Lifting as the Optimal Technique for Active and Competitive Cycling on-the-Saddle Pedaling Propulsion

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Abstract

This technical paper provides conclusive evidence in support of the lifting of the pedals while cycling on the saddle as the optimal means of producing efficient propulsion for all levels of cleated cycling.

The 2007 Paper titled **Effect of Pedaling Technique on Mechanical Effectiveness and Efficiency in Cyclists** (1) discussed the results of an efficiency study of four pedaling techniques tested under controlled conditions using experienced competitive cyclists (Efficiency Study). The techniques tested were:

- The preferred competitive pedaling technique (Preferred technique)
- Lifting the pedals (Lifting technique)
- Pushing down on the pedals (Pushing technique)
- Applying force across the entire pedaling cycle (Circling technique)

The published results of this Efficiency Study indicated that the Lifting technique was considered more mechanically effective than the Preferred, Circling and Pushing techniques. The Preferred technique typically employs lifting force across 75% of the pedaling arc immediately followed by a push down and sweep back of the descending leg.

The resultant data of the Efficiency Study showed that a better Evenness of Torque Distribution at 28% was achieved by the Lifting technique when compared to the other techniques tested. Torque is a measure of the force that causes each pedal to rotate through its axis. An even distribution of torque promotes mechanical pedaling efficiency. The Preferred technique scored the second highest percentage of Evenness of Torque Distribution at 24%.

In terms of Index of Force Effectiveness, the Lifting technique had a greater margin than the other techniques with 64% Force Effectiveness. Force Effectiveness indicates the percentage the torque force that is effectively used to produce propulsion during the pedaling process. At 47% Force Effectiveness the Preferred technique was the second highest of all the tested techniques.

The production of Negative Torque was an important factor also considered in the Efficiency Study. Negative Torque works against Force Effectiveness because it takes useful torque force away from the propulsion process. At approximately -1.3 Newton Meters, the Lifting technique produced less Negative Torque than the other techniques. The Preferred, Circling and Pushing techniques had similar Negative Torque production values of approximately -10 Newton Meters. The mechanical efficiency findings of the Efficiency Study clearly demonstrated that the Lifting technique was mechanically superior than the other techniques.

Paradoxically, the Gross Efficiency results of the Efficiency Study placed the Preferred technique in first place, the Pushing technique in second place, the Circling technique in third place and the Lifting technique in last place. The Authors of the Efficiency Study concluded that even though the Lifting technique proved to be mechanically superior, it was not metabolically efficient (Gross Efficiency) when compared to the other techniques.

However, the Authors also concluded that the lack of adaptation of the test subjects to techniques other than the one they used, presented a limitation relative to the accuracy of the results. The bias of the results towards the Preferred technique could have been caused by the fact that as competitive cyclists, all the test subjects were fully adapted to the Preferred technique. In addition, none of the test subjects was given enough time to adapt to the other techniques tested.

Having recognized this limitation, the Authors suggested that further studies were needed to establish the possibility that a technique other than the Preferred technique, given enough time for proper adaptation, could ultimately deliver better Gross Efficiency results than the ones obtained.

In the year 2012, the Author of this Technical Paper, without prior knowledge of the 2007 Efficiency Study and its results, decided to explore the possibility of using 100% lifting of the pedals, as the sole means of generating pedaling propulsion while cycling on the saddle. Motivated by his desire to improve his road cycling time trials performance, he decided to explore the possibility of effectively using this highly simplified version of the Pro technique.

Several weeks of focused efforts with the Lifting technique showed marked improvement in his overall pedaling propulsion and striking improvements in his climbing efforts. His cycling form was also devoid of the excessive upper body motion exhibited with the Pushing technique he previously used.

Using his systems engineering background, the Author ultimately developed a highly efficient modality of the Lifting technique that he referred to as Lift Propulsive Pedaling (LPP). He used the LPP technique in his overall road cycling and his time trials. He also taught LPP for 7 years to interested outdoor cyclists as well as to the participants of his indoor cycling classes.

