
2002-05

NRC Champion
2000, 2004-6
2006 U.S. National Criterium Championships

Finish – ~250m to go

1 – Teresa Clif-Ryan
2 – Pic
3 – Jen McRae
4 – Laura Van Guilder
~210m to go

1 – Clif-Ryan    2 – Pic    3 – McRae    4 – Van Guilder
2007 U.S. National Criterium Championships

Order is restored, justice is served
2008 U.S. National Criterium Championships

The end of an era? A changing of the guard? The torch is passed?

Pic, 6th  Brooke Miller, 1st
2009 U.S. National Criterium Championships

*Not on your life!*
When even your opponents are happy for you, then you’ve really accomplished something.
And what a way to go!

Tina Pic retired shortly after winning her sixth U.S. National Criterium Championship.
Encore! Encore!

TD Bank Mayor’s Cup Criterium, Boston, September 27, 2009

“...I’d never let Tina win, but it’s nice to see a competitor like her go out on top.”

–Brooke Miller