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ED FOX....................................PUBLISHER
RUSS EBBETS.................................EDITOR
TERESA TAM.........PRODUCTION & DESIGN
FRED WILT......................FOUNDING EDITOR

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2570 W El Camino Real,
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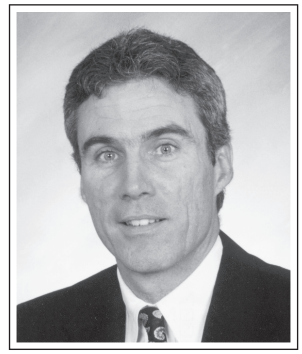
FROM THE EDITOR

RUSS EBBETS



THE OSCAR

Icarus was a character in Greek mythology who suffered from hubris—a lack of fear of the gods. His father built him a set of wings that allowed him to fly. Icarus was warned about flying too high but due to hubris, he decided to fly to the sun. The feathers of his wings were attached by wax. The wings got hot, the wax melted and he fell into the sea and that, to paraphrase Lowell Thomas, "was the end of the story."

The Lions Club is an international service organization that does charitable works in virtually every community in the United States. The Club is made up of business men and women and other community leaders who band together with the mission to make their communities, and hence the world, a better place. Personal disclosure: I have been a Lion for over 20 years.

Most clubs meet once or twice monthly with a standard format that includes a short business meeting, a meal and a 20-minute after-dinner speech by a community expert. The topics can run the gamut from soup to nuts. Proceedings are informal, friendly and usually 90 minutes well spent.

One night, over a decade ago, the dinner conversation turned to drugs and sports. The table talk was rapid fire with several Lions having strong opinions and quick solutions that were supported by references to, "when I was in high school" and "something I heard on talk radio." Now understand, these are business people whose other main concern in life is the lack of downtown parking. Everybody had their two cents.

Most are aware that all large Olympic and World Championship festivals have some sort of teddy-bear type mascot that looks like a cross between Barney and a Smurf with a sing-song name like HiHo, MeNo or Utoe. Years ago, the first thing a victorious athlete would do was run to their coach or handler, grab a flag and the mascot and prance around the track for a victory lap before heading off to the drug tent.

When it came time for me to add my two cents I mentioned that today the medal winners are only allowed to run around with a flag and forbidden from getting flowers or a mascot. One of my fellow Lions thought that was a stupid rule. Then I told him that certain countries were smuggling clean urine inside the mascots that the athletes could dump into their pee cup. He just about fell off his chair.

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ICARUS

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As it turned out our disbelief was mutual. I tried to explain to him that one of the main reasons the Soviets boycotted the 1984 Olympics was that they were not going to be allowed to have all their athletes stay on a cruise ship parked in LA Harbor. Rumor had it the ship had dialysis-type equipment that would insure clean urine. Our mutual disbelief continued. And I couldn't believe that he couldn't believe.

I finished up telling him about the men and women of doping control who now have the job of watching you pee in the cup. Not listening, not waiting, watching. The first time I heard this I wondered what must go through the drug-tester's mind? All those late nights in the lab, eight or nine years of higher education, PhD dissertation and it all comes down to a cup of warm pee. Do you really tell your relatives how exciting the Olympics are?

So imagine my sense of validation a few months ago when I stumbled across **Icarus**, the movie on Netflix. Honestly, I expected some half-baked, conspiracy theorist rendering of what somebody said about somebody else explained by some guy seen in dark profile with a garbled voice. Boy, was I wrong.

Grigory Rodchenkov was the guy. He ran the Russian pharma-archipelago. It was all there. The vials, the clean urine, the transport, the interception and the unbreakable screw caps. There was true scientific precision to all this. The only thing that boggles my mind is how they didn't screw something up at least once with over 200 samples.

It was this evidence that got Russia banned from Rio and then banned from Pyeongchang although they let the drug-free Russians compete even though two later tested positive, if that makes sense. Actually, it only has to make "cents," as in dollars and cents; remember we are talking about the IOC here.

After you get past the wonder of "did this really happen?" Icarus is a sad story. At the 90th Annual Academy Awards Icarus won the Oscar for Best Documentary. Rodchenkov, the central character, seems like a very pleasant guy who was pretty good at the cat and mouse game that is international sport. Today he's a wanted man in Russia. At least one of his colleagues has mysteriously died. He lives in the U.S. now in the Witness Protection Program. No word what he's doing with his Oscar.

HOW FORM CAN ENHANCE PERFORMANCE AND PREVENT INJURY

This article is adapted from the new book, *Running Form: How To Run Faster And Prevent Injury*, by Owen Anderson, Ph.D., published by Human Kinetics, Champaign, Il. www.HumanKinetics.com.

BY OWEN ANDERSON, PHD

The goals of form improvement include reducing the risk of injury, upgrading performance, and fine-tuning running economy. Another positive, though not automatic, benefit of form improvement is that it often creates a smoother-looking running style. Instead of bumps and jerks due to heel-striking ahead of the body, optimal form involves bouncing rhythmically from foot to foot, giving the appearance of efficiency and grace. It can also feel much more powerful because of the reduction in horizontal braking force during each contact with the ground. The larger fraction of stance devoted to horizontal propulsive force, the more effective use of elastic energy to provide forward propulsion, and the better timing of vertical propulsive force (it will reach a peak at a more optimal time, when the foot is not still in front of the body) are all aspects of good form.

RUNNING FORM AND INJURY PREVENTION

More than 19 million people finish road races in the United States annually, and around 54 million Americans engage in running at some point over the course of a year (1). Amazingly, 30 million individuals run or jog at least 50 days yearly in the United States, and there are about 540,000 marathon finishers and nearly two million half-marathon finishers annually (2). These encouraging facts are tempered by the realities that approximately 65 percent of regular runners are injured (3) and up to 92 percent of marathon trainees end up on the shelf (4) for some significant period of time during the year.

Science suggests that the use of proper running form can lower these injury rates significantly. From an injury standpoint, the key problems with common form—the kind of heel-strike, foot-ahead-of-the-body form that is adopted by most runners and promotes these remarkably high injury rates—are that it produces higher impact forces with the ground, greater forces at the knee with each impact, increased rates of force loading after impact, and dramatically augmented hip adduction (inward movement of the thigh during stance) compared with optimal form. Optimal form features midfoot-striking with the foot closer to a point under the body's center of mass. The consequence of the elevated forces and greater hip adduction is a heightened risk of being injured at some point during the training year.

One of the key problems with heel-striking is that it increases an important variable called VALR—the vertical average loading rate of impact force. Research has shown that VALR is the strongest predictor of injury risk in runners; runners with higher values of VALR have greater risks of both bony and soft-tissue injuries (5). In effect, with heel-striking, the impact force experienced by the leg increases too quickly (VALR rises too rapidly), compared with midfoot-striking.

Hitting the ground heel first (as 95 percent of runners do), instead of a midfoot- or forefoot-landing, roughly doubles the risk of running-related injury (6). Heel-striking produces a dramatically higher initial spike in ground-reaction force, compared with forefoot- or midfoot-striking, which is another way of saying that VALR is increased in heel-strikers (Figure 4.1) (7).

As can be seen in figure 4.1,one of the key challenges associated with heel-first collisions is that the loading rate of force applied to the leg upon landing is much higher with heel-striking. In other words, the rate of increase for the force felt by the leg is higher with heel-striking; the leg experiences the force more rapidly, with less time to react. Higher forces on the leg are linked with a greater risk of injury (8), and higher loading rates of force are also connected with a larger probability of getting hurt (5, 9). Runners who shift from heel-striking to forefoot- or midfoot-landing significantly reduce the magnitude of impact force (10).

HITTING THE GROUND HEEL FIRST (AS 95 PERCENT OF RUNNERS DO), INSTEAD OF A MIDFOOT- OR FOREFOOT-LANDING, ROUGHLY DOUBLES THE RISK OF RUNNING-RELATED INJURY

How do other aspects of form influence injury rate? Shank angle at initial ground contact (SAT), maximal shank angle (MSA), and Reversal of Sweep (ROS) are relatively new terms in the study of form, so few investigations have been conducted concerning their effects on injury rate. However, SAT and foot-strike pattern are strongly linked. The greater the SAT, the more likely it is that a runner is using a heel-strike ground-contact strategy. Thus, high SAT should be linked with lofty rates of impact-force loading.

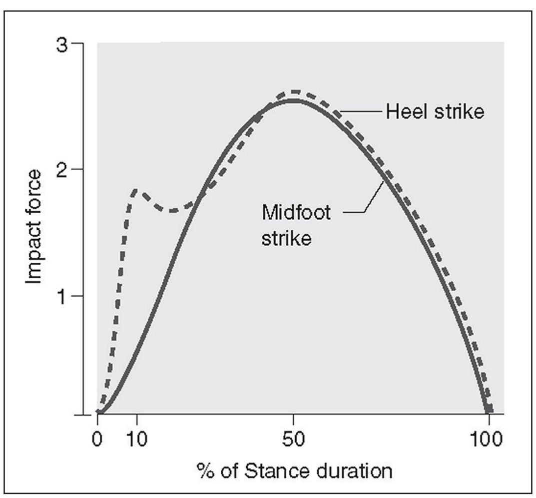

Figure 4.1: Impact forces associated with heel- and midfoot-striking. Note: Just 10 percent of the way into stance the vertical impact force is nearly double for the heel-strike, compared with a midfoot-strike.

THE ROLE OF CADENCE

Considerable research has explored the link between another related running-form variable, cadence, and the risk of injury. A 2014 study conducted by Rachel Lenhart and her colleagues at the University of Wisconsin at Madison revealed that a 10 percent increase in cadence (step rate) during running reduced peak knee-joint force by 14 percent (11), an effect that should lower the chances of developing patello-femoral pain and knee injury. Previous work by the same group had demonstrated that a mere 5 percent increase in step rate diminished total work performed at the knee per step, reduced the extent of heel-strike at initial ground contact, diminished hip adduction during stance, and also lessened the internal rotation of the hip when the foot was on the ground (12). Stance is the portion of gait during which the foot is in contact with the ground and when it appears that the foot is going backward relative to the rest of the body. In reality, the body is moving forward over the foot, and stance occurs from the instant of initial ground contact to the moment of toe-off. Hip adduction is an inward (medially directed) movement of the thigh during stance. An increased hip adduction angle means that the thigh moves medially and more dramatically during stance, compared with normal hip adduction (figures 4.2 and 4.3).

These factors—reduced peak knee-

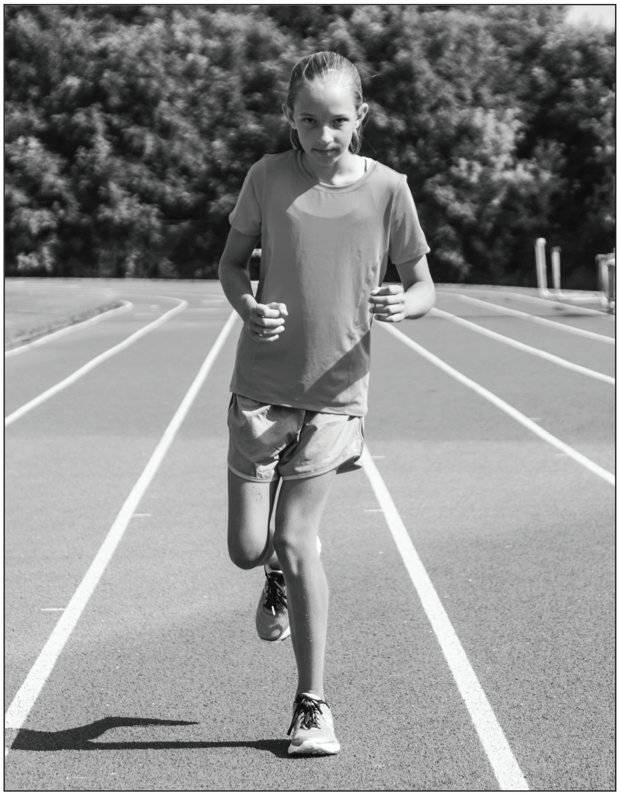

Figure 4.2: Slower cadences are linked with greater adduction angles, which correspond with a greater risk of injury.

