PowerStroke^{TM} Operating Instructions

November 2015
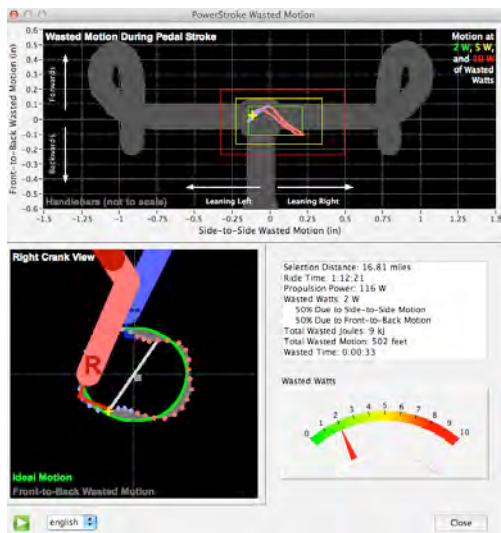
NOTE: THESE INSTRUCTIONS ARE TO BE USED IN CONJUNCTION "ISAAC SOFTWARE INSTRUCTIONS", AVAILABLE SEPARATELY.

Other Velocomp resources:

Take advantage of the large community of Velocomp power meter owners:

www.ibikeforum.com

OR, please email us at

technicalsupport@velocomp.com

Make sure to visit our website frequently to get the very latest in Velocomp product, software, and information updates:

www.powerpodsports.com

www.ibikesports.com

Introduction

PowerStroke is Velocomp's exclusive measurement suite of *front-to-back, side-to-side, and left-to-right* <u>wobble motion</u> of the bicycle, and the analysis of the *Wasted Watts, Wasted Motion, and Wasted Time* caused by wobbling.

PowerStroke works by adding new technology both the PowerPod, and Isaac software.

In PowerStroke mode the PowerPod records its data at high speed (16 times per second), vs. the typical once per second.

Then, Isaac software analyzes the high-speed data, determining the front-to-back, side-to-side and left/right wobbling motion of the bike *each 10 degrees of a pedal stroke.* Wobble measurements and associated Wasted Watts, Wasted Motion, and Wasted Time stats are shown in Isaac's PowerStroke Window.

SETTING UP POWERSTROKE

To use PowerStroke, two, one-time setup steps are required:

1) Purchase and install the PowerStroke upgrade key (not required if your PowerPod came pre-installed with the PowerStroke key)
2) After your first PowerStroke ride, in Isaac software, set the position of your cadence sensor

STEP ONE: PURCHASE/INSTALL POWERSTROKE KEY

NOTE: IF YOU HAVE PURCHASED A POWERPOD WITH THE POWERSTROKE KEY PRE-INSTALLED, SKIP STEPS 1-4 AND PROCEED TO STEP 5!

1. Purchase a PowerStroke Key from www.powerpodsports.com.

2. You will receive an email from Velocomp, instructing you to email the serial number of your PowerPod.

3. To obtain the serial number of your PowerPod, do the following:

    1. Attach your PowerPod to your Mac/PC.

    2. Turn on your PowerPod (click any button; screen lights-up)

    3. Launch Isaac software

    4. Go to "Device/SN and FW Version…"

    5. In a few seconds, the serial number of your PowerPod will appear in a window.

    6. Copy and paste your serial number into your reply email

4. Velocomp will send you another email, with the PowerStroke key included as an attachment.

5. To install the PowerStoke key into your PowerPod, do the following:

    1. Transfer the PowerStroke key from the email to your computer's Desktop

    2. Attach your PowerPod to your Mac/PC.

    3. Turn on your PowerPod (click button; LED lights-up)

    4. Launch Isaac software

    5. Go to "Device/Unlock Feature…"

    6. Follow the prompts to navigate to your PowerStroke key

7. Click the "Upload" button

8. It takes just a few seconds for the key to be installed. At the end of the installation, you'll see a message saying that the PowerStroke feature has been installed.

