PowerOval®
Performances extended

1. PowerOval® performances compared to the circular chain wheel

source: www.noncircularchainring.be
"Why do appropriate non-circular chainrings yield more crankpower ...etc."
Malfait L., Storme G. & Derdeyn M. 2012.
pag 32 & 43. (Reference 9)

PowerOval® **25% ovality**

Crank Power Gain versus round chainring

		90 rpm	100 rpm	110 rpm	120 rpm
	Watt	**7,0**	**10,4**	**15,1**	**19,8**
Crank power gain in %					
at 200 Watt crank power	%	3,49	5,19	7,55	9,88
at 300 Watt crank power	%	2,33	3,46	5,03	6,59
at 400 Watt crank power	%	1,74	2,60	3,78	4,94

The crank power gain (Watt) is **independen**t from any external pedaling load. This means that the **relative** crank power gain (in %) is smaller with higher pedal loading.
For a given external pedaling load, the crank power gain increases more than proportionally with increasing pedaling rate.

PowerOval® **25% ovality**

Unloading Peak Joint Power Extensor Muscles versus round

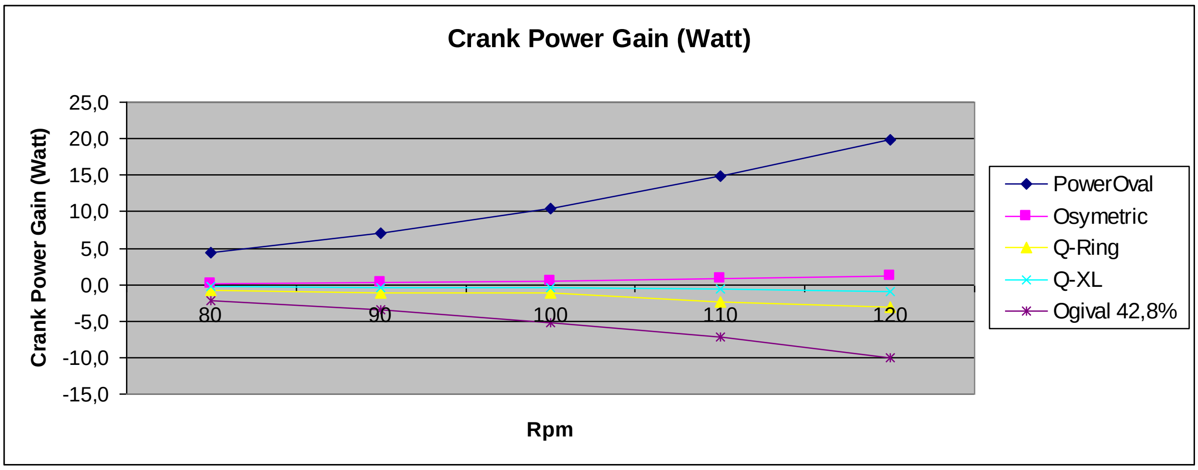
	90 rpm	100 rpm	110 rpm	120 rpm
Decrease Peak-power Knee Extensors				
Watt	-16,9	-21,9	-28,8	-36,7
Decrease Peak-power Hip Extensors				
Watt	0,0	-2,4	-5,1	-7,8

The reduction of the peak-power acting on the joints is more than proportional with increasing pedaling rates. **The reduction of the peak-power on the hip extensor muscles** is remarkable. All ovals of other companies show an unfavourable increase (see below).

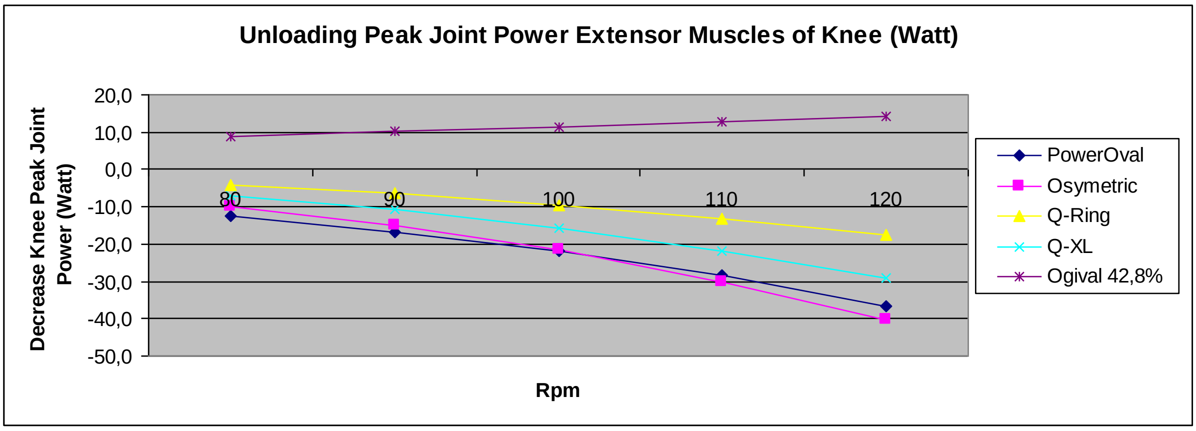
2. PowerOval® performances compared to other commercially available non-circular chainrings (graphs).

