14) Training with Periodization by Chad Butts

Part 1: Introduction

This is the first article in a series written for www.spokepost.com on the periodization of weight training for cyclists looking to improve there strength and power during the long winter months of upstate New York.

Cyclists looking for peak performance FROM a strength-training program must realize that the days of going to the gym all winter and always lifting till you could barely walk out of the gym are gone. To get the most FROM resistance training, the program needs to be periodized, just like training on the bike. There will be easy days and hard days, easy weeks and very hard weeks. For example, take a yearly training plan for bike volume. At the start of the season your volume slowly progresses to a maximum point before decreasing to accommodate increases in training intensity. The same should be true with weight training. Periodization will allow you to monitor and change the level of intensity throughout the phases of your program to ensure the proper stimulus and provide enough recovery. Training on the bike is also devoted to more than one technique or system. There are intervals, endurance rides, threshold intervals, sprints, etc., each of these developing a different system. Likewise, a periodized strength program works different systems at different times to maximize the development of strength and power.

There are basic principles to any strength-training program as well. One of the most important is using proper form during exercises. Never increase the weight if you cannot perform the exercise properly in the same manner and range of motion. Tendons and ligaments take longer to adapt to a strength program than muscle. It is very important to give them time to adapt to the program or a whole winters worth of weight training may be ruined because your knees cannot take it when the LOAD increases. A proper warm-up is also a very good idea. The more intense the session, as later in the program during the maximum strength phase, the longer the warm-up should be. Look for doing 5-10 minutes on the bike or stepper followed by 2 sets of 15 squats with just the bar. After that some light stretching to get the muscle good and loose. Developing abdominal and back strength and endurance is very important for the weight-training cyclist. Your legs constantly push and pull on the pelvis each pedal stroke and it is the abs and back that stabilize the pelvis, which the legs work from. The less stabilization you provide, the less power you can produce.

Because cyclists are training for strength and power on the bike your exercises need to simulate, as close as possible, your position on the bike. Whenever you are performing an exercise you need to ask yourself if you are as close to your riding position as possible. Is your stance the same distance apart when clipped INTO your pedals? Are you training the same range of motion as your pedal stroke? What is your foot angle? Are you pushing with the balls of your feet and not your heels? Every nuance you can think of to make your training specific to cycling will enhance the specificity of your exercises and enhance the amount of strength/power you can transfer to the bike.

Other considerations when starting a strength program is the amount of time you have to devote to the program, how many days per week, what exercises and what ORDER to perform them, number of repetitions, training method, training load, rest interval between sets, number of sets, etc. Each one of these will vary depending on the phase you are in.

Of course there are many other components to a properly periodized resistance program and they change based on the goals of the athlete. For cyclists, a resistance program needs to be based around muscular endurance, the primary factor determining endurance success. Power endurance must also be addressed in a cyclists program because power is no good unless you can sustain it.

Periodized weight training involves a long-term plan broken up INTO specific phases, each training a specific component (i.e. energy systems, hypertrophy, power, etc.). In ORDER to get the most out of your program it must be organized ahead of time. Creating the program, and doing it correctly, is the first step. A template to train by provides more objectivity for your workouts and keeps you ahead of your workouts so all of your focus can go INTO that session rather than planning ahead of time. Just do what your program tells you. At best your program will meet all of your expectations and produce all of the results you expect. At worst, your program will fail to produce the results you expected but at least you have a program of what was done which, with the help of a coach or trainer, can be changed. Next year you will have a program that is more suited to you.

The annual training plan should be broken up INTO 5-6 DISTINCT phases, depending on your goals and weaknesses. Since cyclists typically do not weight train the whole year, a typical program may run FROM Oct./Nov. to

March/April. Each of the specific phases within the plan contains a certain number of microcycles or weeks. It is important that before each phase you test your 1-repetition maximum (RM) for each exercise. This is how you will determine the LOAD for each exercise. It is much safer and more practical to do a 3-5 RM test for each exercise and then estimating your 1RM using a maximum weight chart.

A good weight program for cyclists should include an anatomical adaptation phase (AA), a maximal strength phase (MxS), a power phase (P), endurance phase (End), and maintenance phase (M). Depending on the amount of time and previous training history of the athlete, a hypertrophy phase (H) can also be added.

Each one of these phases has specific requirements for the load, # of reps, # of sets, rest interval, speed of execution, etc. For this first installment we will look at each of these factors and how they can affect the workout and in the articles to come we will look in depth, at each phase of a well-periodized strength program.

Training volume is the quantity of work performed. In its truest sense, volume is the total amount of weight lifted and can be calculated for a single session, microcycle, or macrocycle. This number is the amount of weight lifted per rep., multiplied by the reps/set, multiplied by the sets per exercise. Adding each of the exercise totals will give you that session's total volume. Performance gains occur when this volume is progressively increased with adequate recovery over a period of time. That is what a periodized program is. Novice strength trainers must start slower and accumulate less yearly volume than a veteran weight trainer to avoid detrimental overuse injuries. Muscular endurance and maximum strength training requires a large volume of training due to the higher loads and increased number of repetitions performed.

Intensity for a strength-training program should be prescribed using percentage of 1RM (maximum amount of weight that can only be lifted once). As stated earlier, 1RM can be calculated safely by warming up properly and performing each exercise at a weight that you can lift approximately 3-5 times. Once you have found a weight that you can lift in this range look up the weight and number of repetitions on a maximum weight chart to see what your estimated 1RM would be. It is much safer and just as accurate this way than to try and test an actual 1RM! The minimum LOAD required to see strength gains is 60% of 1RM. The only time you should be below a 60%

LOAD is during the adaptation phase (first one) and during recovery weeks. The LOAD is determined by the phase and what adaptations you are trying to develop.

