CYCLING FUSION™

For the love of the ride inside and out

DEMYSTIFYING POWER TRAINING FOR INDOOR CYCLING

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YOU'RE NOT ALONE

- You're not alone, but you are ahead
- How many ride outside, and train with a Power Meter?
- How many of you know someone who uses a Power Meter?
- How many of you teach at a club with Power Bikes?
- Do you think this is a fad or a trend that will fade away?

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WHAT IS POWER?

- The product of strength and speed of movement
- The energy produced for work done in a given time frame.
- A measure of intensity normally expressed as a watt.
- For the rider, Power = Cadence or pedal speed x gear or resistance (RPM x resistance)
- There is no power when there is no force on the pedals even if you are pedaling.

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WORK, FORCE, ENERGY

- Work is force multiplied by distance
- A force is a push or pull
- Energy and work have the same units and are used interchangeably in many situations.
- Both energy and work are measured in **joules**, the standard metric unit for energy.

JOULES, WATTS, WHAT'S UP?

- The difference between a joule and a watt is the difference between energy and power.
- Power is energy used in a certain amount of time.
- A joule is a unit of electrical energy equal to the work done when 1 amp passes through resistance of 1 ohm for 1 sec.
- A watt is a unit of power equal to one joule per second

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POWER & CALORIES

- A calorie is the thermal energy it takes to raise the temperature of 1 gram of water 1 degree Celsius
- 1 calorie = 4.186 joules, 1 Joule per second = 1 Watt
- Hence power bikes express calories as a representation of the energy you produced, not necessarily the energy or calories you "burned"

WHAT IS A WATT?

- A watt is a numerical measurement for the product of strength and speed
- A person having a mass of 100 kilograms who climbs a 3 meter high ladder in 5 seconds is doing work at a rate of about 600 watts
- The more watts a system uses in a certain period of time, the more powerful it is

POWER IS WORK OVER TIME

- Power is the amount of energy that is converted in a unit of time. Generally speaking, power is the rate at which you can do something:

$$\text{Power} = \frac{\text{Energy (Work)}}{\text{Time}}$$

made image appear after the first bullet item, rather than immediately

Split up the bullet list into two text chunks so the image could appear between the two

- If in the first try you lifted a box to your waist in 2 seconds and in the next trial you took 5 seconds, you were using the same amount of energy in both instances but it generated more power during the first trial (when you used the same amount of energy in half the time).

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POWER CAN BE COMPLICATED

Bicycle Power Calculator

Assumptions:
Constant speed analysis
Drag coefficients reference "Science of Cycling", E.R. Burke, Leisure Press, 1986, pg 126.

Inputs

Wheel Diameter (inches) 27 Crank Length (inches) 6.75
Desired Constant Speed (mph) 10 Rider's Weight (lbs) 150 Bicycle Weight (lbs) 22
% Grade (+ for uphill,- for downhill) 0 Mechanical Losses (3-5% is typical) 5 %
Gear Ratio (#Teeth Rear/Front) 1.00 (28/28) Slowest
Air Resistance Coefficient (lbf*s^2/ft^2) = Cd*FrontalArea Straight Arms (Cd*A =.004)
Rolling Resistance Coefficient (lbf/lbf) .013 (27x2.25" 45 psi BMX Knobby Tires)
Calculate

Calculated Outputs

Total required input power from the rider HP Watts
Power needed to overcome air resistance HP %
Power to overcome rolling resistance in tires HP %
Power needed for elevation change HP %
Power lost to mechanical losses, friction, etc. HP %
Calories burned per mile kcals (assuming 28% efficiency in conversion to human power output)
Average Pedal Force Lbs Average Traction Force Lbs
Pedal Speed RPM Tire Speed RPM

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Accuracy checked by ME288 Product Dissection class, Underlying Equations

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POWER METER BASICS

- A training tool that measures the amount of work done during a given period of time.
- Displays live data during a ride
- Growing popularity for indoor and outdoor cycling.
- A power meter is only a tool, it is **not a training system**