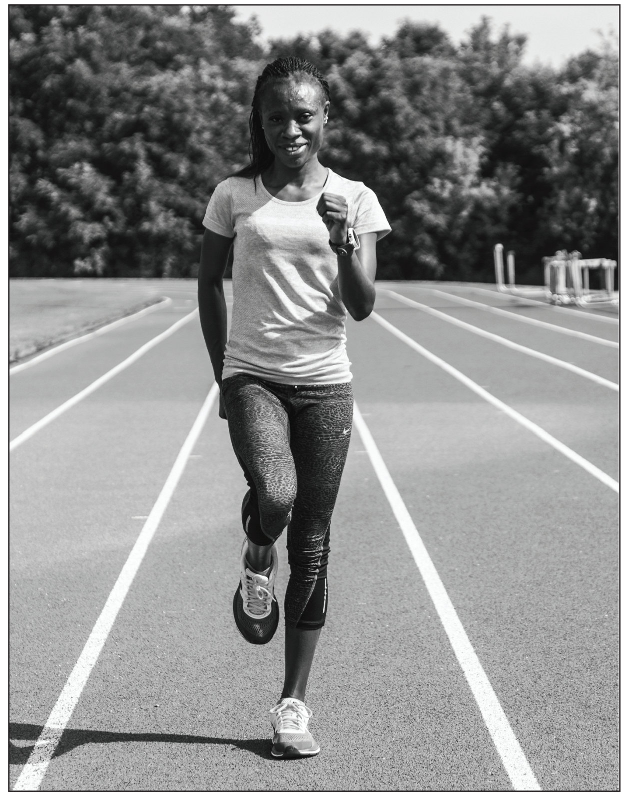

Figure 4.3: Among runners, research reveals that an increase in cadence is usually associated with a smaller hip adduction angle during stance.

joint force and lessened hip adduction and rotation—should diminish the risk of knee injury and another important malady called "iliotibial band syndrome" (ITBS). Runners with ITBS generally run with relatively slow cadences (less than 165 steps per minute) and display high degrees of hip adduction and rotation during stance.

While SAT was not measured in the two studies mentioned above, it is important to note that SAT and cadence are strongly linked. The average runner, for example, tends to run with an SAT of about 16 degrees and a cadence of approximately 160 to 164 steps per minute (13). A runner with a cadence of 180 steps per minute, however, often has an SAT of only six to 10 degrees (14). In the studies carried out by Heiderscheit and his colleagues, it is reasonable to assume that as cadence increased, SAT decreased concomitantly, heel-striking was less pronounced; and thus knee-joint forces, hip adduction, and hip rotation were reduced, decreasing the risk of injury.

COMMON INJURIES AND COMMON FORM

Research has linked an increased risk of suffering a running-related injury with various form-related body alignment patterns, particularly those patterns displayed by the average runner. Three common running injuries—ITBS, tibial stress fractures, and patellofemoral pain syndrome (characterized by strong discomfort in the front of the knee)—have been linked with increased peak hip adduction angle during the stance phase of gait. The important form-related point here is that hip adduction angle is strongly associated not only with cadence, but also with an important variable called "heel-strike distance" (figure 4.4). This is simply the horizontal distance between the center of the pelvis and the heel at initial contact with the ground: the greater the heel-strike distance, the larger the hip adduction angle (15).

In general, heel-strike distance is a direct function of SAT; the greater the heel-strike distance, the higher the SAT. Thus there is a straightforward connection between SAT and the likelihood of injury. A large SAT leads to large heel-strike distances, which promotes hip adduction and injury. The increased inward movement of the thigh associated with greater peak hip adduction angle places more stress on the iliotibial band on

Figure 4.4: Greater heel-strike distance is linked with higher hip adduction and an increased risk of injury.

the lateral side of the thigh and the knee itself and thus can be a source of training-related knee discomfort.

This can be addressed by reducing SAT and thus heel-strike distance. In addition, appropriate, running-specific strength training can improve the strength of the iliotibial band in a functional way and thus reduce peak hip adduction angle, providing runners with further protection from iliotibial band syndrome and knee pain. (Running- specific strengthening techniques are discussed in chapter 14.) Excessive inward movement of the thigh during stance can be considered to be a breakdown in form, which increases the risk of injury.

Overall, an expanded heel-strike distance (and thus larger SAT), increased peak vertical ground reaction force, expanded peak hip adduction, and a decrease in knee flexion at initial ground contact (a straighter leg) have been linked with patellofemoral pain (16) and a heightened risk of both iliotibial band syndrome (17) and tibial stress fracture (18) (figures 4.5 and 4.6).

Exercise scientists recently investigated whether just changing cadence could push these mechanics in the opposite direction, preventing

Figure 4.5: Research indicates that landing on the ground with a straight leg increases the risk of serious running injury.

Figure 4.6: Research indicates making contact with the ground with the leg flexed at the knee lowers the risk of injury.

injury. They wanted to determine if increased cadence would lead to shorter heel-strike distance and thus smaller SAT, reduced vertical ground reaction force, better control of the hip during stance, and a more highly flexed knee at impact with the ground (19). It would be rather magical if higher cadence could produce all of these positive results and would certainly reveal how important cadence is for optimal running form.

CADENCE RETRAINING

The cadence research (15) studied heel-strikers who were running about 19 miles a week with a slow cadence, averaging 164 steps per minute. All of the participants went through a six-week "cadence retraining intervention." To increase cadence, each runner trained (and matched his/her steps) with a metronome, set at a cadence 10 percent greater than the individual's preferred cadence (in this case, approximately 180 steps per minute). All of the participants completed at least 50 percent of weekly mileage with the cadence uplift of 10 percent (180 steps/minute). They were all guided by either the metronome or another audible tool, such as music with a tempo of 180 beats per minute or a metronome-like smart-phone application.

After six weeks of higher-cadence training, the runners had not raised their natural cadence to 180, but they had improved to about 170 steps per minute. This step-rate upgrade had a number of positive consequences. For example, at 170 steps per minute, the runners experienced a decrease in ankle dorsiflexion at initial ground contact (i.e., they had less-pronounced heel-strikes); their peak hip adduction angle was smaller; and the vertical loading rate of force on the leg was lessened. All of these differences are associated with a lower risk of developing three key running injuries: knee pain, stress fractures, and iliotibial band troubles.

RESEARCH HAS LINKED INCREASED CADENCE WITH CHANGES IN GAIT, AND, IN TURN, THE CHANGES IN GAIT ARE POSITIVELY LINKED WITH A DECREASE IN OVERUSE RUNNING INJURIES

This useful study not only revealed that a simple increase in cadence could produce better running mechanics, but also provided a simple mechanism for improving form for the average runner (by using a metronome set at a 10 percent higher cadence than usual). Using this technique, runners can improve their cadence significantly in a short period of time.

The inquiry also supports other research that has linked increased cadence with changes in gait, and, in turn, the changes in gait are positively linked with a decrease in overuse running injuries (20). Interestingly, the simple act of running barefoot tends to increase cadence and is linked with similar advancements in running mechanics, including a smaller SAT, diminished heel-strike distance, and a reduced reliance on heel-striking (21).

Why does a simple form change such as increased cadence lead to better running mechanics? The quicker cadence tends to bring the foot back closer to the body for initial ground contact. This prevents heel-strike distance and SAT from becoming too large and also shortens the braking phase of stance. Higher cadence also limits the extent of ankle dorsiflexion at initial ground contact (in other words, it minimizes heel-striking). Heel-striking is minimized because at a faster cadence, runners don't have time to land on the heel, then place the sole of the foot on the ground, and then move through stance to toe-off, as they are unable to maintain a higher cadence with all of this excess action (compared with landing toward the middle to front of the foot and "bouncing" forward).

With a higher cadence and midfoot-to forefoot-striking, the lower limb is placed in a more spring-like landing posture, with a less straight leg, a more highly flexed knee, and a more neutral or slightly plantar-flexed foot at contact with the ground. This allows better distribution of force through the leg after impact and slows down the peak loading rate of impact force through the leg.

When the foot is more closely aligned with the center of mass of the body, the hip tends to be in a more neutral position. It is not as flexed as it is with a large heel-strike distance and a big SAT. Thus, the muscles which control hip adduction (namely the gluteus medius and iliotibial band) have a greater mechanical advantage and are placed in a stronger position from the standpoint of controlling hip adduction. This is another reason why shorter heel-strike distance, smaller SAT, and higher cadence are all linked with better control of the thigh and knee, and thus lower hip adduction and a reduction in impact forces at the knee.

Cadence and SAT are naturally linked together: It is very difficult for a runner to have a high cadence if she has a big SAT. She also can't have a high cadence if ROS is too minimal because this elongates heel-strike distance and thus the time spent getting the body up and over the foot with each step, increasing the stance phase of gait and automatically slowing cadence. In the study in which runners practiced running with a cadence of 180 steps per minute, the increase in cadence resulted in a decrease in SAT; it is likely this decrease can be attributed to the reduction in heel-strike distance. Conversely, a training intervention that produces a reduced SAT should spontaneously raise cadence. Overall, it is clear that increases in cadence and ROS, and a decrease in SAT, should promote a lower risk of injury. Given the incredibly high injury rate among runners today, it is very important for running athletes to incorporate drills into their training that optimize cadence, ROS, and SAT.

That said, while a shift from heel- to midfoot-striking will certainly reduce stress on the heel, tibia, and knee—and most likely the frequency of heel pain, tibial stress fractures, knee discomfort, and ITBS—it also increases the work that must be performed by the non-heel portion of the foot and Achilles tendon with each step. This temporarily increases the risk of injury to those areas. Therefore, a heel-striking runner should not make a sudden and dramatic plunge into midfoot-landings. Rather, he should very gradually adjust to midfoot-striking over a period of many weeks.

This gradual adjustment can be accomplished by drilling, or using midfoot-strike-enhancing drills on a daily basis. Over the course of many weeks, with daily drill employment, a runner's "drilling form" and spontaneously adopted running form will gradually approach each other and eventually unify in a way that strengthens the foot, Achilles tendon, and calf and does not produce abrupt increases in force and work output for those regions of the lower appendage.

RUNNING FORM AND PERFORMANCE

The best research to date linking changes in running form with actual race performances was carried out by Leena Paavolainen, Heikki Rusko, and others and their scientific team at the Research Institute for Olympic Sports in Jyväskylä, Finland (22, 23). In one investigation, Rusko and colleagues divided experienced endurance runners into two groups. The two collections of athletes were initially similar in ability and trained for the same number of hours (about nine per week over a nine-week period); but the "explosive" group devoted about three of those hours per week to explosive training consisting of short sprints, jumping exercises, hurdling, quick-action leg presses, and high-velocity hamstring curls. In contrast, the control group spent just 15 minutes per week engaged in such activities, instead engaging in larger amounts of traditional endurance training (including steady running at moderate paces).