The number of sessions per week is a big issue with a lot of people because of time constraints. The amount of time you need to spend in the gym depends on experience and how well you respond or recover to each training phase. For the most part, an experienced weight lifter and can tolerate 3x/wk the benefits will be greater than a 2x/wk schedule. However, there is always the law of diminishing returns, which requires consideration. Also, a novice may be able to handle 3x/wk during the adaptation phase but may have to switch to 2x/wk during the strength phase because he/she cannot adapt quickly enough. It is most important to get 3 sessions during the initial phases of the program, when LOAD is low and most of the benefit is coordination and tendon/ligament strength. During the later phases when LOAD begins to increase it is less of a benefit to have 3 sessions/wk because you will need to recover, as fast as possible and for some people, novices and very heavy training, 3 days is too much to allow full recovery.

The number of exercises should depend on the length of time spent in the gym. For the most part, especially during the high intensity cycles, you should not spend much more than an hour in the gym at a time. After an hour, hormones circulating in the blood take a nose-dive, and further work can be detrimental to the building and recovery process.

The number of sets, repetitions/set, lifting method, rest interval, and selection of exercises all depend on the phase you are in and the adaptations you are looking for. Each one of these we will go over in more detail in the coming articles.

Part 2: Adaptation Phase

Muscle is a highly trainable and adaptable tissue. However, the tendons and ligaments surrounding the joints are not as adaptable as muscle tissue and require more time to adjust to the stress of strength training. Therefore, it is necessary to start a strength-training program with a period devoted to progressively adapt the muscles and support structures (ligaments, joints, tendons, etc) for the intense training of later phases. Muscles will always adapt faster than tendons and ligaments. The main goal during this

adaptation phase is overall body conditioning not just of the leg muscles, but the abdominal and back musculature as well. Upper body exercises could also be done during this phase. It is important that intensity start at a low level, approximately 40-50% 1RM and increases be made slowly after complete recovery from the previous sessions. If done properly, this phase will build joint integrity, which can prevent overuse injuries later on in the season and earlier injuries resulting from intense strength training. There is plenty of time during later phases for cycling specific exercises, so for now focus on a balanced program working both sides of the joint, flexors and extensors, agonists and antagonists.

The amount of time to schedule for the adaptation phase largely depends upon strength training experience. The more experienced, the less time required for adaptation. If you have strength trained for the past 3-4 winters but have not in the past 6-months then you should still schedule 6-weeks of adaptation. Those just starting a strength-training program should schedule at least 8-10 weeks of adaptation. Many athletes fail to start strength training early enough to allow 8-weeks of adaptation and end up with an injury. Adaptation is a very important phase because it primes the muscles and support system for the rest of the program. Insufficient adaptation here will lead to higher injury rates and lackluster improvements later on.

The number of exercises should fall within the 10-12 range. Any more than that makes training volume too stressful and impractical and any less makes a well- balanced whole-body workout difficult. The lower work intensities of this phase make it possible to perform more exercises in a session, training the muscles and joints in a multitude of ways. The best method for a large number of exercises at relatively low intensities is circuit training. Circuit training is accomplished by alternating muscle groups or exercises one after another until all of the exercises are gone through once. Then after a brief rest period they are run through again. This continues until all sets are completed. After each set you quickly move to the next exercise giving little chance for heart rate to recovery. This method also trains the cardiovascular system for this reason. Because you are training opposing muscle groups you can quickly move from one exercise to the other while also getting the proper recovery before working the same muscle again. Recovery between sets or exercises should be 20-50 seconds and 2-3 minutes between circuits.

Before beginning the adaptation phase it is important to test for 1RM. The best way to do it is to test for 3-5 RM (weight you can accomplish in good form for 3-5 repetitions) and then using a weight chart to estimate your 1RM.

The types of exercises in this phase should include:

1. Abdominal - Pick 3 - 4 exercises and rotate through them, two one day and another two the next session. Try to get at least these exercises: obliques, crunches on a stability ball, and reverse curls.

2. Back - Depending on how your back responds will determine how many exercises you can do in one session. The low back is used constantly and takes longer to recover to strength training and is more susceptible to injuries so be careful and pay attention to proper form when lifting. To start pick one exercise, such as the dead lift or back extension and stick with it for 2-3 weeks. After 2-3 weeks try and add the other and begin to do both during a session.

3. Multi-Joint Exercises - squats, lunges, step-ups - These are the best exercises for building base strength and support. These exercises are also good for developing general strength and stability.

4. Single-joint Exercises - Knee extensions, hamstring curls - These are great ways to target a selected muscle group. Make sure to work both sides of the joint equally or run the risk of injury due to poorly balanced joints.

5. Leg Press machines - These are good exercises for targeting the prime movers of the leg without stressing the abdominal and back muscles.

6. Upper Body Exercises - Some upper body exercises can help negate the initial soreness in the shoulders and arms felt during those first few weeks of long distance rides. But upper body strength is debatable for cycling unless you are looking at improving your sprint. However, it can be beneficial to have a little upper body strength to help prevent serious injuries during a crash. If you are one of those people who gains mass easily then one day a week of upper body weights is good enough to get benefits without adding a lot of weight.

