PowerCranks™

Instruction and Installation Manual

WARNING

FOR YOUR SAFETY READ THIS FIRST

To the PowerCranks™ novice, riding a bicycle with PowerCranks™ will feel substantially different than when using regular cranks and could be more dangerous. For your safety, get used to these differences, especially before riding in areas that may involve increased danger, such as in traffic, around potentially unpredictable people (such as on "Jogging" or "Bike" paths), or on rough or uneven ground. I recommend riding in a totally controlled environment, such as an empty parking lot or on a training stand, until these differences are well understood. **Riding safely is your responsibility!** PowerCranks**, L.L.C. will assume no liability for any accidents or injuries that occur as a result of unfamiliarity with or misuse of PowerCranks™, [1] and/or increased speed and/or riding in an uncontrolled environment. If others use your PowerCranks™ you will be responsible for the safe use of this product. If you do not wish to assume these responsibilities do not install them on your bicycle and return them to us for a full refund.**

While your PowerCranks™ are intended to be used just like ordinary cranks in training you will not be able to do so until you get used to some major strangeness (which we call features) and get through a very quick learning curve. How strange are they? Just let me say, don't let your grandmother ride on them (unless she competes competitively)! These strangeness features include:

- Getting into toe clips is very difficult. Getting attached to clipless pedals (cleats) is easily done, once learned, but substantially different and, therefore, initially, more difficult.
- Coasting is different and feels strange.
- Cornering could be more dangerous.
- Rising out of the saddle while going over bumps and obstructions is impossible.
- Stopping, especially emergency stopping, can be different and more difficult for two reasons. 1) You may be riding faster and 2) you cannot raise out of the saddle to move your center of gravity backwards, as some do.

One more warning, PowerCranks™ **have precision moving parts and can be broken.** Although strong and reliable, they are, primarily, a training device and may not be capable of taking everything you might be able to dish out. The clutches are rated to accept a tangential force to the pedal of over 100 lbs (most people hardly ever exceed 40). Although it is unlikely that you will be able to break the clutch, if the clutches are torqued beyond their limit they can break. Clutches are warranted against breakage during normal use for two years. If this occurs, return them for prompt replacement or repair. However, because of this possibility, when used during races, expecially important races, one must be careful as to how they are stressed in these situations. If one goes back to regular cranks for races one must expect a reduction in the improvement obtained until the brain is entirely trained, because you may revert to old pedaling patterns when you get tired, as the brain training may take years. **With enough time, once the brain is trained, the improvements you gain from training with PowerCranks™ will stay with you when you go back to regular cranks for races, since, if pedaling properly, one cannot tell the difference between regular cranks and PowerCranks**.™

Introduction

Is this really possible? After many years of riding around on a bicycle you are now (and, probably, for the very first time) going to read an instruction book on how to use a pair of bicycle cranks! Aren't you glad your parents didn't make you do this before they let you ride that first bike they bought you. But, that was in the days before you took your biking performance seriously. Although you may think you pedal properly now, you are about to find out that you really don't. Unfortunately, regardless of how many times you read these instructions, the first time you use your PowerCranks™ they will feel very strange and you will feel very humbled.

I can only assume you have purchased your PowerCranks™ because you want to improve your athletic performance. The fact that PowerCranks™ have humbled every new user (including some of the best athletes in the world) means they must be training muscles not easily trainable (using previously available techniques). As it is not possible to achieve PowerCranks™ benefits in any other realistically available way I consider PowerCranks™ to be one of the greatest athletic training tools ever invented. As long as your sport relies on your legs for speed and/or coordination, training with PowerCranks™ will improve your performance. Unfortunately, the key word in the previous sentence is TRAINING as proper PowerCranks™ use requires a lot of hard work before the benefits are realized. This is especially true if your primary sport involves cycling since it is just as important to retrain the brain as it is to train the muscles and retraining the brain takes much longer than simply training muscles. The improvement you'll see from training with PowerCranks™ is dependent on you and you alone.

How much improvement is possible?

Although PowerCranks™ are too new to know the real long-term potential benefits our data shows a 40% increase in cycling power is possible in less than one year for most users. For cyclists, I believe the full potential may be as much as a doubling of current power with 5 to 10 years of hard work. For runners, speed skaters, cross country skiers, etc., the degree of potential improvement is less clear but it would appear that average runner can improve his/her marathon pace 10-20 seconds per mile in 3-4 months. Elite runners may not see that degree of improvement but any improvement at the highest levels is hard to come by. I would expect, at a minimum, that with enough time your speed should improve as if you are running the next shorter distance. That is, 10,000 meter runners should be able to run at their now 5,000 meter speed. Marathoner's will improve to 10,000 meter speed, etc.

For other athletes, where speed, coordination and endurance is important to their sport but not measured directly (hockey, soccer, football, figure skating, etc.), improvement should be easily noticeable to the athlete but it is much more difficult for us to quantitate.

One more thing, in almost all sports injuries should be reduced. Injury rates in several sports have been correlated to muscle imbalance in the legs. Because of the improved muscle balance PowerCranks™ provides between the right and left legs and the agonist/antagonist (flexor/extensor) muscles, coordination is improved and injury rates should be reduced. This improvement in muscle balance and coordination should also have benefits in even certain sedentary populations, such as the elderly, where the risk of fall should be reduced with very little time on the cranks.

For athletes in other, less physically demanding, sports (golf, bowling, etc.) it is not clear if PowerCranks™ will provide any benefit to your athletic performance but your overall sense of fitness should improve with use.

So, welcome to the world of PowerCranking, where, at first, even the best get to experience a very humbling experience, pedaling with PowerCranks™, and then improve. If you will do the work, PowerCranks™ will improve your performance – the amount of improvement only being limited by your own effort and desire.

Warning

I know you're anxious to get started with the cranks but please, please, please read the following instructions before doing so because the first time you are going to find these cranks REALLY strange. This "strangeness" could affect your safety, especially if riding in traffic or other uncontrolled situations.

Frank Day
Inventor and founder of PowerCranks

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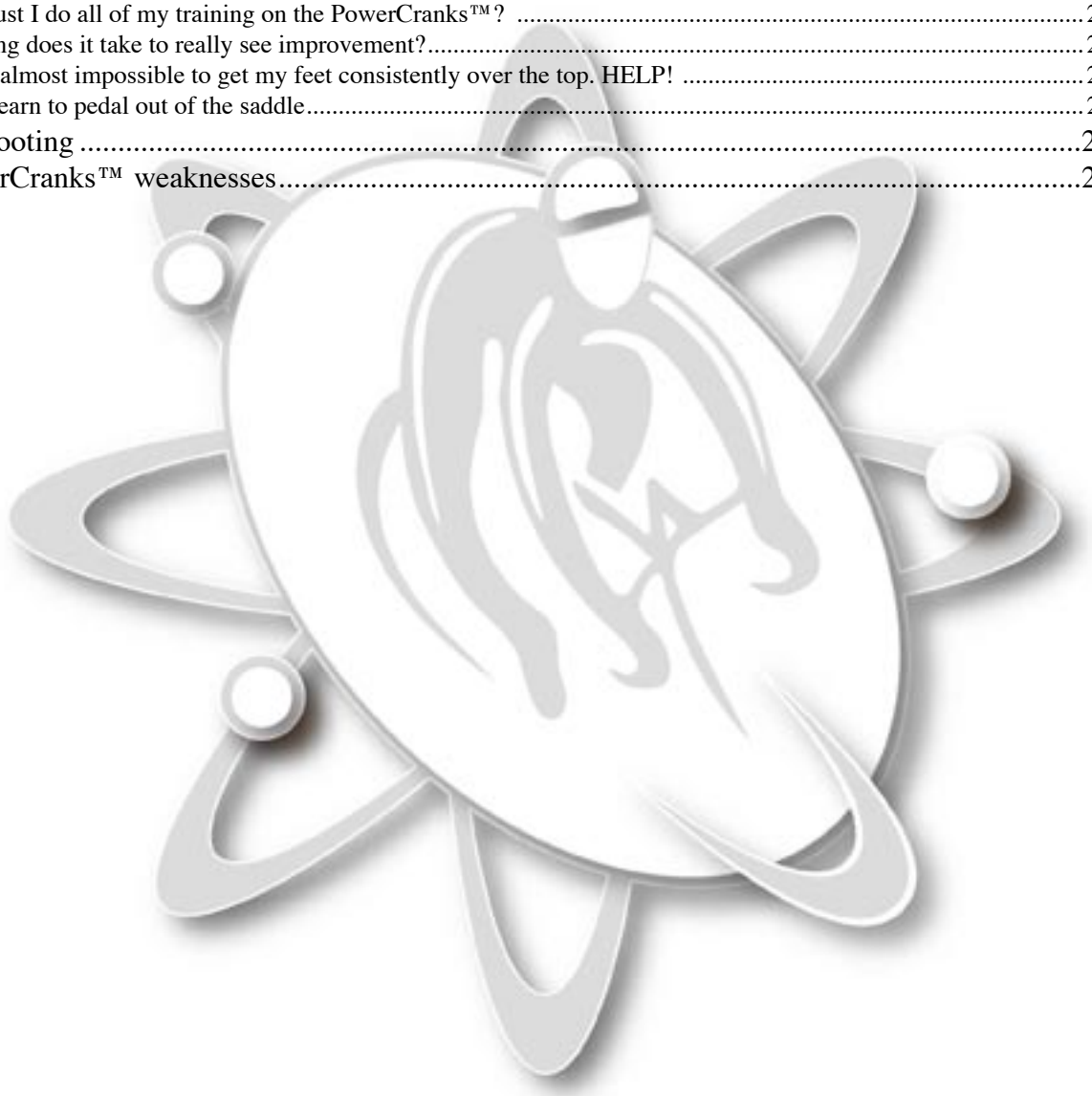


Congratulations on your purchase, get ready to rock and roll

I can only assume you made this purchase because you are an athlete and want to improve your performance. If you have never ridden a pair of PowerCranks™ it is hard to imagine how much room for improvement there is and how well PowerCranks™ will help you achieve your goals. Please read the instruction manual to help you better understand the differences between PowerCranks™ and what you are used to and to better understand how to maximize your benefits from training with this device. Good luck in your athletic endeavors.