9. Download any ride files stored on your PowerPod.

10. Erase your ride data from your PowerPod.

Once installed, your PowerStroke key will be stored permanently in your PowerPod. You will not ever need to install the key again.

STEP 2: SET CADENCE SENSOR POSITION USING ISAAC SOFTWARE

PowerStroke ride files include information regarding the mounting position of your cadence sensor on your left chain stay.

After downloading your first PowerStroke ride, Isaac will prompt you to state where your cadence sensor is positioned on your bike ("Above" or "Below" the left chain stay). Your response will be stored in the profile for your bike, and also be transmitted to your PowerPod.

USING POWERSTROKE ON THE ROAD

Hi-speed PowerStroke recording works "behind the scenes".

When in PowerStroke mode you won't see ANY differences in the on-the-road operation of your PowerPod, EXCEPT that your PowerPod ride memory will fill quickly.   Powerstroke does NOT affect in any way the ride memory of your ANT+ bike computer.

Why does memory fill quickly? In PowerStroke mode, your PowerPod records sensor data at high speed, 16 times per second.

NOTICE: **POWERSTROKE RECORDING MODE USES A LOT OF MEMORY**! IN POWERSTROKE MODE, **MAXIMUM RIDE RECORDING TIME IS 27 HOURS** (WITH MEMORY FULLY ERASED PRIOR TO STARTING THE RIDE)

TIP: WE STRONGLY RECOMMEND THAT YOU **DOWNLOAD YOUR RIDE DATA** IN ISAAC **AFTER EACH RIDE, THEN ERASE YOUR POWERPOD RIDE MEMORY IMMEDIATELY THEREAFTER**.

ANALYZING POWERSTROKE FILES WITH ISAAC SOFTWARE

IMPORTANT: WE STRONGLY RECOMMEND YOU READ THE APPENDIX, WHICH PROVIDES DESCRIPTIONS OF THE CONCEPTS AND MEASUREMENTS THAT ARE DISCUSSED IN THIS SECTION

In these instructions we will concentrate on features unique to PowerStroke; for all other instructions regarding Isaac software, please consult the Isaac Instructions, located in the "Help/Help Documents/Isaac Instructions" menu item of your Isaac software.

DOWNLOADING RIDE FILES

PowerStroke ride files take a long time to download. This is because the files are very large, due high speed data rate used in PowerStroke.

If you've done a very long ride, it can take several minutes to download a PowerStroke file using Isaac; be patient!

Launch Isaac. Use the "Device/Download Data…" command to download ride files from your PowerPod.
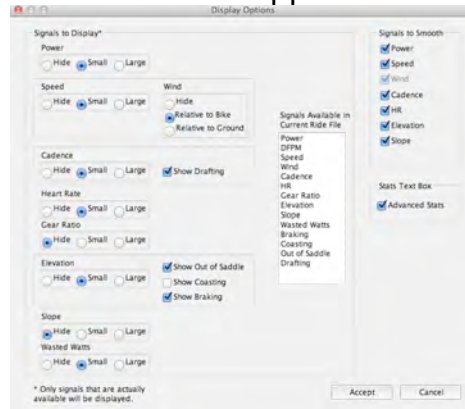
When a PowerStroke ride file is opened, your PowerStroke data is processed behind the scenes. This can take a few seconds; please be patient.
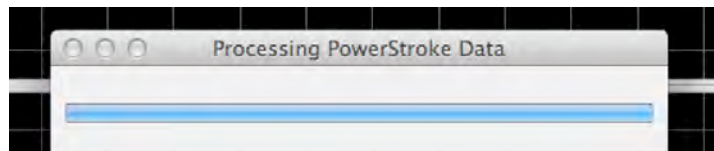
## Displaying PowerStroke Wasted Watts in Main Window

PowerStroke Wasted Watts can be displayed in the main window, as follows:

1) In the main window, touch the "Show" button in the top right of the main window. This window will appear:

2) In the bottom left corner, select the "Wasted Watts" radio button in the lower left corner. Then, select Accept.