The control group improved maximal aerobic capacity (VO_2max) after nine weeks of training, but they were not able to upgrade 5K performance. In contrast, the explosive group failed to advance VO_2max but sped up their 5K times by about 30 seconds (a compromise that most runners would be willing to make).

There were a number of positive changes achieved by the explosive group over the course of the study, including enhanced running economy; heightened maximal speed (measured during an all-out 20-meter sprint); advanced explosiveness during jumping tests; and an upswing in a variable called VMART—the highest velocity attained during a maximal, anaerobic running test on the treadmill. VMART reflects the ability to carry out progressively faster running intervals for a longer time during a challenging workout, or in other words, the development of greater fatigue resistance during high-speed running.

Improvements in running economy and VMART were significantly correlated with better 5K performance. Changes in VMART were strongly linked with decreased contact time, or a shortening of the duration of stance. The stance phase of gait was diminished by about 10 milliseconds per step in the explosive group, which undoubtedly seems small to the casual observer. However, those 10 milliseconds represent extra time "glued to the ground" during running and thus time lost to forward movement. These additional milliseconds add up over the course of a race. To summarize, Rusko's runners used explosive training to decrease stance duration and thereby increase cadence, a key form and performance variable; therefore, they were able to shave 30 seconds from their 5K performances.

THE THREE PHASES OF STANCE

It is important to note that the stance

phase of gait can be divided into three parts:

1. The braking phase, when the foot has just made contact with the ground and horizontal braking forces are being produced

2. The vertical propulsion phase, when the forces applied to the ground are directed in a vertical direction

3. The horizontal propulsive phase, when the foot's interaction with the ground produces forward horizontal forces and the runner's body is propelled forward

Explosive training shortens stance time. Most likely it enhances nervous system responsiveness. This allows a quicker passage through the three components of stance without diminishing horizontal and vertical propulsive forces; it therefore shortens stance in a positive way. In the second inquiry (24), Rusko and colleagues asked 17 male endurance athletes to take part in a 5K time trial and also undertake a variety of tests of running capacity (including an evaluation of running economy and an all-out 20-meter sprint). They found that 5K performance was significantly associated with 20-meter sprint speed and also with ground-contact time (stance duration) and cadence measured during the 20-meter blast. The higher the cadence and shorter the stance duration during 20-meter sprinting, the faster the 5K.

Foot-strike pattern is also linked with performance. Research has found that faster endurance performers tend to use the midfoot and forefoot ground-contact strategies, while slower runners are more likely to be heel-strikers (25). Anecdotal observations also support the connection between higher-level performance and both midfoot-landing and smaller SAT. For example, elite Kenyan endurance runners tend to run with an SAT of between zero and six degrees, while elite American runners often run with an SAT greater than six degrees. Furthermore, elite Kenyans tend to be midfoot-strikers, while American elites tend to collide with the ground heel first (figures 4.7 and 4.8).

A check of top performances in the world for 2016 reveals that for the 10K (road racing) there were 24 elite male Kenyans in the top 30 and no elite American males. On the women's side, for the 10K there were 18 elite Kenyans (including two under the author's management) and only two elite Americans. For the marathon, there were 19 Kenyan men and zero American males in the top 30, and there were eight Kenyan women and zero American females. It is unlikely that the reduced SAT and more pronounced midfoot-landings at touchdown of the Kenyan runners play no role at all in their superiority over American runners. Simply put, great form leads to great performances.

Figure 4.8: Kenyan elite runner Mary Wangui employs a midfoot-strike pattern and an SAT of ~ 6 degrees when she runs.

RUNNING FORM AND RUNNING ECONOMY

Running economy is the oxygen cost of running at a specific speed, and it is strongly linked with endurance performance. In general, the lower the oxygen cost of running at competitive velocities, the faster the performance (26). Just as shorter-duration stance was linked with higher performance in the Rusko research, it is also tightly connected with enhanced running economy (27, 28). Of course, shorter stance time is associated with a smaller SAT and with midfoot-striking, as opposed to heel-striking. These key form variables appear to be directly linked with running economy.

SUMMARY

The running form you choose can either increase or decrease your risk of injury. Deciding to run with a large shank angle at ground contact, a straight leg at ground contact, a heel-strike ground-contact pattern, a relative absence of sweep, or a moderate to low cadence increases the risk of getting hurt.

In contrast, running with an SAT of approximately six to seven degrees, with a flexed knee at initial ground contact, a midfoot- to forefoot-strike pattern, an ROS of about 70 percent of maximal shank angle, and a cadence of 180 or more lowers the chances of injury.

Those factors that advance the risk of injury also harm performance because they are associated with longer stance phases of gait, greater braking forces during stance, and lower cadences. It should be mentioned, too, that injury harms performance by thwarting a key producer of outstanding performance times: consistent training.

Those form factors which decrease the risk of injury are great for performance because they increase cadence, reduce the duration of stance, limit braking effects, and promote the production of maximum propulsive forces during the optimal stage of stance.

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SPRINTING TECHNIQUE: THE KEY TO INCREASING YOUR SPEED

A basic overview of sprint training and technique, including the sprint start.

BY LIAM COULTMAN, THE SPEED PROJECT

Elements addressed in this article include, accelerative sprinting, maximum velocity sprinting, the breakdown of a sprint across 100m, ground contact time, movement mechanics, reactive forces, and perfecting the sprint start.

The genetic makeup of an athlete may bless him or her with natural speed, but without working on proper sprinting mechanics an athlete will never reach full potential. This means speed can be taught and all athletes have the potential to increase their speed.

Mastering proper sprint technique not only allows for an athlete to run faster but also reduces the risk of injury caused by poor mechanics. You could spend weeks working on top speed without seeing any improvement, whilst focused and attentive time spent on sprint form could potentially increase your speed within a few hours.

For the sake of this article we will focus on horizontal sprinting across 100m. Obviously for other sprint events and team games there will be more detailed and more event/sport specific technical elements (bend running, multi-directional, stop-start movement etc.) but this article will provide a good basis of information that can be applied to some extent across all forms of sprinting.

ELEMENTS OF A 100M SPRINT

There are many technical cues involved with sprinting, but as an athlete or coach, you should focus on mastering a few things rather than trying to work on everything at once. Information overload can become a real issue, especially for beginners. Many times I've seen athletes run in a robot-like fashion, whilst overthinking and trying to sprint "perfectly", which is ultimately detrimental to performance.

Breaking a sprint into "elements", then working on aspects within each can help athletes with their learning process. Some coaches do not like to separate phases of a race and prefer to focus on it as a whole, however I think most (myself included) like to break a sprint down into different components because it provides available cues that an athlete can easily understand.

Element 1: The Acceleration Phase

This phase involves blasting out of the blocks by pushing off the rear and front leg hard. Here, you want to pull your rear leg through quickly whilst the body leans forward. Then extend the leg on the front block at the knee and hip upon completion of the drive.

I always tell my sprinters that they should be looking to clear around 3 feet on their first stride out of the blocks with focus on pumping their arms as they drive out.

It's important that the front foot is driven back onto the ball of the foot for the first stride whilst maintaining a forward lean. I've seen athletes land on their heel after their initial stride due to overstriding with a high knee. This will only cause the athlete to decelerate faster and put unnecessary pressure on the hamstrings .

Element 2: The transition Phase

After exploding from the blocks you want to increase velocity and make an efficient transition to an upright sprinting action. After you leave the blocks, try and increase your stride length and frequency with each stride as you come into the upright position over the first 20-30m.

Element 3: The Gliding Phase

This phase begins once the torso is upright. Here you will use your leg strength to maintain a wide but comfortable stride length. At this point you should be completely relaxed, low shoulders, jelly jaw and glide to the finish line.

ACCELERATION AND MAXIMUM VELOCITY

An athlete begins a sprint by accelerating, then (depending on the distance of the race) will transition into maximum velocity sprinting. Track sprinters will accelerate from a dead start where they are not moving, whereas a games athlete, such as a rugby player, is likely to already be in motion. We'll continue to focus on these aspects from a 100m viewpoint and horizontal sprinting.

BREAKING A SPRINT INTO "ELEMENTS", THEN WORKING ON ASPECTS WITHIN EACH CAN HELP ATHLETES WITH THEIR LEARNING PROCESS.

During the 100m an athlete will begin the race by accelerating until he reaches (or comes very close to) maximal sprinting velocity. At this stage it is no longer possible for the athlete to continue accelerating. The focus switches to trying to maintain maximum velocity through sound technique, which will help limit the rate at which deceleration occurs during the remainder of the race.

Deceleration cannot be avoided, however the degree at which an athlete decelerates will ultimately have an impact on one's overall sprinting performance. The most elite sprinters can hold their maximum velocity longer as they have a reduced amount of fatigue affecting their central nervous system and typically decelerate around the last 20m of the 100m.

Ground contact during accelerative sprinting

For faster sprint times it is important to limit the amount of time that your foot spends in contact with the ground during each stride. This is why sprinters run on the balls of their feet and sprinting spikes all have the spikes positioned on the forefoot.

Force production is another important aspect to generate speed when making contact with the ground. The greater the force you apply into the ground, the greater return of impulse production, which creates greater speed. Longer foot-to-ground contact times will allow for greater force generation and impulse production.

So an athlete should limit ground contact times but also have long ground contact times to generate a greater force? This is obviously contradictory information. The goal is to cover the required distance in the shortest time possible. Therefore, although a longer contact time allows for a greater force, it is not favorable to create it by this means. Yes, you will have more powerful strides, but ultimately it will slow you down. Therefore the key is to apply the optimal amount of force possible into the ground during the limited amount of time that contact is made.

Another thing to consider when accelerating is the point of foot-to-ground contact in relation to the athlete's center of mass. You want the point of contact to be behind your center of mass so that there will be less ground contact time. This is why it's important to stay low and drive out the blocks, rather than immediately transfer into an upright position. Take care not to overextend your stride as you will not be able to produce as much force during ground contact and will be more susceptible to injury.

Maximum velocity sprinting

During maximum velocity, as with the acceleration phase, shorter contact times are linked with better performance. Again, this can be achieved through applying optimal vertical forces during ground contact. This will lead to increased speed because you will be able to generate a great enough force impulse to overcome gravity and bound off the ground more rapidly.

One question that is always asked is whether an athlete should focus on increasing stride frequency or stride length. Ultimately this will depend on the athlete and their running style. However, top sprinters can increase their stride frequencies during peak sprinting without decreasing stride length if they apply peak vertical forces. This is why it's so important for coaches and athletes to understand acting forces on the body during the phases of a 100m sprint. This understanding will allow for the improvement and development of each phase without negatively affecting the other.

In the acceleration phase it was beneficial to have the foot behind the center of mass. Bringing the foot back during maximum velocity may only be beneficial to a certain point, after which it will become detrimental to performance and increase deceleration by causing the upper body to lean forward. A good tip is to make sure that when the foot makes contact with the ground, it's placed under the hip.

