DEVELOPING THE ENERGY SYSTEMS

Every year around October or November, I ask my athletes to take their training back a notch and lower the training intensity. Instead of running 7-min mile tempo runs, they are running 9-min mile endurance runs. Instead of time trials, they are doing steady rides 10 beats below their anaerobic threshold. And instead of doing sprint intervals in the pool, the focus shifts back to longer swim sets with perfect technique.

The reasons for this shift in training are many, but a funny thing happens when we make this shift. Although I almost never have an athlete who tells me they can't run 'that fast', I almost always have athletes who tell me they can't run 'that slow'. I'm sure most athletes think I've overlooked the fact that they have improved over the season, taking seconds and sometimes minutes off their previous pace. I'm sure they also think that I have forgotten that they have a race in 6 months and they don't want to be crawling through the marathon!

Rather than just ask you to trust me, I would like to explain to you (perhaps in more detail than you were prepared for) the reason why we bring the training intensity down for at least a month. In another paper, I will explain to you exactly how we plan to do it.

First, and probably obviously, you need to give your body a rest. I don't like to see athletes take a complete break from training – at least not for more than a few days. The various systems that are developed during training decondition at different rates, but some systems start to decondition fairly quickly, so staying with some sort of program is highly desirable. But in order to preserve your finely tuned machine – and your sanity – you need to lower your training intensity.

A second reason for changing up the training is because your body is very adaptable. The same adaptability that allows you to do a 3 hour trainer ride that a year ago would have been unthinkable is also a factor in staleness or plateauing. To keep improving, there has to be variety in your training.

But the main reason for doing long, unbearably slow running, cycling and swimming is because you need to constantly train ALL the systems involved with endurance racing. Let's see what those systems are and how they contribute to your race.

Developing the Energy systems

BODY SYSTEMS: There are twelve body systems. We will take a quick look at the ones that pertain to exercise, specifically running. The primary body systems involved with running are; the skeletal system, the muscular system, the cardiovascular system, the respiratory system, the nervous system, and the energy systems. All of these systems must be stressed in ways that are most similar to our chosen goal. The **cardiovascular system** and **respiratory system** make changes based on the type of demands placed upon them. These two systems make huge adaptations relatively quickly; with some athletes showing as much as a 25% improvement in cardio-respiratory function following a 10-week training regimen.

The **skeletal system** is designed for movement. Movement makes our bones healthier by strengthening them. Movement also lubricates and nourishes joints.

The **muscular system** also makes many adaptations during training. We have 3 types of muscle fibers: fast-twitch, slow-twitch and intermediate. Fast-twitch muscle fibers are those recruited when sprinting. Fast-twitch muscle fibers are capable of rapid and powerful movements. This fast-contracting muscle fiber has a high capacity for anaerobically producing ATP (adenosine triphosphate). ATP is the chemical fuel necessary for muscle contraction. Slow-twitch muscle fibers are predominantly aerobic and have a relatively slow speed of contraction when compared to fast-twitch muscle fibers. Slow-twitch muscle fibers are used for endurance activities like distance running. Intermediate muscle fibers will take on the characteristics of slow or fast- twitch fibers. The type of characteristics that intermediate twitch muscle fibers take on, depend upon the type of training performed by the athlete. If an athlete is a distance runner then his or her intermediate muscle fibers will perform much like slow twitch muscle fibers. A sprinter's intermediate muscle fibers will take on the characteristics of fast twitch muscle fibers. Each muscle fiber type makes specific adaptations at the cellular level. *Muscle fibers not recruited during training will not make the necessary adaptations and therefore will not be able to perform any differently than what they have been trained (or not trained) to do on race day. If you didn't do it in training, don't expect to do it on the race course.*

Our **nervous system** is responsible for controlling muscle contraction. Specificity of training teaches the nervous system which muscle groups and the specific muscle fiber type to call upon during exercise. Neural pathways are created during training that coordinate the timing and contraction of each muscle within the muscle groups used. This is similar to the way a conductor leads an orchestra. Neural pathways require a relatively long time to develop and require frequent reinforcement. *The nervous system has a very small window for improvement, unlike our cardio-respiratory system, so it is vitally important for training to be exact*. Understanding the nervous system's role in training is a very new field and as scientists make new discoveries training methods will be impacted.