What's Different About *PowerCranks*™

Your PowerCranks™ are meant to be used just like ordinary bicycle cranks but, at first, you will notice some major "strangeness" affecting how you ride the bicycle. These "strange" features include:

Strange Feature #1. Getting attached to your pedals.

PowerCranks™ will not operate without your foot being attached to the pedal in some fashion since the pedal will not come up unless you pull it up. If you will be using them on the road, toe clips are not recommended as it is very difficult to get into or out of toe clips and you will tend to pull out of toe clips as you learn to pull back on the bottom of the stroke and lift on recovery. Clipless pedals (cleats) are recommended - almost any brand works acceptably well. Clipping into your Clipless pedals is quite easy but at first will be somewhat difficult because with PowerCranks™ the first foot is clipped in normally but the second will be found pointing down towards the ground and unsupported. This takes a little getting used to and if you start off going uphill you could end up stopped and falling while you are trying to get clipped in. But, once you learn this new skill, getting attached becomes no more difficult than it is now.

Strange Feature #2. Coasting and cornering.

Whenever you stop pedaling you will find both feet, immediately, go to the bottom of the pedaling arc. This feels really weird but it is not a particularly bad thing (other than looking funny) - unless you are going around a corner when your inside pedal will be down towards the ground and could hit the ground and cause you to fall. In addition, when you find yourself riding faster you must be concerned with traction on corners due to increased speed so you may not be able to take corners as sharply as you are accustomed. Therefore, practice cornering. With practice you will be able to hold the inside leg up during sharp corners to avoid the possibility of hitting the ground. This difference actually improves your cornering technique because in proper cornering technique one is supposed to unweight the inside pedal. With PowerCranks™ you are almost forced to unweight the inside pedal. Always be aware of the hazards of increased speed when cornering.

Strange Feature #3. Going over bumps and obstructions.

Going over bumps will be another new experience for you if you, like many people, rise up off the saddle to negotiate these obstructions. The first time you try to raise off the saddle you will find both feet at the bottom of the arc and (if your saddle height is adjusted properly) your buttocks only about 1/2 inch above the saddle. You will, again, find this feels really strange. In this instance, also, occasionally your pedals may drag against high bumps, such as speed bumps. Don't expect to be able to bunny hop anytime in the near future. Get used to this before you venture into unfamiliar territory.

Strange Feature #4. Riding out of the saddle.

Riding out of the saddle is really hard and is the last skill most people learn. Don't even bother trying until you have the mechanics of normal riding down pat. It can be done and there are some drills to help you learn this. With practice, this will become easy (as if pedaling out of the saddle was ever "easy") and natural.

Strange Feature #5. Braking.

Well, not really a feature, except as related to the major feature, increased speed, but I didn't want to break the flow. If, as expected with PowerCranks™ you are moving faster than you are used to, stopping distances will be substantially longer from increased speed. Your total energy is proportional to the square of your velocity and so stopping distance increases with the square of the velocity. **Beyond simply taking longer to stop, emergency braking poses another potential problem.** Many people perform an emergency stop by rising out of the saddle and then pushing their body rearwards (which moves one's center of gravity

back) so they can brake harder with the front brake without going over the handlebars. It is hard to do this with your PowerCranks™ since it is difficult to rise out of the saddle enough to move back. Practice your new emergency stop technique before venturing into traffic or other uncontrolled environments. **Riding safely is your responsibility**.

Strange Feature #6. Another thing to be aware of.

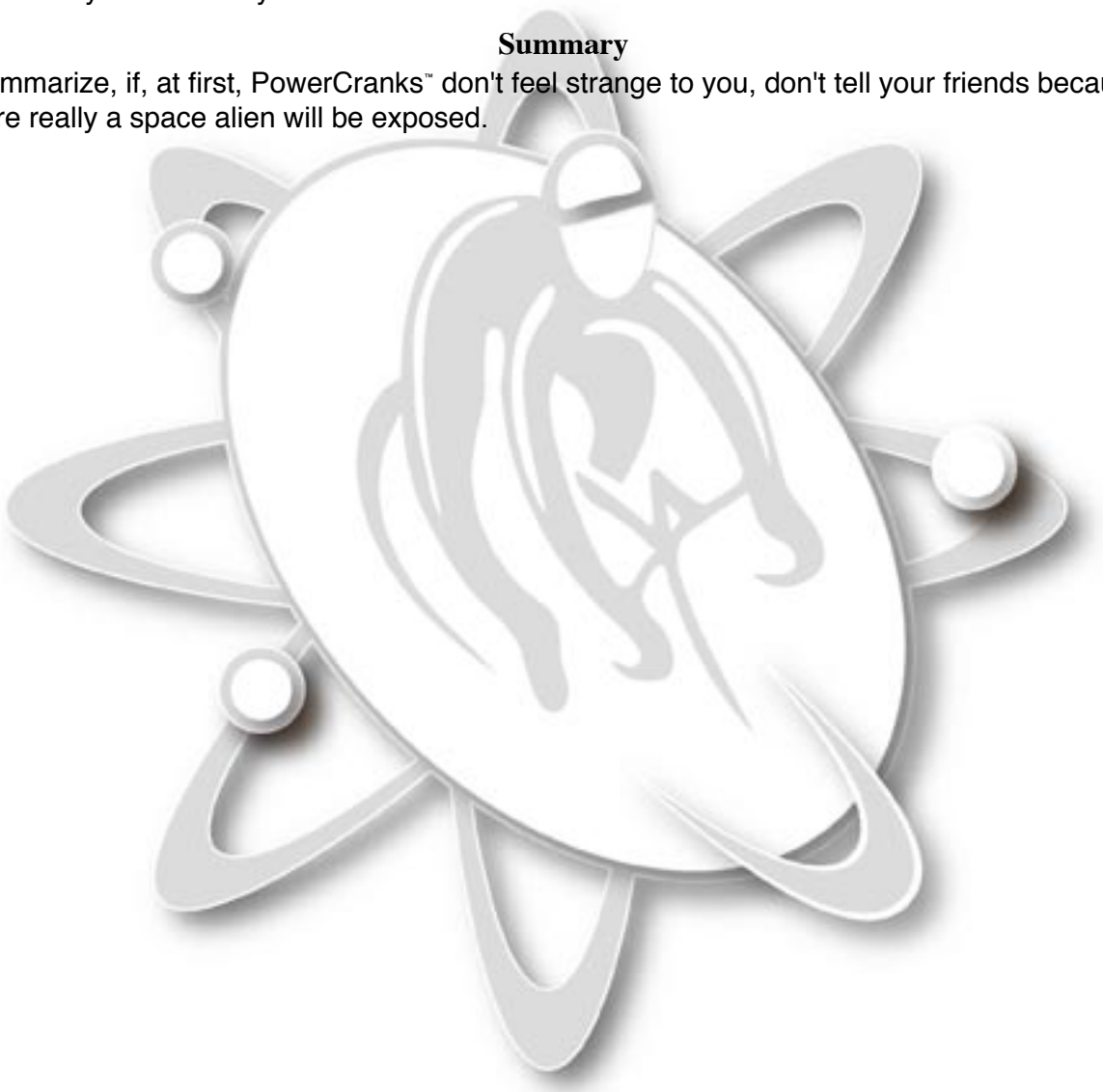
Just as your bicycle chain, wheel, tires, or frame can suddenly fail during use, causing a dangerous situation, so can the PowerCranks™. Please ride with caution.

Strange Feature to your Lawyer: Your Responsibility

Bicycling is inherently dangerous. Always wear a helmet. While it is possible to ride PowerCranks in most environments (such as in traffic, etc.) with reasonable safety (as it is a regularly equipped bicycle) it is your responsibility to ride safely in all situations.

Summary

To summarize, if, at first, PowerCranks™ don't feel strange to you, don't tell your friends because the fact that you are really a space alien will be exposed.