The stride cycle

Touchdown ⇨ Toe off ⇨ Flight ⇨ Touchdown
⇦ (one complete stride cycle) ⇦

The stride cycle begins at the touchdown phase. At the point of touchdown a sprinter loses momentum and slows down due to the braking effect. This is simply where the foot makes its initial contact with the ground.

This is where the ground contact time that we have been discussing begins and then ends after the toe off phase where force is produced when pushing off the surface. This then leads to the flight phase where neither foot is in contact with the ground, and ends with the second touchdown as the rear leg becomes the lead.

Factors affecting technique

Relaxation

A lot of the time you will see athletes tense their whole body whilst sprinting. This is a red flag in relation to technique. It could be down to nerves but is also likely due to trying too hard to generate force and exert power. This causes unwanted tension in the body and will lead to poor form. By overtensing, the body wastes energy, becomes stiff and is unable to move fluently.

Posture

Good posture is essential for sprinting. Many athletes have a tendency to lean forward by overflexing at the hips. A slight tilt is recommended but leaning too far forward will slow you down and ultimately affect your running mechanics.

A good way to ensure you have good sprinting posture is to make sure that all drills are completed with perfect form (A skip, B skip etc.). Poor form during your drills will transfer into your sprinting technique so its highly important that they are performed correctly. Focus on keeping your back straight, head neutral with your spine (this will keep your head above your shoulders) and look straight ahead.

THE KEY IS TO APPLY THE OPTIMAL AMOUNT OF FORCE POSSIBLE INTO THE GROUND DURING THE LIMITED AMOUNT OF TIME THAT CONTACT IS MADE.

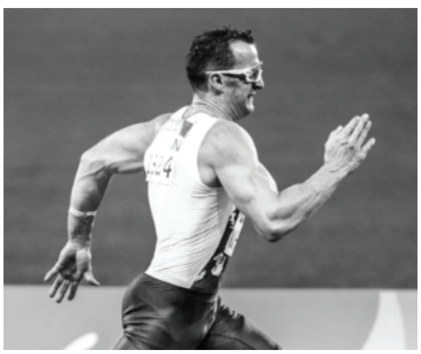
Simple way to improve your posture and strength

A great exercise that I get my athletes to perform are back extensions. Performing this exercise regularly increases trunk strength and improves physical fitness. Back extensions target your erector spinae which contains parallel sets of muscles that run down the spine from the base of the neck to the sacrum. These muscles control extension and flexion of the vertebral column and can increase optimal posture of the spine when performing sprints.

Back extensions also engage the hamstrings and strengthen other muscles which will allow you to become stronger and keep the torso erect when sprinting.

Arm movement

Its vital to recognise that your arms play a vital role when sprinting. Your arms help to propel your legs which will lead to you sprinting faster. I heard sprinting legend Carl Lewis once say he uses the cue "elbow to the sky, thumb to the eye" to ensure his athletes are moving their arms correctly. I like this a lot. It's catchy and easy for my athletes to remember.



As mentioned, for fluidity it is important to stay relaxed. Relaxation in the arms comes from dropped shoulders and no tension in the hand or fist. This will help you achieve a synchronised rhythm with your legs.

Stride length

Be careful when trying to open up your stride when trying to increase the length of ground covered. As mentioned, overstriding means you will generate less power during ground contact which will increase the rate at which you decelerate. It also puts a lot of strain on the hamstring muscles, increasing your risk of injury.

Try to complete every sprint cycle in a circular motion where you are aiming to keep your knees parallel with the ground and your feet flexed upwards towards your shins.

TRY TO COMPLETE EVERY SPRINT CYCLE IN A CIRCULAR MOTION WHERE YOU ARE AIMING TO KEEP YOUR KNEES PARALLEL WITH THE GROUND AND YOUR FEET FLEXED UPWARDS TOWARDS YOUR SHINS.

Starts

Perfecting your sprint starts (especially when using blocks) is arguably the most important aspect of the acceleration phase as it will affect your overall efficiency throughout the race. It's important to practice your starts separately so that you are comfortable using the blocks, moving efficiently and reacting to the gun.

Exercises to Improve Your Sprinting Technique

When it comes to sprint technique there are many drills you can practice which will help you with your form. Here are a couple of exercises you can use that will be beneficial to all athletes who want to improve their speed and technique.

Sled striding

When pushing or pulling a sled you will see that the position you obtain is very similar to when driving out of the blocks. Using a sled is a great way to reinforce this positioning which can help improve your start off the blocks.

Don't make the mistake of loading the sled with lots of weight. The purpose here is to practice your running stride, not to see how much weight you can shift! Focus on stride length, leaning forward and pushing powerfully off the balls of the feet during each stride.

Don't push the sled too far. As in the drive phase of a sprint, you should drive the sled forward for about 30-50m. Repeat this for around 10-20 reps depending on your fitness level. You can increase the amount of reps as necessary.

Hill running

Hill running is perfect for improving your acceleration. The incline causes the body to automatically lean forward when sprinting up the hill. To make it up, you will really have to drive the knees up high and you'll be forced to run on the balls of your feet. Don't worry too much about how steep the hill is but aim for a 15% incline.

Example: Sprint up the hill, then slowly walk back down and repeat. Do this for a total of 5-10 reps for 2-5 sets. Again this depends on your fitness level. Try not to complete these at a high intensity (above 75%) otherwise you will struggle to complete the workout. Aim for 5-8 minutes rest between sets depending on how many reps you perform.

SPRINT FORM CHECKLIST AND REMINDERS

Upper body

Head
- Keep your head in line with your spine
- Focus your sight directly down the track

- Relax your neck and jaw muscles
- Don't clench your teeth

Shoulders

- Don't shrug your shoulders. They should be kept low, not up by your ears.

Hands and arms

- Run with open palm (if you naturally run with a closed fist, stay relaxed and don't clench)
- Remember "Elbow to the sky, thumb to the eye"
- Sync arms with legs
- Remain upright during maximum velocity. Flexing or extending at the hip will limit your range of motion

Lower body

- Run on the balls of your feet and push off with your toes
- Keep stride long but comfortable. Overstriding means less power and unnecessary stress on the hamstrings
- Focus on rapid turnover of sprint cycles with knees parallel to the ground

PERFECTING YOUR SPRINT START

We all know that sprint events can be won or lost by the smallest of margins, right? This means that every millisecond counts and is the reason why athletes spend so much time trying to perfect their start technique and reaction time. When it comes to sprint starts, athletes with the best reaction time, greatest power, and ability to accelerate most rapidly, will excel more than simply the strongest athlete. Therefore, an athlete with a great start may be able to win a race even if he or she is not the fastest athlete in the field.

An athlete with a super quick start leaves the blocks first and starts accelerating. The athlete is then able to reach top speed before the other athletes. So although his/her top speed may not be as quick as another competitor, the ability to reach top speed before anyone else could be enough to take him or her across the finish line in the number one position.

So the importance of a great sprint start can't be stressed enough. Obviously it is not as simple as that, and there are other components of the race that must be accounted for, but a good a start could potentially make all the difference.

I've found that a lot of athletes worry about using blocks and do not feel entirely comfortable using them. Questions like "how far away should the blocks be from the starting line" and "which foot should I have in the front pedal" always come up. These are all things that can be addressed during training, so let's jump straight in and look at how we can go about answering these questions, improving your sprint start and increasing your sprint times.

HOW TO START

Dominant Leg

You'll notice that not every sprinter starts with the same foot forward. It is down to the athlete and coach to determine which leg is the dominant leg simply through trial and error. Some athletes go with the leg they feel is stronger or even do some tests with their coach to determine which one is more dominant. If I have an athlete who is unsure, or just starting out, I get him to practice with both and we can assess which position feels most comfortable and allows for a greater acceleration.

This is ultimately what it comes down to; where you feel more comfortable and which position allows you to generate the most power and get out of the blocks quicker. Essentially that's what your training is for, to see what works well and what doesn't. You can always make adjustments where needed later on after analysis. One thing I will say, make sure that any adjustments are always made during training. Never try out something new at a competition or meet as you risk breaking your routine and under-performing as a result.

Block Spacing

The dominant leg will be placed on the first pedal (closest to the line) and the second pedal will be placed slightly behind that. I use two feet spaces from the line to determine the position of the first pedal and three feet from the line to determine the second. There is no rule as to the exact spacing of the pedals but I've found that this is a good guideline.

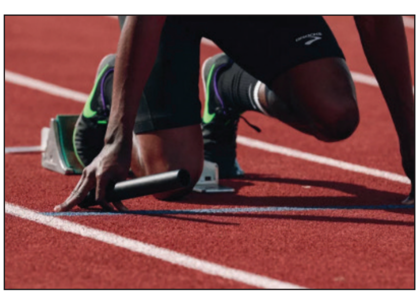
Again, it will come down to where you feel most comfortable but bear in mind, if your feet are too far away from the start line, you will struggle to generate any power, and if your feet are too close, you're likely to stumble onto your face! So if in doubt, use the guidelines i've suggested. Use time during training to get this right!

And I suggest you do the same with the pedal angles. If you want a guideline, I use a 45 degree angle for the first pedal and 55 degree for the second but again, play around with it during training to see what best suits you. It's very important however that once you have your blocks in a good position where you feel comfortable that you take a note of the positioning or remember it exactly. This will allow you to have the same setup every time during training and competition.

This is important as even the slightest changes can lead to variations in your drive phase. It will also give you one less thing to focus on when it comes to race day. Once you get more confident and can determine your strengths and weaknesses, you can tweak during training to make improvements.

Hand Placement

It's important that your hands are placed as close to but behind the line. As with the other points, the width of your hands again will be determined by where you feel most comfortable. Some athletes prefer just outside shoulder width, whereas others, who are perhaps more powerful choose to go even wider so they can get their bodies lower to the ground and generate more power. You have to be strong to do this if you don't want to end up falling flat on your face. I will say however, don't have your hands too close together...definitely not inside shoulder width. This will make you sit in a very high position and make it more difficult for you to explode from the blocks and your drive phase will suffer due to your angles.



Now that you're set up, let's move on.

REACTING TO THE GUN

It's important to develop your reaction time to get off to a flying start. You need to make sure that you react ONLY to the gun. You don't want to have all your hard work in training be for nothing by being kicked out of the race for jumping the gun. It can also be very distracting for the other racers (which is one of the reasons it's now one strike and out!) so don't be that guy (or girl), just don't.

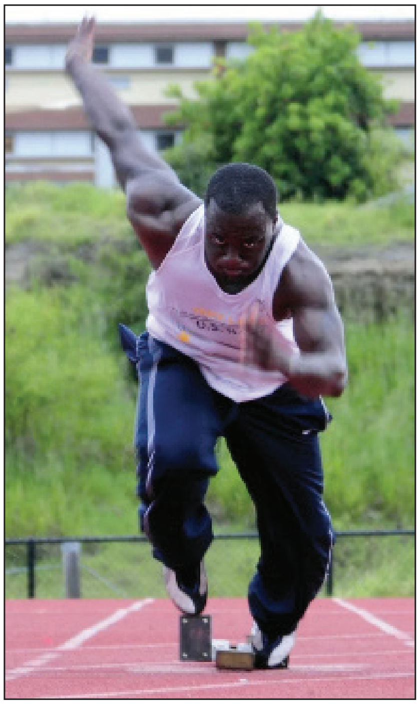
When training, it's a good idea to have your coach or someone call the command out for you when practicing your sprint starts. You can go by voice alone, or use a tool to imitate the bang. For you coaches (or disciplined athletes) I like to give my athletes a forfeit if they false start during training. This will help discourage this action, which is especially good if you have an athlete with a tendency to false start.

