TRACK COACH

2018 / ISSUE 225

TRACK COACH

Fall 2018 — 225

The official technical
publication of
USA Track & Field

USATF

THE DOUBLE PENDULUM PRINCIPLE IN POLE VAULTING 7161

MARAUDER SPEED “GETTING YOU THERE FASTER” 7164

HOW TO DO INTERVAL WORKOUTS CORRECTLY 7173

OLYMPIC WEIGHTLIFTING FOR THROWERS 7176

YEAR-ROUND INDIVIDUALIZED RESISTANCE TRAINING FOR COLLEGIATE TRACK & FIELD EVENT GROUPS 7179

USATF COACHING EDUCATION SCHOOLS 7187

TRACK COACH

FORMERLY TRACK TECHNIQUE

225 — FALL 2018

The official technical publication of USA Track & Field

USATF

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

PUBLICATION

Track Coach is published quarterly by Track & Field News, 2570 W. El Camino Real, #220, Mountain View, CA 94040 USA.

The Winter 2019 issue (No. 226) of Track Coach will be e-mailed to subscribers in January 2019.

SUBSCRIPTIONS

$19.95 per year, U.S. or foreign. Track Coach became a digital-only publication in 2015. Track & Field News subscribers get free access to all Track Coach articles. See www.trackandfieldnews.com. Click on "subscribe"

BACK ISSUES OF TRACK COACH

Many back issues of Track Technique/ Track Coach, #92-208, are available singly at $5.50 (U.S. delivery)/ $9.50 (foreign delivery) each postpaid. No issues previous to #111 are available.

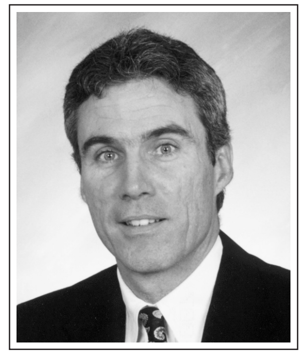
To order, send your check to

Track Coach
2570 W El Camino Real,
Suite 220,
Mountain View, CA 94040

FROM THE EDITOR

RUSS EBBETS

A STITCH IN TIME



Ben Franklin is credited with penning "a stitch in time saves nine." I'm not sure if tailor was one of his many jobs along the way but regardless he made his point. Proactive efforts now can negate long-term problems in the future.

This doesn't seem to work well with politics. I remember one of my poly sci professors smugly telling the class that the #1 job of a politician is getting re-elected. As an early 20-something I thought that was a pretty cynical statement about people who were presumably dedicating their lives to public service. But the serving, I see now, is more of the self-serving kind and the avoidance of dealing with real issues where the politician simply "kicks the can down the road" and lets someone else deal with the problem later. Realizing this one begins to understand why we we've got what we've got.

This delayed action is not a good idea for society and doesn't work well for personal health either. At one time or another we all are guilty of it. We have a little ache or pain and make the decision to "gut it out" figuring it will go away. Sometimes we get lucky. A good night's sleep, a hot shower and the decision to self-medicate may resolve the problem—or at least bury it below our level of waking consciousness.

But sometimes "it" lingers on. Two days turns into a week or month and whatever state you've slipped into is accepted as one's "new normal." Certainly, that is one way to deal with life, but it is a nine-stitch method.

Left to their own devices most conditions will progress if the problem is not addressed. Canadian physician Kirkilday-Willis created a cascade of physical events that sequentially documents the downward spiral of musculo-skeletal conditions that results from letting something "get better on its own."

The box on page 7186 details this natural slide which many may dismiss as natural aging. The problem with accepting this "natural slide" explanation is that it begins to justify a sore muscle at age 19 as a life sentence.

The good news here is that if one can intervene in the first four or five steps of Kirkilday-Willis's ladder the process can be reversed. This could entail a habit change, new routine or therapy intervention that allows one to essentially return to the start and get a "do-over."

CONTINUED ON PAGE 7186

THE DOUBLE PENDULUM PRINCIPLE IN POLE VAULTING

Bussabarger questions whether or not the double pendulum principle actually exists in fiberglass vaulting.

