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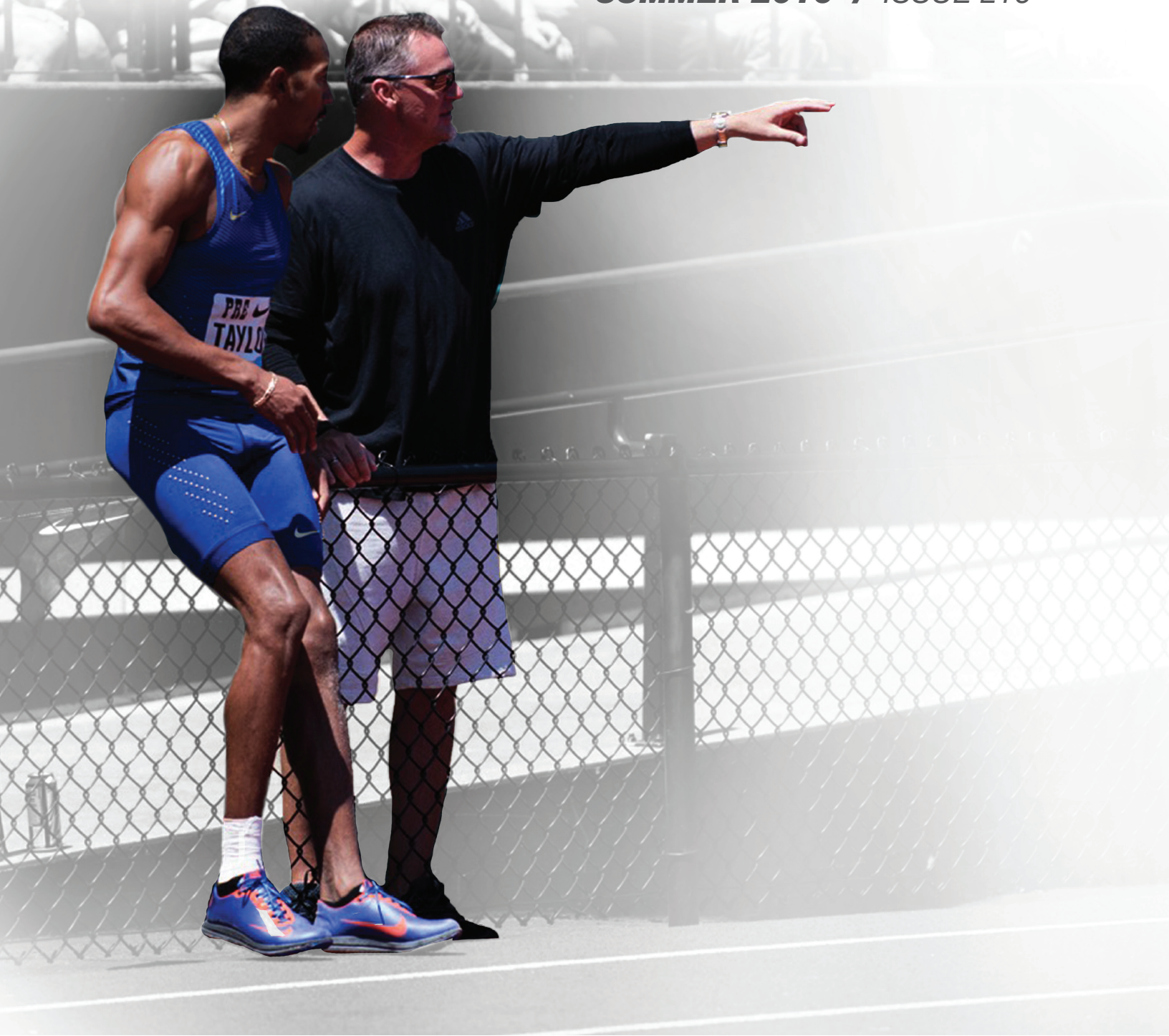

TRACK COACH

Summer 2016 I 216

The official technical publication of USA Track & Field

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TRACK COACH

FORMERLY TRACK TECHNIQUE

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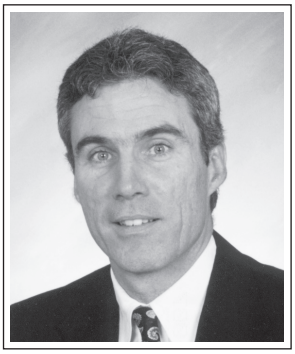
FROM THE EDITOR

RUSS EBBETS



A LEVEL PLAYING FIELD

The anterior cruciate ligament (ACL) is a pinkie finger sized ligament in the knee that limits forward sliding of the tibia in relation to the femur. To a degree it also provides a pivot point (with the posterior cruciate ligament) and limits internal rotation of the tibia as the foot goes from heel strike to mid-stance pronation.

Over the last two decades the ACL has generated much press, especially in women's sports. While ACL tears are not a common track & field injury, they do happen. Even with the advances in orthopedic surgery they can present a career limiting or career ending injury.

Classically the ACL is torn with an action described as a "quick turn with deceleration." The soccer player plants her left leg to wind up and kick with her right foot or the basketball player plants and cuts and "pop" – the ACL is torn.

Shoes and surfaces play a role in ACL injury. I had a professor who played college football in the late 1960's. His college was one of the first collegiate programs in the U.S. to install a synthetic grass field. One of the early selling points of the synthetic surface was that it looked better and offered multiple sports teams a level playing field.

Once upon a time football shoes were referred to as "cleats" and had actual cleat spikes that were about an inch long. On a dirt or grass surface these shoes would dig in and prevent slipping aiding in the pushing, pulling and cutting characteristic of football. The old cleats allowed for some wiggle or play when the foot was in contact with the ground.

But the cleat on a synthetic grass field lost its "wiggle." In fact they grabbed, almost to the point of adhering to the synthetic surface. The sliding or wiggle of the shoe on grass was lost at the foot and transferred further up the closed kinetic chain of the leg to the knee. Biomechanically the knee is basically a hinge joint and the wiggle is rotation, which the knee does not accommodate well.

On the first day of football practice, in the first 90 minutes on the new synthetic field my professor tore his ACL. From what I remember him saying he wasn't the only one. He and his teammates were lost for the season and no one could immediately explain why.

CONTINUED ON PAGE 6895

PROGRAM DESIGN FOR THE TRACK AND FIELD ATHLETE

The planning of training—a problem for every coach.

BY JOHN M. CISSIK

The planning of training for a track & field athlete can be extremely challenging. track & field athletes run, walk, sprint varying distances in training, jump, throw, perform strength training, perform mobility work, perform core work, and may even train in the swimming pool. It is difficult to balance training out so that the athlete has a chance to recover from it.

The table below shows an example of an approach to balancing out a sprinter's training. This is a sprinting athlete who is seeking to improve all aspects of the sprint. In addition, the athlete is weight training, performing plyometrics, and performing mobility work.

On the surface, the training described in Table 1 looks balanced. The athlete is working on acceleration, maximum velocity, and speed endurance with the sprint work. He/she is training the lower body in the weight room, and even performing plyometrics to enhance power.

However, one thing to note is that the athlete's legs never get a chance to recover from the workouts. Monday has high-intensity/short-distance sprints, Tuesday has moderate volume/moderate intensity strength training, Wednesday has maximum velocity sprints, Thursday has plyometrics and more strength training, Friday has long distance/speed endurance work. In other words, the athlete's legs are stressed every day.

Table 2 provides a different set-up for the training outlined in the previous table. The training in Table 2 is designed to enhance speed, power, strength, and hypertrophy.

With the training in Table 2, the same training is being performed as in the original example. The major difference is that it is put together to allow the athlete to recover from the training. Acceleration work and strength training are being performed on Monday. Wednesday sees power training combined with maximum velocity training. Friday involves strength training as well as speed endurance work. In this

Table 1: Sample week of training.

Monday	Tuesday	Wednesday	Thursday	Friday
Speed technique drills, 10-15 minutes Stride length drills, 3-5x5 meters Standing starts, 3-5x20 meters	Power clean, 3x6x60% Back squats, 3x4-8x75-85% Lunges, 3x4-8 each leg Romanian deadlifts, 3x4-8 Back raises, 3x12-15	Speed technique drills, 10-15 minutes Stride frequency drills, 3x20 meters Standing starts, 3-5x60 meters	Bounds, 3x20 meters Hurdle hops, 3x20 meters Power snatch, 3x4x60% Front squats, 3x6-10x70-80% Good mornings, 3x6-10	Mobility work, 10-15 minutes Standing starts, 5x150 meters

manner the athlete is able to use Tuesday and Thursday for mobility work, core training, and recovery. However, this can be complicated to put together.

Track & field athletes perform a great deal of training using diverse modes of exercise. This training has to be put together so that it allows for the athlete to recover, but it also has to be put together so that each type of training complements the others. This is done by linking the training together. Training is linked together by training similar energy systems and/or similar physical qualities.

For example, strength training that is focused on developing maximal strength trains the phosphagen energy system. It also requires short, all-out efforts. This links very well with acceleration training on the track, with jumps, and with throws. Strength training that is focused on hypertrophy work or endurance trains the phosphagen energy system but also involves the glycolytic one as well. This type of training links up well with speed endurance work, jumps with a long approach run, and longer plyometric efforts like bounds or hurdle hops. Strength training that is focused on the development of power (i.e., the Olympic lifts and their variations) requires high-speed, all-out efforts which links up well with plyometrics, maximum velocity training, throws, and jumps.

Putting training together so that the components complement each other and allowing the athlete to get an adequate chance to recover involves careful program design. There are several steps that a coach can follow to make the program design process more manageable.

1. Organize the training program
2. Make general decisions about the content of each block
3. Link the training together
4. Write the first block of training's workouts

ORGANIZE THE TRAINING PROGRAM

Training should be organized into manageable blocks of time. This is one of the benefits that periodization has. By doing this it breaks an overwhelming task into smaller

Table 2: Sample week of training, revised.

	Monday	Tuesday	Wednesday	Thursday	Friday
Strength	Back squats, 3x4-8x75-85% Lunges, 3x4-8 each leg Romanian deadlifts, 3x4-8 Back raises, 3x12-15		Power clean, 3x6x60% Power snatch, 3x4x60%		Front squats, 3x6-10x70-80% Good mornings, 3x6-10
Speed	Speed technique drills, 10-15 minutes Stride length drills, 3-5x5 meters Standing starts, 3-5x20 meters		Speed technique drills, 10-15 minutes Stride frequency drills, 3x20 meters Standing starts, 3-5x60 meters		Mobility work, 10-15 minutes Standing starts, 5x150 meters
Power			Bounds, 3x20 meters Hurdle hops, 3x20 meters		

Table 3: Sample focus and content of the first eight weeks of training.