HOW TO EXECUTE

As mentioned already, it's vital that you go through the same routine and set up each and every time you use your blocks (unless you are trying out something new during a workout) as you don't want anything to affect your acceleration through your drive phase. Nerves, the competition, the crowd watching and the possibility of a false start will give you enough to worry about, so your blocks routine should be second nature. These factors are things that should not be focused on, but let's be honest, we've all thought about them at one time or another, and the pressure only increases as the competition gets higher, so it's important to erase as many limiting factors as possible.

Once your blocks are set up how you want them, make sure that they are securely pressed into the track so that they do not move once you start. Have a few practice starts to test this and go through a routine that allows you to clear your mind and focus solely on the race. I like to picture myself running the perfect race (and winning, obviously) before I get in the blocks.

To get into the sprint start position, crouch down and slowly back yourself into the blocks until your feet are positioned where you want them on the pedals. Get comfortable in the blocks first, as once the announcer says "set" you could end up being disqualified if you move. Begin in the crouched position with your back knee on the ground and resting on the fingertips. During set, take a deep breath in and bring the hips up into a loaded position. Don't come up too high with the back leg, otherwise you will not be able to generate much power and you will end up in an upright position much



sooner and miss out on your speed build-up during the drive phase. DON'T try and anticipate the gun! You could end up being disqualified or missing the actual gun and have an even slower reaction. Wait for the 'B' of the bang and launch yourself out of the blocks, pushing off the pedals with both feet and really pumping the arms rapidly.

It's important that you begin aggressively as failing to do this will reduce your speed during your drive phase of the race. Drive forward for the first 10m then from 10-30m you should gradually begin to come up into an upright position where you should then be nearing full flow and full speed. I should add, the distances of the drive phase can vary depending on how quickly you can accelerate.

The Speed Project aims to supply practical information to athletes and coaches who want to improve their speed and agility for enhanced performance. The site provides access to informational articles, resources, blog posts, and interviews with world-class athletes. The creator, Liam Coultman, is a sprint and conditioning coach, and certified PICP Athlete Performance Specialist. He's currently located at the National Performance Centre for Athletes in Spain. If you have any questions for Liam you can contact him by email: liam@thespeedproject.com. Check out The Speed Project website: www.thespeedproject.com and follow The Speed Project on social media: Facebook: @officialspeedproject / Instagram: @officialspeedproject

AN ANALYSIS OF U.S. MEN'S JAVELIN PERFORMANCE IN INTERNATIONAL COMPETITION 1983-2017

A collection of statistical comparisons showing how much U.S. male javelin throwers need to improve before challenging for medals on the world stage, with suggestions as to how this may be accomplished.

BY DON BABBITT, UNIVERSITY OF GEORGIA

INTRODUCTION

The United States has had a moderate level of success in the men's javelin throw at major championships such as the Olympic Games and World Championships over the past 35 years, dating back to the first IAAF Championships back in 1983. However, in more recent times, this success has dropped off and it is now a rare occasion that a U.S. men's javelin thrower will even qualify for the final in a major championship (see Table 1). For a country of 326 million inhabitants with a strong sporting culture, especially with regard to throwing things, it is quite an underwhelming performance. It is obvious there must be some issues within the developmental system that are not allowing the U.S. to keep up with the other javelin throwing powers in producing world class javelin throwers. The purpose of this article will be to examine and discuss four critical elements that are thought to be part of this current state of affairs:

1. Characterize the development structure and recent trends within the U.S. men's javelin system.

2. Identify what levels of performance are needed to be competitive at the international level and the major championships.

3. Identify factors within the U.S. men's javelin development system that could be holding back greater development.

4. Offer potential solutions to meet these performance targets.

CHARACTERIZATION OF U.S. MEN'S JAVELIN DEVELOPMENT

To begin, let's look at how javelin throwers are developed in the U.S.. The primary means of development for javelin throwing within the United States is through the school systems. High schools, rather than clubs, are much more likely to be the athlete's first exposure to the event. Within the United States there are only 18 states which contest the javelin in high school, with the population of these states making up only 28.3% of the total U.S. population. Although, the population of the states that do get exposed to the javelin in high school is roughly 92 million people, large warm weather states that produce many high level baseball and football players, such as California, Texas, and Florida are not in this group.

Year	Major Championship	Finalists
1983	World Championships	Tom Petranoff (silver medal)
1984	Olympic Games	Tom Petranoff, Duncan Atwood
1987	World Championships	Tom Petranoff, Duncan Atwood
1988	Olympic Games	None
1991	World Championships	None
1992	Olympic Games	Tom Pukstys, Mike Barnett
1993	World Championships	Tom Pukstys
1995	World Championships	None
1996	Olympic Games	Tom Pukstys
1997	World Championships	None
1999	World Championships	None
2000	Olympic Games	Breaux Greer
2001	World Championships	Breaux Greer
2003	World Championships	None
2004	Olympic Games	Breaux Greer
2005	World Championships	None
2007	World Championships	Breaux Greer (bronze medal)
2008	Olympic Games	None
2009	World Championships	Sean Furey
2011	World Championships	None
2012	Olympic Games	None
2013	World Championships	None
2015	World Championships	None
2016	Olympic Games	None
2017	World Championships	None

Table 1: This table lists the finalists in the U.S. men's javelin throwers who were able to make it out of the qualifying rounds and into the 12 spots that move on to the finals in all the major championships contested after 1983.

Over the past 15 years the average level of the top javelin throwers coming out of high school has remained fairly steady, and has not shown signs of an obvious decline. Performance averages for the top 10 throwers in high school each year have fluctuated between 76-83% (~64-68 meters) of the international "A" standard for a given year as indicated in Figure 1. It is important to compare the performance of the athletes relative to that of the "A" standard (the performance needed to automatically qualify for the major championship that year), rather than just use the actual distance thrown, since the "A" standard will often change from year to year. In addition, the "A" standard is normally adjusted based on the performances of the collective group of international throwers so it acts as a good barometer to measure the increase in international performance as a group. This is what is most important to assess when trying to measure one's performance advancement.

Upon completion of high school, which can be equated with the end of the Youth or U-18 stage of competition, the next step is to transition to college or university competition. It is in this stage, when the developing javelin thrower is between the ages of 18 and 23, that he is part of a well-funded NCAA system that includes comprehensive coaching, medical and psychological support, along with world class facilities and competition schedules. As indicated in Figure 1, the average of the top 10 best performers at the NCAA level has hovered between 87-93% (~71-76 meters) of the international "A" standard for that year. This age group, which encompasses both the

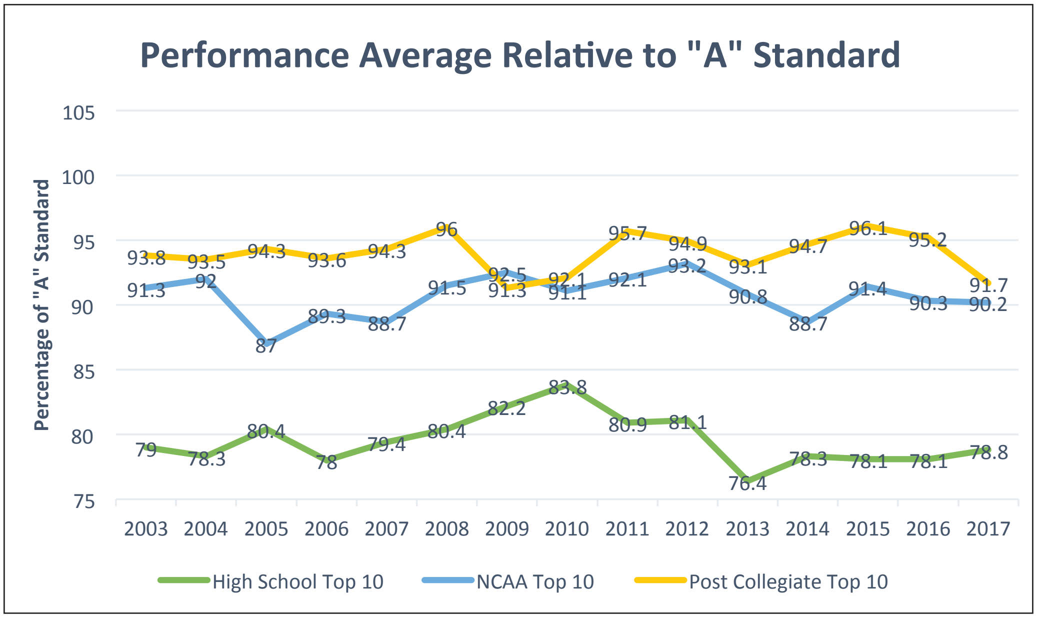


Figure 1: This chart plots the average best mark of the top 10 performers at each level (high school, NCAA, & open) relative to the corresponding "A" standard for a given year. Each score is calculated by dividing the average of the 10 best performers at each level by the "A" standard for that year.

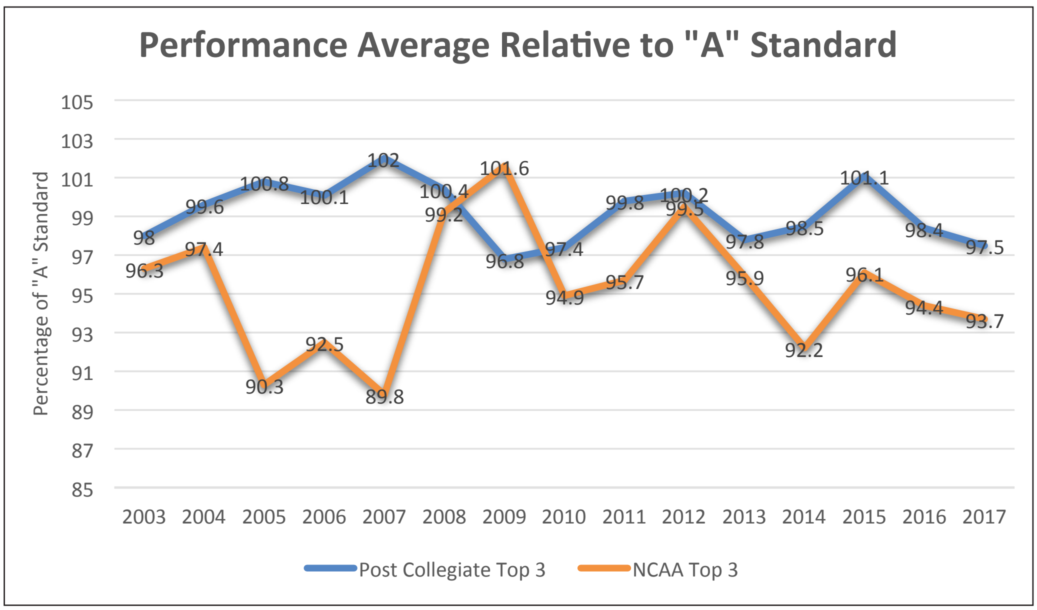


Figure 2: This chart plots the average best mark of the top 3 performers at each level (NCAA & open) relative to the corresponding "A" standard for a given year. Each score is calculated by dividing the average of the 3 best performers at each level by the "A" standard for that year.