In the main window, in the lowest portion of the graph, you'll see your Wasted Watts displayed, divided into one minute increments. By looking at your power/elevation/wind data above, you can associate your Wasted Watts with changes in your riding conditions, such as drafting, climbing hills, or speed.

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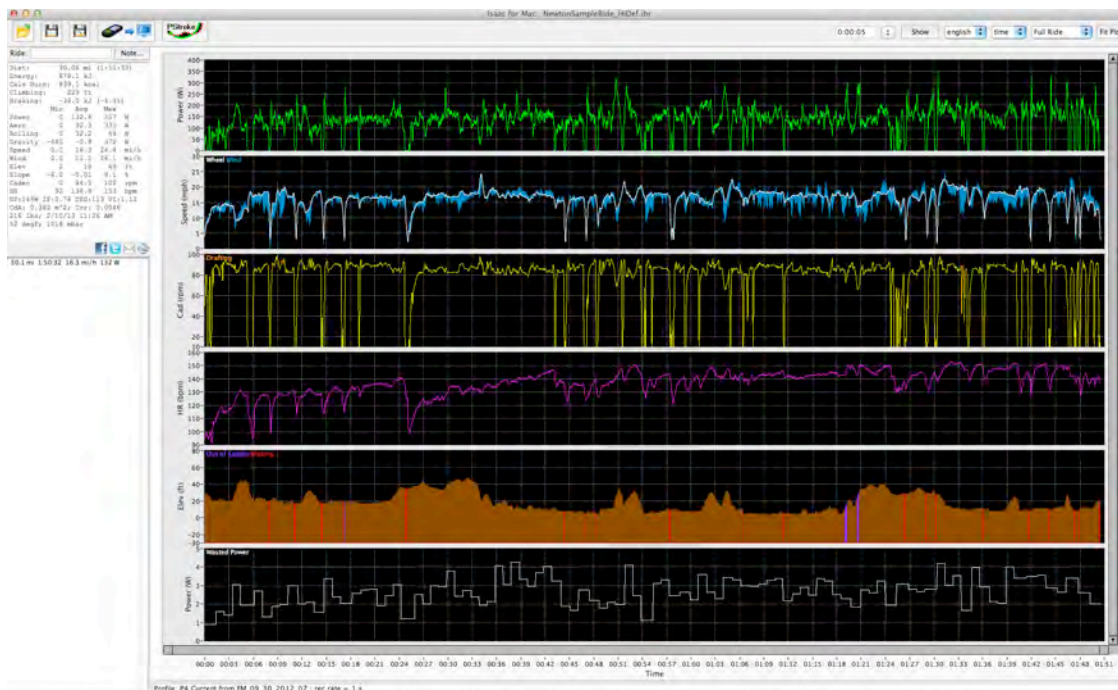
The PowerStroke Window

In these instructions we will use the "Sample Ride" file (located in the Help menu of Isaac) to illustrate PowerStroke functionality.

To see PowerStroke stats for the *entire* ride file, click the PowerStroke icon:

To analyze PowerStroke information for a *selected portion* of the ride, while in the main window, highlight the portion of the ride you want to analyze, then click the PowerStroke icon