The order of exercises is important and can have an impact the quality of your training sessions. Try not to group exercises that stress the same area of the body close to one another. For example, don't try free squats after doing back extensions or dead lifts. The back exercise may limit or affect free squat performance and chances are you will not be working the legs enough and stressing the back too much. It is less important at the beginning of the

phase but becomes more important later when loads increase.

After you have tested your 1RM it is necessary to determine the loads for each exercise. Certain abdominal and other exercises do not require large weights or 1RM testing but instead are trained by performing the exercise to failure a number of times. For all other exercises start at 40-50% 1RM. If you are just starting weight training and have not had any previous sport training then start at 40% 1RM. As you progress through the phase the load will increase and repetitions will decrease. This will continue until a peak of 70% 1RM for this phase. Once you are able to handle 70% 1RM comfortably it is time to move to the next phase. An example of a 10-week loading program follows:

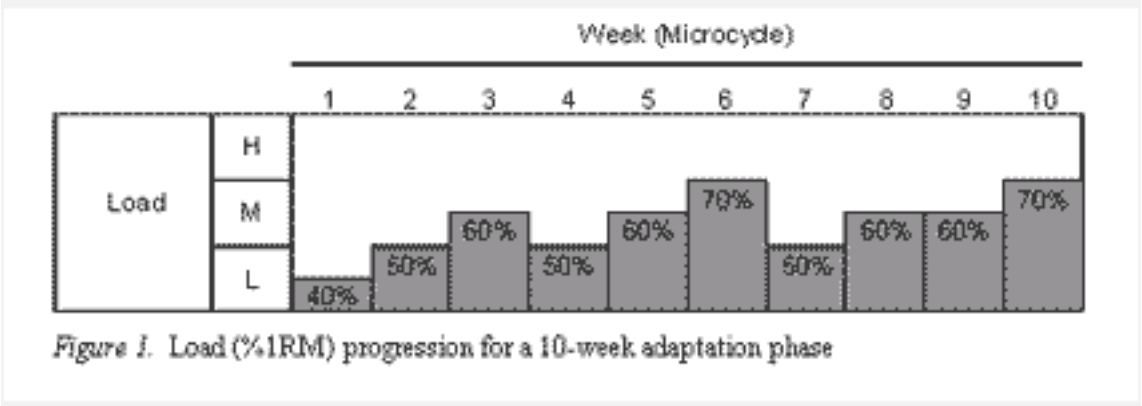

Figure 1. Load (%1RM) progression for a 10-week adaptation phase

The other part of training volume is repetitions and sets. The number of repetitions should be reduced over the weeks as load increases starting with 15-20 for the large multi-joint exercises and 12-15 for single joint exercises. As the weeks continue and the load jumps to the 60-70% 1RM range you should drop the repetitions to 12-15 for the multi-joint exercises and 10-12 for the single joint exercises. Begin with two sets for the first two weeks of the program and then to three on week three. Start the next recovery (Week 4) with two sets and then jump back up to three for weeks 5 and 6. Jump back down to 2 sets for the 7th week and back up to 3 for the remaining 3-weeks. Remember that during weeks 1,2,4, and 7 you are back to 15-20 repetitions.

The main goal of this phase is to progressively increase the training volume. Remember that volume is LOAD X REPS X SETS. So lets take get some data for the aforementioned example. Say for a given exercise your 1RM is 200 lbs. So we begin week 1 exercising at 80lbs (40% 1RM) performing 15 repetitions for 2 sets. The volume for this one exercise once per week is 2400 lbs. If we were to figure out the weekly volumes for the rest of this phase for this one exercise it would look something like this:

	Week									
	1	2	3	4	5	6	7	8	9	10
Volume (lbs)	2400	3000	4320	3000	4320	5040	3000	4320	4320	5040

Figure 2. Weekly training volume for one exercise per week.

Keep in mind that this is only one exercise and these volumes are only one session a week but the principle remains the same and when additional exercises are added and the frequency increases to 3 times per week only absolute volumes will change while the relative load increases and decreases per week would remain the same. You can see the progression in volume over the course of the 10-weeks followed by recovery weeks to provide the proper amount of rest. A program like this will prepare and strengthen the muscles and support system causing a smooth transition to the next phase when load increases even more.

Try to get three days per week during this phase. It is important that while the load is low, the muscles and support structures need as much stimulus as possible.

The next article will discuss hypertrophy training, the next phase, and why it may or may not be good for cyclists. Thanks for reading.

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Part 3: Hypertrophy Phase

Should cyclists and other endurance athletes focus on building muscle mass during their strength-training program? That is a question that arises among many cyclists and coaches, "I want to get stronger, but I don't want to gain a lot of mass and weight." First we must realize that bigger does not mean stronger. Bigger individuals do not necessarily have a lot of lean muscle mass, which is what makes you strong. The larger the muscle, the more force it can produce, plain and simple. So should cyclists and other endurance

athletes include a hypertrophy, muscle building, phase into their strength-training program?

It is no big surprise that the highest rated cyclists within the USCF (United States Cycling Federation) also have the highest anaerobic power outputs. This higher anaerobic power gives these cyclists the ability to attack, respond, climb short steep hills, and sprint faster than those with less anaerobic power, which enhances their chance of success in competition.