Quality	How will it be trained?	Frequency of training per week	Volume	Intensity
Event	Standing jumps Jumps with 3-5 step approaches	2-3x	Low	Moderate
Speed	Acceleration-themed sessions Maximum velocity-themed sessions Speed endurance-themed sessions	3x (one session geared towards each speed theme)	Low	High
Power	Plyometrics Olympic lifts	1-2x	Low	Moderate to high
Strength	Multi-joint strength training exercises	1x	Low	High
Hypertrophy	Multi-joint strength training exercises	1-2x	Moderate	Moderate
	Warm-up drills Cool down drills Mobility workout sessions	Daily	Low to moderate	Low
Injury prevention	Hamstring mobility drills Shin/ankle/foot strengthening drills	With speed training	Low	Low

pieces. In classic periodization, the year is broken down into a preparatory period (i.e., the off-season), a competition period (i.e., the in-season), and a recovery period. These are in turn subdivided into different phases, which are in turn generally subdivided into roughly monthly blocks of training. Each of these can be further subdivided.

When organizing the training program, it's normal to begin at the end—i.e., where the athlete is attempting to go. This means starting with the major competitions of the year and then working backwards. Normally the time around competition is the season, a few weeks after is a recovery period, the rest of the year is preparation. This will vary depending upon the level of the athlete, with elite athletes spending less time on preparation.

MAKE GENERAL DECISIONS ABOUT THE CONTENT AND FOCUS OF EACH BLOCK OF TRAINING

The purpose of this step is to provide a framework for the direction that training will take during the year. Performing this step ahead of time, before workouts are written, also helps to ensure that the athlete's training is continuous throughout the year. For example, Table 3 provides an example of this step for a collegiate long jumper's first eight weeks of training during the school year.

LINK THE TRAINING TOGETHER

Now that training has been organized and general decisions have been made about the content of training, some decisions can be made about how it will go together. The parts of training can be put together based upon energy systems, effort, motions, muscles, or all of the above. It is best to focus individual training sessions around a concept whenever possible (for example, maximal strength, acceleration, power, etc.).

For example, using the information in Table 3, the long jumper's training is going to be focusing on the event, acceleration, maximum velocity, speed endurance, power training, maximal strength training, hypertrophy training, mobility work, and injury prevention drills. Table 4 provides an overview of this information.

From Table 4, several areas are similar with regard to energy systems and qualities. The event training links up well with acceleration, maximum velocity, and speed endurance training. The event training and both acceleration and maximum velocity training link up well with power training. Maximal strength training links up well with acceleration training, event training, and power training. Hypertrophy work links up well with speed endurance training and perhaps event training with a longer run-up. Mobility work and injury prevent work, due to their low intensity, might be best used on recovery days or as warm-up or cool down.

Table 4: Overview of the sample athlete's training components.

Focus of training	Energy systems trained	Qualities
Event training	Shorter run-ups: Phosphagen Longer run-ups: Phosphagen plus glycolytic	Shorter run-ups: Brief, intense, all-out effort. Acceleration, power. Longer run-ups: Longer effort, intense, all-out. Maximum velocity, power. Speed endurance if run-up long enough.
Acceleration	Phosphagen	Brief, all-out effort.
Maximum velocity	Phosphagen, glycolytic	Longer, all-out effort.
Speed endurance	Glycolytic	Longer duration, limited recovery, moderate intensity
Power training	Phosphagen	Brief, all-out effort. Can be longer, all-out effort depending upon volume.
Maximal strength training	Phosphagen	Brief, all-out effort
Hypertrophy	Glycolytic	Longer duration, limited recovery, moderate intensity
Mobility	Glycolytic, could be aerobic depending upon length of effort.	Longer duration, low intensity.
Injury prevention	Glycolytic	Longer duration, limited recovery, low intensity.

WRITE THE FIRST BLOCK'S WORKOUTS

Once the above has been done, the training for the year is planned in concept and it is easier to sit down and plug exercises, volumes, and intensities in. When writing the workouts it is least frustrating to plan four to six weeks out at a time. This is because the needs of the athlete are going to change as the year progresses and this is going to impact the program. Writing the training program too far out will eventually become an exercise in frustration.

Athletes have a limited amount of time to train. They also have a limited ability to recover from that training. Careful program design can maximize the athlete's training time and their ability to recover from training.

John Cissik, M.S., C.S.C.S. is the author of a number of books and articles on track & field and strength training.

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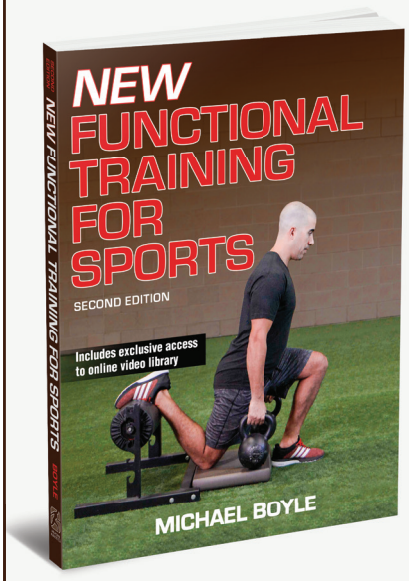

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THE POLE VAULT TAKEOFF

Veteran pole vault observer David Bussabarger continues to be skeptical about Petrov's free takeoff model. This text is adapted from a forthcoming book on the vault by Bussabarger and Bruce Caldwell.

BY DAVID BUSSABARGER
All illustrations by David Bussabarger

INTRODUCTION

The thrust of the following section of my forthcoming book on the vault (co-written with Bruce Caldwell) is to question the so-called free takeoff or the model developed by Ukrainian coach Vitaly Petrov. The Petrov model, particularly his free takeoff concept, was simply a hypothesis with no basis in the real world when originally proposed. Petrov believed/believes that fiberglass vaulters should take off like past rigid vaulters (particularly Warmerdam). That is, the fiberglass vaulter should takeoff "out" and emphasize jumping directly upward at the instant of takeoff in order to produce overhand rotation in the pole to move it to vertical. At the same time the vaulter should avoid bending the pole until he/she is airborne (this and taking off "out" are the most common ideas associated with the free takeoff).

Petrov taught this technique to Bubka. Ironically even Sergey Bubka had difficulty executing a free takeoff consistently and very few if any other elite male vaulters employ/employed a free takeoff as proposed by Petrov.

There are several critical problems with Petrov's free takeoff concept.

(1) The great majority of elite male fiberglass vaulters have always taken off " under". Note that among 6m and better vaulters only Tarasov, Gataullin and Markov consistently took off "out".

(2) Proficient fiberglass vaulters do not rotate the pole in an overhand motion towards vertical like past rigid vaulters. A critical advantage of fiberglass poles is that the bend of the pole allows vaulters to push the point of grip inward as it bends (based on the penetration force of the takeoff) along a low, underhanded path. This allows fiberglass vaulters to grip as much as 3 ½ feet higher than the highest gripping rigid pole vaulters.

(3) A second related critical advantage of bending poles is that the vaulter can develop much greater forward takeoff drive or penetration force during the execution of the takeoff. This greatly increases the energy input into the vault which produces much higher vaults vs. rigid poles, given proficient execution of overall technique. If the vaulter attempts to execute a free

takeoff as Petrov recommends, he/she will be working directly against the development of forward takeoff drive. I am convinced that Bubka was able to achieve outstanding results using a free takeoff because of his unrivaled speed on the runway, which helped compensate for the reduction in the development of his forward takeoff drive.

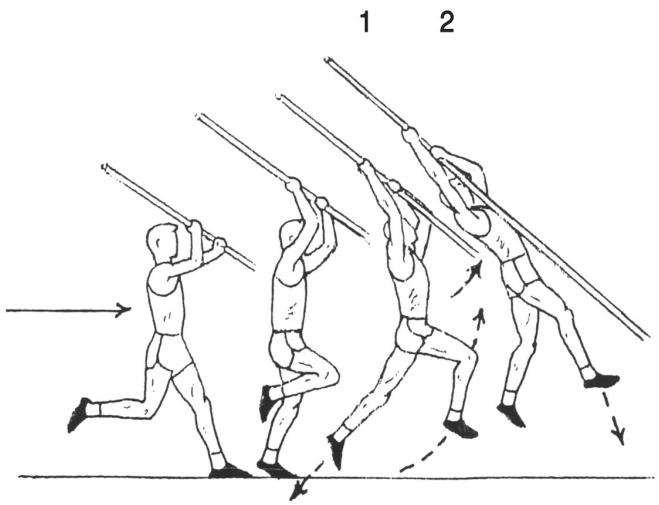
The men's world record in the vault has been essentially stagnant for more than 20 years. It is reasonable to assume that in the future 6m vaults will always be regarded as an outstanding performance. It is also reasonable to conclude that any vaulter who can vault 6 meters must have excellent technique. All 19 6-meter vaulters past and present have a recognizable individual vaulting style. This is strong evidence that no one ideal technical model exists. Therefore it is my opinion that knowledge about fiberglass technique should be derived from the study of the actual technique of the best vaulters and not on a hypothetical ideal technical model.

THE TAKEOFF

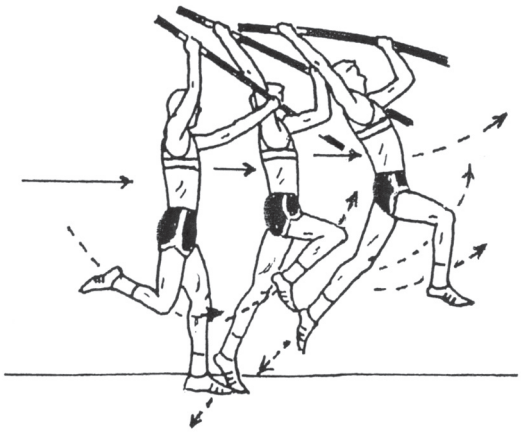
The single greatest difference between the execution of a rigid pole takeoff from the past and an effective modern fiberglass takeoff is that the fiberglass vaulter must place great emphasis on driving forward into and through the takeoff action. Common sense dictates that the more energy a vaulter can successfully inject into the vaulting action, the higher the potential vault. This is not only a matter of how much speed the vaulter can develop during the run, but also how much inward force the vaulter can generate during the takeoff action. THE FACT THAT THE BENDING ACTION OF FIBERGLASS POLES ALLOWS THE VAULTER TO EFFECTIVELY DEVELOP MUCH GREATER FORWARD TAKEOFF DRIVE VERSUS RIGID POLES IS ARGUABLY THE SINGLE GREATEST ADVANTAGE OF FIBERGLASS POLES.

Early coaches and vaulters were quick to understand this point. To quote renowned coach Ken Doherty, author of the famous *Track and Field Omnibook,* "The driving action forward at takeoff must be accentuated in order to get an optimum bend and therefore propulsive force out of the pole." Although this statement is an oversimplification it is still essentially correct. Ironically, today Vitaly Petrov's free takeoff theory, which is almost universally accepted, claims that the vaulter should avoid driving forward into the pole at takeoff. However if one studies the takeoff technique of elite male vaulters one finds examples of vaulters actually executing a free takeoff (as Petrov proposes it should be) to be extremely rare. Even Sergey Bubka, Petrov's star pupil, could not execute a free takeoff consistently. So again, we have a situation where theory conflicts with real world results.