POWER METER EQUIPMENT

SRM

PowerTap

Quarq CinQo

Measuring Power from the Crank or Hub

iBike

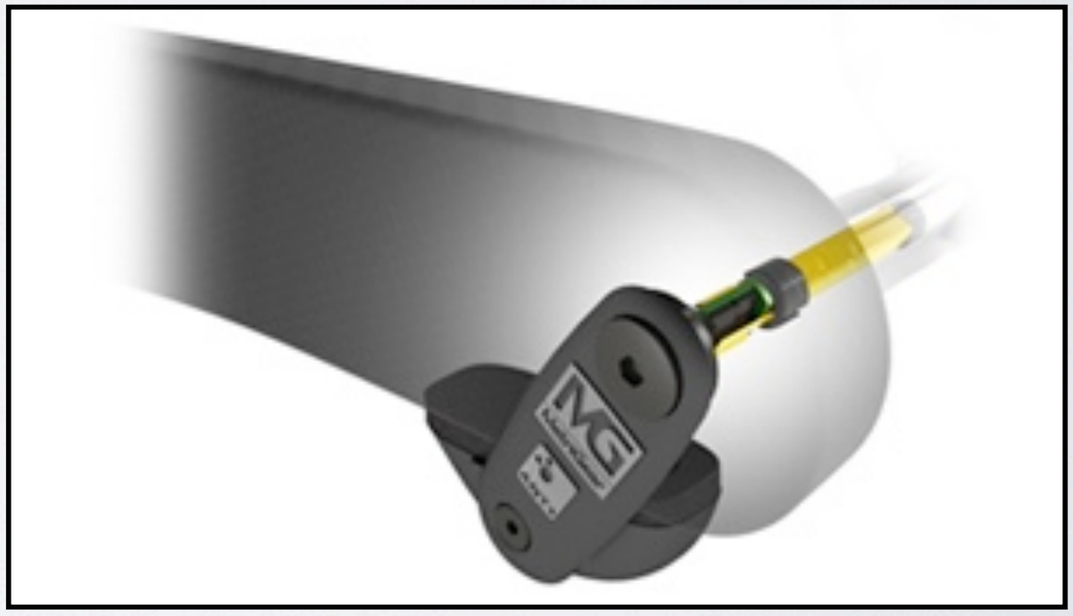
Calculating Power from the Wind & other factors

POWER METER EQUIPMENT

Measuring Power from the Pedal

iBike with iPhone

Power Pedal - Look & Polar



Vector from Metrigear

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POWER METERS INDOORS

CycleOps POWER

400 PRO INDOOR CYCLE

Measuring Power from a PowerTap

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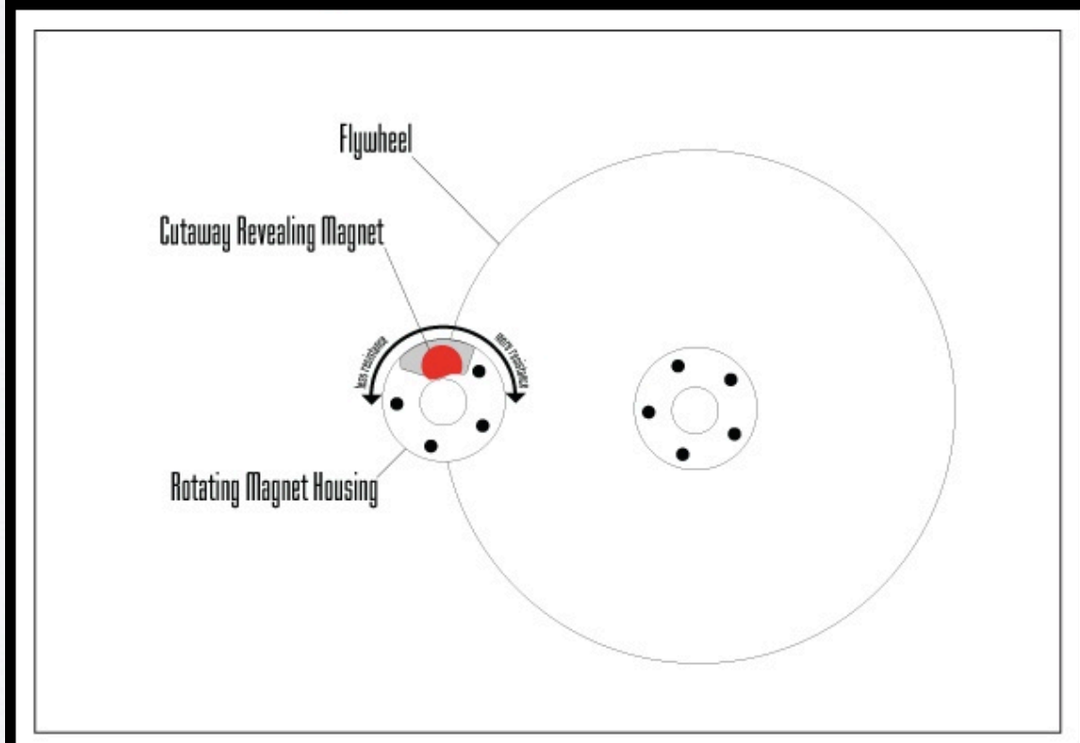
POWER METERS INDOORS

KEISER® m3

(P = F x V)

The Eddy Current

An eddy current is an electric current in a conducting material that results from induction by a moving or varying magnetic field. On the M3 this is generated by 2 opposing magnets passing over the flywheel. The flywheel (a conductor) passes through the magnetic field generated by the two powerful magnets. By varying how much of the flywheel comes into contact with the magnetic field you can increase or decrease the amount of resistance for the rider. As no parts in the resistance system ever touch there is no wear on the system.