Users consistently reported improvements that clearly demonstrated that the LPP technique delivered an efficiency edge when compared to Pushing technique they had used. The Author ascribed this efficiency to the combination of the following factors:

- The inherent simplicity, fluidity and smoothness of the lifting process
- The propulsion support provided by the inertial weight of the free-falling leg structure
- The increased number of muscles involved in the lifting process.

However, lacking independent proof of the mechanical effectiveness of lifting process, the Author understood that some level of formal analysis and testing would be required to fully validate the observed efficiency of the LPP technique.

In 2014, the Author read the 2007 Paper about the Efficiency Study and found in it the mechanical efficiency proof that had eluded him. The reported superior Mechanical Effectiveness of the Lifting technique explained the efficiency edge consistently achieved with the LPP technique. Based on his extensive experience with the adaptation process of the LPP technique, he concluded that lack of adaptation skewed the results away from the Lifting technique.

Once full adaptation was achieved with LPP, its users reported that its lifting process delivered far better power generation results and endurance than the pushing process. This fact was also backed by several competitive results.

In essence, the data of the 2007 Efficiency Study provided critical empirically evidence that in terms of Mechanical Effectiveness, the Lifting technique was was superior to all the other tested pedaling techniques, including the Preferred technique used by elite and Professional (Pro) cyclists. However, it negated the Gross Efficiency of the Lifting technique.

To correct that paradox, the Mechanical Effectiveness of the Lifting technique in combination with proper adaptation to it, would have to be tested against the Preferred technique. The goal was to have a Pro cyclist with reasonable time to adapt to the Lifting technique, perform several timed trials to compare the efficiency of the LPP modality of the Lifting technique against that of the Preferred technique. What follows is a discussion of the parameters and efficiency basis of the LPP technique and performance results of the Preferred and LPP technique tests.

Parameters

Muscular Adaptation

Substantial experience with the Lifting technique has clearly demonstrated that a reasonable muscular adaptation period is required to achieve full lifting potential. Nine muscles have been identified by the Author to be directly involved with the lifting process. They will be referred to as the Lifting Muscle Group. They are the Psoas Major which connects the upper body with the lower body. The Iliacus which flexes and rotates the Femur and when combined with the Psoas muscle this pair is considered to be the strongest hip flexor. The Abductor Longus and Abductor Brevis both of which promote and control the lateral motion of the leg. The Sartorius which is unique in the function of serving as a hip and knee flexor. The Biceps Femoris which performs knee flexion. The Semitendinosus which extends at the hip and flexes at the knee and the Gastrocnemius which is the main plantar flexor of the ankle joint and is also a powerful knee flexor.

Muscular adaptation involves the physiological conditioning to the biomechanical lifting action, as well as the development of the muscular strength required to support the short/long term use of the Lifting technique. This biomechanical conditioning and muscular strength adaptation require the necessary time on task. The more time is allotted to adaptation, the quicker the full potential of the Lifting technique is achieved.

There is very little utilization of the Lifting Muscle Group when the Pushing technique is used. That being the case, a reasonable period of time must be allotted for full adaptation of the Lifting Muscle Group by cyclists habituated to the Pushing technique. On average, approximately four months devoting four hours per week to LPP technique practice is required for full adaptation.

The Preferred technique uses a considerable amount of lifting (75%) combined with a lesser amount (25%) of pushing of the pedals. For this reason, it is much easier and faster for Elite and Pro competitive cyclist to adapt to the 100% lifting effort of the LPP technique. It is estimated that Elite and Pro cyclists could be fully adapted to the LPP technique within a period of 1 month.

During the muscular adaptation period, the abdominal muscles are strengthened by the lifting action of the legs. As a result, this key Core Muscle Group provides additional structural support to the torso and back during the cycling process. The Traverse Abdominis stabilizes the spine and the pelvis. The Internal and External Obliques control the lateral flexion of the spine and its rotation. The Rectus Abdominis flexes the torso forward.