How to Use Your *PowerCranks*™

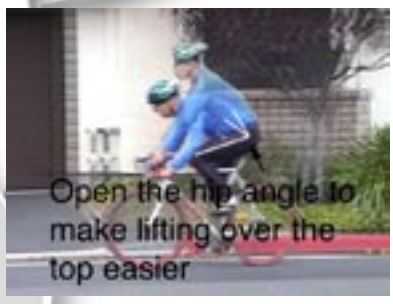
How to Start Pedaling.

This may seem like a silly topic heading directed to professionals and others who are very experienced in riding a bicycle, but I have actually seen people, while they were looking at their feet, both at the bottom of the arc, laughing at how silly they feel and trying to figure out how to get clipped in or how to start, coast to a stop and fall over. So read on.

PowerCranks™ are almost impossible to use using toe clips so get Clipless pedals if you do not already have them, almost any brand will do although, if you have to buy some, some users have described "egg beater" pedals by Crank Brothers as being the easiest to use because of the ease of entry. The first thing you must do to start pedaling is to get clipped in. The first pedal is easy to do because the bicycle will be stopped. The second, however, is not as easy as it seems it should be since the second crank will not be where you expect it. The second crank will be at the bottom of its arc and unsupported. If you have trouble remember to pedal some with the other leg to keep the bike speed up so you won't fall over while you are trying to get in. Also, don't run into anything while you are looking at your foot trying to get things together. Once you're clipped in the next thing you must understand is that you cannot start pedaling without lifting at least one leg and that this is easiest to do while sitting on the seat. It is easiest to start pedaling with a single leg (choose your dominant leg) and then join in with the other. **Therefore, I recommend that the first time you use your** PowerCranks™ **you should do so on a stand or have someone hold or be available to balance your bicycle until you understand how to get into the cleats and start pedaling. Put the bike into a low gear. Start pedaling by either lifting one foot up the back stroke, as in pedaling, which will drive the bicycle, or lifting forward, counter to pedaling, which will allow you to get into a power position rapidly. Start pedaling with one leg. When that pedal is coming over the top and 180° from the other pedal start pedaling with the other leg after it is clipped in. If the pedals are not right you <u>will</u> know it! One way to tell if you are not 180° is the timing of the legs will be off, you will feel like you are galloping. If they feel right, they are right.** If they don't feel quite right go back to riding with one leg, wait for what seems like a right moment as that leg comes over the top, and start pedaling with the other leg. While this sounds difficult it really is quite simple and natural, and will soon become easy and unconscious

General Suggestions for all cyclists.

1. Ride in a more open position



Lifting your feet completely over top dead center requires you to lift each leg about 14 inches and put it back down at the cadence rate you are pedaling. Few will have much endurance for this at first, especially at any cadence above 60 or so. This is especially true in the aero position where one has to bring the knee up closer to the chest without any help (see figure). Try this drill. Stand up straight and lift one foot 14 inches off the floor. Now repeat this with your upper body bent over. Notice, the more you are bent over the closer you must bring your thigh to your chest and the harder this becomes to get the foot the entire 14 inches off the floor. This is why the aero position is so hard to use in the beginning with PowerCranks™ and going into the extreme aero position can actually rob you of power. Therefore, most new users will need to start out riding with a much more open hip angle (i.e., to be in an almost upright , "touring", position). Don't worry, after a few weeks you will be ready to try to assume a more aerodynamic position, and after several months you should be able to return to (or close to) your present position, if you so choose. You may find it useful to raise your handlebars and slowly lower them as you adapt. **A highly aerodynamic position will not increase your speed if it robs you of more power than you gain in aerodynamic benefit.** Your fastest position will probably change as you develop your knee lift ability more fully.

2. Training your brain is as important as (and much more difficult than) training your muscles

In cycling, it won't matter if all of your muscles are fully trained if your brain does not have the proper unconscious pedal coordination to use those muscles without your needing to think about it. This brain retraining may take many years to occur fully such that, until this time, race speeds on regular cranks may be substantially less than that seen during training. Suggestions on how to minimize this problem can be found below in the section entitled "Preparing to race on regular cranks."

Specific Suggestions for Road Cyclists.

1. Work on Endurance First

Road racing requires a combination of aerobic endurance and short periods of anaerobic acceleration and peak power. New PowerCrankers must first work on their aerobic endurance before worrying about acceleration. Therefore, the more time you spend riding with your PowerCranks™ the faster you will improve and the faster you will become comfortable riding in this race environment on the cranks. This is psychologically very difficult for the serious cyclist because most will take a big hit in weekly mileage for awhile and not be able to ride the PowerCranks™ at the cadences they are used to so they will be afraid of losing ground or afraid of not performing at their usual level. However, this period of reduced mileage and reduced performance will not last very long and you will not lose much when you go back to regular riding. New users have actually, during the racing season, started using PowerCranks™ about 6 weeks before a big race, used PowerCranks™ exclusively in the build up for the race (until about 2 days before) and seen improved performance over what they would have otherwise expected. This is tough to do psychologically but most should see benefit.

The key to increasing distance and endurance is to pedal at low cadences rather than high cadences. This is because you have not developed the hip flexor capability to perform the increased frequency and number of repetitions necessary for any given distance at higher cadences. On each ride it is acceptable to do some work at higher cadences to try to develop that skill but the early work should be mostly devoted towards developing the aerobic base.

Most new users report the cranks no longer feel strange to them in about 2 to 3 weeks. However, do not expect any substantial overall power improvement for about 6 weeks. This has to do with the time it takes to see training effect in the new muscles you will be using. While some efficiency improvements will be seen at lower power outputs on short rides very early, the user must expect this process to take some time. Of course, improvement will continue to occur for many years. (How long have you been working on your quads?)

2. Push Big Gears

It is easier to get your endurance up by riding at low cadence than at high cadence. While it goes against the current common wisdom, you will find your speed improving much faster if you concentrate on pushing bigger gears (to keep the cadence down to between 70 to 90, see above) while you develop the power and endurance to maintain increased cadences. As your lifting ability improves you will find both speed and cadence improving and your ability to accelerate will remain constant even though you are pushing bigger gears

3. Worry about cadence last

Once you have developed the ability to ride long distances easily in big gears, then you can start working on increasing efficiency at higher cadences for the periods of time when acceleration becomes an important part of the race. Soon you will be back riding with your friends, using less energy than before, being ready to use increased power reserves to match any break away efforts by others or for bridging efforts, when necessary.

4. Don't forget to work on pedaling out of the saddle

Learning how to pedal out of the saddle will be important to help you to learn how to accelerate quickly and easily in a wide variety of situations and will help you to feel comfortable with the cranks faster. Pedaling out of the saddle takes a huge amount of energy since you should be applying your full weight to the pedals while pulling up, at least some, on the "recovery" pedal. On regular cranks you can control your power out of the saddle by subtly adjusting the back pressure on the upward portion of the stroke but you cannot do that on PowerCranks™. The only way to control your power out of the saddle on PowerCranks™ is by how much weight you put on the handle bars. Every pound you put on the handlebars takes a pound off the downward pedal and will allow you to learn how to control your power to sustainable levels. When learning how to pedal out of the saddle it is easiest to do one legged drills out of the saddle (something that can actually be done on your PowerCranks™) to learn the different motion and coordination. It also helps to keep the cadence down, which is easier to do by riding uphill or in a big gear.

5. See "Preparing to race on regular cranks." below.

Specific Suggestions for Track Cyclists.

1. Work on endurance first

Depending on the event track cycling involves much more tactical acceleration than sustained endurance, which requires riding at higher cadences. However, we recommend that track cyclists must first work on their base endurance before worrying about acceleration. Therefore, the more time you spend riding with your PowerCranks™ the faster you will develop your endurance and the faster you will be able to work on high cadence work and acceleration improvements. This means, to see maximum benefits, one should do all bicycle riding on PowerCranks™ until one has enough endurance to ride reasonable distances, pedaling constantly and not having to think about the pedaling motion.

2. Work on being able to pedal out of the saddle early.

Make sure you learn how to pedal out of the saddle. Since maximum sustained acceleration is a most important part of your sport one should learn this skill as soon as possible. This is usually the last skill most new users learn but the track cyclist should try to learn it as soon as possible. Also, work on the ability to continue to apply power on the up stroke as you transition back to the saddle after the first sprint. Pedaling out of the saddle takes a huge amount of energy on PowerCranks™ since you should be applying your full weight to the pedals while pulling up at least some on the backward pedal. On regular cranks you can control your power out of the saddle by subtly adjusting the back pressure on the upward portion of the stroke but you cannot do that on PowerCranks™. The only way to control your power out of the saddle on PowerCranks™ is by how much weight you put on the handle bars. Every pound you put on the handlebars takes a pound off the downward pedal and will allow you to learn how to control your power to sustainable levels. When learning how to pedal out of the saddle it is easiest to do one legged drills out of the saddle (something that can actually be done on your PowerCranks™) to learn the different motion and coordination. It also helps to keep the cadence down, which is easier to do by riding uphill or in a big gear.

3. Work on Cadence next

Once you have developed good endurance and good unconscious pedaling coordination, it is now time to work on increasing cadence and developing high cadence endurance. With time you will develop the ability to choose larger gears for races than you do now, without affecting your ability to accelerate or ride at high cadences but improving top end speed.