NOTE: FOR BEST QUALITY OF POWERSTROKE ANALYSIS, SELECT AT LEAST A TWO MINUTE PORTION OF YOUR RIDE

Here is the PowerStroke window for the entire ride:
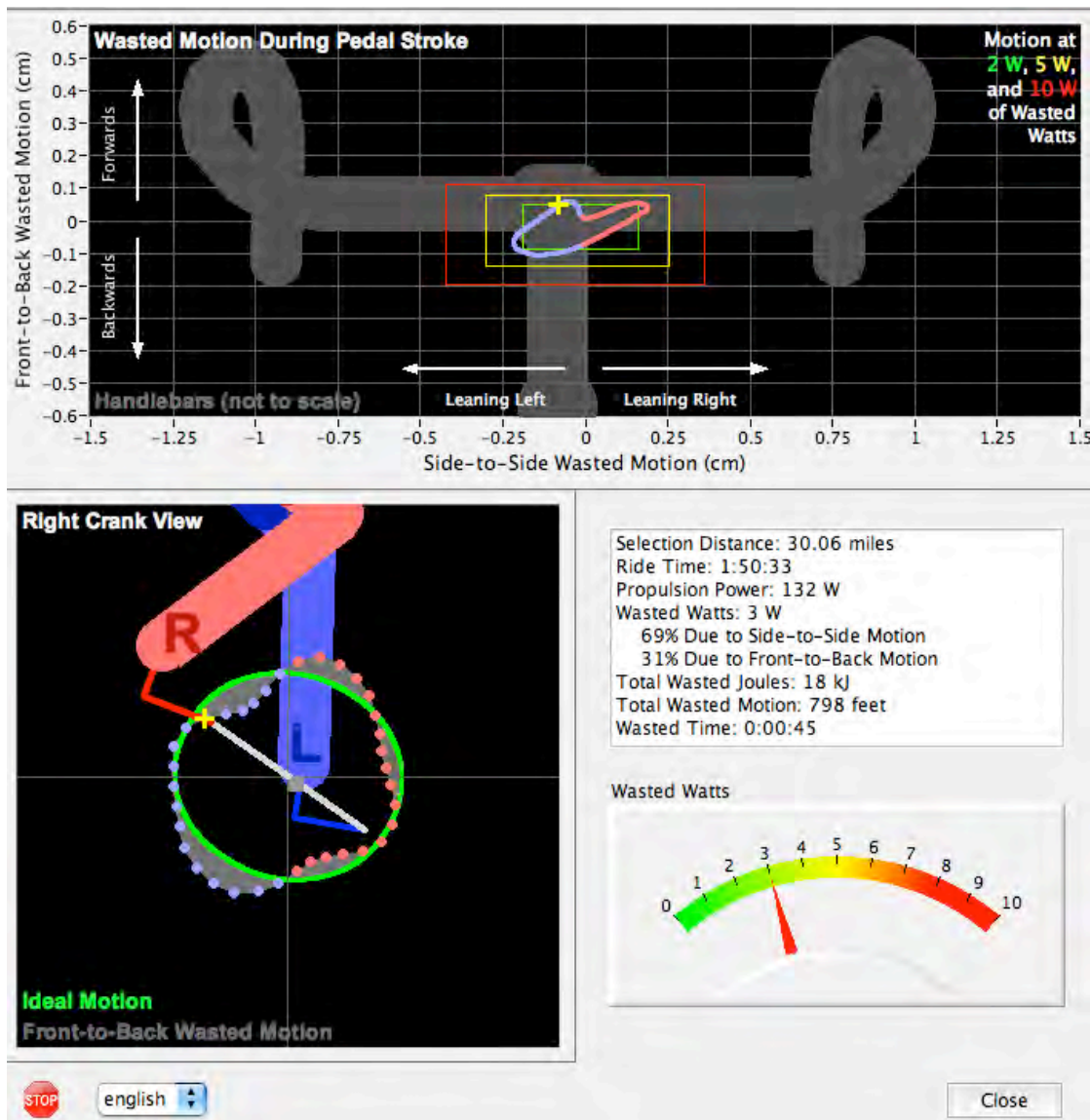
NOTE: IN THE "WASTED MOTION" PLOT AND "RIGHT CRANK" PLOT, RIGHT STROKE INFORMATION IS COLORED IN PINK. LEFT STROKE INFORMATION IS COLORED IN LIGHT BLUE.