It is not clear to the Author how much direct influence does the Core Muscle Group contributes to the power production capacity of the Lifting Muscle Group. However, a strong Core Muscle Group is essential for the support of a stable cycling posture and sustained flexed torso. A stable cycling posture provides better control of the bicycle and a more streamlined position. Wind tunnel studies have shown that torso flexion is critical to a cyclist for the elimination of aerodynamic drag in direct proportion to the achieved degrees of flexion. This Technical Paper will also demonstrate that torso flexion is fundamental for increased generation of propulsion related Kinetic Energy.

Muscular Exertion and Discomfort Dispersion

Cyclists that use the Lifting technique, can apply more force with far less discomfort than those using the Pushing technique. With a properly executed Lifting technique such as LPP, the use of the pushing muscles is largely minimized, and with it the burning sensation that comes with their sustained use. While undergoing adaptation, users of the Lifting technique experiences less discomfort with no burning sensation in their lifting muscle group.

When fully adapted and at optimal lifting strength, the muscular discomfort sensation of the lifting muscle group has been reported to be minimal during average power production and more manageable during sustained high-power production. Outdoor and indoor cyclists using the Lifting technique while operating at sustained high-power production levels of effort, report their limiting factor to be anaerobic stress rather than muscle fatigue.

This reduced muscular discomfort at higher than nominal sustained power could be due to the larger count and the greater area covered by the Lifting Muscle Group, which is noticed to spread out the discomfort instead of concentrating it.

Mental Adaptation

The process of mental adaptation to the Lifting technique varies from individual to individual amongst those cyclists that are habituated to the Pushing technique. Mental adaptation occurs much faster amongst Elite and Pro cyclists. As pointed out before, they are used to lifting as part of the pedaling process so, for them it is a matter of completing what used to be a partial lifting process. Elite and Pro cyclists using the LPP technique have reported that though not immediate, it is much easier for them to eliminate their tendency of pushing down on the pedals.

The Author has developed physical and mental cues that are helpful in overcoming the reiterative tendency to push down on the pedals ingrained through years of using the Pushing technique.

Bicycle and Cleat Setup

The three key elements for the efficient execution of the LPP modality of the Lifting technique are the setup of saddle height, the cleats, and the longitudinal (fore or aft) position of the saddle.

Saddle height ensures that maximum lifting action is achieved by the legs. The position of the cleats is vital for the best possible transfer of the power (watts) generated by the lifting action without any loss due to the unnecessary mechanical motion of the foot. The fore or aft position of the saddle is key for the production of the maximum possible inertial mass necessary to optimize the Kinetic Energy produced by the descending legs.

Optimal setup positions for the cleats and the saddle have been developed by the author through empirical data gathering and extensive testing.

Kinetic Energy as a Lift Assistive Force

Of all the pedaling techniques discussed in the 2007 Technical Paper, the Lifting technique is the one that makes the best use of physics during the pedaling process.

The Mechanical Effectiveness results of the 2007 Efficiency Study were considered by the Author to be foundational towards the potential preeminence of the Lifting technique in competitive cycling. The following analysis of the LPP technique, demonstrates that the musculoskeletal force pounds induced upon the structure of the descending leg due to torso flexion plus the weight of the mass of the structure of the descending leg, produces a Resultant Weight. This Resultant Weight is a critical factor in producing a propulsion assistive force in the form of Kinetic Energy in support of the superior Mechanical Effectiveness of the Lifting technique.

Assuming that the prescribed adjustment of the saddle is accomplished during setup, the Resultant Weight imposed on the pedals by each descending leg structure is considerable.

Table 1 provides the Resultant Weight imposed on the descending left leg structure of a test subject at 24 Descent Angles. A static fixture was created for each Descent Angle in order to measure each Resultant Weight value.