source: www.noncircularchainring.be
"Why do appropriate non-circular chainrings yield more crankpower ...etc."
Malfait L., Storme G. & Derdeyn M. 2012.
pag 32 & 43. (Reference 9)

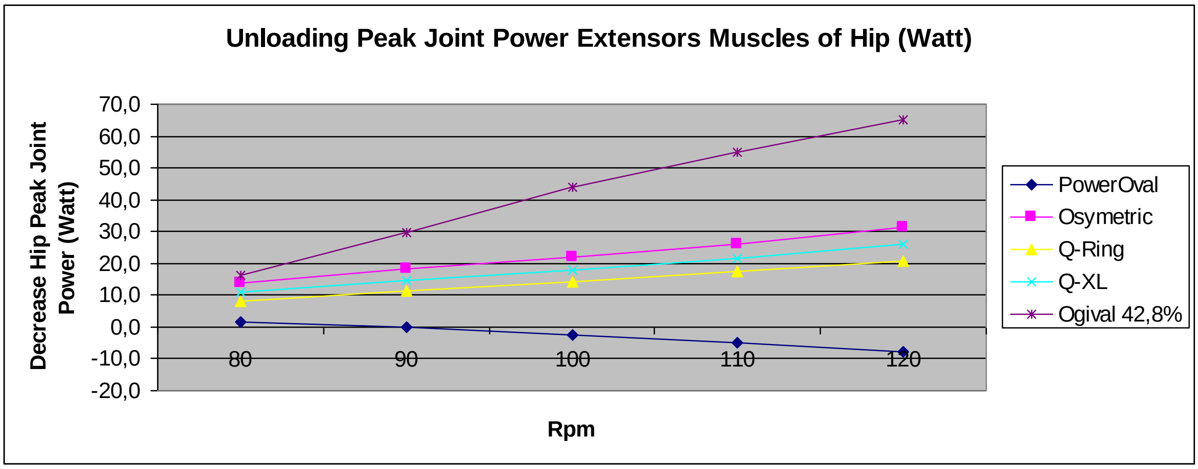
2.1 Crank power gain versus a round chainring as a function of pedaling cadence.



2.2 Reduction of peak-power in the extensor muscles of the knee-joint versus round chainring as a function of pedaling cadence.



2.3 Reduction of peak-power in the extensor muscles of the hip-joint versus round chainring as a function of pedaling cadence.



3. PowerOval® performances compared to other commercially available non-circular chainrings (tables).

source: www.noncircularchainring.be
"Why do appropriate non-circular chainrings yield more crankpower ...etc."
Malfait L., Storme G. & Derdeyn M. 2012.
pag 32 & 43. (Reference 9)

code			
	(yellow)	**favourable**	compared to a round chainring
	(orange)	**unfavourable**	compared to a round chainring

Type non-circular chainring	Ovality	Crank orientation Vs major axis (clockwise)	Crankpower Gain versus round (Watt)		
			90 rpm	100 rpm	110 rpm
PowerOval®	25 %	68°	7,0	10,4	15,1
Polchlopek	21,5 %	78°	3,7	5,4	7,9
Osymetric	21,5 %	102°	0,3	0,5	0,8
Q-Ring	10 %	106°	-1,2	-1,7	-2,4
Ogival	42,8 %	105°	-3,5	-5,2	-5,1

Competition ovals have the crank offset mostly at 105° to 110°. Indeed, in this crank position, the **vector** of the pedal force is almost maximal, but the direction of the pedal force vector is far from being optimal and consequently the tangential pedal force component (which generates the crank power) is rather small and only generates a "modest" crank moment that contributes relatively little to the crank power output. That crank position with greatest force vector is certainly no guarantee for crank power maximization over a full crank cycle. Moreover, in that mounting position the above mentioned non-circulars have their largest gears close to the less effective pedaling sectors (dead-point zones). At increasing and higher pedaling rates these ineffective positions become more distinctive (see 17, Reference list).

code			
	(yellow)	**favourable**	compared to a round chainring
	(orange)	**unfavourable**	compared to a round chainring