NOTE: CLICKING THE PLAY (>) BUTTON IN THE LOWER LEFT CORNER CAUSES THE WASTED MOTION AND CRANK VIEW PLOTS TO ANIMATE. THE YELLOW CURSOR (+) SHOWS THE COMPARABLE DATA AS THE CRANK TURNS

NOTE: THE GREEN/YELLOW/RED RECTANGLES IN THE WASTED MOTION PLOT CORRESPOND TO THE GREEN/YELLOW/RED COLORS IN THE WASTED WATTS GAUGE

There are four sections to the PowerStroke Window. Each will be described individually.

WASTED MOTION PLOT
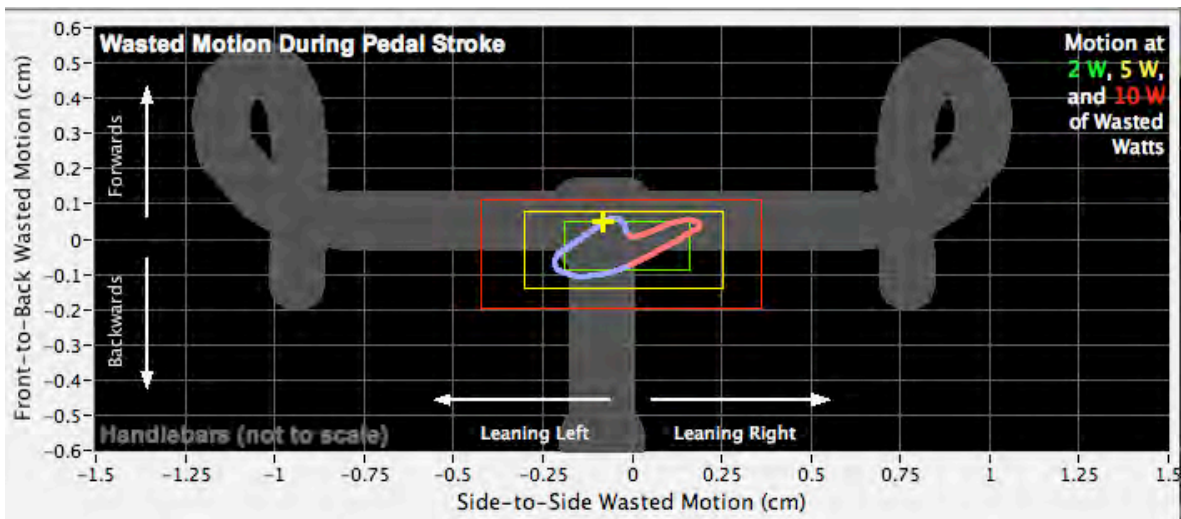
The Wasted Motion Plot shows the motion of the bike, relative to the center of mass of the rider, both side to side, and front to back, as the cyclist pedals through a complete turn of the crank.

The amount of bike motion underneath the rider (in inches or cm, depending on units selection) is shown on the vertical and horizontal axes. Horizontal is side-to-side; vertical is front-to-back. To help with the visualization of this movement, handlebars are shown in the view.

The cyclist's actual motion for the pedal stroke is traced out by the blue/pink curve. Where the curve is blue, the cyclist is pushing down with his left leg; pink is right leg.

The more the cyclist pulsates left/right, or front/back, the larger the curve expands, and the more the handlebars move around. Less wasted motion will keep most of the curve within the green box (2 watts) of wasted motion; larger amounts of wasted motion will push the curve into the yellow, or even red boxes.

If the bike did not move AT ALL underneath the cyclist the curve would shrink to a pinpoint at the center of the green box, and the handlebars would be stationary. But zero motion IMPOSSIBLE, because the cyclist can never be absolutely motionless with respect to the bike. **So, the training goal is to reduce the size of the curve, getting it consistently within the green box**.

Crank Stroke Plot

All cyclists know that their bike is propelled down the road by the power (Propulsion Power) they apply to the pedals. And many cyclists know that the bulk of their propulsion power comes unevenly during each crank stroke—only a small portion of their propulsion power is applied at the top and bottom of the crank stroke, and most propulsion power is applied between.