4. See "Preparing to race on regular cranks" below.

Specific Suggestions for Mountain Bikers.

1. Work on endurance first, stay on the road

It would be very difficult to take your PowerCranks™ into extreme off-road conditions safely. In general, I recommend that mountain bikers do most of their PowerCranks™ training on a road bike (or their mountain bike on the road) while using regular cranks off-road. Don't really worry about going off road until PowerCranks™ riding is very comfortable on the road and some reasonable endurance has developed. It would be best if one could start PowerCranks™ training in the off season, so substantial PowerCranks™ endurance can be developed before one needs to start working of off-road technical skills training. During the season, one should try to ride on the PowerCranks™ immediately before off-road training rides and one should spend well over 50% of your riding time using PowerCranks™. Some professional mountain bikers have developed sufficient skill to do almost all of their training, including most off road training, on PowerCranks™.

2. Learn to pedal out of the saddle early on.

Mountain bikers tend to spend much more time out of the saddle than roadies, due to the mountainous terrain and the need to avoid obstructions. Therefore, one should develop this PowerCranks™ skill as soon as possible such that endurance training better simulates races. See the suggestions above under road and track cycling for specific recommendations as to how to learn and control this skill.

3. See "Preparing to race on regular cranks." below.

Specific Suggestions for Triathletes.

1. Work on endurance first and cut back on your running some

PowerCranks™ are the ideal training tool for the triathlete since one activity will improve both running and cycling. Therefore, I recommend, especially in the beginning, devoting much more time than usually allot-

ted for cycling training (once you have worked through the very early adaption - you don't want an overuse injury). As with cyclists, the more time you spend riding with your PowerCranks™ the faster you will improve both your running and cycling. Read the specific recommendations for cyclists. To see maximum benefits, one should do essentially all bicycle riding on your PowerCranks™ except as recommended under "Preparing to race on regular cranks," below.

2. Spend more time on the bike and watch your running improve

Even with almost no running activity, you will probably start to notice a sense of running smoother and easier after only a few weeks. Many have reported that they feel running improvement is the first noticeable improvement. Part of each ride, after the basic adaption, should contain some low gear, high cadence work to help develop your running leg speed.

3. Evaluate your weaknesses and divide your time appropriately

After you have developed endurance whereby you can ride all of your regular training rides "easily" with PowerCranks™ you will have to decide how to best divide your training time between the three sports as it will probably be different depending upon your specific strengths and weaknesses. I will only state with great confidence that your training mix will be different than what you are doing now, and cycling will be a larger component than it is now.

4. If you See "Preparing to race on regular cranks." below.

Specific Suggestions for Sprinters and Mid-Distance Runners.

1. Ride in a very open position

Since you don't run crouched over, it is not necessary to emulate your cycling friends in proper aerodynamic pedaling technique. Ride upright to more closely simulate your running motion. **A highly aerodynamic position to increase your speed on the bicycle will probably do nothing to improve your running speed.** To better reproduce the running motion one should move the saddle as far forward as possible and ride upright (See picture in general hints for cyclists) or ride on a training stand completely upright (hands off the handlebars).

2. Work on endurance first

As with sprinter and mid-distance runners, long distance runners are primarily interested in developing hip flexor strength and endurance and have no need to change pedaling habits. However, as race distances increase aerobic capacity becomes a more important element to success. Substantial aerobic capacity starts to develop with only 30 minutes continuous exercise 3 days a week. But, if your typical race lasts 2 hours you will need increased time on the cranks. While not confirmed, I anticipate long distance runners need to ride on PowerCranks™ for about 45 - 60 minutes 3 or 4 days a week with one session per week as long (time wise) as the long run of the week. If you are injured then you should increase your time on the PowerCranks™ because of the reduced pounding your body takes compared to running on the road.

3. Work on leg turnover rate.

Work on riding at the highest cadence possible for slightly longer than your average race.

Specific Suggestions for Long-Distance Runners.

1. Ride in a more open position

Since you don't run crouched over, it is not necessary to emulate your cycling friends in proper aerodynamic pedaling technique. Ride upright to more closely simulate your running motion. **A highly aerodynamic position to increase your speed on the bicycle will probably do nothing to improve your running speed.** To better reproduce the running motion one should move the saddle as far forward as possible and ride upright (See picture general hints for cyclists) or ride on a training stand completely upright (hands off the handlebars).

2. Work on endurance first

As with sprinter and mid-distance runners, long distance runners are primarily interested in developing hip flexor strength and endurance and have no need to change pedaling habits. However, as race distances increase aerobic capacity becomes a more important element to success. Substantial aerobic capacity starts to develop with only 30 minutes continuous exercise 3 days a week. But, if ones typical race lasts 2

hours one will need increased time on the cranks. While not confirmed, we anticipate long distance runners need to ride on PowerCranks™ for about 45 - 60 minutes 3 or 4 days a week with one session per week as long (time wise) as the long run of the week.

3. Learn your leg turnover rate.

Try to get to the point that you can ride the PowerCranks™ at a slightly higher cadence than your leg turnover rate when you are running at race speed.

Specific Suggestions for Other Athletes.

PowerCranks™ are an excellent cross training tool for other athletes who depend on their legs for speed, agility and coordination. Further,

1. Ride in a more open position

At first, most users will find it very difficult to consistently raise the legs over top dead center of the pedaling arc, especially while in the fully crouched position. Most of you don't perform crouched over, so don't emulate your cycling colleagues in proper pedaling technique. Ride upright to more closely simulate your running motion. **A highly aerodynamic position to increase your speed on the bicycle will do nothing to improve your running speed although if you are a speed skater who competes in such a position, you should probably try to reproduce that position when using PowerCranks™.** To better reproduce the running motion one should move the saddle as far forward as possible and ride upright (See picture general hints for cyclists) or ride on a training stand completely upright (hands off the handlebars).

2. Work on endurance first

Even if your sport is a burst activity sport and you don't see a need for much aerobic capacity, if you can develop improved blood flow to your leg speed muscles to improve your ability to recover between bursts. This training will improve your abilities at the end of the event, preventing fading in the second half, fourth quarter, or at the end of your performance.

3. Work on leg turnover rate.

If your sport involves burst activity, i.e., short periods of maximum effort with periods of recovery, such as football, rugby, tennis, etc. you should work on riding at the highest cadence possible for short periods then recovering at low cadence and repeat. If your sport involves sustained activity such as cross country skiing, train like the long distance runners.

Preparing to race on regular cranks

PowerCranks™ are meant to be used in training and you should race on regular cranks. But many find they are faster on their PowerCranks™ in training than they are on regular cranks. Why? Well, if the highest cadence you can maintain on your PowerCranks™ is 75 and during a race you ride your regular cranks at a cadence of 90 or 100 it won't take long before you are forced to return to the old inefficient way of pedaling just to survive. In addition, it should be clear to you that all of this high cadence time on regular cranks is also "undoing" all the brain training you have been trying to achieve which will slow your overall progress.

Is there any solution other than racing on your PowerCranks**?**™ There is, but you will have to work at it. The most important thing to racing on regular cranks with PowerCranks™ efficiency for an entire race is to have the basic endurance down for the type of racing you are doing then race like you train. If your typical race is a track race that lasts 2 minutes this is a very different story than an Ironman race where the bike may last 5 hours. Once the basic endurance is down one should then practice riding regular cranks in the PowerCranks™ fashion. The only way to be pretty sure that you are riding in the PowerCranks™ fashion is to keep the cadence down to at or below what you can do for these distances on your PowerCranks™. If you ride at higher cadences on regular cranks than you can do on the PowerCranks™ you know you have to revert, which will only slow you down. Therefore, as an important race approaches I recommend that once a week or so you do a long training ride on regular cranks concentrating on keeping the cadence at or below your PowerCranks™ cadence and concentrating on pedaling in the PowerCranks™ manner. This will take some mental discipline to ride regular cranks as your PowerCranks™ but if you don't practice it you will not ride your true potential come race day. Someday your PowerCranks™ cadence will come up to a point where one will not have to work on this skill, but this may take a couple of years.

DRILLS

Since triathlons generally do not allow drafting, this type of cycling involves more of an individual ef-

fort time trial so sustained top speed and endurance is the most important skill to learn over cycling tactics. Whereas, the running part of the sport again involves aerobic endurance running where the goal is the ability to maximize aerobic leg turnover and good stride length.

Bicycle road racing and stage racing involve much more in the way of tactics where conservation of energy and acceleration is equally, if not more, important than sustained top speed. Learning how to conserve energy in the peleton while learning how to also ride in aerobic high power time trial mode and for short periods at very high sprinting cadence all seem to be important skills to learn. Efficiency at higher cadence may be the most important skill to learn once basic endurance and increased power is achieved.

Criterium and track racing involve much more in the way of tactics where acceleration is much more important than sustained top speed. Efficiency at higher cadence and the ability to pedal circles at the highest cadences may be the most important skills to learn.

Mountain biking involves much out of the saddle pedaling and the need to have smooth, controlled power to avoid losing traction in poor conditions. The need for a smooth, powerful stroke at a wide variety of cadences (both in and out of the saddle) should be emphasized.