Our energy systems are necessary to produce energy for movement. We have **three energy systems** that are capable of providing chemical energy for physical movement. Each system provides energy in a different way and serves a specific purpose. Muscles primarily use stored fat and carbohydrate for fuel during exercise. While we are running, stored fat and carbohydrate are continuously broken down into glucose and converted to ATP for muscle contraction, all thanks to our energy systems. This is also why carbohydrate replacement is so important during races.

ENERGY SYTEMS:

Immediate Energy: The ATP-CP System

Performances of short duration and high intensity, such as a 100-yard dash, are made possible by this immediate and rapid supply of energy. This energy is provided almost exclusively from the high-energy phosphates or phosphagens ATP and CP (creatine phosphate) stored within the specific muscles activated during the exercise.

Short-Term Energy: The Lactic Acid System

High-energy phosphates must continually be re-synthesized at a rapid rate for strenuous exercise to continue beyond a brief period. During intense exercise, energy comes mainly from stored muscle glycogen. Through a process called anaerobic glycolysis, muscle glycogen is broken down into glucose to supply muscles with ATP. ATP is the chosen fuel for muscle contraction. Anaerobic glycolysis performs the critical role of rapidly supplying energy beyond that available from the Immediate Energy System. *The Short-Term Energy System is used when an athlete sprints the last few hundred yards of a race*.

High intensity exercise uses stored carbohydrate for fuel. When carbohydrate is broken down anaerobically, lactic acid is formed. As lactic acid seeps out of the muscle cell and into the blood, hydrogen ions are released and the resulting salt is called “lactate”. Lactate production accelerates as exercise becomes more intense. Eventually the rapid production of lactic acid overwhelms this energy system. *Athletes training for shorter distance races like the 5K, 10K, or Sprint Triathlons must train at an intensity level that recruits this energy system*. By recruiting and training this energy system, the trained athlete will develop greater levels of enzymes within each cell capable of recycling lactic acid, thereby allowing the properly trained athlete to run at a higher intensity level for a longer period of time.

Long-Term Energy: The Aerobic System

For exercise to continue indefinitely, a long-term energy system is necessary. Enter The Aerobic System. This Long-Term Energy System requires the use of stored fat and carbohydrate AND the presence of oxygen to initiate the chemical reaction for the production of ATP. *The presence of oxygen required for the Long Term Energy System is a huge differentiating factor from the Short-Term Energy System. Every long training run or ride you do at this low intensity level works to develop the long term energy system.*

Fat is the primary source of fuel for muscles at low levels of exercise intensity. Stored lipid represents the body’s most plentiful source of potential energy. The quantity of lipid available for energy is almost unlimited; due to the fact that its energy content is more than twice that of carbohydrate or protein. In

other words, when fat is broken down into glucose it supplies more than twice the amount of ATP than does carbohydrate.

The Long Term Energy System also requires the presence of oxygen. Blood lactate does not accumulate at the same level with the presence of oxygen. During light exercise, any lactic acid formed during exercise is rapidly oxidized by the heart and muscle fibers so blood lactate levels remain fairly stable. *The absence or low level of lactic acid presence allows muscle contraction to continue for longer periods of time allowing athletes to complete the marathon distance*.

These 3 Energy Systems are interrelated….physical movement requires the use of all three systems. ***Training one of these energy systems will have an impact on the other two systems. For example, during base aerobic endurance training even though the long term energy system is primarily used, by training this system to become more efficient, the short term energy system benefit becomes more efficient as well. Targeting the specific energy system required for your chosen distance is important because the majority of your training time should be spent training at that intensity level for training that energy system***.