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POWER METERS INDOORS

Schwinn MPower

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CALCULATED NOT MEASURED

- Outside of CycleOps, all other indoor stationary bikes have calculated not measured power
- Measured power is much like your electric meter at home, measuring actual usage
- Calculated power uses the combination of your RPM and the "gear" you are on and looks up the Watts from an internal table in the bike console's computer
- Accuracy is less for calculated power, but that does not diminish the value of training, or the principles to apply

I DON'T RIDE OUTSIDE

WHY SHOULD I CARE ABOUT POWER?

- Power Training will increase muscular strength.
- Power Training will improve the toning of your leg muscles
- Power Training will improve your cardiovascular fitness as a natural by-product of focused training at higher intensities
- Power Training will help prevent "plateaus" in fitness development or weight loss
- Power Training will add variety and motivation to your existing workout routine

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I RIDE OUTSIDE

WHAT'S THE BIG DEAL ABOUT POWER?

- Power Training will improve climbing, possibly more than any other method for improving this critical aspect of cycling
- Power Training will help you target very specific types of riding; climbing, sprinting, time trialing, etc.
- Power Training will allow you to make comparisons between your own workouts, and between different riders
- Power Training allows you to evaluate your relative strength within a given area of cycling
- Power Training will add a lot of variety to your workouts

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KEY FACTS ABOUT POWER TRAINING IN GENERAL

- Power is the best predictor of performance
- Power is not a better method of training than heart rate, it is simply different
- Watts represent a mechanical feedback, compared to heart rate which represents metabolic feedback
- The main goal in Power Training is to increase one's Watts per pound in each Power Zone

HEART MONITOR VS POWER METER TRAINING

- It's not a contest
- It's not proprietary
- It's not elitist
- It's not a religion
- **It IS about knowing when to use each training system**

ONE COMPARATIVE STUDY

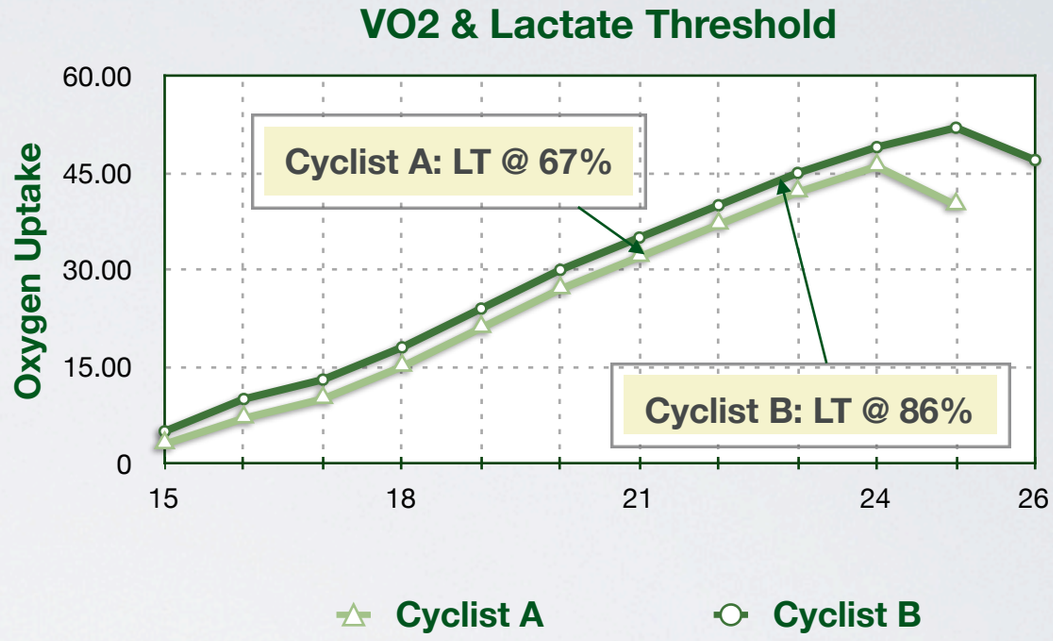
In an attempt to answer the question "what's the ultimate workout tool?" scientists from South Africa's Sports Science Institute put the two devices to the test. The hard-core cyclists who used expensive power meters barely lost the race to another group of hard core cyclists who used a $50-$100 heart rate monitors. In the head-to-head race, during the four week test, the power meter riders performed intervals at 80% of peak power while the heart rate monitor cyclist rode intervals at their 80% peak power heart rate without a power meter. The final test was a 25 mile time trial to measure power improvements. Results though statistically identical gave the edge to the heart rate cyclists who improved power output by 5% versus 2.3% for the power meter riders. Though conventional wisdom favors power meters for training, researchers concluded **that one is not better than the other**. What is important is that these training tools collect, display, provide feedback with useful data, and other valuable functions.