BY DAVID BUSSABARGER
ILLUSTRATIONS BY DAVID BUSSABARGER

The fundamental principle underlying rigid pole vaulting was the double pendulum. Simply put its goal was to make the vaulter's body into a pendulum rotating about the pole while the pole became a 2nd inverted pendulum rotating about the box.

Because the pole was rigid it could only move towards vertical in an overhanded rotational motion. As a result vaulters were forced to design their takeoff action around the limitations of the pole's movement. Proficient rigid vaulters sprang directly upward as they left the ground in order to reduce takeoff shock and to generate overhand rotation in the pole. Immediately after leaving the ground the vaulter dropped his lead leg and pushed his chest forward and upwards towards the pole. At this point in the vault the vaulter literally became a pendulum rotating about his closely spaced hands.

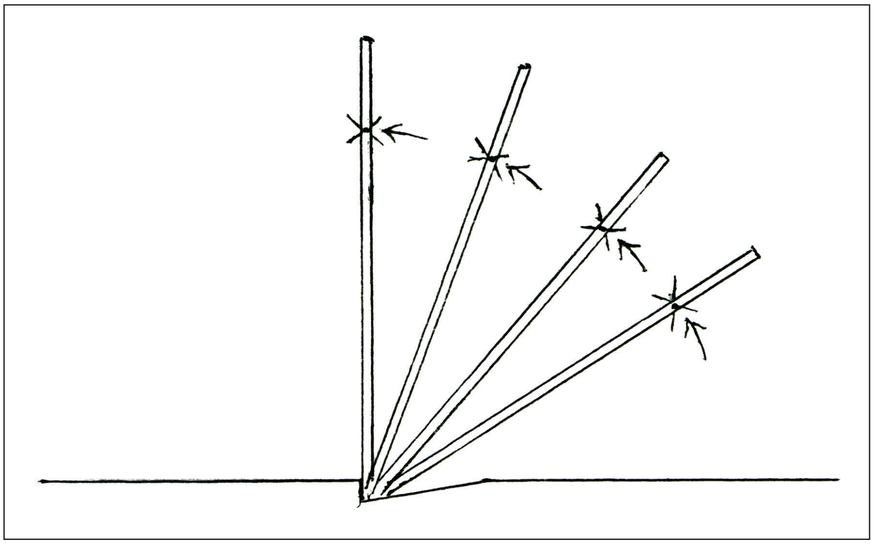
The first fiberglass poles that could bend reliably without breaking were introduced around 1960 (Herb Jenks's Browning Sky Pole). Initially all the best fiberglass vaulters were accomplished rigid pole vaulters. As a result traditional rigid pole technique, including the double pendulum, was adapted to fiberglass vaulting with relatively few changes.

Common early technical adjustments included reducing the hand shift slightly during the plant so the hands remained farther apart during the vault and extending vertically before pulling and turning.

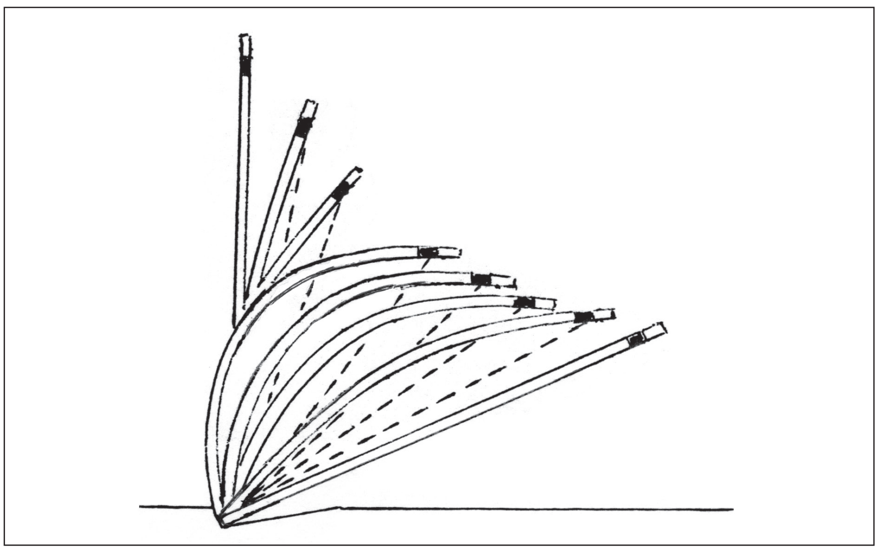
The concept of actively bending the pole was something new in vaulting so in the beginning vaulters typically only bent the pole 20 to 30 degrees.