Type non-circular chainring	**Ovality**	**Crank orientation versus major axis (clockwise)**	**Difference peak-power (Watt) knee-extensor muscles versus round**			**Difference peak-power (Watt) hip-extensor muscles versus round**		
			90 rpm	100 rpm	110 rpm	90 rpm	100 rpm	110 rpm
PowerOval®	25 %	68°	-16,9	-21,9	-28,8	0,0	-2,4	-5,1
Polchlopek	21,5 %	78°	-18,0	-24,6	-33,1	8,5	10,0	10,8
Osymetric	21,5 %	102°	-14,9	-21,6	-30,9	18,1	21,9	26,6
Q-Ring	10 %	106°	-6,4	-9,6	-13,7	11,5	14,2	17,5
Ogival	42,8 %	105°	10,2	11,5	12,8	29,8	44,1	54,5

All ovals of other companies show an unfavourable increase for peak-power on hip-extensor muscles.

Conclusion:

- The graphs and tables above show **undeniably** that **the PowerOval® chainring is by far the best performing non-circular chainwheel on the market**: greatest kinetic crank power gain, great reduction of peak load in the knee extensors and **being the only oval reducing the peak load in the extensor muscles of the hip.**
  These positive effects increase more than proportional with increasing pedalling rate.
- When cycling the extensor muscles are predominantly used and contribute the most to the crank power. Any reduction of the (peak-)load of the extensor muscles is advantageous from the point of view of muscle fatigue and thus **allows the cyclist to hold a given crank power longer** (see 4, Reference list)**.**

4. Experimental confirmation of the theoretical performance figures.

The theoretical crank power gain and the reduction of the peak-loading in knee- and hip joint published in www.noncircularchainring.be (Reference 9) have been checked and confirmed by experimental tests at leading universities.

4.1. Experimental tests crank power gain (Reference 19)

In late 2010, comparative tests between the **PowerOval®** prototype and a conventional round chainring were carried out (with 18 "well trained test subjects") in the biomechanical laboratory of the department "Kinesiology" at the University of Leuven, Belgium (Prof P. Hespel). Maximal crank power output was measured during a series of short intermittent sprints on a isokinetic (predetermined fixed pedaling rate, moment/torque to maximize) bicycle ergometer. For **all** pedaling cadences between 40 rpm to 120 rpm (included) the **PowerOval®** prototype showed crank power gains compared to round. These experimentally measured figures **confirm** and even surpass slightly the crank power gains calculated with the bio-mechanical model, more specifically in the pedaling frequency range of 80 rpm till 100 rpm, normally used by Elite cyclists in competition. This study has not been published yet.

4.2 Experimental tests knee- and hip joint loading (Reference 18)

On April 28, 2014 G. Strutzenberger et al., Department of Sport Science and Kinesiology, University of Salzburg, Austria issue a research report: *"Effect of chainring ovality on joint power during cycling at different workloads and cadences"*.
In this study, the commercially available chainrings, round (Dura Ace Shimano), the Q-Ring oval of Rotor (10% ovality) and the Osymetric (ovality 21.5%) are investigated with 14 elite cyclists.The research results of Grutzenberger et al. fully confirm the theoretical findings of Malfait, Storme & Derdeyn. *Compared to a round chainring, the load on the knee joint decreases and the load on the hip joint increases with increasing ovality and with increasing cadence. These alterations of the joint loads are independent of the external power supplied to the pedal.*
Very important here is the finding of the increasing load (joint moments/-power) on the hip joint when cycling with non-circular chain wheels **in general**.
However when cycling with the PowerOval® chainring, the *increase* is converted into a *decrease* of the peak-power in the extensor muscles of the hip-joint.
This is accomplished by changing the parameter "crank position relative to the major axis of the oval". In the "optimal crank position" there is a balance between maximizing the kinetic crank power gain and minimizing the kinetic load of knee- **and** hip-joint.

4.3 Experimental confirmation of the "zero-results" of the other commercially available non-circular chainrings.

The above mentioned "zero-performances" of the other commercial available non-circular chainrings are confirmed by a myriad of **manufacturer-independent** scientific studies and testing, for example (see the Reference list)

-for Q-Ring
Jones AD 2008 (ref 6)
Peiffer JJ 2010 (ref 12)
Mateo M 2010 (ref 10)

Diamond ND et al. 2010 (ref 1)
Leong C-H et al. 2017 (ref 20)

-for Osymetric
Ratel et al. (2004) (ref 15)
Horvais et al (2007) (ref 3)
Rambier N. (2013) (Master Thesis, onder supervisie van prof. Ph.D. Fr Grappe, Université de Franche-Comté, Besançon) (ref 13)
Leong C-H et al. 2017 (ref 20)

-for Ogival
Grosjean et Grappe (2013) (ref 2)

5. References

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