Runners could care less about cycling efficiency but they do care about aerobic leg speed. Runners should try to develop the ability to sustain high cadences for at least as long as they tend to race.

Burst activity athletes do a lot of anaerobic running for very short periods. These athletes are mostly looking to develop blood flow to the hip flexors (the limiting muscles) to shorten the recovery period after an anaerobic burst to quicken the time required to be fully ready for the next play. In addition, they are looking to improve leg lift to improve running economy, speed and coordination.

These drills are directed at helping you evaluate your progress and develop and learn the optimum cadence and gearing for various aspects of bicycle racing and triathlons. However, the most important PowerCranks™ "drill" is simply spending as much time as possible using the cranks in training. The drills and testing you will choose will probably depend upon the type of racing you do.

If you can manage, these drills are best done with the intent of increasing and evaluating power output. Actually measuring power during these drills, such as on a CompuTrainer™ or with one of the new bicycle power output devices, is ideal in evaluating progress.

Measuring *PowerCranks*™ adaptation tests.

Any of these tests can be done on the road or on a trainer. If done on the road you need to keep in mind varying climatic (esp. wind) or road (esp. hills) conditions can affect results which could interfere with an accurate evaluation of your progress.

Maximum cadence test - Put your bike in the lowest gear and see how high you can get your cadence before falling out of synch. This test should probably not last more than 15 seconds. If you do not have the ability to monitor cadence directly, monitor your top speed in your smallest gear. Increasing top speed (cadence) is the indicator of improvement.

Sustained maximum cadence - Put your bike in the lowest gear and see what is the highest cadence you can maintain for one minute before falling out of synch. If you fall out of synch before one minute is up, repeat at a lower cadence until you can do this. If do not have the ability to monitor cadence directly, monitor your lowest speed in your smallest gear during this minute (highest sustained speed). Increasing lowest speed is the indicator of improvement.

Sustained high cadence - Put your bike in the lowest gear and see what the highest cadence you can maintain for ten minutes is before falling out of synch. If you do not have the ability to monitor cadence directly, monitor your lowest speed in your smallest gear during this period. Increasing lowest speed is the indicator of improvement.

Sustained cadence test - Put your bike in the lowest gear and see what the highest cadence you can maintain for one hour is before falling out of synch. If you fall out of synch before one hour is up you will need to repeat the test on another day at a lower cadence. Brief, deliberate stops at stop signs will not invalidate the test but inadvertently falling out of synch does. If you do not have the ability to monitor cadence directly, monitor your lowest speed in your smallest gear during this hour. Increasing lowest speed is the indicator of improvement.

Power lifting - Put your bike in the highest gear. Find a course about 1 mile long, unencumbered by cross streets, stop signs or stoplights. Time yourself for the course paying attention to pulling up on the back

stroke and try to accelerate for the entire distance. Think about lifting during this test. Note your time and speed at the end of the course. Lowered times and/or increased top speed is the indicator of improvement.

Power equality - Put your bike in the highest gear and see what the highest speed you can maintain on a predetermined course is using only one leg. Repeat using the other leg. Your speed should be similar with each leg if your legs are equally strong.

Crank length evaluation For those with adjustable cranks repeat any of the above tests using different crank arm lengths. You should be able to determine the best crank length for you for your current fitness level and for the kind of riding you do.

Sustained maximum power test - See how long you can pedal continuously while out of the saddle.

Improving pedaling smoothness drills.

Isolated leg drill #1 - put it in an easy gear and while riding at a moderate speed start pedaling with one foot for 30 seconds. Try to maintain speed and concentrate on a smooth even pedaling stroke. After thirty seconds start pedaling with both feet, concentrating on smoothness. Then do this same drill with the opposite leg. Keep repeating for 10 repetitions on each leg.

Isolated leg drill #2 - The same as above but modify the times. 45/15 secs, 60/60 secs, etc.

Isolated leg drill #3 - The same as above but modify the drills by doing the isolated leg pedaling out of the saddle.

CompuTrainer Isolated leg drill. Put the CompuTrainer on SpinScan. Pedal with the left leg only (the side with the crank arm magnet) and try to maintain a left right power ratio of 50-50. This means you are pulling as much as you are pushing. See what the maximum power you can sustain while maintaining this split is. You may repeat this for the other side, trying to pedal at the same power and keeping the same feel but to get SpinScan output you will have to change the crank arm pickup to the other side or use regular cranks.

Modified CompuTrainer isolated leg drill #1 - The same as above but modified to try to maintain the highest spin scan number possible.

Modified CompuTrainer isolated leg drill #2 - The same as above but modified to try to maximize the forces at the top and bottom of the stroke. This is different than #1 above because you will try to be at the highest power possible. Maximum spin scan numbers are generally obtained by limiting power on the up and down to what can be done across the top and bottom.

Lifting hell - For those with adjustable cranks, increase the crank length as long as possible. You won't believe how much difference even a few millimeters makes. This forces you to lift your legs higher, improving your lifting ability when you go back to your regular crank length and enhances your ability to pedal efficiently in a good aero position.

Spinning made easy - For those with adjustable cranks, decrease crank length slightly. You won't believe how much difference a few millimeters makes. You should be able to increase your cadence well above your normal top, working on fast twitch fibers and high speed coordination.

Bounce test - Put your bike in the lowest gear and see how high you can get your cadence without "bouncing" in the saddle. This really works on improving the transition between “pushing” and “pulling” at the top and bottom of the stroke which is what “spinning” is all about. Increasing top speed (cadence) without bouncing is the indicator of improved smoothness.

Optimum cadence and gearing testing

These tests are probably best performed on a calibrated ergometer, such as CompuTrainer™ or using a new power measurement device, in which conditions can be controlled (don’t forget to calibrate the CompuTrainer before each session) but can be done on the road or using uncalibrated training stands if one accounts for variations between or during sessions due to weather or possible calibration variables.

OCT #1 - Put your bike on the largest front chain ring and then vary the rear cog in a series of tests. Ride a similar course (about 1 km to 1 mile) at a constant heart rate. See which gear gives you the highest average speed. Note your cadence at this speed. This should be close to your optimum cadence for sustained speed.

OCT #2 - Put your bike on the largest front chain ring and then vary the rear cog in a series of tests. Ride a similar course (about 1 km to 1 mile) at a constant speed. See which gear gives you the lowest heart rate. Note your cadence at this speed. This should be close to your optimum cadence for sustained speed.

OGT #1 - Put your bike on the largest front chain ring and then vary the rear cog in a series of tests. Ride a similar course (about 1 km to 1 mile) at your optimum sustained racing heart rate. See which gear gives you the highest average speed. Note your gearing at this speed. This should be close to your optimum gearing for sustained speed.

OGT #2 - Put your bike on the largest front chain ring and then vary the rear cog in a series of tests. Ride a similar course (about 1 km to 1 mile) at a constant speed just under your best sustained speed. See which gear gives you the lowest heart rate. Note your gearing and cadence at this speed. This should be close to your optimum gearing for sustained speed.

Leg control and coordination drills (and how to impress your friends)

These drills are useful to help you gain improved leg muscle control and to help prevent boredom on long winter nights. Don't worry, these can and have been done (except Look ma, no brains).

Front and Back - Pedal forwards with one leg and backwards with the other. Switch.

Two for one - Pedal forwards with one leg and forward with the other leg at half the cadence. Switch.

Two forward, one back - Pedal forwards with one leg and backward with the other, at half the cadence. Switch.

Look ma, no hands - (This is a training stand only drill) Pedal out of the saddle with your hands off of the handlebars. You will be "running" on your PowerCranks™.

Look ma, no brains - Perform "Look ma, no hands" on the road. (just kidding)

Drills for runners

Runners are primarily interested in increasing the force that drives the body forward and the ability to throw the leg forward to improve stride length and leg turnover rate. This forces only occurs when the foot is touching the ground which corresponds to the bottom of the pedaling arc and when the foot is traveling forward, which corresponds to the top part of the stroke. Runners should concentrate on these portions of the stroke. A runner who owns (or who has access to) a CompuTrainer could use the SpinScan feature of this device to maximize these forces.

Another of the important aspects of running is hip rotation to increase stride length. You cannot easily rotate your hips on a bicycle seat easily but you can rotate your shoulders in relation to your hips while you ride. So, pedal sitting on the seat, hands off the handlebars, leaning back. While pedaling swing your arms and rotate your shoulders in relationship to your hips, like running. (a training stand only drill)

PowerCranks™ Science

The athletic training problem.

Athletes rely on brain, nerves, and muscles to perform specific actions for varying periods of time. Training the brain and nervous system is important because without proper timing of the muscular contractions movements will be uncoordinated and inefficient. The natural and unconscious muscle firing pattern is called coordination. But perfect coordination is not enough for most sports because without sufficient training the muscles will not have sufficient blood flow to sustain repeated contractions for any period of time, such ability is called endurance. Athletic performance is improved with improved coordination and endurance.