www.bicycling.com/article/0,6610,s1-1-8-18611-1,00.html

LIMITERS

A limiter is a physiological, mechanical, environmental or other circumstance that constrains or“limits” performance. Put in terms of Power, we would say that there are a variety of factors that can limit how much power we can produce. Consequently, as we work towards improving our power, we need to understand how these limiters can impact our degree of success in reaching our goals.

LACTATE THRESHOLD



Speed	Cyclist A	Cyclist B
15	3.00	5.00
16	7.00	10.00
17	10.00	13.00
18	15.00	18.00
19	21.00	24.00
20	27.00	30.00
21	32.00	35.00
22	37.00	40.00
23	42.00	45.00
24	46.00	49.00
25	40.00	52.00
26		47.00

Threshold Reached, exhaustion shortly thereafter if speed & effort continue to increase

VO2 & LT will limit power production

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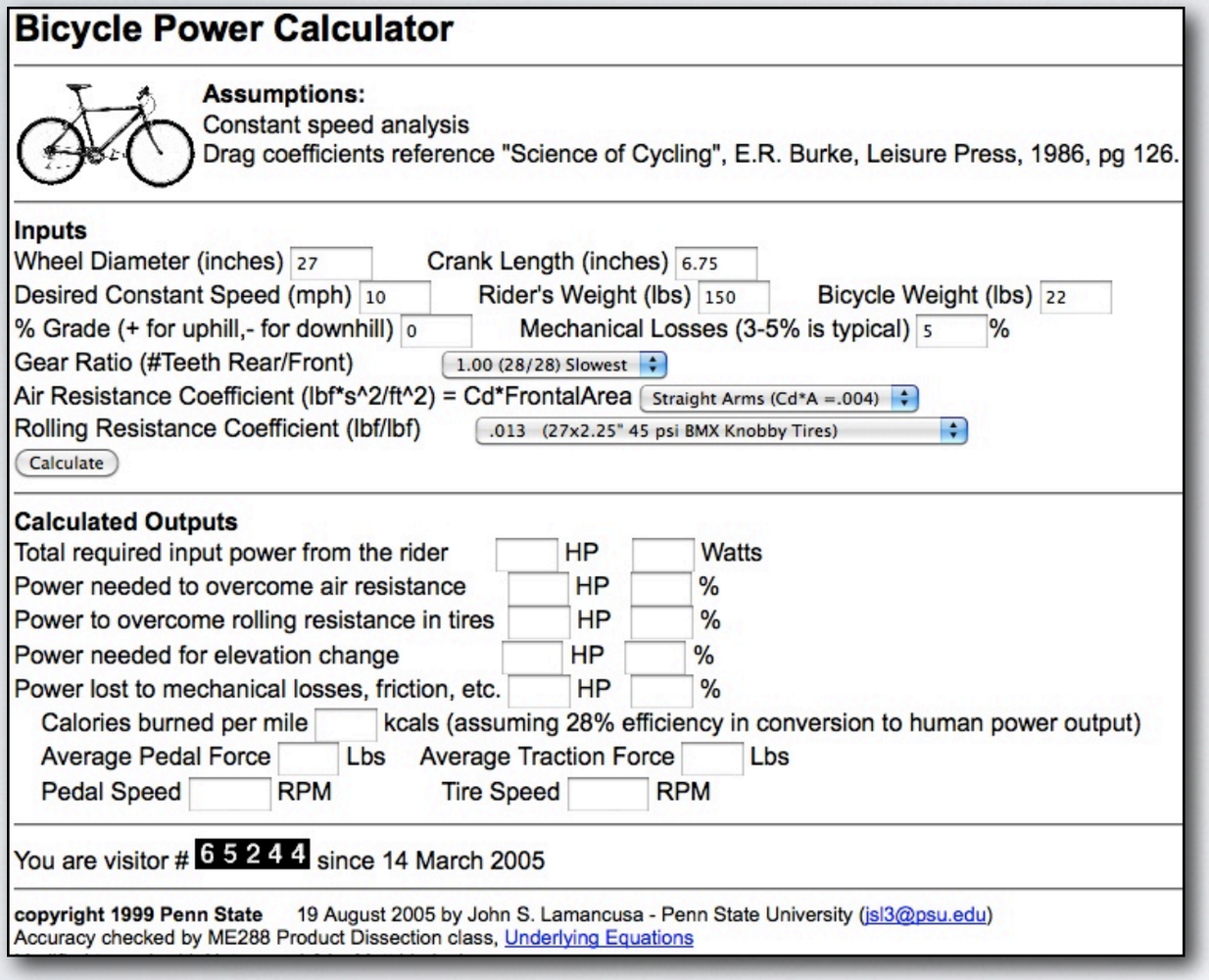
OTHER "LESSER" LIMITERS