Torso flexion adds a substantial amount of additional weight to the one that would have been derived solely from the mass of descending leg structure. As many as 15 to 20 LBS imposed by the degrees of torso flexion at certain Descent Angles were noted. A torso flexion angle of approximately 50° was used to derive the Resultant Weight values of **Table 1**.

More aggressive torso flexion postures such as the Elite and Pro level position for riding on the drops or a time trials and triathlons extended bars position would have produced even higher Resultant Weight values. From the Resultant Weight in LBS of the Angles of Descent below, the Average Resultant Weight was calculated and was utilized to derive the Kinetic Energy values provided in this Technical Paper.

Angle of Descent	Resultant Weight in LBS
7°	22.5
14°	26.2
21°	37.2
28°	40.0
35°	42.4
42°	47.1
49°	52.2
56°	49.5
63°	40.9

70°	39.5
77°	37.6
84°	39.3
91°	40.7
98°	46.2
105°	48.1
112°	53.0
119°	58.0
126°	60.1
133°	63.0
140°	59.2
147°	56.1
154°	52.0
161°	48.1
168°	47.1

Table 1 – Resultant Weight Imposed on the Pedal

Average Weight = ∑ Resultant Weights/Angles Count

Average Resultant Weight = Average Resultant Mass = 1,106 LBS/24 = 46.1 LBS

Assuming that the descending leg structure of the cyclist is in free fall (no muscular force is applied to it), its Resultant Mass is subjected to an Angular Velocity (2) defined by the equation below. This Angular Velocity **ω** is based on the Revolutions per Second ***n*** that the cyclist applies to the pedaling crank. Since

1 Revolution per Second = 2π Radians per Second

Then, Angular Velocity $\omega = 2\pi n$ Radians per Second

The Revolutions per Second can be easily derived from the Revolutions per Minute (RPM) the cyclist applies to the pedaling crank. The Angular Velocity **ω** imparts a Tangential Velocity ***v*** to the Resultant Mass of the descending leg, where

Tangential Velocity $v = r\,\omega$

In this case ***r*** is the length (Radius) of the pedaling crank from the center of its point of connection to the bicycle to the center of its point of connection to the pedal.

The Tangential Velocity remains unchanged as long as the RPM of the cyclist remain constant. An increase in RPM will increase the Angular Velocity and thus, will increase the Tangential Velocity of the Resultant Mass of the descending leg.

The combination of the Tangential Velocity ***v*** and the Resultant Mass ***m*** of the descending leg play a critical role. This is because

Kinetic Energy = ***mv***

Thus, Resultant Mass of the descending legs multiplied by the Tangential Velocity produces Kinetic Energy as a propulsion assistive force.

Thus, Kinetic Energy is always provided in support of the lifting process as long as any Tangential Velocity is present.

A change in either Resultant Weight or Tangential Velocity will produce a change in Kinetic Energy during the fall of the descending legs. This produces an immediate gain or loss of the propulsive Kinetic Energy delivered by the descending legs.

The Resultant Weight values of **Table 1** show that given an optimal RPM, the Kinetic Energy produced by a descending leg can be substantial and can dramatically improve pedaling propulsion. Conversely, given considerably less than optimal RPM (typically below 60 RPM), the Kinetic Energy produced by the descending legs will add some, yet minimal support to the pedaling propulsion process.

Step 1 – *Calculation of Average Tangential Velocity*

Using an OMNI Centrifugal Force Calculator (3), the average Tangential Velocity values for a range of RPM shown in **Table 2** were calculated based on the average Resultant Weight of the left descending leg structure of the test subject.

The following values were provided as input for the calculator:

Average Resultant Weight imposed on the Mass of the descending leg structure = Average Resultant Mass = 46.1 LBS

The Radius of the pedal crank = 172.5 mm

The Angular Velocity in RPM = 60, 70, 80, 90, 100 and 110 RPM

The OMNI Centrifugal Force Calculator automatically performed the necessary unit conversions and provided the Tangential Velocity values shown in **Table 2**.