Studies researching the effects of weight-training and cycling performance show improved short-term anaerobic power performance as well as long-term cycling performance signified by increased time to exhaustion at a given sub-maximal workload (Hickson et al.1988, Marcinik et al. 1991). The increase in cycling performance of the aforementioned studies correlate well with the increase in leg strength of the subjects involved. However, the muscular adaptations responsible for the increases in anaerobic power and work capacity are still unknown. These gains in performance may be the result of increased muscle fiber size and the changes in contractile properties induced by strength training. The increased myofiber size following weight training may improve slow twitch muscle fiber velocity (VMax) and reverse the decline in VMax of fast twitch muscle fibers and peak tension development in all fibers (Fitts and Widrick 1996). Since larger, stronger, faster muscle fibers generate more force, cyclists who strength train, and include a specific hypertrophy phase to increase muscle fiber size, may be able to exercise or perform longer at a given sub-maximal workload due to stimulation of less muscle mass and reducing the force contribution from each active muscle fiber.

The basic premise behind this hypertrophy training is that a bigger muscle is more forceful. A muscles cross-sectional area is directly related to its strength. By adding a muscle building (hypertrophy) phase in our strength-training program, we can maximize the size of the muscle early on, when endurance training volume is low, and maintain these bigger muscles throughout the rest of the program. Many do not realize that endurance training actually reduces the size and power of the muscles over the course of the training year. By starting the season with larger muscles, you will end the year with more muscle mass than if you had not weight-trained at all.

To get the best results of hypertrophy training the best results come from the method of body builders. It is important to realize that this phase does not cause nervous system adaptation and mostly results in increased muscular

size. Training the nervous system will be the focus of later phases. This method of training will be focused on the prime movers of cycling, the glute, hamstring, and quadricep muscles. The primary objective of this phase is to cause large chemical changes in the muscle, which affect the muscle fiber components. This method uses moderate loads, 70-80% 1RM, while performing as many repetitions as possible, usually between 8-12. It is very important to execute the maximal number of repetitions possible, to the point of muscle failure, and in some cases continuing to hold the contraction as long as possible. The goal is to maximally fatigue the muscle. Obviously there are certain exercises where this method will be contraindicated, i.e. free squats, and advised only with a spotter.

To reassess your strength after the adaptation phase and update your training loads you should re-test for 1RM. Begin the hypertrophy phase lifting 70-80% 1RM, one that allows only 10-12 repetitions. If you can perform 15 repetitions it is time to increase the weight until you are back within the 10-12 range.

The number of exercises will decrease form the previous phase to 5-8. All of these exercises should be the prime movers of cycling while continuing abdominal and back exercises. The speed of execution should be moderate to fast during the concentric (lifting) phase of the exercise and slower for the eccentric (lowering) phase to simulate the speed of contraction used during cycling.

Perform between 4-6 sets of each exercise and allow 2-3 minutes of rest between each set and 3-5 minutes between each exercise. Remember, the goal is to exhaust the muscle, so start with an exercise and complete all sets before moving to the next one.

Be sure to stretch the muscles following the workout. A stretched muscle will recover much faster by aiding blood flow to the area and maintain muscle fiber length. It is also important to replenish energy stores following such exhausting workouts. Proper nutrition will aid in training recovery and allow you to train as hard as possible.

There are many other methods of hypertrophy training, each with their own masochistic twist but the difference between them is most likely marginal as long as the basic concept of muscular failure is followed.

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Part 4: Strength Phase

Following the hypertrophy phase comes the strength phase. During this phase loads increase to their maximum level and focus is shifted to many brief all-out sets designed to maximally stress the nervous system and large muscle fibers. It is during this phase that we take advantage of the muscle mass gained from the last phase and start training the nervous system to recruit as much muscle as possible.

The ability of the muscle to produce maximal strength is largely, but not solely, determined by it's cross sectional area (CSA). This is why the strength phase is often preceded by a hypertrophy phase. However, strength is also determined by the ability to recruit a large number of muscle fibers and training the muscle to recruit them in proper synchronization. Since we have done our best to increase muscular size, this phase will focus on maximal stimulation of the muscle fibers and training proper synchronization of the nervous system to these muscles.

A Lifting weight is composed of several phases, the concentric (lifting phase), isometric (static) phase, and the eccentric (lowering) phase. Cycling is somewhat unique in that it only has concentric contractions. The pedal stroke is a powerful concentric contraction followed by a recovery phase and repeats over and over. Since the method of lifting should be specific to the sport of cycling, most of the emphasis should be placed on the concentric phase of the lift, contracting in an explosive burst of power. However, eccentric contractions (lowering) should not be ignored and is actually the portion of the lift that produces the most tension within the muscle. So do not start a

concentric-only lifting routine simply for specificity sake, but really concentrate on the lifting phase, more on this later.

In contrast, the abdominal and back musculature is in a constant state of isometric contraction to stabilize the pelvis while cycling. These muscles are never shortening (concentric) or lengthening (eccentric) to a large degree but are still producing a lot of force. It is the similar to pushing against a brick wall. You are not moving the wall so your muscles are not shortening. The wall is not moving you so your muscles are not getting longer (eccentrically), yet your muscles are still producing force. This is what the “core” musculature is doing the entire time you are cycling. They contract enough to hold the pelvis stationary providing a solid base of support from which the legs can produce power. When these core muscles fatigue at the end of long rides or from long periods of high power output, as in a time trial, they cannot stabilize the pelvis as efficiently resulting in back pain and a loss of power. So specific training of the abdominal and back muscles for the sport of cycling requires isometric and endurance exercise. These exercises should be added to your routine during the strength phase and rotated with other “core” exercises (crunches, back extensions, etc.).