The great exception to this trend was John Pennel (USA). Pennel became the 18th man over 15 feet with a metal pole at the young age of 20 in 1960. In 1963 he set his first WR with a fiberglass pole at 16-3/4.95m and went on to set six more WRs that year, culminating with a leap of 17¼/5.20m to become the first man over 17 feet.

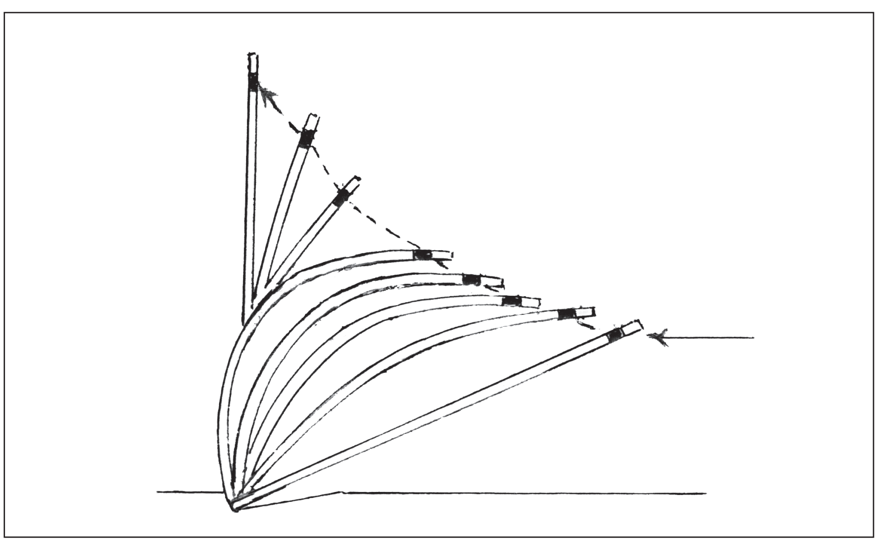
Arguably more important were Pennel's many technical innovations, particularly his very wide hand