THE TAKEOFF



Ron Morris typical rigid pole takeoff



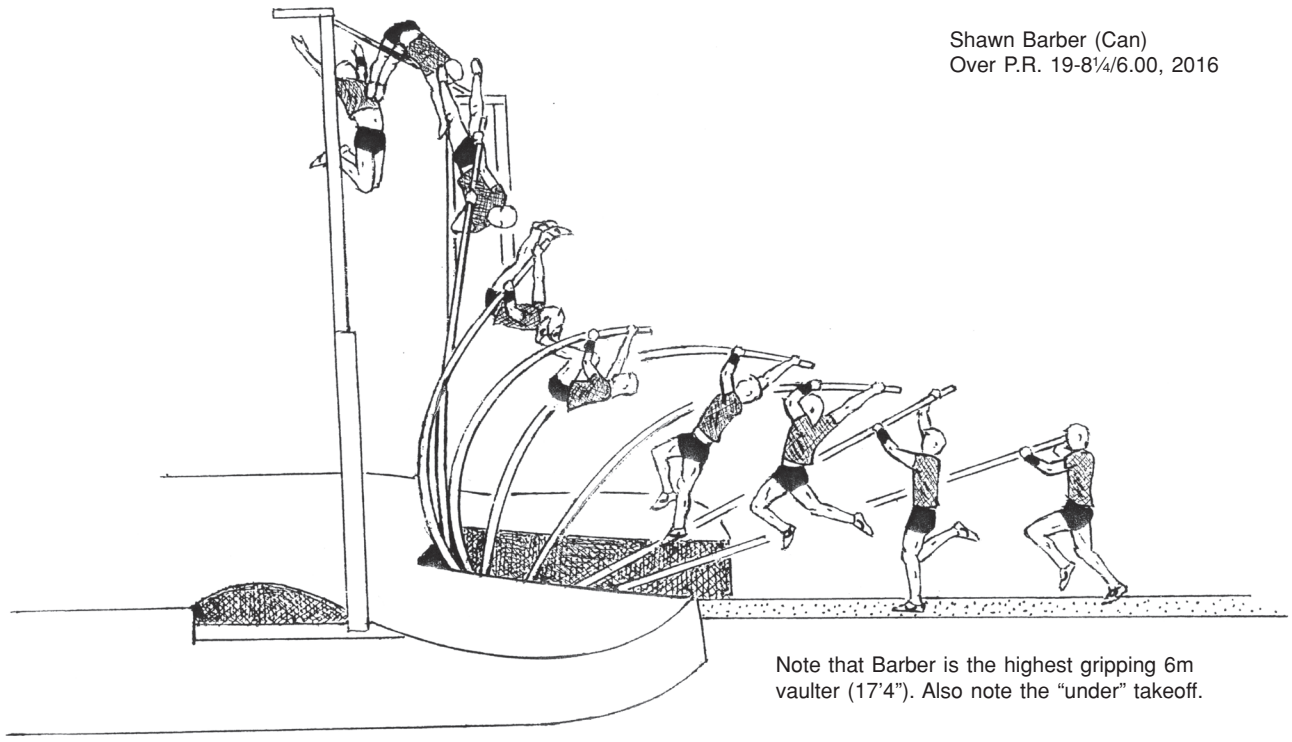
Kjell Isaksson basic figerglass takeoff

The rigid pole takeoff was designed to (1) Use a pronounced gather/spring-up action to generate overhand rotation in the pole. (2) Use a following arch/hang action to begin converting forward momentum into upward rotary momentum. In contrast, as previously stated, fiberglass vaulters must emphasize the development of forward drive into and through the takeoff.

This means (1) The vaulter must emphasize sustaining/attaining maximum speed on the final strides of the run before the takeoff. (2) The vaulter must emphasize keeping his/her posture erect during the final strides of the run. (3) Vision should be straight ahead or only slightly upward as the vaulter leaves the ground. (4) The gather/spring action must be streamlined or minimized and the springing action should be more forward/upward (versus upward) to conserve forward momentum. (5) The vaulter must control the position of the hips during the execution of the takeoff and not allow them to rotate ahead of the shoulders. (6) The vaulter should emphasize pressing the torso/c.o.m. inward during the takeoff which allows the vaulter to use his/her body weight to increase the force of the takeoff. (7) The overall action of the takeoff should be executed in as continuous a manner as possible.

John Pennel was the first fiberglass vaulter to continuously drive the lead knee upwards during the takeoff. Today the great majority of elite vaulters use this technique. Its most important advantage is that it unifies the takeoff action and promotes continuous forward movement through the execution of the takeoff. Some fiberglass vaulters, such as world record holder Renaud Lavillenie, still use a variation of the two-phased rigid pole takeoff. However the overall movement of the takeoff is more continuous and its direction of movement is much more forwardly oriented versus past rigid pole takeoff technique. Finally there are also many variations of the fiberglass takeoff that fall somewhere in between these two takeoff styles.

There are many observable variations in the action and positioning of the lower arm during the takeoff (including differences in hand spread). At one extreme many elite vaulters press the lower arm outward or upward and keep it fully extended during the takeoff. When combined with a wide hand spread this maximizes leverage action against the pole and facilitates bending stiffer poles. On the other extreme some elite vaulters successfully use little if any pressure/extension of the lower arm against the pole during the takeoff. Again there are many variations of lower arm action and positioning that fall somewhere in between these two extremes.



Note that Barber is the highest gripping 6m vaulter (17'4"). Also note the "under" takeoff.

APPLYING BASIC SCIENCE TO FIBERGLASS TECHNIQUE

From a basic science point of view, theories cannot be correct if they contradict what is happening in the real world.

BY DAVID BUSSABARGER

INTRODUCTION

From a basic science standpoint your ideas/arguments cannot be correct if they contradict what is actually happening. For example, for several decades now it has almost been universally accepted that vaulters should take off "out", and that taking off "under" is an undesirable flaw in execution. There have been studies done by biomechanists which have found that taking off under reduces takeoff velocity. So, the farther under the takeoff point, the greater the loss in velocity. This is because if the vaulter takes off under, he/she contacts the pole before leaving the ground, which produces resistance against the continued inward movement of the vaulter, thus reducing takeoff velocity.

Although this sounds convincing, in the real world, the great majority of the best fiberglass vaulters take off (took off) underneath. For example, as stated in my book, among the 19 6-meter or better vaulters, only Tarasov, Markov and Gataulin consistently took off "out." The takeoff point of Bubka and Lavillenie varies/varied from vault to vault, sometimes out and sometimes under. The other 14 typically take off under. At the extreme end, Brits, Ecker and Galfione all normally took off 18" to 24" under.

So, the obvious question is how can so many vaulters jump so high with such a supposedly serious flaw in execution? My point of view is that from the perspective of basic science there has to be something wrong with the conclusion that taking off under is a disadvantage or a technique flaw. A possible solution to this conundrum is that the critical point is not the velocity of the vaulter as he/she leaves the ground, but rather the velocity of the vaulter as he/she contacts the pole. As of yet, I have found no takers for this idea because so many in the vault community are completely convinced that their current thinking is correct./ David Bussabarger.

APPLYING BASIC SCIENCE

It is the writer's point of view that the best method for developing an accurate understanding of fiberglass technique is to apply basic science to the problem. In the most fundamental sense, science is based on

first observing phenomena in the real world, then coming to conclusions about said phenomena using reason/logic and finally verifying these conclusions based on empirical evidence (observation of the real world, experience and or experimentation). Using this methodology should be within the reach of any reasonably intelligent person and should not require a specialized university degree.

A critical related point in science is that an idea, theory or hypothesis cannot contradict reality and still be considered to be valid. For example Einstien's Theory of General Relativity proposes (among other things) that the passage of time is not absolute but rather relative to specific circumstances. One prediction of this theory is that time is slowed by close proximity to a large mass such as the earth. Conversely, time should speed up as distance from a large mass such as the earth increases. Real world proof of this theory is the current GPS satellite system. GPS satellites depend on onboard clocks that must synchronize with clocks on receivers on the ground for the system to work. As Einstien's theory predicts, the clocks on the satellites, which orbit at 12,500 miles above the earth, run faster than those on earth (so they must be adjusted to synchronize with the receiver's clocks on earth). If the satellite's clocks did not run faster than those on the earth, Einstien's entire Theory of General Relativity would be considered false or invalid by scientists.

A great many coaches and vaulters claim that certain variations in execution, such as the "tuck and shoot" rock-back and extension style and taking off "underneath" are undesirable flaws in execution (the writer assumes that the reader is familiar with and understands these common terms). These coaches and vaulters present seemingly convincing theories, scientific studies, and arguments (some of which are based in physics and biomechanics) to "prove" their point. The problem is that is that said theories, studies and arguments conflict with what the best vaulters actually do in the real world. For example, based on thorough studies done by the writer, most of the best vaulters of all time take off "under." Seven of the top 10 vaulters in the world in 2015, including world record holder Renaud Lavillenie, are tuck and shoot style vaulters.

Therefore, keeping in mind the example of Einstien's Theory of General Relativity, the conclusions of these coaches and vaulters must be considered false if the methodology of basic science is followed, because they conflict with reality. Another way to approach this idea is to say that any given variation in execution must be PROVEN IN THE REAL WORLD to limit performance before it can be legitimately claimed to be a flaw in execution. An obvious example here is taking off on the wrong foot (the right foot for right handers).

Continuing to use basic science as a guide, the development of accurate information on fiberglass vaulting technique should begin by studying the technique of a good number of the best vaulters. Currently there are 19 vaulters who have cleared 6m or better. These 19 vaulters make an excellent group to use for study. An important point here is that since vaulting performance has been essentially flat among elite men for over 20 years, it is very reasonable to conclude that 6m will always be an outstanding performance and that any vaulter who can clear 6m must have outstanding technique.

The writer recommends the careful analysis of each phase of the vault (and every aspect of each phase), looking for elements of technique that are common to all the vaulters in this group. Once isolated, these common denominators can be used to form a foundation for the technique of all vaulters. Aspects of technique that change from vaulter to vaulter in this group should be considered acceptable variations in technique. Some examples are variations in the specific takeoff point, variations in the action and position of the lead leg during the takeoff, variations in the action and position of the lower arm during the takeoff and so on.

It is recommended that if a coach is working with a vaulter who instinctively uses any given acceptable variation in technique, the coach should adopt it as part of the vaulter's natural style. This approach to coaching will require the coach to have broader understanding of vaulting technique vs. using one model for all vaulters (such as the Petrov model). However the writer is convinced that a more open-minded approach to coaching will produce superior results. Note that it is this writer's point of view that a great many talented vaulters are ruined by coaches who try to force fit them into their idea of one ideal technical model. Keep in mind that Renaud Lavillinie was able to break Sergey Bubka's 20-year-old world record using an unorthodox technical style that was considered faulty or incorrect by the great majority of vaulters and coaches at the time.

REVVING THE CARDIOVASCULAR ENGINE

Kellogg, leaving no stone unturned, describes precisely what's needed for long term cardiovascular—and competitive—development. This article is adapted from *The Coach*, Issue #33, Spring 2006. It first appeared in *Run Strong*, (2005, Ed. Kevin Beck) published by Human Kinetics.