Generally, when our bodies are subject to a stress it will respond to that stress by setting into motion mechanisms that improve the body's ability to meet that stress should it be seen again. If the stress is not repeated then these mechanisms will slowly fade away and no improvement will be seen in abilities if the stress should recur. With repeated similar challenges the brain learns muscle firing patterns so responses become natural and unconscious and the muscles also change to become more adept to responding to the challenge. If the stress is not seen regularly then these mechanisms are not reinforced and the ability of the body does not improve. However, if the stresses come regularly then these mechanisms are reinforced and soon the muscles involved (including the heart) have improved capillaries, more enzymes to convert sugar into useful energy molecules, more contractile elements, etc and the ability of the body to sustain work is improved and the nervous system more easily fires the necessary muscles without thinking about it. If the stress is again regularly increased then the body will try to continue to adapt. Our ability to improve is primarily limited by the need for rest time as these changes only occur when the body is resting (which is the main reason for a "taper" before a big race). Voluntary and regularly applied stresses are generally called practice or training, whether a pianist learning the coordination and control to play beautifully or an athlete developing the power and coordination necessary to optimize performance. The improved ability of the body, in response to these stresses, over time is called training effect.

Muscles require available high-energy molecules in the cell to contract. This energy that is used must be replace after contraction if the muscle is to be ready for the next request. If a muscle is only asked to perform for short periods of time then it can use stored energy to produce the contraction and then restore these energy supplies after the need is through, a process known as anaerobic contraction because it can occur without needing additional oxygen. However, if the muscle is stressed for long periods of time it must develop the ability to restore its energy stores at the rate they are being consumed while being exercised or it will soon run out of energy. This long-term sustainable exercise rate is determined primarily by the available blood supply and Improving this ability requires the development of additional blood supply and increased cell enzymes that make the high-energy molecules from sugar and oxygen. This sustained energy use is called aerobic metabolism because it uses delivered oxygen. The new blood supply will develop in muscle if the muscle sees recurent anaerobic stresses. These improvements are called training effect.. It is generally accepted that the minimum stress necessary to condition a muscle aerobically is 30 minutes 3-4 times per week.

Every joint in the body has at least two muscles that go across the joint doing the opposite thing, flexing or extending the joint. In humans the muscles in the leg used to cause standing are called the antigravity muscles. The antigravity muscles (the gluts, quadriceps, and calf muscles) get a reasonable amount of exercise in just performing everyday activities (walking, sitting and standing, and picking things up from the floor). The opposing muscles of the legs are very strong (the iliopsoas, the major hip flexor, is the major muscle used when doing sit ups, and is kept strong in even the most sedentary people because most of us get out of bed at least once a day and we sit up to do so) but they have almost no aerobic capacity because they are only rarely called upon to perform any sustained hard work since they do not have to regularly perform against gravity. Because of this difficulty, incorporating them into activity have, until now, made them almost impossible to train as aerobic muscles. Almost all normal activity can be performed without severely stressing these muscles. Even running stadium steps, one hardly ever lifts the foot more than 6 inches off the ground and one never does it for more than a few minutes at a time. Using stepping machines for prolonged periods does not stress this muscle because the springs in the stepping machine helps lift the foot up and most users do not take large steps.

One of the major benefits for PowerCranks is turning these underutilized muscles into aerobic muscles, then they can be used more effectively in all sports that rely on leg speed, endurance, and coordination. This is what PowerCranks™ are designed to do because they actually force the athlete to train these muscles so they can be incorporated into their athletic activities.

The pedaling efficiency problem.

Unless you are riding a bicycle simply for the fresh air, mental relaxation, and physical exercise you probably care some about how fast you are going. The speed you ride depends mostly upon the sustained power your muscles can generate and then how much of that power you can transmit to the road. Your speed is then determined by the balance between the power to the wheel and the retarding forces generated by rolling and air resistance. Unless you are now actually generating enough power to be going pretty fast, aerodynamics has little effect on your speed. If you are trying to learn how to go fast on a bicycle it is much better to put your efforts into increasing your power than improving your aerodynamics until you are substantially over 20 mph. There is little benefit to having a perfect aerodynamic shape if you cannot transmit much power to the road to go fast. How much peak power your muscles can generate is primarily determined by muscle size. How long you can generate any given power is primarily determined by blood flow to the muscles. The difference between the power the cyclist's muscles actually generate and the power actually delivered to the road is called pedaling efficiency and is mostly determined by the direction the forces are applied to the pedals. A weaker cyclist with better pedaling efficiency can actually get more power to the road, where it counts and ride faster than bigger "more powerful" riders!

Figure 1

Figure 2

Regarding how much of your power you can get to the road, or pedaling efficiency, everyone knows it is more efficient to pedal as shown in Figure 2 than Figure 1. Isn't one of the reasons you bought clipless pedals was so you could pedal like Figure 2? But, before PowerCranks™, studies have shown **even professional cyclists, most of the time, pedal as shown in Figure 1, contributing negative torque during the recovery portion of the pedaling movement.** (See: Whitt and Wilson, Bicycling Science, The MIT Press 995, p. 63) So you might ask, "Why do I (and everyone else) continue to pedal in this inefficient manner, even though I have clipless pedals and know better?" The answer derives from how all of us learned to pedal as children.

Since our first tricycle, we have **always** pedaled using conventional cranks with crank arms fixed 180˚ apart — and, until we became serious about cycling as a sport, we were **never** attached to the pedals. Therefore, our nervous system learned that "best" pedaling technique involves keeping contact with the pedal on the upstroke which requires a small amount of back pressure on the pedal during the recovery. Keeping contact with the pedal facilitates rapid application of power on the down stroke. **This is the most efficient pedaling dynamic if one is not attached to the pedals but it is not if you are attached!** By age 7 or 8 your nervous system could pedal in this "most efficient" manner without thinking and you continued to reinforce this motion for many years. In order to actually lift completely over the top for an hour at a cadence of 90 one must lift each foot about 14 inches 5,400 times an hour. So, even though you now have and "use" clipless pedals your pedaling dynamic has never changed. By now you have probably several millions of repetitions using this less than optimum technique. The more "experienced" and better you are now, the more difficult this ingrained pattern is to change. **If it were possible to correct this poor pedaling dynamic by previously available techniques the pros would have figured out how a long time ago, but they have not!** Even the best pro cyclists can improve pedaling efficiency training with PowerCranks

The Solution

PowerCranks™ have solved this training problem by combining two fixes into one product;

1) a patented technological innovation forces the user to use these new muscles in the proper coordination pattern and,

2) the ability to mount them on your everyday bicycle so enough repititions can be performed to turn the muscles into effective aerobic muscles and retrain the unconscious coordination.

The technological innovation places a very strong one-way clutch between each crank arm and the crankshaft. Because of this, PowerCranks™ work like regular cranks when pedaled as in Figure 2 but they don't work at all if you try to pedal as in Figure 1. If either leg ever stops pedaling in the more efficient fashion of Figure 2, even briefly, **you get immediate feedback as your pedals fall out of synch**. In medical terms, this type of feedback is a simple operant conditioning system (a negative feedback system) used to effectively change unconscious behavior.

PowerCranks™ forces one to exercise the hip flexor muscles because they only work if one lift's each

foot about 14 inches each revolution of the cranks. They give immediate feedback the moment one begins to get lazy which retrains the brain. The user will quickly realize how poorly these muscles are trained by how hard this activity is in the beginning.

The second key to PowerCranks™ success is the fact they can be mounted on your primary training bicycle and used every day. Regular exercise for prolonged periods is the key to aerobic muscle conditioning. By being mounted on a bicycle that is used everyday the aerobic conditioning of these hard to train muscles occurs easily. In addition, whenever you are riding with PowerCranks™ you give your brain negative feedback whenever muscles are fired inadequately for efficient pedaling. Retraining the "natural" unconscious coordination also occurs "easily" although it is becoming evident that it may take many years to completely erase the old habits. So, with PowerCranks™, while you are improving your unconscious nervous system coordination you are also improving your hip flexor muscular strength and aerobic capacity. The length of time you will be able to maintain these changes during a race will depend mostly upon how well you are conditioned to this new manner of pedaling. (How long did it take you to get your quads up to their current conditioning?) Eventually you will be able to pedal as shown in Figure 2 for very long periods, without thinking about it, sustaining the huge speed increases that come naturally from more efficient pedaling while using greater muscle mass. **It is the failure to have regular and frequent long-term repetition of the proper pedaling motion that results in the failure of other training methods to effect this change**. **Therefore:** PowerCranks™ **has solved this pedaling efficiency training problem!**

So the way to the winners podium for the athlete is the same as the way to Carnegie Hall for the pianist - practice, practice, practice using proper technique.

Installation and Removal of your *PowerCranks*™

Installation

1. If you are a man (women rarely need this advice) change into old clothes and clean your chain and

chain rings! If you do not you may find yourself in trouble with your, wife, girlfriend, or mother. If you ladies forget this step, I expect, it is unlikely that your husband, boyfriend, or father will notice. You may also want to wear something like latex, gloves while doing this work. An alternative clean approach is to let your local bike shop (where they are paid to get dirty) do this.