What's much less obvious is that the cyclist must ALSO supply power to wobble the bike side-to-side, and front-to-back. Because this power does NOT move the bike down the road, it is wasted effort: Wasted Watts.

The Crank Stroke plot focuses on the bike's forward-and-back wasted motion of the bike, during a crank turn. Indeed, this forward/back motion captures the pulsating motion of the cyclist's body. The cyclist weighs much more than the bike, so small motions of the cyclist's body results in larger motions of the bike. There is a spring-like push-pull pulsation between cyclist and bike that creates the unique pattern shown in the Crank Stroke Plot. If the bike and rider had no spring-like motion, the bike and rider would move with the small and gentle pulsation pattern as shown in by the green line in the Crank Stroke Plot, as the legs exert torque and accelerate the bike and rider down the road.

Aided by the Crank Plot, the training goal is to minimize excessive forward-and-back pulsations caused by the cyclist's spring-like body motion, and to make the overall motion of the bike close to the ideal of smooth, even acceleration and deceleration caused by application of power to the pedals.

Reading the Left/Right Crank Plot

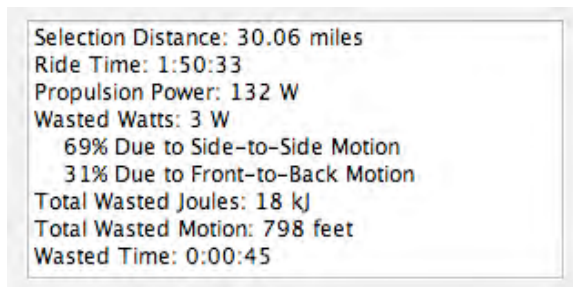Here is a snapshot of the left/right crank plot
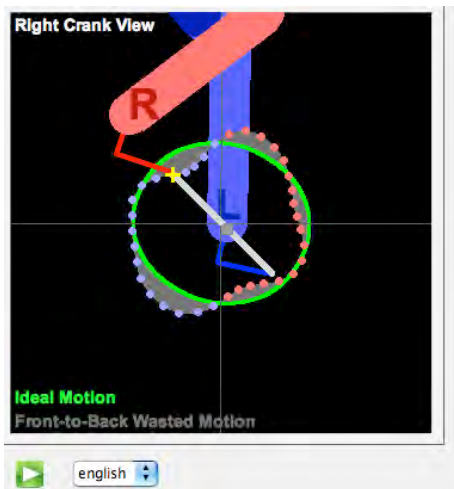
Here's how to get the most out of the Crank Stroke plot:

1) The Crank Plot shows the pedaling motion of the cyclist as the crank turns, as viewed from the right (gear side) crank
2) Clicking the green Play (>) button at the bottom left animates the Crank Plot, and also the Wasted Motion plot
3) The cyclist's actual front-to-back movement is represented by pink and blue colored dots. Each dot represents the actual motion of the cyclist, for the time period selected, as the bike crank turns. The dots are provided at 10 degree increments.
4) Pink dots show the movement of the bike while the right crank stroke is applied. Blue dots show the movement of the bike while the left crank stroke is applied
5) The yellow "+" cursor appears both in the Crank Plot and the Wasted Motion plot, allowing the two plots to be lined-up with each other
6) The Green Oval shows the Ideal motion of the bike. This idealized motion was determined from published papers that measured top cyclists' power stroke, in a laboratory environment
7) The actual motion of the cyclist is shown relative to the ideal motion. Where the dots are "outside" of the circle the motion is relatively higher than ideal; where the dots are inside the motion is not as much as ideal
8) The shaded grey area shows where Wasted Motion occurs. The smaller the shaded area, the less the wasted motion
9) Deviations from the ideal are caused by any (or all) of these factors: poor bike fit, improper frame size, excessively flexible frame material, improper pedaling style.