During the strength phase the goal is to create maximal tension within the muscle, activating as many fast twitch (FT) muscle fibers as possible. This requires lifting very heavy loads that result in a high recruitment of FT fibers from the first repetition rather than eventually stimulating them as others fatigue, like hypertrophy training.

Exercises in this phase should not be performed under a state of fatigue. Training for strength is different than hypertrophy training where the goal is to push to the point of total exhaustion and burning fatigue. Strength training requires lifting heavier loads (85-100% 1RM), which can only be performed for 3-6 repetitions. Strength training also requires longer rest periods of at least 3-minutes. You should get to the point of fatigue but it should not be burning fatigue but the muscles just cannot produce the force required to lift the load. There is a distinction between these two methods and sometimes it is blurred, but at the end of each set your legs should not be burning as much as hypertrophy training with 80% 1RM for 8-12 repetitions.

The strength phase is also the beginning of very specific exercises that mimic the motions of cycling. The previous phases were preparing the muscles (adaptation) and making them as big as possible (hypertrophy) which does not necessarily require many cycling specific exercises. The goal was to get

the muscles ready. Now the goal is to teach the nervous system and muscle to contract specific to the sport so that the strength gained can be carried over to the bike. Remember, strength is the result of big muscles and training the nervous system to recruit these muscles in the proper sequence and order specific to your sport. So in order to accomplish this all exercises during this phase should be specific to the sport of cycling. No more free squats, two-legged leg press, etc. All exercises should be performed one leg at a time, as in cycling, and with the body position (hip angle, feet width, etc.) as close to your bike position as possible. Examples of these exercises are lunges, step-ups, single-leg press, single leg extension (watch those knees), single leg curl, etc. A spin bike can also be used as a great strength exercise by increasing the resistance and turning as many repetitions as possible for 20-30 seconds. This is about as specific to cycling as you can get. You will have to again test for 1RM at the beginning of this phase but don't forget that you must test for 1RM with the exercises you plan to do and if you are doing all single leg exercises these 1RM tests must also be performed with each leg (test for 4-6RM and extrapolate 1RM from the maximum weight chart). Be very careful not to injure yourself and do these only after you have completed the other phases to make sure the muscles and support structures can handle it.

Since this method will only permit approximately 5-6 exercises within an hour only prime movers and multi-joint exercises should be trained during this phase. Remember to keep the exercises as well as your position as specific to cycling as possible.

Training loads for this phase must be within 85-100% 1RM. The number of sets will increase to 6-9 since you will only be able to perform 2-6 repetitions per set. Remember, this should be a periodized program, don't start off doing 95% 1RM for 8 sets. Start off at the lower load range for 6 sets and then gradually increasing either weight or number of sets over the next 6-8 weeks, increasing volume each week. Do not forget to schedule a recovery week of easy lifting every 3-weeks. All lifts should be performed in an explosive powerful manor in order to maximally stimulate the large fast twitch muscle fibers and train the nervous system for maximum power!

The maximal lifts during this phase overload the central nervous system (CNS) stimulating it to fire as many muscle fibers as possible and in the right combination or synchronization. This makes intent and effort of the lift very important. Even though the load will be heavy and the speed of the lift will be slow every lift should be done with the intent to move the weight as fast and

as explosive as possible. Complete concentration and all out effort is required for each and every lift to get the maximum benefits.

Part 5: Power Phase

Following the strength phase it is time to focus on training maximal power, the speed at which your muscles can produce force. It is important that this phase be preceded by a strength phase. The athlete must be able to move the load explosively. No visible increments of power are possible without clear gains in strength. The greater the strength, the easier it becomes to overcome resistance or inertia and the more explosive a movement will be.

The first two weeks of the power phase should be devoted to easing into a power-training schedule. The strength gained in the previous phase is of no use to a cyclist who requires acceleration and power for launching and covering attacks and sprints. The bigger, stronger fast-twitch muscle fibers now need to be further modified through power training to contract faster, increasing the rate of force production.

Proper intent and focus during every repetition will ensure you are maximally stimulating each muscle fiber. Physiologically, this type of training is stimulating primarily FT muscle fibers. They are trained to contract quickly, decreasing time to peak force and increasing the coordination and recruitment capabilities of the nervous system (NS). The NS also decreases its stimulation of opposing muscle groups that may otherwise counteract and slow down the movement. Adaptation results in better synchronization of muscle stimulation and increased recruitment of the muscle mass. Motor units and their firing patterns become larger activating a greater number of muscle fibers in a shorter period of time. Although cycling is predominately an endurance sport, winning and losing is determined by a rider's power!

The goal of this phase is to perform each repetition with as much force and speed as possible. Again, it is important to start every exercise, set, and repetition with the intent to lift the load as explosively and as powerful as possible. The exercises in this phase will remain as specific as possible and should remain unchanged from the previous phase.