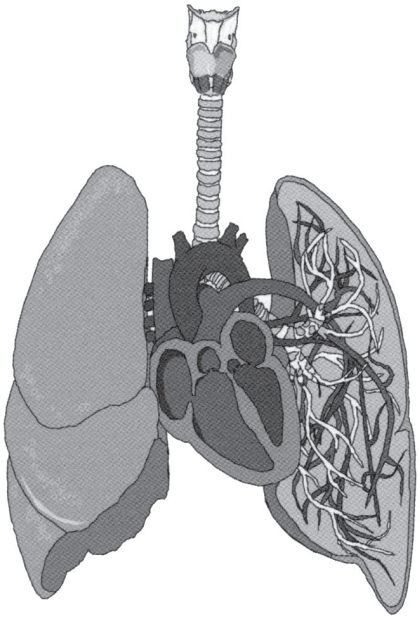
BY JOHN KELLOGG

The late Kiyoshi Nakamura, coach of 2:08 marathoner and former Fukuoka and Boston champion Toshihiko Seko, was fond of comparing a distance runner's development to a steady fall of raindrops slowly forging a hole in a huge rock over a period of many years. On some days the rain falls hard, on other days it falls gently, and on some days it does not fall at all. But in the final analysis, the process cannot be rushed, and we must wait patiently for the natural order of events to run its course before we can admire the finished product.

Too many runners are in search of "magic" workouts, when in fact the real secret to ultimate success is the patient, prolonged cardiovascular development alluded to in the rain analogy. Other runners and coaches pay mere lip service to concepts such as *base training* and *long-term improvement* without realizing how much running is actually required to fulfill a runner's ultimate career potential. Of course, you must love running or know that you can come to love it to sustain the kind of dedication embodied in Nakamura's analogy. By taking a proper long-term approach, progress will often be slower, but it will be more complete.

When deciding on a long-term path for your running, it is important to consider *universal* principles (those that work for everyone) before examining experiment-of-one success stories or principles that might apply only to certain types of athletes. Several principles apply across the spectrum of body types. These include the following:

- Gradually work toward base mileage levels that are as high as can be safely tolerated (obviously, this figure varies from athlete to athlete and depends on factors such as experience and age).
- Learn to stay comfortable on easy runs to ensure proper recovery.
- Spend an optimal amount of time at a high-end aerobic pace (at or near the lactate threshold).
- Include regular speed maintenance (in the form of short,



alactic strides—that is, bursts of speed too brief to incur lactic acid buildup-drills, and hills.

- Build toward a seasonal peak with limited injection of oxygen-uptake training and harder, faster anaerobic tolerance training.

This article focuses on how to implement all of these concepts into your training over not just a single season but over a period of years; I discuss how each relates to aerobic development, which for our purposes equates to cardiovascular strength.

BUILD BASE MILES GRADUALLY

For any distance runner, there is a distinct correlation between acquired lifetime training mileage—particularly during base-training periods—and subsequent race performances. This raises a question: Is talent for fast performances in the distances also accompanied by the ability to handle high training mileage? Possibly, but *most* runners can safely increase their mileage over time by running more slowly for much of it and by applying other principles to their training to increase their speed. Some of these principles involve common sense. Getting adequate rest, nutrients, and fluids; wearing appropriate shoes; and varying the running terrain are obviously important. Also crucial is making smooth, safe, and gradual transitions when running on new terrain, when wearing new shoes, or when training at speeds you have not touched on for some time.

It is always best to establish the highest base mileage that continues to provide a favorable cost-to-benefit ratio—that is, figuring out the highest mileage you can attain without injury or without detriment to your other training. You will find your own personal mileage sweet spot only by trial and error and by patiently building your fitness through the years. Then and only then will the training "secrets" widely sought by distance runners everywhere begin to reveal themselves to you.

In the 1970s, it was common for many American high school distance runners to average more than 100 miles per week during their preseason base-building period. This was not considered outrageous at all; it was merely the kind of thing serious runners did if they had big dreams. It was no coincidence that high school marks in the distance events were at an all-time high during this period, followed by a banner crop of American road runners and long track-event specialists in the ensuing years.

This higher mileage fell out of favor among high schoolers in the 1980s and the first half of the 1990s, apparently as a result of media influences. Subsequently, both top-end performances and the depth of these performances seemed to significantly decline during this period Since the late 1990s, there has been a return to higher mileage and more aerobically based training, and performances as of 2004 have returned to pre-1980 levels.

Upon closer inspection of the careers of the 1970s and 1980s elites, it becomes apparent that the runners who used high-mileage training *year-round* in high school tended to outperform all others during their high school years, but were often surpassed later in life by athletes who had been somewhat slower in their youth. What is common among the elite adults of that era is the fact that most were exposed to high mileage in restricted amounts during their teenage years (which likely enabled them to safely make the jump to marathon-type training later in life), yet they saved their bodies for more year-round high mileage in adulthood. The implication here is that a gradual progression toward higher mileage, with brief forays into high mileage territory during the teen years, sets a runner up for a long and maximally efficacious competitive career.

Regardless of training volume, frequent use of intense anaerobic interval training and racing in youth is a surefire way to thwart a runner's future development. So if you're a younger runner or a youth coach concerned about burnout, be far more wary of extravagant training intensity than extravagant training mileage.

The lesson here for younger runners is: Be patient! It takes years to create a sufficient mileage foundation for truly effective training and for

reaching your ultimate potential. For example, Kyle Heffner had personal bests of 4:27 for the mile and 9:42 for the two-mile in high school—well above average performances, but nowhere near the national level. Kyle was only able to handle an average training load of 50 to 55 miles per week in high school and was not structurally comfortable running 100 miles in a single week until his senior year of college, when he was barely able to run six miles at 5:00 per mile. Yet he dedicated himself to full-time training after college and patiently continued to build his mileage until he could run up to 145 miles per week, much of it at 8,000 feet of elevation and on difficult terrain. The increased training load enabled him to make huge improvements in all his personal bests from 5,000 meters up to the marathon. He went on to earn a berth on the 1980 Olympic marathon team with a 2:10:55 (4:59 per mile) and was ranked 17th in the world at the marathon distance. By gradually increasing his base mileage as he matured physically into his mid-20s, Heffner extracted the most out of himself as a distance runner.

During each new preseason, experiment with slightly higher mileage than you have previously run; for example, you may try an additional 50 miles or so spread out over a one-month period if you've got a few years of experience under your belt. Start by bumping up the volume for a few days at a time. This doesn't have to be done in seven-day blocks; two to four days at a time of higher mileage—say, 10 to 20 percent above your daily norm over the past several months is sufficient at first. Recover from that injection of volume with a lower block of mileage for two to four days or as long as it takes to feel some "snap"; then increase again for several days. An example for a runner accustomed to 40 to 45 miles a week might include a pattern of days with mileage like this: 6, 5, 6, 10, 7, 10, 8, 5, 6, 5.

DURING EACH NEW PRESEASON, EXPERIMENT WITH SLIGHTLY HIGHER MILEAGE THAN YOU HAVE PREVIOUSLY RUN.

Run extremely relaxed when you are increasing your mileage to previously unattained levels. Do not increase the mileage and the intensity (speed) of your basebuilding runs simultaneously until you have completed several seasons while incorporating each separately. You can and should run some short (15- to 30-second) buildups or strides every second or third day to provide variety, but avoid intense anaerobic work and races during these introductory high-mileage stages.

With each passing year, you should be able to increase the mileage itself and the length of the high mileage blocks, so that you are eventually capable of several weeks in a row of very high volume without the need to reduce your mileage and without incurring stress-related problems because of the volume. With each season, your average pace may also become faster than it once was, but don't force this. Just allow the faster running to come to you over time as your body becomes ready for it.

During base training, most of your effort should come from the mileage and the monotony of it all, not from a series of hard workouts. Through an increased number of muscle capillaries, a higher density of oxygen-processing muscle mitochondria, more red blood cells, and other changes directly and indirectly related to the cardiovascular and circulatory systems, you will lay the groundwork for strength that will ultimately sustain you not for a season, but for the duration of your running career!

Begin introducing the higher mileage in short doses, particularly if you are still growing or in your first two or three years of running, allowing your body to absorb the training by dropping back in volume for a while between high-mileage segments. This plan follows the stress-recovery or stimulation-adaptation principle. Expand your boundaries with higher mileage and with longer installments of high mileage from year to year as you mature. In short, keep Kiyoshi Nakamura's raindrops analogy in mind and do not try to rush things too quickly. Start at the bottom rung of the fitness ladder and gradually work your way up.

Some sessions (and how they fit together to form an overall training program) actually facilitate future mileage increases by reducing injury risk and by enhancing the effectiveness of the high-mileage training itself. Particularly important are alactic strides and other speed maintenance workouts which provide variety in footstrike characteristics, rhythm, and muscle fiber recruitment. These sessions also help increase lower-leg integrity and allow you to segue seamlessly to faster-paced running as the competitive season approaches. Spending certain time periods at the high end of aerobic effort (near the lactate threshold) is also very cost-effective; I describe this in more detail later in this article.

MAXIMIZE RECOVERY ON EASY DAYS

Runners often reach a point in their training when everything goes smoothly and a fairly quick pace seems surprisingly easy. During these times, improvements may be rapid; however inserting slower easy days can yield better results over a period of several years, although short-term gains may not come as quickly. In practical terms, if you are nearing your prime racing years—around 28 to 32 for men, perhaps a bit older for women—you may benefit from running a little quicker *average* pace on your daily runs. If you are in your teen years, however, you will likely be better served in the long term by incorporating more *slow* running, especially if you are in the process of increasing your mileage. In so doing, you may sacrifice a modicum of high school glory, but will likely achieve more in adulthood; this holds true whether your event of primary focus is the mile or the marathon.

Much of your running during the preseason or base-building periods should not only be perceptually easy; it should actually be slower pace wise than you may think is beneficial. Running "slowly"—even two minutes a mile slower than marathon pace—confers cardiovascular benefits while still allowing recovery; blasting along at close to marathon pace will not introduce significant additional cardiovascular benefits but will almost certainly interfere with recovery if sustained over days or weeks.

Of course, short strides (for speed maintenance) and some faster tempo runs during this base-building phase of training are necessary on occasion, but going too fast too often—even if it feels good at the time—can backfire by the time the peak of the competitive season arrives, as you likely won't be well-rested often enough to perform the quality sessions necessary for maximal competitive success. It is certainly possible to be fit enough from an aerobic standpoint to override your structural integrity and create overuse injuries without feeling as though the pace is fast. That is, a fairly quick pace on daily runs may seem easy to you if everything has been "clicking" on recent outings, but the impact stress, cellular overload, and muscle contractile force required usually cannot be sustained for months on end; staying close to 60 to 65 percent of max heart rate is more advisable.

Peaking for your most important competitions later in the season does not require you to be in better racing shape during a preseason than you were at the same point in previous preseasons. If you do things intelligently, you will often run better at the end of a competitive season after being slightly slower at the beginning of that season. Keeping the pace extremely relaxed and slow on many recovery days acts as a kind of insurance policy toward this goal. Most people run too fast on their easy days and never get adequate recovery; thus, they accumulate and experience chronic fatigue, often without realizing that they could be feeling much fresher. Most of your easy runs should give you the sensation of storing up energy for your next faster effort.