RPM	Tangential Velocity (ft/sec)
60	3.556
70	4.149
80	4.741
90	5.334
100	5.927
110	6.519

Table 2 – Tangential Velocity for the 46.1 LBS Average Resultant Mass

Step 2 – ***Calculation of Kinetic Energy***

Having calculated the Tangential Velocity, an OMNI Kinetic Energy Calculator (4) was then used to determine the Kinetic Energy (average) that the descending leg structure provides in support of the lifting leg. The following values were provided as input for the calculator:

Average Weight imposed on the Mass of the descending leg structure = Average Resultant Mass = 46.1 LBS

The Tangential Velocity at each of the given RPM.

The OMNI Kinetic Energy Calculator provided the Kinetic Energy values shown in **Table 3**.

RPM	Kinetic Energy (Joules)
60	12.283
70	16.721
80	21.833
90	27.636
100	34.122
110	41.279

Table 3 – Kinetic Energy for 46.1 LBS Average Resultant Mass

This analysis shows that pedaling at a higher RPM provides enhanced pedaling efficiency. It has also been observed by the author that this Kinetic Energy based supportive action can be felt at certain combinations of gear tension and RPM. During those times, a seamless propulsion task transfer can be perceived, whereby the lifting muscular force of hands over the task of propulsion to the Kinetic Energy derived force within a given pedal.

This phenomena however, is not noticeable at very high tensions which require substantially reduced RPM. At those RPM levels Kinetic Energy is substantially diminished. However, the elegance and simplicity of the lifting action in combination with the powerful force provided by the Lifting Muscle Group deliver the necessary force to carry on quite effectively with the propulsion task.

Power Production and Modulation

Since the Kinetic Energy produced by the descending leg structure support the lifting process, it is easier for the Lifting Muscle Group to achieve higher levels of power generation with less effort. This is achieved by providing the necessary muscular lifting power to generate the RPM required to efficiently overcome most terrain challenges.

Once fully proficient with the Lifting technique, by achieving a powerful, fluid and continuous lifting action on the saddle, the cyclist will be able to produce and modulate the RPM that will ultimately deliver the necessary power.

In terms of peak and sustained power values during the tests, a peak of 815 Watts was generated on the saddle by the LPP Tests Pro cyclist in the first LPP test. Peak power levels of 900 Watts plus could be achieved on the saddle by Elite or Pro cyclists under the right circumstances. Operating within the 320 plus Watts sustained power range during the tests, the LPP Test Pro cyclist was also able to deliver segments with sustained power values of 400 to 500 plus Watts.

By its smooth and simple lifting action, the Lifting technique allows to more closely modulate the muscular effort and RPM of the propulsion process. This results in a more controlled power generation that is helpful for the overall management of the cycling effort

Performance Results

Lifting Technique (LPP Modality) Road Tests

A Pro cyclist was selected for the validation of the mechanical assumptions, long-term adaptation, setup optimization, technique execution and performance results of the lifting technique.

The Author chose Stephane Roch (5), an accomplished competitive Mountain Cycling Professional and winner of the California Endurance Series to be the LPP Tests Pro cyclist.

A 20 miles track in San Diego, California with a varied terrain and 1,100 feet of vertical ascent was chosen to perform the LPP Tests (6). The formal tests were run in spring and fall of 2015. The dates were designed to accommodate the competitive racing schedule of the LPP Test Pro cyclist and to provide the best possible climatic conditions for the tests. These were performed at between the hours of 7:56 and 8:40 in the morning to minimize the impact of wind and at temperatures between 60º to 67º Fahrenheit to minimize the impact heat, thus maximizing cycling performance.

A fully optimized Grand Tour Pro level test bike (7) with a Shimano Dura Ace DI2 electronic shifting system was provided for the tests.