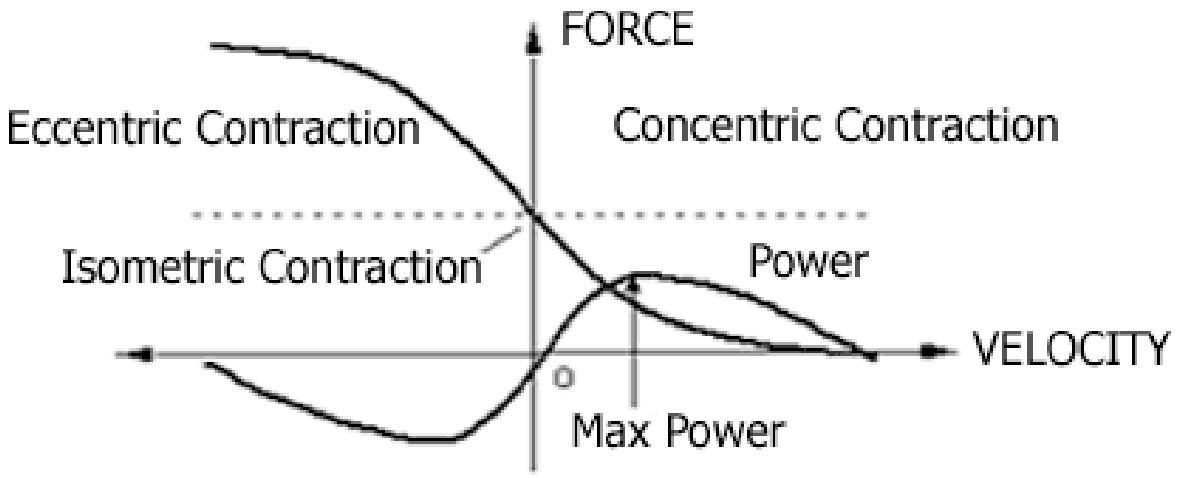
During the first few weeks of the power phase cyclists need to be very diligent, not wasting any energy on unnecessary exercises. Only the most

specific exercises should be performed with the highest intensity possible (when I say intensity I mean concentration on each lift, being explosive and powerful, as if you were trying to jump through the roof with the weight on your back)! Following the initial two-weeks of the power phase some additional exercises may be performed but it is best to stay as specific as possible. Continue endurance and isometric work for the abdominal and back muscles.

The most specific method of power training for cyclists is training specific movements mimicking the pedal stroke as close as possible. This means single leg exercises through an identical range of motion at the knee and hip joint as when mounted on your bike. Also keeping foot stance equal to axle width, and foot angle (heel pointed in or out) the same as when clipped in. Don't be afraid to get specific and actually measure these things with tape and a goniometer for the joint angles. Only once you do this and then practice these ranges of motion and stances while lifting weights will it be as specific as possible. Soon you will become familiar with these specifics and doing the exercises outside of these angles will seem foreign. When possible focus on pushing through the ball of the foot except when heavy loads place too much pressure and soreness develops. Placing a 45-pound plate on the floor and just using the front of the foot to do your lunges etc. is also a good way to get specific. Again, be careful when if you are attempting this because it places a lot of pressure on the meta-tarsal and seasmoid bones in the foot and has the potential for causing stress fractures. So only do this with exercises with a low relative load.

The load during weight lifting for power should be between 30-50%. Figure one shows the relationship between force and velocity. The graph depicts concentric and eccentric muscle actions. Muscular power is determined by the product of these changes (P = FV) and reaches a maximum at approximately one-third of the maximal velocity and one-half of the maximal force (Zatsiorsky, 1995). In other words, maximal power is exhibited when the external resistance requires 50% of the maximal force or 1RM. This is the load you want to work at because it is what you are trying to maximize. It may seem like the load is very light but remember that the goal during this phase is to produce as much power and explosion in the lift as possible to enhance nervous system coordination and firing. If you were training at a higher weight the explosion would not be as fast and the NS would not get the maximal benefit leading to sub-maximal power development. Keeping the loads light, at 30-50% 1RM, permits a lifting speed and velocity that maximizes the power produced giving the muscles and nervous system the best possible stimulus.

Figure 1. Depiction of the Force-Velocity curve.



Since the key to power training is the speed and power of the movement a low number of repetitions is suggested as long as there is proper intent and focus. All repetitions should be performed dynamically, non-stop, and at the highest rate possible. Be as smooth as possible and never snap the joints as the limb extends!

Cyclists must train to use their strength at a very high rate of contraction, and not just at the top of the pedal stroke. Those cyclists with the greatest power not only apply a greater amount of force at the top of the pedal stroke but also continue to produce force and acceleration around the entire pedal stroke. They can do this because they have trained to be powerful allowing them to not only match the speed of the crank, but to accelerate it throughout the pedal stroke.

The whole point of power training is you guessed it, to increase power. But the reason increasing power is beneficial to cyclists is that the nervous system increases stimulation and becomes more efficient leading to better coordination and recruitment of muscle mass. Soon, less force is necessary to maintain a given movement or workload. The smaller the force required means less muscle has to be activated to execute a given task and more muscle fibers are spared, leaving more unfatigued fibers to be activated if needed or saved until the final sprint. It's all about efficiency. Simplified (there are other factors), the fewer the number of muscle fibers required for a given quantity of work, the greater the efficiency and endurance. Strength is nothing to cyclists unless trained to be fast and powerful.

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Part 6: Muscular Endurance

The last phase of a periodized strength program for cyclists, with the exception of a maintenance phase, is the muscular endurance phase. Throughout this training program the muscles have enlarged in the hypertrophy phase, hopefully, got stronger during the strength phase, increased power in the power phase, and now we are trying to maximize muscular endurance. A powerful set of legs does not do a cyclist much good if they can only last for one hard attack. We need to train the muscles to retain most of the power gained previously, and be able to produce this power again and again.