In 2003, Weldon Johnson ran 28:06 for 10,000 meters and placed fourth in the U.S. track championships in 2001 and 2003. He often did easy runs at 7:00 to 8:00 per mile, a pace that even many 35:00 10K runners might consider too slow to be of benefit. Yet this pace was functionally comfortable for him. Because of his overall high mileage (between 100 and 150 miles per week) and because of his accumulated lifetime volume (and buildup to this volume), even this slower pace was sufficient for maintaining capillarization of his muscles and some fitness as long as other crucial training bases were covered regularly. This last point is important. Weldon did not always run slowly; otherwise he would risk being a plodder and would never maximize his potential. He performed his share of challenging workouts leading up to competitions (even performing intense anaerobic ones during his base phase), but he always made sure he was reinvigorated for his faster sessions when they were scheduled, even taking an extra (unplanned) easy day from time to time. Meanwhile, many midpack runners run at medium speeds on easy days and are rarely relaxed and rested when it is time to run hard. As the Japanese standouts of both sexes have long demonstrated, extremely slow miles—even if done a pace most would consider jogging—really do have a beneficial effect as long as they're supported by the requisite sharpening work, particularly, but not only, for marathoners. It's all grist for your mill.

SPEND TIME AT YOUR LACTATE THRESHOLD

To understand the cardiovascular benefits of training, you need to understand what occurs in your body—in particular your heart and bloodstream—when you run at specific intensities for specific periods of time. Properly allocating the amount of work you do among various well-defined intensity levels

is vitally important in terms of your long-term development as a competitive athlete.

When examining specific training speeds, familiarity with a few terms promotes better understanding and facilities discussion of the involved physiology; among these terms are lactic acid, blood lactate, and lactate threshold.

Lactic acid is the end product of anaerobic glucose metabolism (glycolysis). During intense efforts ranging from 200-meter track sprints to hour-long road races, glucose is converted to pyruvic acid, which is in turn reduced to lactic acid. Lactic acid dissociates quickly into lactate (its negative ion) and free protons, and it is usually referred to as lactate. It was long thought that the protons were responsible for interfering with muscular contractions, causing the "tying up" experienced during all-out efforts lasting longer than about 40 seconds (e.g., 400 meters and 800 meters or a long sprint at the end of a 5,000-meter race). More recent research (Robergs 2001) shows that this may not be the case. However, excessive lactic acid production during exercise goes hand in hand with the experience of tying up, and thus it is prudent to limit the amount of time at the effort level that results in this production; otherwise, chronic soreness, staleness, and possible injury may result.

Crucial to limiting the amount of time you spend with excessive lactic acid production is knowing your lactate threshold (LT). Your **lactate threshold** is the point during increasing exercise intensity at which a rapid accumulation of lactate entering the bloodstream (**blood lactate**) follows an "inflection point;' or a change in the normal level of blood lactate. When lactate is produced faster than it can be cleared and begins to accumulate in the blood, a state of oxygen debt sets in and exercise intensity must drop; if it doesn't, biochemical obligation will cause activity to grind to a halt. Thus learning to stay just on the "safe side" of lactate production is absolutely invaluable (see the discussion of lactate threshold velocity).

LEARNING TO STAY JUST ON THE "SAFE SIDE" OF LACTATE PRODUCTION IS ABSOLUTELY INVALUABLE

Lactate threshold velocity (LT pace) is the speed (expressed in meters per second or kilometers per hour) or, more commonly, the pace (expressed in minutes and seconds per mile or kilometer) required to bring a runner to his or her LT or just below the point of rapid lactate accumulation. Most well-trained runners can maintain their LT pace (what could loosely be called high-end aerobic pace) for about 20 minutes before surpassing this point. A near-LT pace may be maintained for an hour or more, but once the threshold is reached, the accumulation of lactate is inevitable, so the effort will likely alternate between high levels of aerobic metabolism, and anaerobic metabolism, and the pace will eventually have to slow. At such times, the runner will reach the respiratory compensation point, resulting in extreme hyperventilation.

Experiencing this point in training may help the athlete learn to monitor the pace just below the LT in a tempo run during training. From the runner's point of view, the effort level just below the LT could accurately be called "maximum steady state"; because all systems usually remain perceptually in equilibrium until the LT is reached. The ability to recognize the pace corresponding to LT—and by extension, the physical signs of reaching LT—is critical; the benefits of training as frequently as possible at this pace are substantial, while training at faster than LT pace can only be done in relatively short bursts because of lactate accumulation and its deleterious effects on working muscle.

So how can you determine your own lactate threshold? You can use data from a heart rate monitor to estimate where your LT occurs, but it is usually best to rely on sensory feedback (running by feel) to find that high end of aerobic effort. Many runners try to rush the process and begin doing hard tempo runs without first becoming attuned to the finer sensory signals that indicate that they are reaching their threshold. With enough background training at speeds somewhat slower than your maximum steady state (which you achieved with proper base building), you can turn your own body into an exquisitely tuned "lactate analyzer." This is something you must do to get the most out of your threshold workouts, especially when you begin to phase in sessions that might cause you to slightly exceed your threshold.

One of the first noticeable changes occurring at the lactate threshold is in the breathing pattern. Depending on the ability of the fibers of the working muscles to take in and use oxygen and to store fuel (also depending on the intensity of the work itself), you begin to breathe either harder or faster or both once

you reach your LT. This is due to the fact that extra carbon dioxide is produced from the buffering of lactate by bicarbonates in your blood, from increased burning of carbohydrates to produce energy, and from lactate affecting chemoreceptors in the brain. Once you begin breathing harder and faster (hyperventilating), you've reached your respiratory compensation point and have already surpassed your LT. You also begin getting the first hint of tightness, perhaps in the legs, but possibly in the arms or abdomen, when you've operated above (faster than) your LT for several minutes.

At some point, you will want to find the fastest pace that keeps you feeling relaxed and in a good groove, the pace that trains you yet doesn't strain you. This strong, purposeful running is often referred to as a "high-end aerobic pace." This effort level is not a hard pace if sustained for only 20 minutes or so, but it certainly isn't jogging, either. The most effective training speed is at (or slightly slower than) that which you can maintain for about an hour in an all-out, evenly paced race. Beginners will not be able to run at a strong pace for a full hour or more, yet they have a high-end pace, too. They just cannot maintain it very long and may have to run in short segments with walking or jogging breaks when training at this effort level. Lengthening the amount of time you can maintain your high-end pace is part of what cardiovascular development is all about.

Some experienced runners can spend time training at their LT, or high-end, pace nearly every day, but most people are better served by including a greater number of very easy days in between their high-end outings, with perhaps one and one-half to two easy days for every high-end day. Again, cardiovascular development may take somewhat longer with these very easy days included, but it is usually more thorough after several years. Also the baseline fitness you establish with slower runs will contribute to a more ideal running weight; this will allow you the most productive high-end tempo runs.

A good high-end run should feel like one of those outings that begins as a planned easy day but then spontaneously progresses into a memorably awesome, fast run because you begin to get a floating, weightless feeling. As you become more fit, the pace should feel as though it is establishing itself, and you are just along for the ride. One of the keys to achieving this enjoyable and effective state is to start extremely slowly and to remain at this slow pace longer than you think is necessary. Your transition from slow shuffling to faster running should be so gradual that there is no definable point of effort increase. Conscious relaxation assists in achieving a near-effortless maximum steady state. As you gain fitness, you may find that you can reach the high end of aerobic effort sooner during your runs without a conscious attempt to do so. You may also find that you can summon the magic at will and summon it more frequently.

On most high-end runs, you should have the discipline to pull the ripcord, i.e., bring the fast portion of the run to an end, before you experience undue struggling or tying up. The amount of time you accumulate before struggling actually contributes more to your aerobic development than does the time spent fighting on after beginning to suffer. You can occasionally go ahead and release the hounds with a very fast finish to a continuous tempo run if you really feel awesome and want to fly, but try to avoid doing this too often or the effect will be similar to over-racing. Of course, if you are extremely tired and cannot find the groove you want, you should stay at an easy pace throughout the entire run.

You can and should perform lactate threshold training for different lengths of time and at various speeds. On continuous threshold efforts, you may skirt right on the brink of struggling and run for a moderately short time (20 minutes or so) or you might hold back slightly from that pace and stay even more controlled for up to an hour. Performing runs of various lengths in this fashion provides a slightly different stimulus for improvement from workout to workout and relieves the possible monotony of grinding out the same pace on every high-end run. Most coaches and physiologists agree that 20 minutes seems to be the "ideal" duration of a true lactate-threshold run, although marathoners often go twice this long. Track athletes typically de-emphasize threshold runs in favor of faster interval work during the competitive season, whereas road racers—especially marathoners-keep them as a staple throughout.

Do not hammer these sessions in an attempt to hit a predetermined pace; just allow perceived effort (sensory feedback) to dictate the speed. By all means, avoid racing your high-end runs, either against your training partners or against your times from previous outings. Your aim is to lock into the pace that will train you, yet force a slower runner to strain, i.e., relax a runner,

kill a jogger. This pace may vary from day to day, so focus instead on your effort level.

One final note, it is a good policy to wear *racing flats* for most high-end workouts. Doing so ensures a more natural foot strike and fosters better foot, ankle, and lower-leg strength and flexibility, which will ideally reduce injury risk. Wearing racing flats also affords you the opportunity to achieve the fastest pace for any given effort level. Finally, regardless of your distance of choice, include year-round regular speed maintenance in the form of short alactic strides and drills.

BUILD TO A PEAK OF HIGHER-INTENSITY TRAINING

When you first experience a nonlinear increase in lactate as a result of increased running intensity, bicarbonates in the blood buffer the lactate entering the bloodstream, which precipitates an increase in CO_2 production. This stage of exercise is known as the *isocapnic buffering period.* At some point, as the intensity increases (or as moderate intensity is prolonged), lactate production exceeds the buffering capacity of the system, resulting in an additional drive to breathe, which marks your respiratory compensation point. In practice, this means you begin hyperventilating and start to have a tight, straining feeling, a sign that you've crossed your lactate threshold.

Isocapnic Buffering Zone

The isocapnic buffering zone is a highly effective training zone that is also fairly safe for many hard workouts are slightly faster than your maximum steady state (at or slightly above your threshold). This involves a very thin window of effort intensity, i.e., even the slightest misjudgment in pace or in duration of effort can send you sailing into distress. The state you want to achieve is a pleasantly challenging or barely uncomfortable feeling that is just short of the onset of hyperventilation. You should be pushing, but should not quite be in trouble. Particularly competitive runners tend to make these workouts harder than they need to be for maximum effectiveness. As with continuous high-end, or LT-pace, running, you might need to experiment to get the effort intensity just right. Consequently, you need to spend some months improving and learning to recognize your maximum steady state before focusing on training in this nebulous area between comfortable and uncomfortable.

THE STATE YOU WANT TO ACHIEVE IS A PLEASANTLY CHALLENGING OR BARELY UNCOMFORTABLE FEELING THAT IS JUST SHORT OF THE ONSET OF HYPERVENTILATION.