A: Rigid pole rotated to vertical



B: Fiberglass pole imaginary rotation



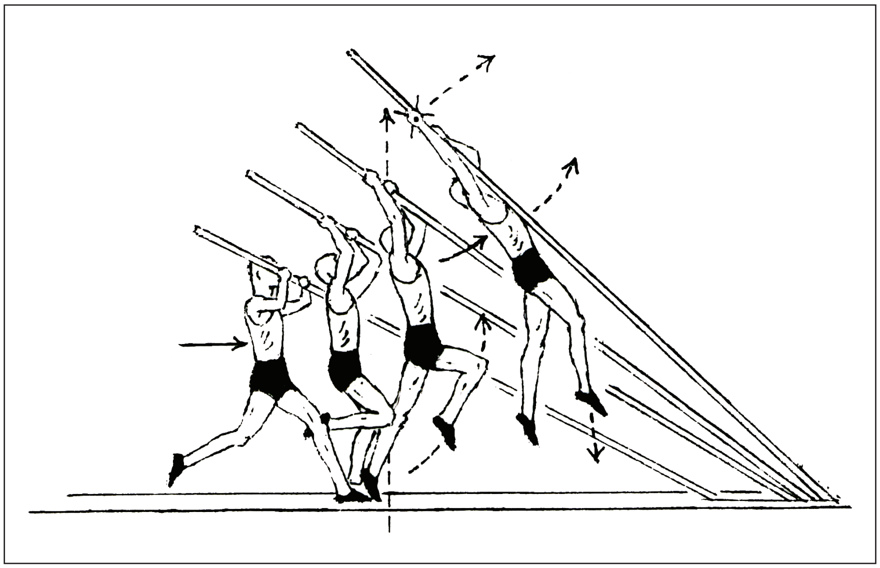
C: Fiberglass pole rolling wave motion

spread for the time (about 28”) and his total reinvention of the takeoff. Pennel realized that because of the pole’s flexibility, the vaulter could emphasize driving forward through the takeoff while springing off the ground in a forward-to-upward direction. This created much more kinetic force of movement during the takeoff, which in combination with his wide hand spread and higher grip produced much greater pole bend (90 to 100 degrees). The writer calls this the “Penetration Style” takeoff. The great majority of elite vaulters adopted variations of this takeoff style from roughly the late 1960s onwards, a trend that continues to this day.

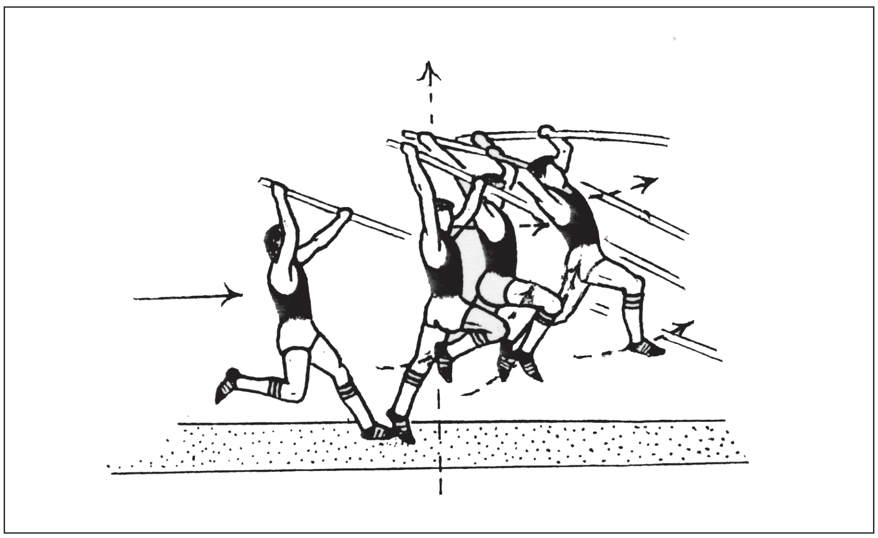
The salient point here is...

(1) Because of Pennel’s wide hand spread and penetrating takeoff action his body never became or acted like a pendulum during the vault.. Note that because of his takeoff and hand spread Pennel’s swing became focused on the sweeping action of his trail leg rotating about his hip. In other words he did not rotate about his top hand, a critical factor in establishing pendulum body movement.

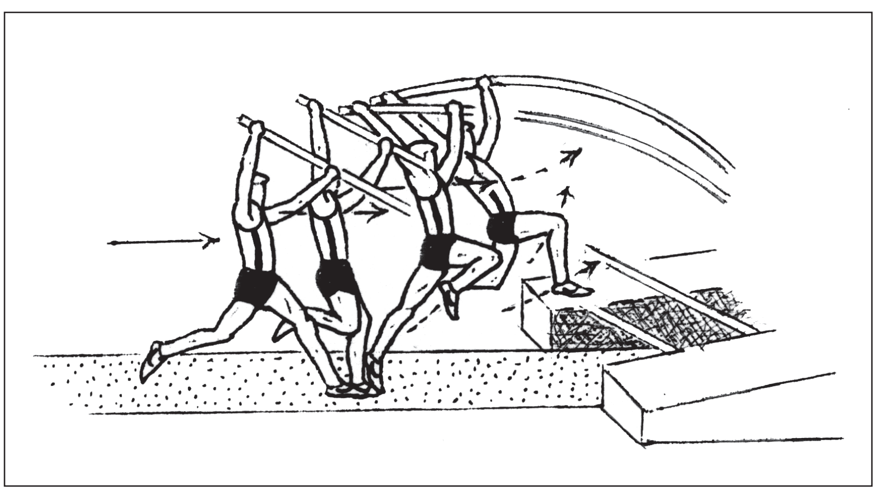
(2) Because of Pennel’s penetrating takeoff and increased pole bend, the pole no longer rotated to vertical in an overhand fashion like a rigid pole. Note that many argue that because the theoretical axis of bending poles produces the appearance of rotational movement when charted, fiberglass poles rotate to vertical like rigid poles. It is the writer’s point of view that (A) This is in effect imaginary rotation. (B) The true movement of the pole in a proficient fiberglass vault should be plotted based on the movement of the top hand on the pole through