PowerStroke Ride Stats Box

```
Selection Distance: 30.06 miles
Ride Time: 1:50:33
Propulsion Power: 132 W
Wasted Watts: 3 W
    69% Due to Side-to-Side Motion
    31% Due to Front-to-Back Motion
Total Wasted Joules: 18 kJ
Total Wasted Motion: 798 feet
Wasted Time: 0:00:45
```

This box provides numerical summaries of the PowerStroke data analyzed, for the portion (part or all) of the ride file selected in the main window:

1) "Selection Distance" is the down-the-road distance that has been selected for analysis
2) "Ride Time" is the total time of the distance analyzed
3) "Propulsion Power" is the average power produced by the cyclist for the period analyzed
4) "Wasted Watts" is the *total* watts wasted, due to side-to-side and front-to-back motion. Beneath the Wasted Watts are the percentage watts split between front-to-back and side-to-side
5) "Total Wasted Joules" is the energy wasted for the distance analyzed, due to Wasted Motion
6) "Total Wasted Motion" is the total distance wobbled during the down-the-road distance
7) "Wasted Time" is an indicator of how much time was wasted due to Wasted Motion. This indicator assumes that 100% of wasted watts is converted into Propulsion Watts

PowerStroke Wasted Watts Gauge

This gauge shows the Wasted Watts for the data analyzed. The colors in the gauge correspond to the box colors in the Wasted Motion plot.

APPENDIX: POWERSTROKE CONCEPTS AND MEASUREMENTS: "WOBBLING"; "WASTED MOTION"™, "WASTED TIME"™, "WASTED WATTS"™; "IDEAL MOTION"; PROPULSION POWER

PowerStroke includes Velocomp's exclusive measurement suite of *front-to-back*, *side-to-side*, *and left/right wobble motion* of the bike, and the *Wasted Watts, Motion, and Time* caused by wobbling.

This appendix discusses concepts and measurements that are central to PowerStroke.

Wobbling

Riders are connected to their bikes through the pedals, seat, and handlebars. On average the rider and bicycle *must* move down the road at exactly the same speed (except, of course, in a crash!).

However, during the short time period of a crank revolution the rider isn't "glued" to the bike. In fact, *the bike **wobbles** underneath the cyclist, both side-to-side and front to back.* More technically, the bike moves (wobbles), relative to the center of mass of the bike + rider system.

The PowerStroke precisely measures the side-to-side and front-to back wobbling of the bike, not in a laboratory environment, *but in real-life bike rides.*

Wobbling is measured by the PowerPod's accelerometer, and is defined as the average distance the bike deviates side-to-side, and front-to-back, from the rider's center of mass during the period of time selected by the user. Wobbling motion is reported in two graphs in the PowerStroke window: 1) side-to-side vs. front-to-back, and 2) Front-to-back and left/right vs. crank angle.

Wobbling and Wasted Motion

Wobbling is extraneous movement of the bike—that's Wasted Motion. "Wasted Motion" is reported in three ways: the Wasted Motion graph, which plots the side-to-side vs. front-to-back movement of the bike relative to the rider; the Ideal Motion crank plot, which shows actual front-to-back motion vs. crank angle; and the Wasted Motion measurement, which shows the *total* amount of side-to-side and front-to-back movement of the bike, in feet or meters, for the period of time selected by the user. Wasted Motion is reported in the PowerStroke Stats Box.

Propulsion Power

It takes power to propel the bike/rider down the road. ***Power meters measure propulsion power.***

Propulsion Power is reported in the PowerStroke Stats Box, and is the same as the "Average Watts" number reported in the main window of Isaac.

Wobbling and Wasted Watts

Wobbling requires the cyclist to expend energy (watts) to power the wobble—that's Wasted Watts.

"Wasted Watts" is the amount of power required to move the rider's center of mass through the motion measured by the accelerometer. Wasted Watts are consumed both in side-to-side motion, and front-to-back motion. The "split" of Wasted Watts between front-to-back and side-to-side motion is reported in the PowerStroke Stats Box.