You can train most effectively in the isocapnic buffering region by using repeats that feature short rest periods relative to the run periods. An example of such a workout is 10 to 15 X 3 minutes at about 8 to 12 seconds faster than the pace you could run for one hour in an all-out, evenly paced race, with 30 to 60 seconds recovery between each 3-minute bout; less experienced runners should gravitate at first toward the longer recovery interval. Just take enough rest that you are ready to go again and achieve that same nearly uncomfortable feeling by the end of each bout, but pace yourself so that you need only 30 seconds or so between reps. If you feel you are going over the intensity after 8 reps, you can end the session when you finish the 10th rep. If you feel great through 10, you could do 12 or even 15 reps. Remember—do nor be a slave to numbers written on a workout schedule. Other sample sessions that achieve this training include 5 X 7 minutes at slightly faster than one-hour race pace (LT pace) with about 2 minutes of walking or jogging recovery or 3 X 15 minutes with 3 minutes recovery of mostly jogging. Regardless of the parameters you choose, remember to monitor your physical signs to determine what "zone" you're in and whether you're pushing roo hard for the workout.

Breaking up a workout into segments in this fashion allows you to spend more time in the isocapnic buffering zone than would be prudent in a continuous run (although continuous high-end runs are important in their own right and should never be neglected). For example, if you ran longer than, say, 25 minutes at your LT pace, you might drift from being under control to a state of hyperventilation and suffering. However, you could amass more than 30 minutes at a marginally faster pace with less distress (and with less continuous pounding) by running those medium-length segments with short rests as outlined previously. Trial and error shows that spending a total of 30 to 45 minutes at your LT pace or slightly faster with these short rests between the work bouts is most effective. Of course, you must first have enough background running to be capable

of running at a fairly strong pace for about an hour!

VO_2max Zone

To produce energy aerobically, your working muscles must consume oxygen. Oxygen uptake (also known as VO_2) is a measure of how much oxygen your body is consuming at any given time. It is usually expressed in milliliters (or sometimes in liters) of oxygen consumed per minute of exercise. The V in VO_2 stands for ventilation. A dot over the V represents "per minute" oxygen uptake.

There is an upper limit to how much oxygen your body can consume. This figure varies according to hereditary factors, with training (including childhood activity), and sometimes with living conditions such as high altitude. This maximal oxygen uptake is customarily referred to as VO_2max and can be expressed in either absolute terms (usually milliliters of oxygen consumed per minute) or in relative terms (milliliters of oxygen consumed per minute per kilogram of body mass) to compare values between individuals. Running performance at VO_2max is strongly assisted by anaerobic energy production, which means that lactate levels can be very high after several minutes of running at maximal oxygen uptake.

Exercise physiologists normally take measurements of an individual's VO_2max using a maximum effort running test on a treadmill. When following most testing protocols, in which the subject begins at slow speeds and then increases the intensity at regular mtervals, there is a speed associated with working at VO_2max, that is commonly referred to as velocity at VO_2max (or VO_2max pace). Of course, this value varies from runner to runner, but it is normally the pace that a runner could sustain for roughly nine minutes in an all-out, evenly paced effort.

When training at your VO_2max, you want to minimize the negative effects of lactic acid accumulation so that your movements remain efficient, muscle groups are recruited in harmonious concert, and aerobic energy production dominates your efforts as long as possible. Therefore, prudent use of training in this zone involves shorter repeats of 2 to 4 minutes each at this pace, with nearly equal rest-to-run ratios and with about 15 to 20 minutes total time spent at the pace.

Examples of VO_2max workouts would be 8 to 10 X 2 minutes on, 2 minutes off jogging some or all of the rest period) or 5 x 4 minutes on, 3:30 off. This format works the respiratory muscles, improves the ability of the left ventricle to deliver more blood per stroke, induces maximal oxygen uptake, and provides a small (but not excessive) degree of anaerobic tolerance training. As with easy runs and high-end continuous runs, you can perform these "VO_2max repeats" on a cross country course or on a track. These workouts are quite challenging after accumulating 15 to 20 minutes at this pace, but with adequate recovery periods your lactic acid levels should stay somewhat under control, so that you will not tie up and resort to flailing, struggling movements, or even slow down while increasing your effort. For maximum effectiveness, you should pace yourself so that you can run the last few reps in a VO_2max session faster than you ran the early reps.

It is normally best to keep the run distances or durations constant within the workout, i.e., use all 800s or use all four-minute runs rather than using ladder (also called pyramid) sets or step-down sets. This trains you to monitor effort better and to mount rising fatigue with additional effort in a more linear fashion. It is also desirable to vary the distances from session to session. This provides variety in duration of effort and prevents you from obsessively comparing times from previous workouts, which leads to forcing too fast a pace too early in the session.

If you are feeling pleasantly "itchy" and want to run a little faster than your usual VO_2max pace, an effective session consists of running repeats of 30 to 60 seconds each at the speed you could maintain for about six minutes in a race, with equal rest periods in which you jog exactly twice as slow as the speed you are using on the work bouts. For example, a high school runner with recent bests of 4:35 for 1,600 meters and 10:00 for 3,200 meters might choose to run repeats of 200 meters in 36 seconds each (about midway between 1,600 race pace and 3,200 race pace), with a jog of 100 meters in 36 seconds between each 200. He continues until it becomes difficult to maintain the pace of the faster segments without tying up. High schoolers are invited to do such workouts; they just shouldn't form the cornerstone of a younger runner's training program, as too often happens.

As with most timed sessions, oxygen uptake workouts should be those in which you let a strong, challenging rhythm come to you, not sessions in which you write down rimes and hit them at all costs. Most people

make enormous improvements in their race times or places once they add a few weeks of these (and faster) workouts, then they incorrectly conclude that hard interval running is the most important type of training. Do not adopt the attitude that killer workouts automatically create fast races; this is not entirely correct. Superior aerobic fitness plus a few judiciously spaced fast workouts (including a killer one here and there) create fast races. Once you have built an adequate base, you can do fast workouts as often as once per week, and "killer" ones perhaps once every three weeks.

OPTIMIZE YOUR RUNNING TIME

The reason you should work at certain percentages of parameters such as LT pace and VO_2max pace is to optimize your time spent running. Over a few months, the person who spends a fair amount of time training within the most favorable guidelines—at speeds that are proven to provide the best return for the investment—gains an advantage over an equally talented fellow runner who strays outside of these boundaries and trains haphazardly roo often. This advantage may be minimal during the course of one or two seasons, but if you follow the correct guidelines, the differences become more pronounced after several years of persistent and methodical training.

Having offered that advice, it is crucial that perceived effort almost always trumps rigid numbers. Your LT pace and your VO_2max pace will not be exactly the same every time you attempt to run at some percentage of either of those parameters. Weather conditions, recent diet and hydration, recently run sessions, and so forth all add up to produce workout-to-workout fluctuations In your rate of lactate production or rate of oxygen consumption. It is also all too common for runners to use all-time personal bests or atypical performances when determining their training paces from charts, rather than relying on recent races or on performances they normally produce.

When given the option, runners with big goals are usually headstrong about hitting specific times rather than applying principles to their workouts, but it is more important to get the desired effect than it is to satisfy the stopwatch. Times should be guidelines only. Making a daily practice of hitting fixed times at all costs is often a prescription for reckless overtraining and subsequent burnout.

In the same vein, regimented, canned systems that lay out, months in advance, an unmodifiable list of specific daily workouts are about as effective in running as a similarly inflexible scheme is in monetary investment. You may profit a few times by visiting a casino and applying an algorithmic system, bur the odds are not in your favor over a longer time frame. You are much better served by diversifying your portfolio while following proven long-term investment principles.

Using this approach, you may have seasonal ups and downs, but you will come out ahead in the long haul if you keep your cool. Once you have enough in the bank, you can then use some of your resources to take those really big risks on occasion. With that in mind, be wary of strictly paced cookie-cutter training systems offered in books or magazines. Instead, be somewhat flexible and think of critical training speeds (and percentages of them) as a kind of road map, a way of pointing you to the neighborhood the pace should be in on certain workouts. The more often you can hit the exact level of effort that yields the desired result for each session, as opposed to merely adhering to precise pace-per mile constraints, the more cumulative benefits you will reap over the course of several seasons.

No aspect of fitness stands alone. All physiological systems must be optimized This is where rigorous, controlled laboratory studies often muddle the training picture by examining only a few factors at once, therefore being of limited scope, particularly if the test subjects are rats, whose "running careers" last only a few months. What is best is to experiment with these restricted findings to see if they blend in favorably with the greater context of long-term training.

It is myopic, for example, to believe that raising maximal oxygen uptake is the Holy Grail of training and that 40 miles per week is sufficient total mileage for a serious distance runner. Drawing that conclusion is analogous to quaffing a soft drink, getting a quick energy burst, and reasoning that simple sugars and caffeine are the nutrients that matter most in meeting day-to-day energy requirements. Yes, this will provide a quick fix, but it is not optimal over an extended period. In order for you to reach fruition as a runner, you must incorporate the full spectrum of training, with each energy system worked at its proper time and in satisfactory balance with the training of other systems. To quote Kiyoshi Nakamura, "When you break down

(Continued on page 6894)

DISCOMFORT

Every runner is familiar with discomfort. If you expect to improve, you must train harder, and with that comes. . . discomfort. This piece is adapted from *The Inner Runner,* Dr. Karp's new book which is available from amazon.com or run-fit.com/books.

BY JASON KARP

I used to coach a recent college graduate who commented on the fact that many of the best college distance running teams in the U.S. are based in cold climates. He believed this was more than coincidence because he thought that running in cold, icy, snowy weather makes runners tougher. Anyone can run when the weather is nice, after all. But it takes a warrior to brave the elements and run outside in cold climates. I'm not sure if I agree that running in the cold makes you a better runner, but it certainly demands something of you that more temperate climates don't. Successful runners have a certain toughness about them, a willingness to be uncomfortable, to train despite less than ideal climatic conditions. While that toughness, like certain physiological traits, is largely genetic, you can acquire toughness through training, as you become more capable of tolerating high degrees of physical discomfort. While running easy every day is easy, don't shy away from difficult workouts, even in the rain or the cold, as they will help you develop the toughness you need to become a better runner and handle life's difficulties and different conditions.

At a recent track meet, I was talking to a fellow runner in his fifties before the start of our race. He told me, "After all these years, I still get nervous before every race." I smiled and responded, "That's because you know it's going to be uncomfortable." To which he responded, "That's a big part of it."

Runners do something very unique—we seek out discomfort. Yet we get nervous and anxious about it. Every interval workout and every race is physically and even emotionally uncomfortable. After you get past a certain point, whether with your total running experience or with your specific workout on Tuesday, that's all there really is. Runners deal in discomfort. It's our currency. The million- dollar question is why do we do this? Why do we put ourselves in a position in which we're going to be physically uncomfortable, especially when we know the anxiousness and nervousness and physical symptoms it causes? Most people go through every day of their lives never experiencing what that feels like.

The answer, at least for me, is quite long and difficult for non-runners to understand. Sometimes, it is even difficult for me to understand. I am reminded of what Friedrich Nietzsche said: "He who has a why to live for can bear with almost any how." The self-exploration, the complete and utter freedom of all-out

physical effort is my why. It makes me feel alive. The anxiousness that preempts the discomfort keeps me on that razor's edge—just enough to make me aware of my thoughts and feelings, to know that I am human, yet not so much that it incapacitates my ability to perform.