The main goal of endurance training is to enhance the muscles ability to deal with, or delay the onset of fatigue. This type of training can also improve anaerobic endurance as well with the use of relatively large loads for a high number of repetitions, usually between 50-100. The ultimate benefit to endurance weight training is an increase in physiological efficiency of the muscles. Endurance training after a periodized program for strength allows the muscles to be able to sustain a greater force or power output for a longer period of time than if they were solely trained for endurance. Also, as a result of strength training and increases in muscle size, a smaller number of motor units are required to perform a given task. So not only do the muscles become more efficient, but they can also do more work.

Endurance weight training should not increase the size of the muscle diameter and may even lead to a slight decrease in fiber size as the muscle adapts to become more metabolically efficient, just as it does with long hours on the bike. But this type of training is critical for increasing the muscles ability to complete work effectively since fewer muscle fibers are needed to perform a given task. In order to fully adapt to the endurance phase, 8-10 weeks of this phase is required.

There can be two types of endurance training methods. One is for training

shorter 5-10 minute anaerobic efforts and another for long, aerobic activities. The first is ideal for more intense efforts lasting 2-10 minutes such as attacks and long sprint finishes. The second method is used to train for longer efforts greater than 10 minutes where most of the energy is coming from aerobic metabolism. Both methods are beneficial to cyclists because both efforts occur during a race. The two methods have similar physiological effects except short endurance training will require a larger load and shorter duration.

Short endurance training is best performed using an interval type method of lifting in which the rest interval between each set is inadequate for full recovery from the previous set. This constant exposure to such high levels of fatigue trains the muscle to cope with the pain and exhaustion of such efforts. The load for short endurance training should be 40-50% 1RM. The load, number of exercises, rest interval, and speed of execution should remain the same while only increasing the number of repetitions, typically every other week.

The number of exercises should be 4-8 with 2-4 sets per session. Since the sessions are not as structurally demanding on the muscles, exercises sessions can be stretched to 1-1.5 hours. The rest interval should be no more than 1.5-2 minutes and the frequency should be 2-3 times per week. The number of repetitions is the only factor that should change during this type of endurance training and usually is increased every other week. Start with sets of 50-60 reps at a time (first 3-4 weeks) and progress to grouping exercises such as the lunges and leg press, performing 50-60 reps on each with little to no rest in between. Then progress in the next couple of weeks to three exercises in a row and then to four in a row the last couple of weeks. Keep the rest interval between these sets low, 2-3 minutes. These are demanding workouts so be sure to come into them recovered and with and energy drink!

Since cycling is an aerobic sport, which requires the application of force against a given resistance for long periods of time, the training must imitate this by performing very a high number of repetitions and doing them nonstop. Only very short rest periods are afforded since dealing with severe fatigue is the goal. Instead of repetitions, sets are determined by minutes. Sounds like fun huh…

Since the duration is longer, the load is lowered to 30-40% 1RM and the number of exercises remains the same. Sets remain 2-4 and the rest interval should never surpass 30 seconds between sets. An example would be starting with 4 minutes of nonstop work on the leg press at 30% 1RM and

then moving on to the hamstring curl for 4 minutes, and then lunges for 4 minutes, etc, etc, nonstop and then taking a short rest period of 2-3 minutes. Over the next couple of weeks increase the duration of the sets to 7, 10, and 15 minutes respectively while keeping the number of exercises the same. That's right, this is about 45 minutes of nonstop lifting by the end of the phase!

Cycling involves both types of endurance so I would suggest long endurance workouts twice a week and a short endurance workout once during the week. If you are only doing 2 sessions a week, just alternate between the two.

Bompa, T.O. (1999). Periodization Training for Sports. Champaign, IL: Human Kinetics.

Part 7: Maintenance

The conclusion of a 6 month periodized weight program is a blessing for most endurance athletes but before you say goodbye to your fellow muscle heads at the gym you may want to seriously think about a maintenance phase and continuing it, at least once a week, throughout the season. The strength gained from training remains as long as the neuromuscular system maintains those cellular adaptations. Once strength training ceases, these adaptations are lost. So during the racing season a cycling specific strength plan may avoid the drastic reduction in strength seen from complete cessation of strength workouts.

Cycling is an endurance sport and through the training year putting in lots of miles will actually cause muscles to decrease in size. This is a natural adaptation to becoming more aerobically fit. Many cyclists who strength train have a very strong early season when strength benefits are at there peak, but as the season continues lack of strength training leads to decreased muscle strength and power. To maintain good strength and power performance, cyclists need to incorporate a maintenance phase during the competitive season either on the bike or in the gym, or both.

For cycling, endurance is the dominant component of training and should constitute some portion of the maintenance phase. For this reason many cyclists do not lift heavy weights during the season. This does not mean occasional strength training does not play a role. Cycling is also a power

sport, and maintaining maximal strength is important because if strength declines, power and endurance decline with it regardless of how well trained in those areas.

On the bike strength workouts combined with gym training offer the best solution to maintaining the strength acquired from the gym, and endurance got from the bike. Power should take care of itself with other bike workouts typically performed throughout the year.

However, strength training should take a back seat to bike training during this phase. The volume of strength training will be very low, 1-2 times a week, so that the most effort can be placed for technical and bike training.

Alternating gym and bike workouts every other week can be an effective way of breaking up the stimulus. If there is no racing during the week two sessions may be useful. Strength training on the bike involves a high gear and low cadence while climbing a steady incline of 4-6 minutes. Cadence should be in the 50-60 range.