2. Remove your present cranks from your bicycle. Save your crankshaft attachment bolt (and washer). Some types of crank axles (spindles) are incompatible with PowerCranks™ (see example). If you have one of these you will need to replace your bottom bracket. If you have Shimano splined cranks you will need to remove the "dust cover" to be able to use your attachment bolt and washer (see Figures 1) or, as an alternative you can go to your bike store and get two replacement bolts. If you ordered the wrong adapter type for your spindle you can return the cranks for a replacement or you will need to replace the bottom bracket assembly. If you replace your bottom bracket assembly, a cheap one will do and the size will need to be determined by your bicycles physical dimensions but a good starting size is 110-112 mm, unless you have a triple chain ring option where you may need an even longer spindle. Too wide and the pedals will be wider apart than many like, too narrow and the cranks will rub against the frame and not work properly.

3. Reattach your chain rings to the PowerCranks™ spider. The PowerCranks™ spider will fit chain rings with standard 130 mm BCD. If you need to purchase 130 mm BCD chain rings, we recommend that you increase the size of your large chain ring at least 4 or 5 more teeth than your present chain ring, as you will soon want and need it. If you have the triple chain ring option you will need properly sized spacers (about 3/16 inch thick) that properly positions your 74 mm BCD inner ring in relation to the others. Your old cranks may or may not have these spacers, depending on its design. Check with your bike shop if you have difficulty.

4. You must remove the retaining dust caps from your PowerCranks™ to install them. Newer model retaining dust caps are not interchangeable as the spider side are left threaded and the non-drive side are right threaded. **Caution:** If you take the crank arms apart to see how they work (another common symptom of chronic testosterone poisoning, see your doctor), replace them very carefully so as to not damage the clutch. If they do not go back together completely or easily see trouble shooting below.

5. **CAUTION. If you have a splined variety spindle it is very important that the splines line up with the keyways because, if they are not lined up properly, when you tighten down the spindle bolt you can damage the keyways such that you will not be able to later engage the splines when they are properly lined up.** Place the crank assembly over the squared or splined end of the crankshaft, align carefully and push snugly. If the assembly rubs up against the bottom bracket housing you should replace your bottom bracket assembly with a longer spindle size. As an alternative, in tapered square spindles, shims can be used to move the PowerCranks™ away from the bottom bracket.

6. Replace your chain on the chain ring then readjust your front derailleur, if necessary. This step is necessary now to help you support the spindle in order to properly tighten the spindle bolt in the next step.

7. Secure the crank to the crankshaft using the bolt (and washer, if applicable) that you had previously removed. Ensure the bolt and washer fit properly in the hole and does not damage the threads needed to remove your PowerCranks™. On newer models the spindle bolt must be one that uses an 8 mm allen wrench for tightening. **Tighten very tightly.** Some customers have had problems with the bolt continuing to loosen with use. This can occur with both types of adapter types (tapered square and splined) but this seems to occur more often with the Shimano splined type. Why some have this problem and others don't is not entirely clear but is probably related to failure to adequately seat the spindle adapter on the spindle and to tighten enough. **Therefore, check the tightness of this bolt after each ride in the beginning until you are certain no loosening is occurring with use. If loosening continues make sure your**

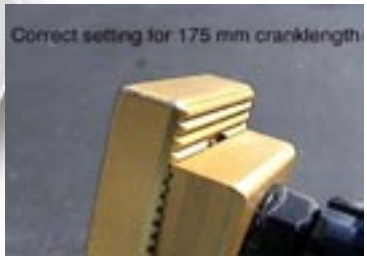
spindle adapter is mating properly with your spindle and you are tightening adequately or try using a moderate thread adhesive (like blue LocTite™) to keep in place.

7. Screw on each retaining dust cap (a coin works well). Remember, on the new models the spider side retaining end cap is left threaded. Be careful to ensure the caps screw on cleanly as the steel threads of the retaining end cap can gaul the aluminum threads of the spindle adapter. The retaining dust cap keeps the clutch assembly aligned correctly on the bearing surface. The retaining end caps should be screwed down completely and when in place should allow the crank arms to still spin around easily in the backwards direction. **Tighten the set screw. while the new design should prevent the retaining dust caps from working off during use, they have been known to come off, probably due to vibration. The set screw adds another degree of security against this happening.**

8. Reattach your pedals. Caution, if you are not careful about how you screw in your pedals the steel threads of the pedal can gaul the threads of the aluminum crank arm, eventually making your cranks unusable.

9. Before riding the first time, go to instruction booklet for hints and cautions.

Adjustable Crank Instructions



The adjustable cranks can be adjusted in 2.5 mm increments. The method of adjustment is self explanatory. When the moveable part is flush with the crank arm end it will be 185 mm. Move 4 increments for 175 mm or 6 increments for 170 mm, etc. The figure shows correct adjustment for 175 mm crank length.

Removal

You will sometime in the future want to remove your PowerCranks™ to put them on another bicycle or to reinstall your regular cranks for a race. **You should do this a couple of days before the race because, when you go back to your regular cranks, they will feel very strange and you will want a short period to readapt.** Removal is very simple.

Newer Models (Model2, Cranks with retention dust caps with a hollow center)

1. Insert your 8 mm allen wrench through the retaining end cap access hole and unscrew the bolt. As it comes loose it will push the adapter off the spindle.

2. If necessary, remove the retaining end cap to remove the spindle bolt to use in the reapplication of your regular cranks back on your bicycle.

3. See Storage below.

Older models (Cranks with solid retention dust caps)

1. Loosen the set screws and remove the retention dust caps.

2. a. Shimano splined bottom bracket instructions. A normal crank removal tool will not push off your crank because this tool works by pushing against the end of the spindle and the splined spindle is hollow, so there is nothing to push against. Here is the solution. Simply loosen the bolt a few turns but don't remove it. The bolt then acts as the end of the spindle for the crank removal tool. Then use a normal crank removal tool to pull out some on the crank. If, when doing this, it gets hard but is not loose enough to remove by hand, you may have to loosen the bolt some more turns and try again until the cranks are loose enough to remove by hand.

2. b. Tapered square bottom bracket instructions. Remove the crankshaft attachment bolt and washer. Because of the deepness of the hole it is easy to forget this bolt is there, since it is not readily visible. **If you forget this step, step 3 will be very difficult!** Using an appropriate sized crank puller, screw it into the provided 22 mm threads **all the way**. Because of the deepness of your PowerCranks™ spindle adapter your crank puller will probably have to be threaded as deep as it will go in order to allow it to push against the crankshaft to remove the cranks. If you cannot reach the axle with your crank puller reinsert the bolt and use it to make the whole less deep as Noted above in 2. a.

3. Use the crank puller to remove the spindle adapter.

4. See Storage below.

Maintenance

Your PowerCranks™ are almost maintenance free. They do have two enemies however, water and dirt. While designed to minimize the ability of both water and grit to enter into the clutch mechanism, if these do the clutch could eventually be damaged. Water will rust these parts and to minimize this possibility, the clutches should be kept well oiled or greased. Dirt or grit can damage the clutch directly. While PowerCranks™ can be ridden in the rain without damage they should not be left outside at night or out in the rain. If ridden in very severe rainy weather or dust storms or through lakes or steams or left in the rain, disassemble the crank arm from the spindle adapter, clean and dry the clutch and bearing surface then re-oil or grease. (This drying can be easily done by placing the crank arm into a warm oven and drying the other parts with a dry cloth) If you suspect dirt contamination, one should disassemble the crank arm from the spindle adapter and clean the clutch and bearing surface, then re-oil or grease. Only in the instance of known contamination should it be necessary to remove the clutch from the bearing race for cleaning. Otherwise, you should keep the clutches lightly oiled, the main purpose being to prevent oxidation (rusting) of the clutches which will be worse than any dust. If you have to remove the clutch from the bearing race be extremely careful about replacing it as the small outer bearings can become dislodged (see troubleshooting) which can prevent your being able to replace the crank arm on the shaft, or, if it falls out, causing decreased performance or clutch failure. Should your clutch fail after the warrantee period you may return it to PowerCranks, LLC for replacement for a reasonable charge.

Annually.

Simply remove the crank arm from the spindle adapter. While oil or grease is not really necessary for proper clutch function (after all, when pedaling correctly there is no motion between the parts) it is necessary to repel water and prevent rust. Therefore, ensure there is an adequate amount of bicycle grease or oil in the clutch. Do not pack the clutch with grease as this can prevent proper functioning. DO NOT USE WATER BASED OR PARAFFIN CONTAINING CHAIN LUBRICANTS, SUCH AS WHITE LIGHTING, AS THESE WILL DAMAGE THE CLUTCH.

Storage

PowerCranks™ need to be stored in a manner that will prevent rust from forming in the clutch. Do not store outside on a bicycle, exposed to the elements or in other damp or moist environments.