We learn about ourselves when we're uncomfortable. One of the things I learned very early in my running life is that *running forces you to learn about yourself in ways that you just can't get in the rest of your life.* During those moments in every race, in every interval workout, when it's physically uncomfortable, we are presented with a question: Do we back off from the discomfort of the pace to make it hurt less, or do we meet that discomfort with all of the courage we have and push through it to achieve the result we want to achieve and to learn about ourselves in a very unique and extraordinary way?

We are asked in no uncertain terms, "What are you going to do right now?" Few other times in our lives are we asked such a decisive question at such a decisive moment. It's very revealing. Sometimes, we find out things about ourselves we can be immensely proud of. We are proud of ourselves for dealing with the discomfort in a positive way, to rise above something uncomfortable to find something extraordinary. Other times, we find out things about ourselves that are less desirable, things we would rather not admit, things we don't really want to know. It is in those revealing moments that we learn about how we handle difficult situations.

For better and for worse, we get to know who we are. If we fail or disappoint ourselves, we can make a pact with ourselves to handle those situations better next time. When I'm in the middle of a workout, I often think about how I'm going to feel after it's over, that sense of calm and pride that washes over me in the moments afterward, when I get to bask in the glow of what I have just completed, when I can take a look back at the track as I leave the stadium and say, "I defeated you today." But that is not enough. I must earn the calm and the pride. As it is written in the book of Romans (5:3-5): "...we rejoice in our sufferings, knowing that suffering produces endurance, and endurance produces character, and character produces hope..."

Running gives us the opportunity to seek out discomfort so that we may learn to deal with it, rise above it, and become hopeful about our future. And that's very much like life. Just like in running, there are moments in life that are difficult and test our resolve. When we are faced with problems, when we are faced with an enormous amount of stress, do we back off and hide under the bed sheets, or do we meet that problem or that challenge head on?

The trick to running, if there is a trick, is to become comfortable with being uncomfortable. How do you do that? By subjecting your body to the training. By running more miles, by running more miles faster, by pushing yourself just a little harder in the last two miles of your long run, by trying just a little harder on the next-to-last rep of the interval workout rather than waiting for the last rep. Runners accept that the race will hurt, and look at it as a challenge to become the courageous people they want to be.

Be courageous with your running. The encounter with discomfort is purifying. It allows us to test the strength of our will by providing an obstacle, and we learn to what extent we are in control of ourselves.

REVVING THE CARDIOVASCULAR ENGINE

Continued from page 6892

a car, it is nothing more than pieces of iron, rubber, plastic, and glass. But when they are all put together in a correct way, it becomes a car. What would happen if even one of many screws is deformed?"

Each workout should have a purpose. A well placed easy, shake-out run is just as important a training tool as a seven-mile run at a strong pace, and (depending on the time of year) it's likely more important than 10 stomach-knotting 400s as far as long-term development is concerned. Do not merely train harder than your competitors; train smarter! Follow the proven principles that have elevated great runners to the pinnacle of the sport. Above all you must be a runner, not just a person who runs, to achieve your full potential. That is, if you love training and racing enough to persevere through the difficult times, you will likewise relish those magic moments of effortless soaring.

John Kellogg is a full-time professional running coach. *Revving the Cardiovascular Engine* is adapted from *Run Strong,* (2005), edited by Kevin Beck, published by Human Kinetics.

FROM THE EDITOR

Continued from page 6874

In retrospect we see it was a combination of shoes and surface. In the years that followed all the big shoe companies crept into that market and the changes to the shoes have been significant. Cleats have become shorter and the shoes more flexible and while ACL tears are more endemic (even epidemic) to some ball sports ACL injuries have remained an infrequent track & field injury.

Part of the reason why track & field does not suffer from this injury is that the "quick turn with deceleration" is not usually part of the sport. Sure it can happen avoiding a fall in a tight relay race or to dodge the spectator who aimlessly wanders onto the long jump runway but these are more accidental or chance encounters. Track & field by design is almost always linear (straight ahead) movement patterns.

A second factor has to do with the nature of training a track & field athlete undergoes. For the runner there are thousands and thousands of steps. The repetitive action of these ground contacts establishes efficient movement patterns that in turn stress the holding elements (ligaments, tendons, joint capsules) producing anatomical adaptation of these stressed tissues resulting in greater resiliency.

For the field eventers coaches have long championed "proper techniques." While varying schools of thought may quibble over technical nuances, at the end of the day most coaches would agree on the fundamental movement patterns of each discipline. To that end strengthening programs have been developed and refined which again, ultimately result in event-specific anatomical adaptation.

A fourth area of note is that track & field athletes are generally in better shape. I realize I'm being critical here but I'm also willing to bet dollars against donuts that if you counted the training days per year, pounds lifted, measured the work output in watts or newtons of force produced or whatever other quantification method you chose, the time, effort and energy put forth by the track & field athlete would be greater.

Track & field is an applied sport. It prizes the ability to run, jump and throw. Core stability, foot strength, balance and coordination and development of the five biomotor skills are all fundamental training concepts in track & field. Collectively "we" get this.

The ball sports tend to gloss over these fundamentals. Maybe it is due to time and facility constraints. Greater import is given to offensive tactics, defensive strategies and how to effectively run a time out. In track & field, we don't get time outs, it's always time NOW.

I recently did some consulting work with a local college that had 19 ACL tears in 41 athletes the previous season. As we ran the athletes through a battery of tests I was consistently struck by the pasty white skin, lack of muscle tone and a sheer lack of athleticism of these D1 scholarship women. The level playing field of Title IX? The new strength coach was beside himself on what to do. I found myself channeling my mother with "if we don't do stop this, somebody is going to get hurt."

Whenever I see a crutch-bound, leg-cast athlete hobbling along I always nod some encouragement and hope for a quick recovery for these people. Not only do they have to overcome their own self-doubts during their recovery they'll also be trying to beat the odds that this doesn't happen to them again. Who knew a level playing field would present such an unseen challenge and be a road to ruin for so many?

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RUNNING GAIT

MAKING IT BETTER

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BY DR. KENT KURFMAN

There is no "free lunch" when it comes to changing how a runner runs. Change one component of a runner's form (for instance, changing a runner from a heel-striker to a mid-foot striker), and you will also change how he uses his thigh muscles, lower legs and feet and change the stress on the bones and joints in his legs, sometimes for good, sometimes not. How a runner lands (heel, midfoot, or forefoot) is not as important a factor as we'd like to think, unless he is running at really short and really fast race paces (such as an 800 or 1500 meter race). What's more important is how far in front of the body his foot lands. Too far in front and his overall velocity will slow and he will be at more risk of injury. Running is a combination of automatic, subconscious programming as well as volitional (mentally-controlled) adjustments, all of which add up to running as a skill. The skill of running is developed as part of our overall movement development in our childhood, but can be made better and more precise with deliberate practice.

The key to increasing runners' efficiency/ economy (how easily/ smoothly they run) is to decrease any faults known to cause injury or interrupt their forward step progression. This often involves eliminating form asymmetries and improving the ability to optimally place energy into the ground during each step to push themselves forward. Sounds simple, doesn't it? Unfortunately, it's not always that easy for the therapist, particularly when the runner in front of you has a mix of problems such as weak hips, a painful knee or IT band and a history of back pain. As the jazz musician Thelonious Monk once said, "Simple ain't easy." There are ways for all of us to steer forward, though, by concentrating on key essentials that all runners need to master when improving their own form.

CUES FOR RUNNING BETTER: HOW AND WHAT

Before we get into what to optimize, we need to lay down a foundation of how to optimize form. Common sense tells us that we optimize form by directing ourselves or the runner we're working with by communicating how we want him/her to run and by having the runner practice this new way of running until it becomes natural. In other words, we give the

runner a set of directions, or a cue. Cues for running form can be divided broadly into two types—internal and external.

Internal cues are those that involve directions to a runner to change the position, direction, or motion of his legs, arms, or trunk. These are the most common ways that a runner will try to change his form, things such as trying to land on the midfoot rather than the heel or trying to keep his arms swinging front to back rather than side to side. The characteristic of all internal cues is that they rely on the runner using his own sense of movement to detect and correct his form.

External cues are those that use feedback besides our own sense of movement to help us detect and correct our form. Examples are using a metronome to match our footsteps to a given cadence to increase our step-rate, using a mirror or simultaneous video feed to watch and work on smoothing our form-faults, or even just listening to the sounds of our footsteps and trying to make them quieter. The common characteristic (and strength) of external cues is that they require us to try to aim for a standard, a "target," that gives us instantaneous feedback on whether we are succeeding or not.

We use a combination of these internal and external cues to help all runners, but there's a distinct advantage to external cues. Runners just do not perceive how they are running, for instance, whether they are landing on their midfoot or heel. Runners need feedback, some sort of simultaneous cue, to synchronize with their running form. These cues need to be simple, need to be deliberately practiced and need to be gradually removed, or weaned, as the runner learns the newer way of running. Finally, any cues you give a runner need to be positive: a runner needs to know what to do, not what not to do. For instance, telling a runner to land with his foot under his body works better than telling him not to land on his heel.

Sounds like a lot to swallow, doesn't it? In truth, it is. It's why so many of us who work with runners on their gait rely on tools such as cameras, sensors and force plates to help quantify what runners are doing. Do not be discouraged, though. Short of having your gait professionally evaluated, there are simple things that you can and need to do to optimize your running form on your own. With this in mind, here are a few of the keys that all runners should look at when optimizing their form.

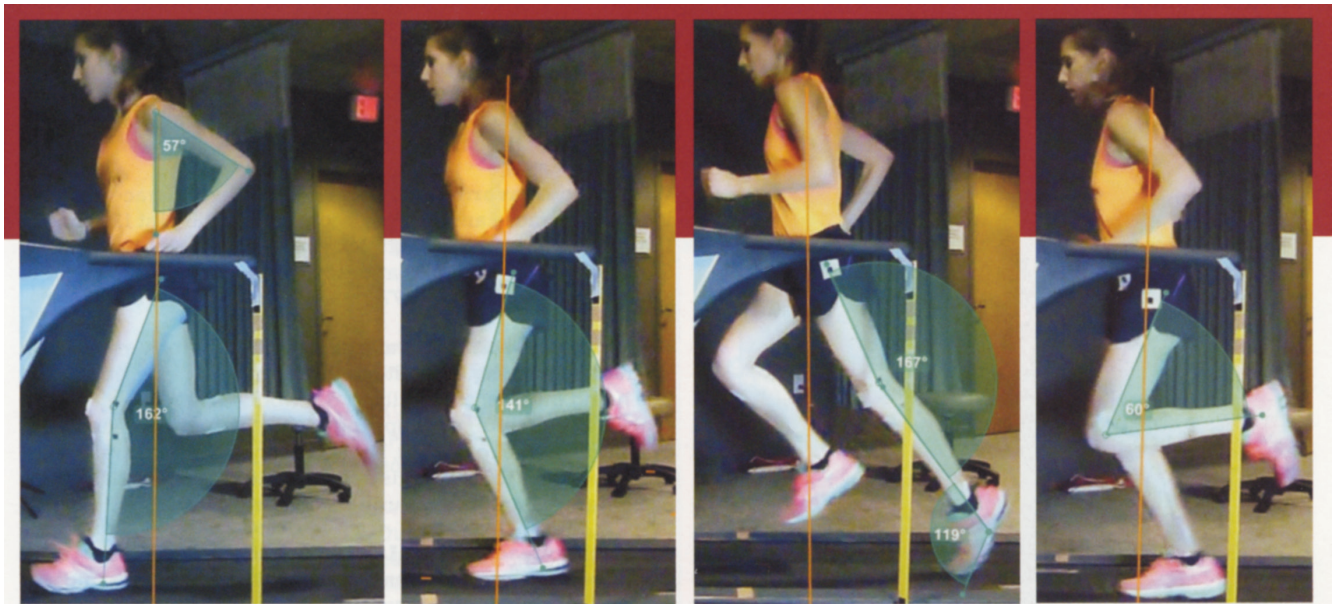
CADENCE/STEP RATE

Changing runners' cadence (the number of steps they take per minute) has become a go-to for individuals trying to change their form, and it is no wonder why. Running cadence is easy to monitor (count the number of steps you take in 15 seconds and multiply by 4), use a metronome, or by using your running GPS watch. The reasons for changing your step rate are simple. If your step rate is low (160 steps/minute or lower), you are probably overstriding and landing too far in front of your body. In addition, slow cadences go hand-in-hand with long contact times, the amount of time that your foot is on the ground. More time on the ground allows you to lose the energy absorbed in your footstrike and allows more time for you to wobble at the hip, knee, or ankle and increase compressive forces at the knee. Consequently, increasing a runner's cadence can be a great correction for a runner who lands aggressively on his heels. The faster you step, the less time you have to get that foot out in front of you and the more chance that you will land with a softer heelstrike or even a midfoot strike.