Five trials were conducted and only one trial (LPP2 at 05/10/2015) had the impact of a moderate cross wind affecting the performance results. The first two trials were conducted using the Preferred technique used by the LPP Test Pro cyclist. The remaining three trials were executed with the LPP modality of the Lifting technique. Detailed test results are provided within the above noted Reference (6). What follows is a summary of those LPP test results:

Date, Technique, Reference Designator

2/27/15	3/4/15	4/28/15	5/10/15	9/6/15
Preferred	Preferred	Lifting	Lifting	Lifting
P1	**P2**	**LPP1**	**LPP2**	**LPP3**

Fastest to Slowest Time (Min:Sec)

LPP3	LPP1	P2	LPP2	P1
50:57	51:09	52:15	52:58	57:58

Highest to Lowest Normalized Power (Watts)

LPP3	LPP2	LPP1	P2	P1
315	311	307	304	262

Highest to Lowest Maximum Power (Watts)

LPP1	LPP3	LPP2	P2	P1
815	708	678	620	611

Lowest to Highest Work Performed (Kilojoules)

P1	LPP1	P2	LPP3	LPP2
834	849	867	893	899

Highest to Lowest Watts Per Kilogram

LPP3	LPP2	LPP1	P2	P1
4.85	4.79	4.73	4.68	4.04

Lowest to Highest Average Heart Rate (Beats Per Minute)

P1	P2	LPP2	LPP3	LPP1
147	160	162	166	167

Lowest to Highest Average Cadence (Revolutions Per Minute)

P2	LPP3	LPP1	LPP2	P1
94	96	97	99	105

Discussion

With the advent of power meter technology as applied to cycling, efficient and sustained power generation has become a critical marker for competitive cycling training and racing. Finding better ways of creating and sustaining competitive propulsive power has become a key pursuit in the competitive cycling world.

The motion dynamics analysis provided in this Technical Paper shows that a considerable amount of propulsive Kinetic Energy can be freely generated by using the lifting technique. This Kinetic Energy generation is optimal at the high RPM levels that Elite and Pro cyclists typically perform. The LPP Tests Pro cyclist performed the LPP tests within a 96 to 99 RPM range.

Optimal Kinetic Energy was also promoted during the LPP tests by the aggressive torso flexion the LPP Tests Pro cyclist used while riding on the drops of the LPP Tests bike. As noted within the Kinetic Energy analysis section of this Technical Paper, aggressive torso flexions induce a much higher Resultant Weight to the descending legs structure, thus, promoting higher Kinetic Energy generation.

With all those elements in play and having provided reasonable time for the LPP Tests Pro cyclist to adapt to 100% lifting, the initial LPP test (LPP1) was performed in 51 minutes and 9 seconds. This performance was over a minute faster than the best Preferred technique test (P2).

It is interesting to note that the LPP1 effort produced two days of soreness of the LPP Tests Pro cyclist Lifting Muscle Group. This indicated that even though he was adapted enough to produce a considerably faster time than his best time with the Preferred technique, he was not yet fully adapted to 100% lifting. As he fully adapted to 100% lifting, his remaining LPP test trials produced larger propulsive power generation without the post-trial soreness of his Lifting Muscle Group.

LPP1 was completed 1 minute and 6 seconds faster than P2 while using 18 Kilojoules less. This indicated that far more speed was produced with less muscular effort. The Author deduces that a substantial amount of the free Kinetic Energy generated during the LPP1 test was used to generate propulsion thus saving muscular exertion and promoting pedaling efficiency.