D: Dutch Warmerdam (USA) rigid pole takeoff/double pendulum



E: Sergey Bubka (UKR)—the free takeoff



F: Tim Mack (USA)—the penetration style takeoff

the vault. This reveals that the pole has a rolling wave-like movement as it bends.

In conclusion, once the vaulter develops a proficient fiberglass takeoff with the hands on the pole more than roughly one foot apart and the pole is fully bent the double pendulum will be eliminated from the vault.

A related point here is Vitaly Petrov's "free takeoff" concept. Petrov claims that fiberglass vaulters should retain the upward springing action seen in rigid vaulters (in coordination with extending both arms) as they leave the ground to improve pole rotation. Despite the fact that this concept has been widely accepted since the 1980's, very few elite vaulters have used/use a free takeoff action (new 6m vaulter Timur Morgunov its currently its most prominent exponent). This is probably because it is more complicated and difficult to master compared to the penetration style takeoff. In addition, if, as the writer argues, fiberglass poles do not rotate to vertical, then there is no mechanical advantage for the free takeoff other than it slightly increases the angle of the pole as the vaulter takes off. It is certainly debatable whether or not this offers any significant advantage in itself.

It is the writer's view that the primary reason for the increases in hand grip seen in elite vaulters over the years is the result of improvements in the execution of the penetration style takeoff. Petrov's star pupil former WR holder Sergy Bubka (UKR) is reported to have had a hand grip of 17 feet. However it must be taken into consideration that Bubka was a massive one tenth of a second faster over the final 5m of the run

(Continued on page 7172)

MARAUDER SPEED
"GETTING YOU THERE FASTER"
A PRATICAL GUIDE TO SPEED & SPEED DEVELOPMENT

MIKE THORSON, FORMER DIRECTOR OF TRACK & FIELD/CROSS COUNTRY AT THE UNIVERSITY OF MARY, BISMARCK, N.D.

Speed—Stride length multiplied by stride frequency. It is defined as the ability to perform specific movement in the shortest possible time.

Velocity—the rate of speed in a given direction.

GOAL (Mission Statement) The goal of any speed development program: **.01/stride Improvement.** Example: time improvement in a 100m dash would be .5. 40m—.2. (Seagrave, Speed Dynamics)

SPEED CAN BE SIGNIFICANTLY IMPROVED THROUGH A SYSTEMATIC TRAINING PROGRAM

Speed is both a biomotor quality and a motor skill. Sprinting can be learned through educating the neuromuscular systems in the body and enhanced through basic learning skills. **Speed = A neuromuscular skill.** It is in the motor unit where speed begins and must be perfected! The techniques involved in sprinting must be rehearsed at slow speeds and then transferred to runs of maximum speeds.

Remember, sprinting involves moving the body's limbs at the highest possible velocity. The stimulation, excitation and correct firing of the motor units make this possible for high frequency movements to occur. This complex coordination and timing of the motor units and muscles must be rehearsed at high speeds in order to establish the correct motor patterns.

When we talk about speed, it is normally in terms of runs of 95-100% intensity over 30-60 meters, or up to six seconds of running at maximum effort.

Speed is the product of two very basic parameters: stride length (SL) and stride frequency (SF). Of the two, SF, which is measured in single strides per second, is the most important.

The **Speed Equation**: *Stride Frequency X Stride Length* = **SPEED**.