Note that *Propulsion Power measurements do NOT include Wasted Watts*. Wasted Watts are a hidden "tax" paid by the cyclist's body, to power the wobbling motion of each and every crank stroke.

Wasted Watts will vary throughout a bike ride; a graph of Wasted Watts vs. distance/time can be shown in the main window of Isaac.

Average Wasted Watts for the time/distance selected are reported in the PowerStroke Stats Box. Additionally, the "split" of Wasted Watts between front-to-back and side-to-side motion is reported in the PowerStroke Stats Box.

Wobbling and Wasted Time

Any energy consumed by wobbling takes away from energy that might be used to cross the finish line sooner—that's Wasted Time.

Wasted Time is an index, measured in seconds, that estimates the amount time that the cyclist would save during the period selected, if the Wasted Watts were converted into Propulsion Power.

Wasted Time for the time/distance selected is reported in the PowerStroke Stats Box.

Is *all* wobbling "bad"?

Of course not! For example, in a sprint, side-to-side wobbling is extreme—producing huge amounts of short-term power, but at reduced economy, due to wobbling.

And even when not sprinting, some amount of wobbling is both natural and normal.

But the best cyclists—the ones with good bike fit and trained pedaling style—have visibly less wobbling. *These cyclists have distinctively smoother—and more economical—riding styles.*

Whether driving a car or pedaling a bike, economy is a good thing!

Excessive wobbling, and what causes it

M*ost cyclists wobble far more than they need to.* Excessive wobbling can be a result of improper bike fit, frame size/type, and pedaling style—either singly, or most often, in combination.

PowerStroke compares your actual wobbling to the smooth motion of top cyclists, showing you if your wobbling is excessive.

By reducing excessive wobbling, the cyclist reduces wasted motion/watts/time, *and becomes a better, more economical cyclist.*

The PowerStroke Crank Plot: Your actual motion vs "Ideal" motion

Top cyclists have had their pedal and power strokes measured in the laboratory. As they turn the crank and apply power, these cyclists produce smooth, optimum acceleration and deceleration of the bike.

The PowerStroke Ideal Motion Crank Plot displays, as a green oval, the ideal, the lab-measured pedal stroke. The same plot overlays your actual front-to-back motion. Deviations of your motion from the ideal are shaded in grey.

FREQUENTLY ASKED QUESTIONS

How does PowerStroke work?

PowerStroke adds new technology both to the PowerPod, and Isaac software.

In PowerStroke mode the PowerPod records its data 16 times per second (vs. usual once per second).

 Isaac software analyzes the high-speed data, determining the front-to-back and side-to-side wobbling motion of the bike *each 10 degrees of a pedal stroke.*

Wobble measurements and associated Wasted Watts/Motion/Time stats are shown in Isaac's PowerStroke Window.

Can other power meters do what the Newton PowerStroke does?

Nope, and for two reasons!

Strain gauge sensors do not—*and cannot*—measure wobbling motions, and the wasted watts/motion/time caused by them.

Furthermore, most power meters broadcast their data once per crank revolution—about 1.33 times per second, and most ANT+ bike computers record power data only once per second. The PowerStroke records data 16 times per second, *more than 10 times more often than conventional power meters broadcast it, and 16 times more often than other cycling computers record it.*

How precise are PowerStroke measurements?

PowerStroke accelerometer measurements are accurate within +/- 1%.

Does PowerStroke work any PowerPod?

Yes!

If you already own a PowerPod, purchase the PowerStroke upgrade key, available at www.powerpodsports.com. Your upgraded PowerPod PowerStroke will be ready to ride: no additional calibrations or other changes are required.

How long a PowerStroke ride can I record?

PowerStroke ride files can be up to 27 hours long.

OTHER QUESTIONS?

Please contact us anytime with your questions:

technicalsupport@velocomp.com