Efficiency Related Comment*: Any opposition or interruption of the falling action of the descending legs negatively affects their Kinetic Energy generation and impairs propulsion. The reason for this is that any reduction of Tangential Velocity immediately negates Kinetic Energy. In the case of the Preferred technique, this reduction of Tangential Velocity can be due to the hesitative transition from lifting to push down and sweep back. This shift to a pushdown process tends to stop the lifting and thus, interrupt the free-falling process that the lifting action promoted. The approximately even application of force around the pedaling arc of the Circling technique and the large force application of the Pushing technique while coping with an opposing leg that adds no value to the pushing process also negate free Kinetic Energy.*

It is the author's opinion that the simultaneous creation of a lifting based propulsion force and a Kinetic based propulsion force leads to a more uniform and fluid motion that promotes higher speeds and sustains Positive Torque across the pedaling arc. A recorded -1 Newton Meter of Negative Torque was produced by the Lifting Technique during the 2007 Efficiency Study and that was achieved without any adaptation or fluidity of the lifting process. The Preferred, Circling and Pushdown techniques were confirmed to produce approximately -10 Newton Meters of Negative Torque, thus, impairing propulsion.

The LPP technique delivered a slightly higher Normalized Power (NP) generation than the Preferred technique. However, it is noted that for a difference in NP of 4 Watts more, LPP1 was 1 minute 6 Seconds faster and for a difference in NP of 8 Watts more, LPP3 was 1 minute 18 seconds faster. Thus, LPP1 and LPP3 delivered higher power usage efficiency. In addition, the LPP1, LPP2 and LPP3 tests yielded higher Peak Power values than the P1 and P2 tests.

The LPP technique delivered a higher Heart Rate on all its runs which also correlated with the higher Cadence of LPP tests. As discussed in the second paragraph of this section, promoting higher Cadence produces higher Kinetic Energy and increased pedaling efficiency.

For more detailed LPP testing information see Reference (6).

The Lifting Technique in High Level Competition

In June 29 of 2014, after some intense training which included learning and adapting to the LPP technique, Mr. Tyler Johns went to Coeur d'Alene, Idaho to participate in an Iron Man Triathlon considered amongst the toughest in the mainland of the United States.

With over 5,000 feet of climbing across the 112 miles cycling stage, this test demanded a highly efficient cycling performance to set up a successful rolling terrain marathon stage. Getting out of the water in the 1,167th position with a 2.4 miles swim time of 1 hours 22 minutes and 51 seconds, Mr. Johns started his cycling stage.

Riding the 112 miles course at an average speed of 20 miles per hour in a time of 5 hours 38 minutes and 41 seconds, Mr. Johns produced the 161st fastest cycling time out of 2,124 participants. During that cycling performance he surpassed over 900 competitors ahead of him and finished in the mid 200th position overall. When summing up his performance to the Author of this Technical Paper, Mr. Johns reported that the LPP allowed him to fully rest his Quads for the marathon stage and was an extremely effective technique for overpassing his competitors in the climbing segments of a grueling cycling stage.

After running the marathon in a time of 4 hours 31 minutes and 26 seconds, Mr. Johns placed 361st out of the 2,124 competitors with an overall Iron Man time of 11 hours 45 minutes and 49 seconds. A truly remarkable feat for his first and only triathlon.

Conclusion

The discussed parameters of the Lifting technique in conjunction with the performance results of the Pro level LPP tests, provide ample basis to assert that the Mechanical Effectiveness of the Lifting technique as established by the 2007 Efficiency Study, when combined with the necessary Lifting technique setup and adaptation, produces a superior pedaling technique on the saddle for all levels of cleated cycling, including the elite and Professional racing levels.

(1) THOMAS KORFF, LEE M. ROMER, IAN MAYHEW, and JAMES C. MARTIN – Effects on Pedaling Technique on Mechanical Effectiveness and Efficiency in Cyclists. American College of Sports Medicine, 2007

(2) THOMAS WALLACE WRIGHT – Elements of mechanics including, kinematics, kinetics and static applications. Second Edition: 276-278

(3) Omnicalculator.com/physics – Centrifugal Force Calculator Option, 2021

(4) Omnicalculator.com/physics – Kinetic Energy Calculator Option, 2021

(5) JOSEPH L VILELLA – LPPedaling.com Website – LPP Pro Rider

(6) JOSEPH L VILELLA – LPPedaling.com Website – LPP Test Results

(7) JOSEPH L VILELLA – LPPedaling.com Website – LPP Test Bike