- Hydration & Electrolytes
- Fuel availability
- Altitude
- Heat & Humidity
- Sickness & Medication

INSIDE VS OUTSIDE POWER



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All the factors that go into calculating power when we move outside

- Yes, there will be differences in the Watts you generate indoors, and what your power meter measures outdoors

- There will always be variations due to the enormous influence environment has on the rider and the equipment

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WATTS PER POUND

- Watts per pound reflects your "power to weight ratio"
- Watts per pound is calculated by dividing power output by body weight. *Example: if you average 150 watts and your weight is 150 pounds = 150/150 = 1 watt per pound*
- Watts per pound is easier for Americans to understand than Watts per kilograms
- Watts per pound can be used by coaches and cycling instructors to keep the entire class at the same effort level regardless of the rider's size or weight.

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WATTS PER POUND

- Climbing ability is very dependent on the power to weight ratio of the rider (plus bike & whatever is being carried)
- The great equalizer - Watts / Kg or Lb
- Why not KG? In class Watts/Lb can be done in your head
- Watts per pound is an equalizer which allows riders an accurate comparison of their power
- There is little difference between women and men in power generation except at the elite level

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ONE WATT PER POUND

The Gateway To Outdoor Riding

- Below 5 mph, it is extremely difficult to keep a bike on line, rolling straight, safe and steady.

- Below 5% grade it's not much of a hill.

- Road construction guidelines range from 5% to 12%

- **Make it a goal to sustain it**

Grade	5%	6%	7%	8%	9%	10%
MPH						
5.0	0.5	0.7	0.8	0.9	1.0	1.1
6.0	0.7	0.8	0.9	1.0		
7.0	0.8	0.9	1.1			
8.0	0.9	1.0				
9.0	1.0					

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IMPLICATIONS FOR CLASS

- There has been a tendency to abandon Heart Zone® training for Power Training
- Do not fall prey to such thinking, it is simply unnecessary.
- Make a point to have dedicated heart rate oriented classes, building cardiovascular endurance, raising VO2, improving Lactate Threshold, etc.
- Having raised a rider's limiters, you can push power even more.

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INTRODUCING POWER IN THE CLASSROOM

- Use previous sections to feed a few points per class about why all riders - indoors and out - benefit from Power Training
- Use Games as a way of de-mystifying and un-intimidating Power Training
- Learn RELATIVE CUEING

RELATIVE CUEING

- Establish everyone's "Basement" or warm-up power. Surprise your students after 5 minutes into class
- Use Heart Rate (Zone) if the class is mostly wearing heart monitors
- Use RPE to get everyone to the same subjective level of difficulty
- Use % of body weight to cue increases or decreases

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POWER GAMES

- X Songs to X Gears - Works well for Keiser M3, possibly others
- 10% per Minute - Increase Watts by by 10% of rider's body weight
- Where's My Sweetspot - What cadence/gear ratio provides the highest power rating at a target heart rate
- 20% per Song - How high can we go, and for how long?
- 5 X 5 - Use 10 songs - increase Watts or HR, 5 separate times in alternating turns. Suggest 10 BPM & 10% of body weight

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HELPING WITH PURCHASING

- Performance; consistency in how it feels at the same power level as you go from bike to bike
- Physical characteristics; Ease of installation, Weight, Price
- Data quality; what does their display show, are those the data points you want to use
- Software capability; is there an ability to retrieve your data from the bike for each workout
- Calibration requirements; you'll have to do it, the only question is if it's easy or not

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CYCLING FUSION®

BRINGING INDOOR AND OUTDOOR CYCLING TOGETHER

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