Junior (U-20) and U-23 categories of competition, is on par with the other top javelin throwing countries in terms of depth of performance.

The post-collegiate stage of development for men's U.S. javelin throwers sees the group having to deal with a more challenging situation with regard to coaching, medical, and other support services. It is this transition, from having almost every need being taken care to sometimes taking care of everything yourself, that provides the biggest test. Despite these challenges the average of the 10 best performers of the post-collegiate group has been consistently higher than what has been seen for the top 10 NCAA throwers each year at 91-95% (~75-79 meters) of the international "A" standard each year. However, this increase is minimal.

Now that the measures of performance for each of the developmental levels have been quantified, the next step is to focus more closely on the top three competitors in both the NCAA and post-collegiate group since each country is only allowed to send a maximum of three competitors per major championship. By focusing on the top three throwers from each group, it will allow one to see what level of performance the best throwers, who have a real chance to make the major championships, are actually achieving. When these calculations are tabulated, one can see in Figure

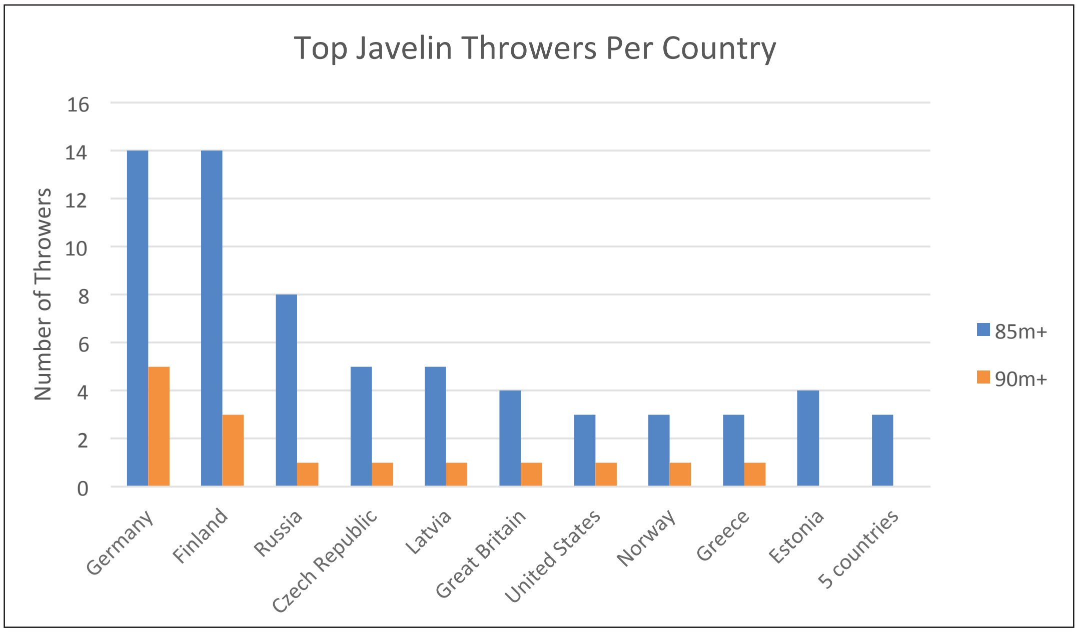


Figure 3: This charts shows the number of javelin throwers per country who have thrown over 90 meters and 85 meters with the new rules javelin that was implemented in 1986. Results from 1991 were not counted because of the use of the rough-tailed javelins that were since outlawed.

2 that the average of the top three performers from the NCAA group registered between 90-101.6% of the international "A" standard for the years 2003-2017. In this same time span the post-collegiate group registers between 97-102% of the international "A" standard. What appears to stand out is that the average performances for the NCAA group and the post-collegiate group are very similar and overlap in some cases. This seems to indicate that there is not much more development going on with the top throwers in their post-collegiate years.

The fact that the performance level of the top throwers in both groups is right near the "A" standard suggests that they are able to produce results that do meet the "A" standard, but that these throwers rarely throw past this more than once in a given season. The progress seems to end once the "A" standard, which is currently 83 meters, is reached. This notion is supported by the fact that the U.S. has had 13 male throwers in history who have eclipsed the 83-meter barrier, while only a mere 3 have gone on to throw more than 85 meters (see Figure 3).

JAVELIN PERFORMANCE AT THE INTERNATIONAL LEVEL

With today's current javelin performances at the international level, it is almost always necessary to throw at least 85 meters to have a chance at a medal at a major championship. This type of high-end distance has only been achieved by three U.S. athletes with the new rules javelin (Tom Petranoff, Tom Pukstys, and Breaux Greer). Petranoff earned a silver in the 1983 World Championships, and Greer a bronze in the 2007 World Championships. It should be noted that all three of these athletes have now been retired for at least 10 years at the time of this writing.

Examination of Figure 3 shows clearly that the U.S. who tied for the same amount of high caliber throwers as much smaller countries like Norway and Greece, and well behind the javelin throwing powerhouses of Germany, Finland, and Russia, has a high performance javelin tradition equaled or surpassed by many countries with a much smaller in population than the U.S.

After spelling out the current levels of U.S. men's javelin throwing, let us now examine actual performances achieved at the major championships by U.S. throwers and how they

Tom Petranoff

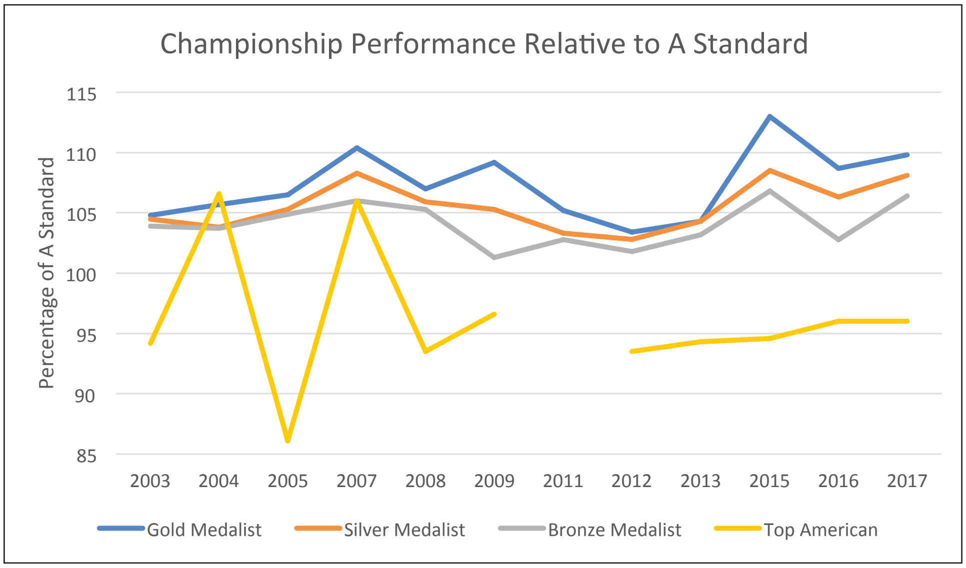


Figure 4: This chart summarizes the performances by the three medalists and the top performing American javelin thrower for each major championship. The performance levels, as reported on the y-axis are the result of dividing the meet performance by the A standard for that given year.

compare with that of the medalists. To begin, let's look at the actual performance that were achieved at the major championships and report them as a proportion of the A standard for that given year. These results are summarized in Figure 4. As expected, the top American performance at the major championships was generally 6-7% below what was needed to be in contention for a medal.

In only two cases during the 2003-2017 time frame did an American javelin thrower achieve a medal-producing level of performance. The first was Tom Petranoff who earned a silver medal at the 1983 World Championships. In 2004, at the Athens Olympic Games, Breaux Greer was able to produce the farthest throw in the javelin competition at 87.25 meters. However, this was done in qualifying and did not carry over to the final in which this result could have won a gold medal. Greer was able to come back to earn a bronze medal at the 2007 World Championships in Osaka, Japan, producing a result that was 106.1% over the A standard for javelin that year. In the past 15 years, however, American javelin throwers have not been able to come close to producing a performance that can get them in contention for winning a medal at this level of competition.

The next question that must be asked is what is the cause for this lack of results in major international competition? Is it that the performance levels are too low for the American throwers going into the meet, or is it a lack of execution at the big meets? The answers seem to indicate that it a combination of both. In order to complete in a major championship you must hit a qualifying standard within a given qualifying period to show you are worthy of participating in such as meet. However, hitting one long throw, and maintaining a high standard of throwing are two different things. The average of the top three marks for the three medalists and the top performing American javelin thrower going into major championships are presented in Figure 5. This charting format gives a much clearer picture of the level of throwing fitness going into a meet, for it shows the eventual medalists almost always had a three-meet average of better than 100% of the A standard going into the meet, while American javelin throwers, with the exception of Breaux Greer in 2004 and 2007, had an average below 100% of the A standard. It was on only three occasions (~8% of the major championships during this time frame) that a men's javelin medalist had a three-meet best average below that of the A standard (Kovals 2008, Murakami 2009, & Walcott 2012) leading into the major competition. All were first-time medalists.

Now, turning to execution in competition, the specific question that needs to be answered is how well does the thrower perform relative to the fitness level that he is taking into the meet. An attempt to quantify this result was done by taking the performance result from the competition and divide it by the average of the top three meets of a given athlete going into the competition. The result of this calculation was termed the championship execution quotient. Examination of Figure 6 shows that it was rare to see American javelin throwers produce a championship execution quotient higher than that of the medalists.

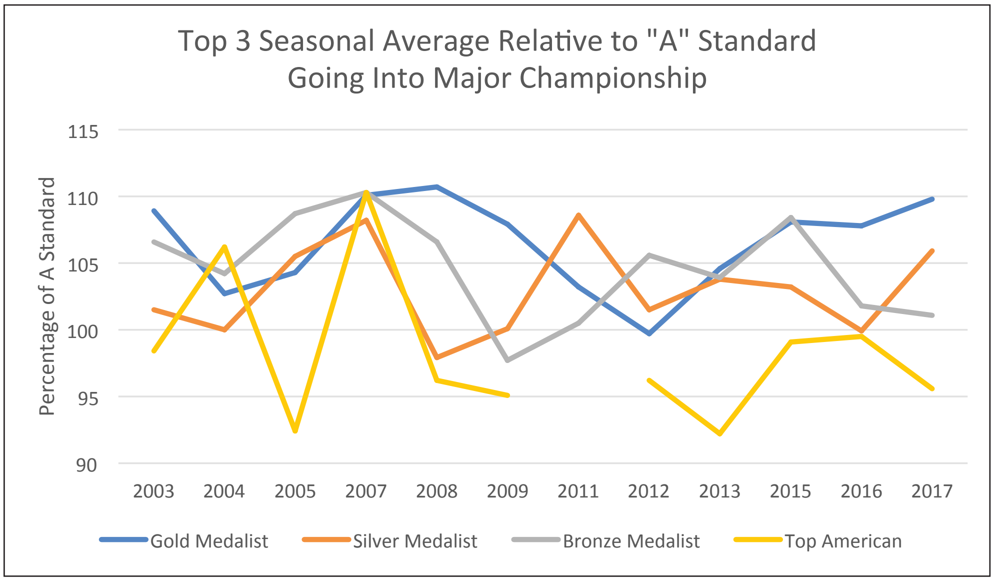


Figure 5: This chart highlights the performance average as of the medalists and top performing American at the major championships by averaging the top three performances during the season leading into the competition and dividing it by the A standard for that given meet. These percentages are reflected on the y-axis of this chart.