For a long time, the go-to number for optimal step-rate was 180. If you were running at 180 steps per minute, your form was considered optimal. After further research, we have come to more accurate ways to advise runners on cadence. The best advice to most runners using a slow cadence is to advance their step rate in five percent increments. For a runner who's dealing with knee pain and running at a step rate of 160 steps per minute, the first change would be to bump him up to 168 steps per minute and probably no more than 176 steps per minute during easy training. The other thing to keep in mind is that runners' step rates naturally change at faster paces. The faster you run, both your stride length and step rate should increase. For elite runners during the final 400 of a 5000 meter race, it can well go into the 190s to low 200s.

VERTICAL OSCILLATION/ BOUNCE

When we measure runners in the clinic, one important quality we measure is how much the runner bounces, how much his center of mass rises and falls during each step. Ideally, from each midstance (the lowest part of the step cycle) to each mid-swing (the highest point), we should see about three to seven centimeters of movement. Less than that, and the runner is just skimming the ground, not applying



Footstrike: Optimized foot, knee and lower leg alignments here, with a near-vertical tibia and footstrike occurring close to the center of mass line.

Midstance: Normal hip, knee and ankle flexion angles, preparing her for a powerful push-off.

Toe-off: Note the mild knee flexion and well-extended hip alignment—an excellent example of proper stride drive.

Swing reversal: Proper, well flexed swing leg alignment which diminishes the work required to advance her swing leg forward.

enough push into the ground to spring forward. Too much bounce and the runner will lose the force of his stride in a different way, by moving upward rather than forward. Often these problems are related to problems such as inflexible hips or weak gluteals and require work on mobility, strength, and power, as well as specific form drills such as hill sprints. As a rough guide, though, pay close attention to the horizon when you are running. If there is a mild bounce with each step, you are usually fine. No bounce means that you need to land with a bit more spring or stiffness at your knees and ankles, and too much bounce means you should soften your footstrike.

ARM SWING

If you want to see the most variable quality of running gait out there, just stand at the side of any 5K race and watch the way that runners swing their arms. You will see arms held low or high, out to the sides or close, or (most commonly) sawing back and forth across the body as if the runners were punching themselves. Truth be told, runners get away with lots of these arm swing patterns and often do well. The research on arm swing shows that it is probably less important than we would like to think in terms of overall performance. The more you work on keeping your elbows flexed and arms close to your side, moving from the shoulders and swinging forward and back rather than across your body, you will use less energy to support your arms and not be distracted from running faster. In the clinic, unusual or asymmetrical arm swing patterns are tip-offs to other problems, such as limited hip mobility or inadequate trunk/back muscle strength and control.

These are just a few of the things that you, as a runner, can do to improve your form. Running is most definitely a skill. With a little practice (easily integrated into each run), you can improve your form, lessen your chance of injury and increase your performance all at the same time.

KENT KURFMAN, PT, DPT, OCS, MTC, has been a physical therapist for 25 years and an avid runner for 36 years. He oversees the Running Academy at ATI Therapy, a multifaceted program of running injury prevention and treatment. He continues to race regularly, including five finishes at the Boston Marathon.

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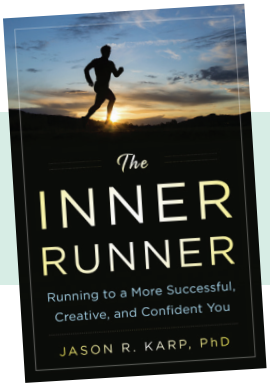

THE INNER RUNNER: Running to a More Successful, Creative, and Confident You —*by Jason R. Karp*

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USATF COACHING EDUCATION

2016 Calendar of Schools

Level 1

Date	*Location*
Sept. 30-Oct. 2	Community College of Philadelphia - Philadelphia, PA
Oct. 14-16	Benedictine University - Lisle, IL
Nov. 5-6	Nazareth College – Rochester, NY
Nov. 12-13	Cardinal Stritch University - Milwaukee, WI
Nov. 12-13	Tennessee State University – Nashville, TN
Nov. 18-20	Eastern Michigan University - Ypsilanti, MI
Nov. 18-20	Johnson & Wales University - Denver, CO
Nov. 18-20	Life University – Marietta, GA
Nov. 19-20	Allen High School – Dallas, TX
Nov. 26-27	UNLV - Las Vegas, NV
Nov. 26-27	Residence Inn Kansas City Airport - Kansas City, MO
Dec. 2-4	IMG Academy – Bradenton, FL
Dec. 9-11	Westerville South High School - Westerville, OH
Dec. 10-11	Houston Baptist University – Houston, TX
Dec. 16-18	Public School 9 - New York, NY
Dec. 17-18	Fresno State University – Fresno, CA

Level 3

Date	*Location*
Nov. 30	Podium Education Project - Orlando, FL
Dec. 4-10	USATF/IAAF Academy – Bradenton (IMG Academy), FL Jumps and Youth Specialization

FIRST "LEARN BY DOING CLINIC" COMPLETED WITH GREAT REVIEWS FROM ATTENDING COACHES AND ATHLETES

USATF Coaching Education completed the first offering of its new "Learn by Doing Clinic" on Saturday, August 27 at the Olympic Training Center in Chula Vista, California.

Described as an "outstanding event" by attendees, the clinic was a one-day interactive learning opportunity for coaches to gain skill acquisition in the four broad athletics event areas: Jumps, Sprints/Hurdles, Throws, and Middle/Endurance Running.

True to the program's name, coaches gained in practicum experience by working with athletes on skill progressions, teaching drills, analysis/corrections, and coaching cues. Clinicians are Master Coaches from the Coaching Education Certified Instructors. At the completion of the clinic coaches earned the USATF Skill Specialist Certificate.

The "Learn by Doing Clinics" were developed as an extension of the USATF coach certification pathway (Level 1,2, 3). There is no pre-requisite for coaches to attend.

USATF Coaching Education anticipates a full calendar of one-day "Learn by Doing Clinic" events throughout the USA in 2017. Contact Terry Crawford, terry.crawford@usatf.org, if you are interested in hosting a clinic at your facility.

IAAF/USATF Academy for Jumps or Youth Specialization

December 4-10, 2016
IMG Academy - Bradenton, Florida

Offering: Upon completion of the USATF/IAAF Academy, coaches will receive an IAAF Level V diploma and USATF Level 3 certification. The IAAF Academy Diploma for Elite Coach is the highest recognized achievement awarded through the IAAF Coaches Education and Certification System (CECS). It is recognized around the world and indicates that a coach is not only highly experienced but has the knowledge to coach or instruct at the highest international levels of the track & field profession. In addition to the IAAF Diploma, all USATF Level 2 coaches who complete the course will receive a Level 3 certification in their selected event, which is the highest coaching honor in the US. The school is a six day intensive classroom and laboratory setting.

For more information and faculty bios, click here.

***NEW* Youth Specialization Academy**:
USATF and IAAF are partnering to offer the Youth Specialization Academy, designed to introduce all coaches to the best research and practices for specializing in coaching youth athletes. Utilizing a long-term athlete development model for coaching youth through elite, the specialization academy will include topics in the following:

- Growth and Development Cycles for the Developing Athlete
- Physiology of the Developing Athlete: Skeletal and Muscular
- Stages of Mental and Emotional Growth
- Training Theory for the major event areas based on age appropriate progressions
- Talent Identification
- Coaching Ethics and Modeling for the Developing Athletes
- Blending the Support Team and the Coach: at the high school meet or at the Youth Olympics
- Strength Training; When, How much, Who
- Basic Skills and Drill Progression in the Broad Events

Grants: USATF Coaches Advisory Committee will award three grants for tuition, shared room and board, valued at $1,585; Deadline for grant applications is **September 30, 2016**. Apply for Grants at: http://www.usatf.org/Resources-for---/Coaches/Coaching-Education/Special-Programs/2016/Coaching-Enhancement-Grants.aspx

IAAF Academy Application: Click on the application link below and submit with complete resume to Terry Crawford, Director of Coaching: terry.crawford@usatf.org. Application deadline is **November 8 or when the academy reaches maximum capacity**. Academy is expected to reach capacity quickly, so it is recommended that interested coaches apply early.

Click here to download the application

2016 PEP SYMPOSIUM

Celebrating 31 Olympic Medalist Coaches and USATF High Performance Program

Wednesday, November 30, 2016
Hilton Hotel, Walt Disney World, Orlando, Florida

"The Best High Performance Symposium for all Track and Field Coaches in the USA. Do not miss it!"

What is it: The Podium Education Project (PEP) is an annual High Performance symposium which brings together coaches and sport scientist to review and present the most cutting edge methodology and coaching practices. It is designed to provide an exchange of knowledge between scientists, elite coaches and podium level coaches who have achieved the status of developing a medal-winning athlete at the highest level (National Championships, Youth Olympics, Junior and Senior World Championships, Pan American Championships and the Olympic Games).

Who should attend this symposium: Coaches seeking to advance their knowledge at the highest level of the sport, sport scientists and academics who are interested in cutting edge information on human performance, youth coaches and high school coaches who are developing USATF's future stars. All interested individuals desiring to network with some of the top scientists, coaches from around the globe.

Grants: The Coaches Advisory Committee selects 8 grant recipients to receive $500 towards their PEP travel expenses. Apply now: http://www.usatf.org/Resources-for---/Coaches/Coaching-Education/Special-Programs/2016/Coaching-Enhancement-Grants.aspx

Registration: Registration for the PEP is $125; Coaches who are members of the coaches' registry receive the discount price of $75 by selecting "PEP Coaches Registry Registration" and entering your USATF membership number. If you have questions, e-mail Terry Crawford. Register early as space will be limited! Click here to register.

For more information and bios of international speakers and clinicians scheduled to speak click here.

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