IMPLICATIONS FOR TRAINING:

The level of intensity at which accumulation of lactate begins is called the "lactate threshold". This is a critical event for our bodies because Lactate Threshold (LT) is an intensity landmark. Once this threshold is reached, exercise duration is limited. The duration of a workout or a race is greatly reduced when exercising above LT. By training at or near the LT, the body improves its ability to process lactate while also teaching the muscles to conserve precious glycogen and glucose fuel sources. In addition, the muscles' contractile mechanisms become more resistant to fatigue. *The result of this type of training is an increase in your speed and the ability to maintain this level of effort for longer periods of time. Obviously all runners of every distance can benefit from some Lactate Threshold training*.

Measuring LT remains an estimate; even when determined in a lab, because it varies on a daily basis due to fatigue, diet and changing environmental conditions. Train yourself to be aware of your breathing rates and patterns during training session. Aerobic endurance training is performed at a "conversational" level, meaning you can carry on a conversation with your training partner. This low intensity training level is called "steady state" by some. In steady state your body is able to meet the demands of the exertion level comfortably and you will generally have a feeling of running fluidly, as if running at this pace could go on forever. Lactate production is low enough to allow extensive training sessions to the limits of the athletes' aerobic endurance and slightly beyond. Slow twitch, endurance muscles become stronger, more capable of using oxygen to produce energy while learning to conserve glycogen and glucose. *Extensive endurance training is the most commonly used intensity by endurance athletes, especially triathletes and marathon runners.*

Marathon distance track workouts are performed at a moderately hard intensity level. Workouts done up to the highest level of aerobic intensity without going deeply anaerobic are quite effective for

teaching the body to conserve glycogen and glucose while becoming more proficient at using fat for fuel. At this intensity level, fast-twitch muscle fibers take on the characteristics of slow-twitch fibers. This adaptation can be very important for distance runners. This "sub-anaerobic' type of workout, sometimes called 'tempo', helps raise the athlete's lactate threshold.

Short distance runners, 5K and 10K runners train at a higher intensity level of exertion, Lactate Threshold and VO2 max. This means heart rate and breathing rate will be higher than in steady state. The runner will feel some discomfort, legs and/or arms may feel heavy, hot or tingling. These are signs you are in your lactate threshold zone. Duration is measured in minutes rather than hours!

Training in this *dis*comfort zone has many benefits for *shorter distance running*. LT training fortifies the body against muscle failure by training the nervous system to call on more of its muscles for endurance activities. At higher levels of intensity, fast-twitch muscles are called upon to support the slow-twitch muscles. The Short-Term Energy System is stressed, triggering improvements in the areas of lactate tolerance and removal.

Measuring Intensity - How do you know which training zone you are in? Over the years, many athletes have come to rely on heart rate monitors as the only indicator of intensity. Heart rate is a reliable but sometimes incomplete measure of intensity. Performance is often limited by the muscular system, rather than the cardiovascular system (especially on the bike)….so relying solely on a heart rate monitor may limit athletic performance. Experienced athletes develop an ability to assess the level of exertion based strictly on the sensations emanating from the body's many systems.

Borg's Rate of Perceived Exertion Scale- Perceived exertion is quantifiable using the Borg Rating of Perceived Exertion (RPE) Scale. Borg's RPE is applicable to any sport. It is based on a number scale of six to twenty with six representing no exertion at all and twenty as maximum, all-out effort. A score of six parallels a heart rate of about 60 beats per minute; and a score of twenty parallels a heart rate of about 200. Heart rate parallels aside, the beauty of RPE is that if the exercise intensity is *perceived* as hard, it probably *is* hard. Conversely, if the exercise intensity is perceived as easy, it is easy…if it walks like a duck….quacks like a duck….

So, learn to tune in to how you feel while you run! Assess your running form, listen to your foot strike and your breathing rate, do you detect any aches or pains? Learn to listen to your body and recognize the signs and signals at different levels of intensity. Most importantly, you need to train at the correct intensity level for your training based on the distance you are training for. *The longer the distance you are training for, the lower the training intensity level.* In a short period of time you will come to know when you are in the right training zone for your run and which workouts are appropriate for your chosen distance.