When working it the gym, limit your session to 2-3 exercises of the prime movers. So basically the same exercises as the strength and power phase. Exercises such as leg press, lunges, step-ups, etc. are good choices. Make the session efficient, spending no more than 30-45 minutes in the gym. Remember, this is a maintenance phase and the goal is to maintain our fitness not improve it, so doing as little as possible to maintain strength will afford more energy for adaptations to bike training.

Keep the sets low, 1-4 depending on what you are training. More sets for strength and less for endurance. Resting intervals can be longer than usual and you should recover completely during the break. For strength maintenance the load should be higher than that seen in competition but no so high that you run the risk of over-training and injury. The load should be 5-10% lower than that during the normal strength phase, so about 75-85% 1RM. Decreasing the load prior to major competitions and emphasizing power will enhance recovery and explosiveness.

Thanks for reading; I hope you have enjoyed this training series. The last article will deal with recovery and supplementation during the early season!

Bompa, T.O. (1999). Periodization Training for Sports. Champaign, IL: Human Kinetics.

Part 8: Strength & Cycling

Strength training and cycling gets a lot of press this time of year, most notably from on-line cycling chat rooms discussing the best things to do during the off-season to prepare for the coming year. Usually, some dogmatic insists that strength training has nothing to offer an aerobic sport such as cycling leading to a barrage of replies insisting strength training has beneficial and performance enhancing capability for cyclists. I too believe that strength training is beneficial in the development of a stronger cyclist, one that should receive more attention. There is no doubt that cycling is an aerobic sport and strength training does little to improve a cyclist's aerobic system and endurance, unless untrained to begin with. However, due to the continual and constant interplay of aerobic and anaerobic efforts that occur during a race, improving cycling performance is a different matter.

Anaerobic power is a crucial part of racing success and is often the determinate in winning and losing. You can have the strongest aerobic system in the race but if you don't have a strong anaerobic system to get you in the winning break and then attack it, you will be very unsuccessful. The higher rated cyclists within the USCF undoubtedly have significantly higher anaerobic power outputs than lower rated cyclists (Tanaka, 1993).

First of all, most of this discussion is a matter of definition. Is training for strength the same thing as performing 12-15 repetitions at 80% of your 1 repetition maximum (1RM)? Is an endurance weight training protocol considered strength training? Even though the loads lifted are typically lower than with strength training they are usually heavier than the forces applied through normal cycling? So when someone says that strength training does not benefit cyclists, what kind of strength or weight training protocol are they talking about? A well-periodized weight-training program, one that switches focus from adaptation, hypertrophy, strength, power and endurance will undoubtedly enhance cycling ability and performance when performed at the proper time and combined with appropriate on-the-bike training. This increase would be greater than if strength-training solely on the bike.

Strength training will not improve aerobic performance when defined as an increase in VO2max . Although, athletes concurrently training for strength and endurance show similar increases in VO2max as athletes training just for endurance (Kraemer et al. 1995). Even though strength training does not improve endurance it probably does not hurt it either given the proper training. It has been proposed that the body cannot adapt maximally to both

training stimuli (aerobic and strength training) if they are initiated simultaneously (Hunter et al.). Starting weight training early in the cycling season, soon after the end of the previous season, may allow athletes to handle the added stress of training for endurance later on without much trade-off in either adaptation. However, research conducted by Hunter et al. has shown that well-trained endurance athletes may not experience the attenuated gains by adding strength training to an advanced endurance-training regimen (Hunter et al.). Starting a strength program early is important because it ensures maximal adaptation and strength gains before the addition of endurance training, which may limit or slow further increases in strength.

Strength training promotes an increase in the size or cross sectional area of all fiber types, including the aerobic type I muscle fibers (Fitts and Widrick 1996). Researchers have discovered that type IIa fiber percentage increases and type IIb fiber percentage decreases following strength and endurance training (Fitts and Widrick 1996). This suggests that even strength training causes fiber type transformations from type IIb to IIa. Strength training may also further improve the contractile properties of the type I fiber, most notably the myosin light chains, a part of the myofiber that deals with the velocity of shortening (Vmax). Strength and power training may alter the properties of the muscle fibers mainly through the expression of faster myosin light chain isoforms. This adaptation also occurs with endurance exercise but may occur to a greater degree with the increased loads and forces demanded of the muscle during strength and power workouts in the gym. These changes increase power and peak tension development of the fibers trained (Fitts and Widrick 1996). Endurance exercise causes type II fibers to express a slower isoform of the myosin light chains causing reduced energy expenditure and increased efficiency, a beneficial adaptation for endurance. Strength training concurrently with endurance training may reduce the expression of this slower isoform and result in a more powerful aerobic fiber.

These adaptations from strength training cause each muscle fiber to produce more force, reducing the relative force requirements from each fiber when presented with a sub-maximal load. This would also result in less fibers being activated to accomplish a given sub-max workload and delay the recruitment of less efficient type II muscle fibers (Hickson et al. 1988).

I am not saying that these are not aerobic events, but neglecting to strength train may increase the loss of power seen with endurance adaptations, decreasing aerobic and anaerobic power outputs. Although cycling is mostly aerobic and average race power outputs average a surprisingly low 150-200

watts, a level easily maintained by most cyclists, it is the brief attacks and sustained time trailing that usually determines the winners and matching these high power outputs and sustaining them long enough will give you a much better chance at success!

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