Some of the notable instances when this did happen was with Greer (2004), Furey (2009), Dolezal (2013), and Hostetler (2017).

It should be noted that one potential explanation for these mediocre execution quotients is that the American performances at the major championship were done in qualifying, where there are only three throws, so it is hard to directly compare this result directly to meets where they had a full complement of six throws, as they did in their other competitions. On the other hand, the reason that (in all but Greer's case) the throwers were unable to advance to the final, despite a good performance quotient, was their performance average going in to the meet was too low (see Figure 5).

To highlight these data further, Figure 7 provides trend lines for performance data for each of the four groups. This makes it easier to see what the trends are in performance over the past 15 years. One can see that from Figure 7 that the execution quotient for the American javelin throwers has tended to rise over the years, yet it is still far behind that of the medalists. This implies that there is much work to be done in order for U.S. male javelin throwers to be contesting for medals at major championships. They must both increase their average meet performance, and not settle for just getting the A standard, and they must increase their execution quotient

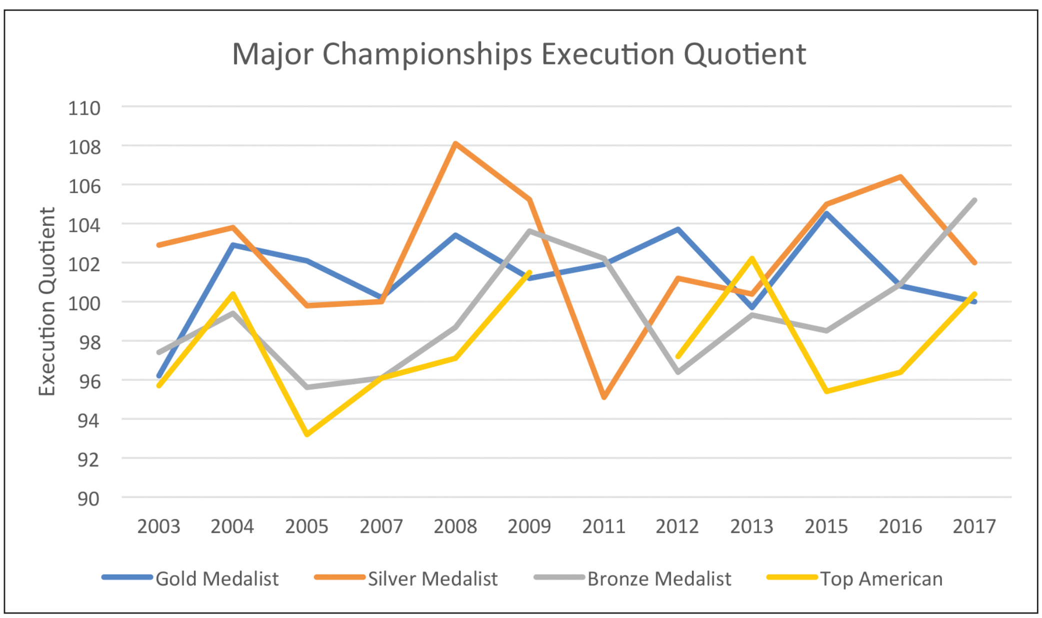


Figure 6: this chart shows the major championship execution quotient, which is a measure of how well a performer throws relative to the average of their three best meets going into a major championship. It is calculated by dividing the thrower's performance at the major championship by the average of his three best competition results leading into the major championship. The result comes out as a percentage and is listed on the y-axis of this chart.

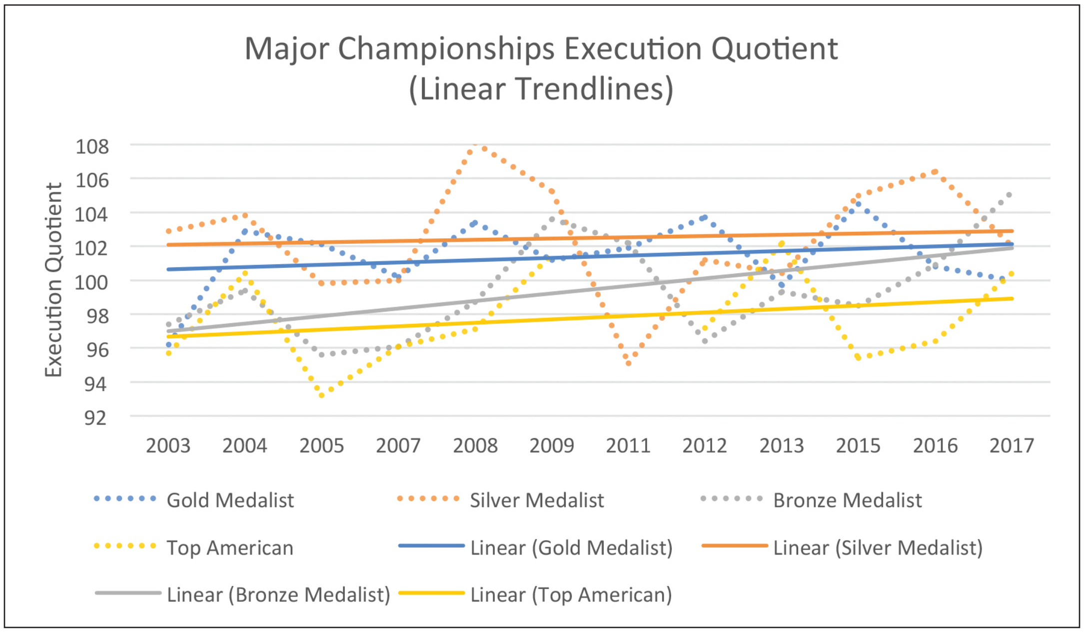


Figure 7: this chart highlights the linear trend lines for the results of the four groups as portrayed in Figure 6.

and do a better job of maximizing their potential at these meets.

PAN AMERICAN GAMES

Interestingly enough, the U.S. men's javelin throwers have been quite successful at the Pan American Games in both winning medals and producing high execution quotients. In the four Pan American Games that have been contested in the 2003-2017 time period, the U.S. male javelin throwers have produced a medal at each championship with an execution quotient over 100%. However, if one looks at the performance quotient for these four throwers after the preliminary rounds one will see results that are very similar to what is seen at the major championships. These results are listed in Table 2.

This could be explained by a couple of possibilities. First off, these throwers all threw their best throws (all of which were seasonal bests, except for Greer, who was very close) in the final. By having the extra three throws in the final, they had more chances to get better than they had in major championships. Secondly, being in a competition in which one knows he can be competitive, even if one starts off slow, gives one the confidence to get it together over six competition throws instead of packaging the pressure into three throws with an uncertain advancement standard. Going forward, these are two critical perspectives that need to be considered and addressed if progress is to be made in improving performance at the major championship stage.

FACTORS HOLDING THE U.S. BACK

In determining what has hindering the U.S. from being more successful at the international level, it appears that the post-collegiate portion of development must be enhanced. For the past 15 years the U.S. has been very good at developing a large pool of javelin throwers each year who can throw 73-76 meters while in their early twenties. The athlete pool at this level has been deeper than any other country, including powerhouses like Germany, Russia, and Finland. Figure 8 shows the breakdown of the javelin performance pools by country for last

Table 2

Year	Name	Final Distance	E.Q. Final	E.Q. Prelims	Medal
2003	Breaux Greer	79.21m	100.3%	98.6%	Bronze
2007	Mike Hazle	75.33m	101.8%	95.3%	Silver
2011	Cyrus Hostetler	82.24m	103.8%	98.4%	Silver
2015	Riley Dolezal	81.62m	100.7%	95.2%	Silver

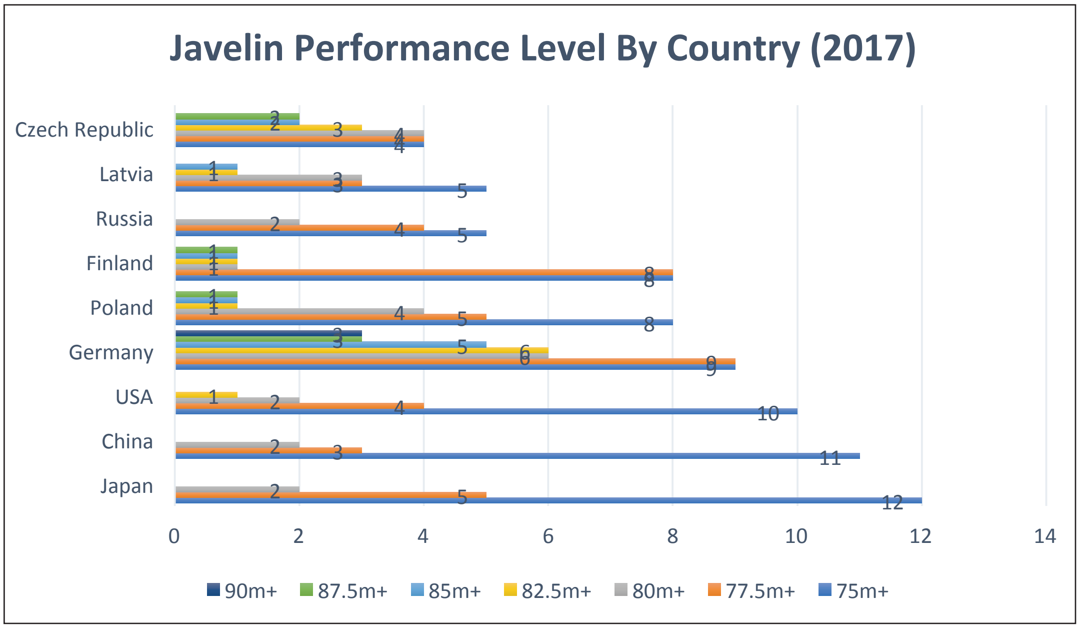


Figure 8: This chart highlights the number of javelin throwers in each country based on the seasonal best for the year 2017.