Questions and Answers

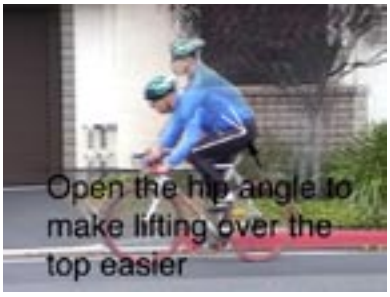
Why must I do all of my training on the *PowerCranks™?*

You might wonder why you, a cyclist, won't benefit substantially by riding on PowerCranks™ a few times a week or, 50% or, even, 75% of the time. While it is possible to develop some aerobic capacity in the hip flexors riding intermittently (something runners and other athletes can do) it is not really possible to retrain the unconscious pedaling coordination if you keep going back to regular cranks. This is because regular cranks give you (and your brain) absolutely no feedback when you start pedaling in the old fashion, confusing the brain as to what is acceptable technique. So, even though you may develop some aerobic capacity that would allow you to pedal properly for longer periods of time, you won't be able to do so because you won't pedal in that fashion unless you are thinking about it, and no one really thinks about pedaling while riding. It does no good to have a capability you do not use. If you were to ever stop training on PowerCranks™ I would expect the gains you have made to slowly deteriorate back to your previous pedaling style.

How long does it take to really see improvement?

Even though you may train properly, using only your PowerCranks™, do not expect any substantial overall power improvement for about 6 weeks, and then only for shorter distances. This has to do with the time it takes to develop some aerobic capacity (training effect) in the new muscles you will be using. While some efficiency improvements will be seen at lower power outputs on short rides very early, the user must expect this process to take some time. "Improvement" may come slower to those who continue to race on regular cranks, because of the difficulty in changing the way the brain unconsciously thinks about pedaling. Therefore, if your endurance and skill will allow you, I recommend doing all of your riding, including races in the beginning, on your PowerCranks™. Of course, improvement will continue to occur for many years. After all, how long have you been training your quads?

I find it almost impossible to get my feet consistently over the top. HELP!



At first, most users will find it very difficult to consistently raise the legs over top dead center of the pedaling arc. But, within a couple of weeks almost everyone should be able to pedal properly without too much problem for reasonable periods of time. If you are still struggling I suspect one of four main culprits contribute to this. 1. Your handlebars may be too low. 2. Your seat may be too low. 3. You may be trying to ride in the drops or using aero bars, trying to assume to much an aero position. 4. Your crank length is way too long for your leg length.

The common element in all of these problems is the need to bring the knee too close to the chest, a very difficult thing to do 80 - 90 times a minute without any help from the other leg. Almost everyone has to start riding in an upright “touring” position, which opens the hip angle, making it easier to lift the leg the 13 - 14 inches necessary to get the leg over the top. After several months you should be able to return close to your present position, if you so choose. Trying to improve body position aerodynamics too much can actually slow you down if it causes a bigger drop in power than you gain in reduced drag.

I can’t learn to pedal out of the saddle

As stated earlier, pedaling out of the saddle seems to be the most difficult skill to learn for most users. This probably has to do with the fact that we don’t spend as much time out of the saddle and the pedaling motion is much different. To understand this different motion I suggest you come out of the saddle and then pedal one leg at a time. You can then work on two legged pedaling on slight hills in higher gears (to keep the cadence low). Soon, you will be able to come out of the saddle at will. A Quicktime video demonstrating how to learn this skill is available at the web page, www.powercranks.com.

Troubleshooting

Problem. I took my cranks apart and cannot get them back together.

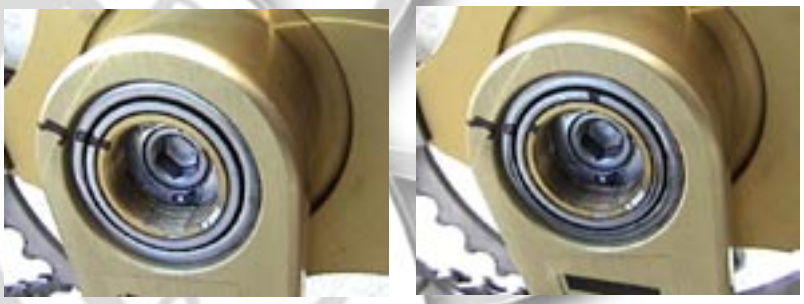
Answer: One or more of the very small outer bearings have probably become cocked. Inspect carefully (as this is difficult to see, Figure 4 shows an example) and push back in place any offending bearings. The parts should go together easily. If they don't there probably is a problem with these bearings.

Problem. One or both cranks do not free wheel backwards.

Answer: If the cranks are new, one or both retaining dust caps are probably binding the parts together. Back off a small amount on the retaining dust cap. Don't forget to retighten the set screw. If the cranks have worked properly and you are now having problems you may have a foreign substance binding the cranks. Remove and clean to see if this fixes the problem.

Problem. My cranks seem to slip when I apply hard pressure on the pedals.

Answer: There are three possible explanations. 1. The hardened steel race may be slipping on the aluminum spindle adapter. 2. The clutch may be broken or misaligned. 3. The Clutch may be slipping in the aluminum crank housing. The diagnosis of what is going on is quite easy. Use a magic marker to draw a line across all of these elements - see illustration - then go-- out, ride the bike and make the slipping occur and reexamine. The most common reason for this occurring is the steel race on slipping on the aluminum spindle adapter. If this is occurring the lines at this junction will no longer line up - see illustration. The second most common reason is the clutch is broken. This is usually due to a small spring breaking in the clutch and is very difficult to see, so it will still look normal. However, in this instance, the lines will still line up even though slipping occurred. The third, and most rare occurrence is the clutch slipping in the clutch housing. In this instance the lines between these two elements will become misaligned. In all of these instances the offending part will need to be returned for repair. The benefit to doing this troubleshooting is you will only need to return the offending part for repair/replacement (saving postage) and it will facilitate our determination of what is wrong, hastening the fix and early return to you.



Problem. My left crank seems to slip under light pressure on the pedals.

Answer: You probably have splined cranks and did not line up the splines properly during installation or your spindle bolt has loosened and the splines are no longer engaged. The left crank will seem to slip if either the left crank or the right crank is not properly engaged with the splines. Reinstall the offending crank(s), taking care to ensure the splines engage the keyways. It is possible you have damaged the keyways of the splines from this misalignment and the part may have to be returned for repair. If the cranks are on OK then the clutch is probably broken and will need to be replace. Call PowerCranks™ for instructions.

Problem. My spindle bolts keep working loose.

Answer: Make sure you really torque this bolt down, many do not use proper torque. Still, it is not clear why some people have a lot of problems with this and most don't. This occurs most commonly with the splined crank type, again reason unknown. Several different fixes have solved this problem for users. Use a moderate strength thread adhesive or locker (don't use the industrial strength stuff, after all you will want to remove them someday, see below if you do). Others have just continued to tighten the spindle bolt, allowing the adapter to “work” itself in, until the problem goes away.

Problem. I used a thread locker (like LocTite™) on my retaining dust cap or spindle bolt and now I can’t get

my cranks off.

Answer: Even the industrial strength LocTite will weaken at about 300° Fahrenheit (135° Centigrade). Careful application of heat from a propane torch will weaken the bond, allowing loosening of the part, without damaging the clutch by melting the plastic retaining rings. This procedure has been performed many times by various people without problem so don't be overly concerned. Just don't be cavalier in your approach. Remember, after you loosen the part, everything will be hot and need time to cool before you can continue.

Past *PowerCranks*™ weaknesses

During development and early consumer use I experienced three significant problems with PowerCranks™ that have affected their reliability for some customers. I believe I have fixed each of them but the best way to find weaknesses in a product is to put them in the hands of consumers. If you experience these or any other problems please contact us so the product can continue to improve.

First, in our very early iterations, the retaining dust caps frequently would work off. These retaining dust caps just screwed on and had no way of securing them in place. If the retaining dust cap falls off while riding you won't know it until the crank works off sometime later. It will then be very hard to find the retaining dust cap and your cranks will be useless until you can get another one. My fix was to put a setscrew in the retaining dust cap but, even with this, the setscrew would still, occasionally, vibrate loose (or the user forgets to tighten it) and retaining dust caps would still, occasionally, work off. This was especially prevalent on the spider side where slipping of the crank arm would tend to unscrew the retaining end cap. Therefore, the newest model uses left handed threads on the spider side retaining end cap to stop this from occurring. If you still have this problem you may need to put something tacky (sticky, not unfashionable, white wood glue or rubber cement generally works well) on the threads of the retaining dust cap to prevent the loosening of these important parts of the cranks without preventing removal.

Second, the bond between the aluminum spindle adapter and the steel bearing surface is sometimes inadequate to hold high forces powerful riders can apply. This causes slipping which interferes with the natural feel of the cranks. This has mostly been corrected but can still, occasionally occur. This defect generally does not appear until the user has advanced to the stage of applying considerable power to the pedal (riding out of the saddle). If it occurs the offending adapter part will probably need to be replaced.

Third, water and dirt can damage the clutch. When the cranks have been exposed to extremely wet or muddy conditions they should be taken apart and cleaned, oiled and reassembled to prevent rust or remove grit, which can interfere with the clutch operation. This remains only a potential problem as very few clutches have failed and it is not clear these failures were due to this problem.

I want you to feel comfortable to ride your cranks just like you would ordinary cranks and I will continue to strive to make them as trouble free as possible, although all must realize they are a training tool and the harder they are ridden the closer they will be to failure. Please report any performance problems you encounter with your cranks so I may continually strive to improve this product for those who follow.