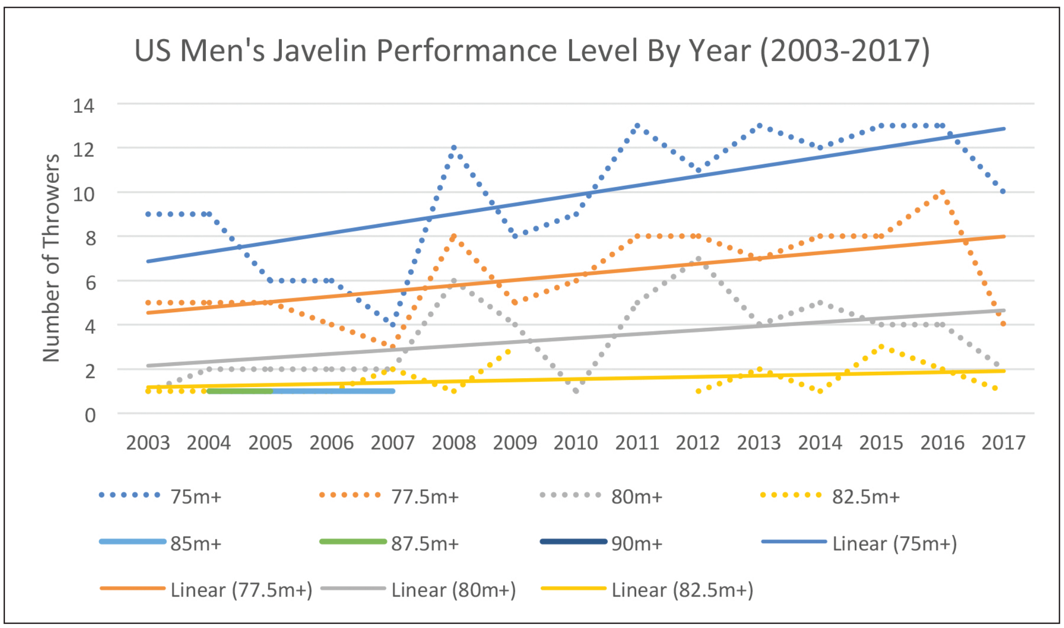


Figure 9: This chart shows trend line (and actual data) for the number of javelin throwers with seasonal bests in each distance category for each year going to 2003 to 2017.

season (2017). One can see that the U.S. also has a considerable number of active throwers with personal bests in the 78-80-meter range as well, but there seems to be a sharp cutoff in performance once throwers get to the 82-83 meter range. This distance also happens to be where the international A standard is, which is also in line with the mark needed to qualify for a major championship final these days. As seen in Figure 9, the trend for the past 15 years has been for the number of 75m-80m javelin throwers to increase, while the number eclipsing the 82.5m+ barrier on a yearly basis has remained steady.

The stagnation in producing more 82.50m javelin throwers is the part of the development process that needs to be examined more closely to see how things can be improved. In terms of performance numbers, if the top end level of performance does not improve at all during the season, then U.S. men's javelin throwers will need to improve their execution quotients to levels above 100% to have a chance to qualify for the major international finals. In order to be in the running for medals a higher level of consistent performance that is 101-103% of the A standard is needed. At this point in time, this would mean a consistent level of performance in the 84.50-86.00 meter range. Only

Tom Petranoff, Tom Pukstys, and Breaux Greer have managed this level of execution and performance with the new rules javelin. This realization turns us to the next question of how do we sent up a system and/or environment to enable this to happen.

POTENTIAL SOLUTIONS

In offering solutions it must be noted that javelin throwing is a very specialized sport. It is only contested outdoors and is vastly different from the other throwing events (shot, discus, hammer) that are often called the “heavy throws”. There is often a higher injury rate associated with high-level javelin throwing, and recovery from injuries involving the elbow, shoulder, and back can sometimes take well over a year. Because of these distinctions many head coaches in the NCAA system will steer away from putting a lot of resources into the javelin because it is felt that the risks outweigh the rewards.

To be clear, because of the specialized nature of the javelin, it will take a lot of investment to produce a high-level javelin thrower. It is obvious that the countries with the best javelin throwers do put a large amount of training capital into developing these athletes since they have the best chances to produce medals for their country (e.g. Finland, Czech Republic, & Germany). This is not the case with the U.S., which has great track and field diversity, and produces many more medals in athletics than any other country. If the U.S. would like to have any chance of winning medals on a consistent basis in the men’s javelin throw in the future, it will have to commit more resources, and have a firmer long term plan to do so.

Areas that need to be addressed are as follows:

1. Pair up the best potential javelin throwers with a top javelin coach (not a throws coach who is working with a variety of different types of throwers), and give them enough time—2-4 years—to come together and figure out the best training paths.

2. If a certain coach and athlete are successful, support them staying together and help them with what they need to be successful.

3. Make it possible to have a competitive and successful schedule at home and abroad (Europe & possibly Asia) so the throwers can prepare properly for a whole season.

    a. This is hard to do when you are not certain when/where you will be competing. Just chasing the A standard and hoping it all works out is not a recipe for success.

    b. Get used to throwing well on the road and in uncomfortable situations. 81m in Europe is better than 83m in Tucson.

4. Help with continuing education for the coach/athlete pairs, and give them an opportunity to visit Germany, Finland, or the Czech Republic and see what they do, what their team spirit is like, and how they see life inside and outside of athletics. The U.S. throwers/coaches can meet up at a camp/summit/or online to discuss these things and pass the knowledge on. These types of things have been done in the past but need to be done more often and systematically to become a larger part of our javelin culture.

All of these suggestions take money and support so it may not be all possible at once, but these types of measures are those that will keep us more competitive on the world stage. It appears we have the pool of athletes, but not the long-term vision and resources to be successful at the 85m+ level. Any one of these recommendations would be a good start.

USATF COACHING EDUCATION

2018 CALENDAR OF SCHOOLS

http://www.usatf.org/Resources-for---/Coaches/Coaching-Education/Calendar-of-Schools.aspx

Level 1

May 19-20	Allen High School - Allen, TX
May 26-27	Cerritos College - Norwalk, CA
June 1-2	Christian Brothers College High School - St. Louis, MO
June 1-3	National Training Center - Clermont, FL
June 8-10	Morristown Medical Center - Morristown, NJ
June 8-10	Drury Inn La Cantera - San Antonio, TX
June 9-10	Wellesley College - Wellesley, MA
June 17-19	UNC Greensboro - Greensboro, NC
June 18-19	Stillwater High School - Stillwater, MN
June 23-24	Benedictine University - Lisle, IL
June 29-Jul 1	Ithaca College - Ithaca, NY
July 7-8	Ironwood Throws Facility - Rathdrum, ID
July 20-21	The Orthopedic Specialty Hospital (TOSH) - Murray, UT
July 20-22	Johns Hopkins University - Baltimore, MD
July 20-22	Nassau Community College - Garden City, NY
Aug. 3-5	Yale University - New Haven, CT
Aug. 3-5	Bishop Gorman High School - Las Vegas, NV
Aug. 10-12	St. Martin's University - Lacey, WA
Aug. 11-12	San Diego Mesa College - San Diego, CA
Sept. 28-30	Community College of Philadelphia - Philadelphia, PA
Oct. 12-14	Marian University - Indianapolis, IN
Oct. 13-14	University of Southern Maine - Portland, ME
Nov. 10-11	Ventura College - Ventura, CA
Nov. 17-18	Allen High School - Allen, TX
Nov. 17-18	Wellesley College - Wellesley, MA
Nov. 24-25	Virginia Wesleyan University - Virginia Beach, VA
Dec. 1-2	Tennessee State University - Nashville, TN
Dec. 7-9	Westerville South High School - Westerville, OH
Dec. 8-9	Cerritos College - Norwalk, CA

JOIN AN ELITE GROUP OF COACHES AND EARN LEVEL 2 CERTIFICATION THIS SUMMER

Don't miss the opportunity to learn from top coaches and join an elite community of coaches in the USA and around the globe who hold USATF Level 2 certification, July 16-21, 2018 at Marian University, Indianapolis, Indiana for the 2018 USATF Level 2 Program; applications for the program are now available.

Recognized by NCACE and the IAAF, Level 2 is designed to elevate a coach to new professional levels with applied sports science modules and in-depth training methodology in a chosen event discipline. Boasting expert instructors and an event manual dedicated to the individual events within each discipline, Level 2 provides coaches with the knowledge to implement sophisticated training programs, and the ability to explain the "why" behind the program to athletes.

Event disciplines

Choose any of the following:

- Sprints/Hurdles/Relays
- Endurance
- Jumps
- Youth Specialization
- Throws

Qualified coaches may apply for the Instructor Training Course (ITC). Class size is limited and ITC requirements apply.

Application requirements

- Must be a 2018 USATF member
- Must be a current USATF Level 1 coach
- Minimum three years of track & field or cross country coaching experience

Click below for more information on the USATF Level 2 Program or to begin an application. Applications will be accepted through June 1, 2018 or until capacity is reached in an event discipline.

http://www.usatf.org/Resources-for---/Coaches/Coaching-Education/-groups-coaches-education-level2-asp.aspx

USATF CROSS COUNTRY SPECIALIST COURSE HEADS TO CHICAGO, JUNE 16-17, 2018

The third iteration of the USATF Cross Country Specialist Course is scheduled for June 16-17, 2018 on the campus of North Central College, Naperville, Illinois. Legend and world-class distance coach, Dr. Joe Vigil, and veteran distance coach and coach educator, Scott Christensen, return as the lead instructors.

The 12-hour course features technical classes, laboratory training sessions, cross country specialty drills, periodization training for the cross country season, team building strategies, and long term athlete development for the endurance runner. In addition to the classroom and laboratory time, coaches will participate in interactive discussion sessions.

Don't miss your opportunity to learn the theory and skills that has produced High School State Championships, over six NCAA Cross Country Championships, and IAAF World Cross Country Champions and to become a USATF Specialist coach. All coaches whom complete the course and achieve a passing score on the final exam will be awarded a USATF Cross Country Specialist certificate.

Registration for this limited enrollment course is now open and can be completed at the link below.

USATF.org/XCCOURSENCC

2018 USATF COACHING ENHANCEMENT GRANT PROGRAMS

USATF is pleased to offer select grants for the 2018 year to assist coaches in opportunities to enhance their professional growth. All applicants must be a member of the USATF Coaches Registry to be eligible; program description, application deadline and additional criteria are outlined below. For additional opportunities and to submit a grant application, click the link below.

USATF.org/CoachesGrants

National Championships Mentorship Grant
Location: Des Moines, Iowa
Date: June 21-24, 2018
Application Deadline: May 13, 2018

This unique mentorship program will provide an up close and personal experience of the strategies, meet prep, mental preparation and "in the moment" coaching for an emerging elite coach in a chosen event. The grant recipient will shadow one of USATF's Master coaches through the rounds and final of a chosen event. A group administrator will lead rap sessions after each round to discuss the grant recipients' experiences.

Grant: Four (4) $900 grants are available towards travel expenses. Coaching credential to be included. The grant recipient may use funds for any travel expenses and receipts must be submitted to Terry Crawford, terry.crawford@usatf.org, within 30 days of the event for reimbursement.

Criteria:

- A coach cannot have an athlete competing during the designated dates of the Mentorship.
- A current coach who is either a head High School Coach for 8 years or a college assistant or head coach for minimum of 5 years.
- Has coached an athlete at the Junior or Senior USATF Outdoor Championships in the last five years or coached a high school athlete at the State Championships.
- USATF Level 2 Coaching Education certificate in any of the event disciplines.
- Member of the USATF Coaches Registry
- Two paragraph position statement on the value of attending the mentorship, submitted with application.

Emerging Female Grant

The Emerging Female Grant is provided by USA Track & Field, and provides a select number of minority, women track and field coaches the opportunity to attend USATF Coaching Education courses (Level 1 or Level 2) during the 2018 calendar year.

Grants:

LEVEL 1: $500 grant towards travel expenses and registration for any 2018 Level 1 School. Applications will be accepted ongoing until funds are expended. Applicants are encouraged to apply early for best consideration.

LEVEL 2: Grant provides tuition / shared room & board at the 2018 Level 2 School (July 16-21, Marian University, Indianapolis, IN). Applications will be accepted until April 30, 2018. Applicant must be accepted into the Level 2 School to be eligible.

Requirements

- Must be a current USA Track & Field Member
- Be a current member of the Coaches Registry
- Provide a resume of coaching background/experience
- Provide a letter of recommendation or three references

USATF

USATF.ORG