That equation, however, means very little to your typical sprinter. In layman's terms: **The goal of the sprinter is to put big forces into the ground in a short time. The longer an athlete is on the ground the greater the loss of stride frequency.**

THE MARAUDER SPEED PROGRAM IS BASED ON FOUR KEY CONCEPTS

1. Speed improvement results from training at continuous *high*, *varying* intensities! Speed training must be done at maximum speeds with many repetitions to train the correct motor patterns.

2. Skill development (sprint mechanics) must be learned, rehearsed and perfected before it can be done at high speeds.

3. Flexibility must be developed and maintained on a daily basis.

4. An athlete's strength development must be parallel with developments and increases in speed. (Functional Strength=SPEED)

THE BASIC COMPONENTS OF MARAUDER SPEED

1. **SPRINT MECHANICS** An athlete may run only as fast as his/her technique allows. Only through good sprint mechanics will an athlete function at the ultimate/optimal stride length/ stride frequency.

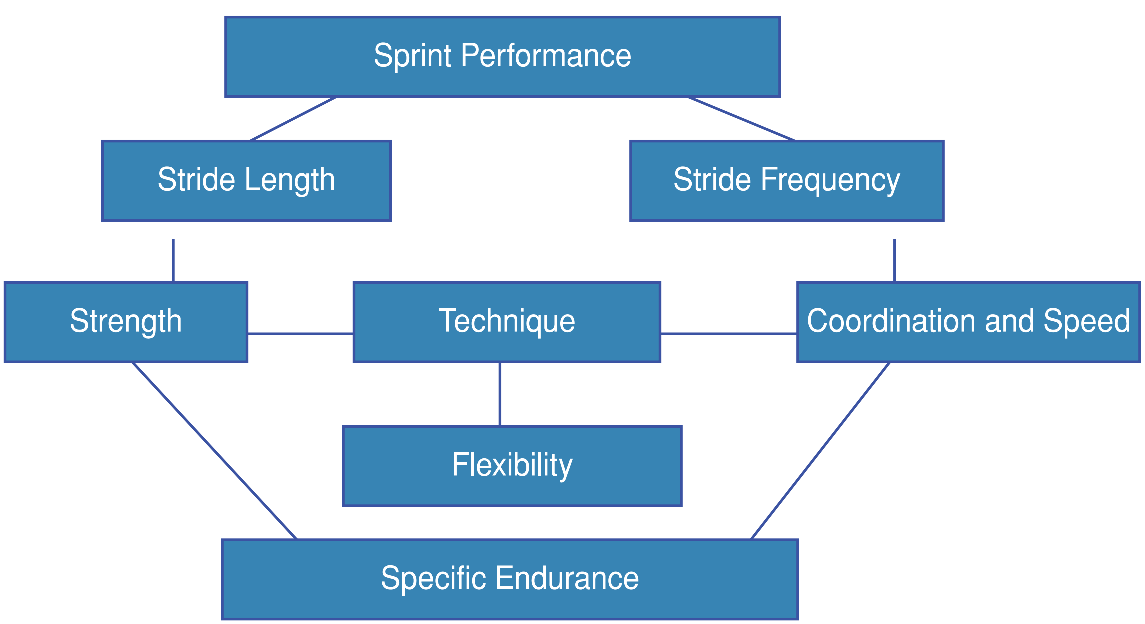
2. **FLEXIBILITY** Only through gaining flexibility through a series of stretching exercises and dynamic warmup drilling can athletes gain the *range of motion* required for top-level sprinting.

3. **NEUROMUSCULAR (CNS) FIRING STIMULUS** The brain begins all movement patterns by sending impulses to the nerves, causing muscles to contract. Speed gains result from a perfected activation of motor units implemented through correct training.

4. **MAXIMUM VELOCITY TRAINING** Only through brief intervals of maximum velocity will the athlete develop and "educate" the proper motor patterns. "Very fast training" at near 100% intensity is needed if the athlete is to be "fast" on meet day! **An athlete cannot ask the body to do something in competition that it hasn't been trained to do**. Maximum velocity training needs to occur on a very continuous year-around basis. Remember, "If you don't use it, you lose it."

5. **STRENGTH** can be gained through a number of different means, including regular weight training, body weight exercises, hill running, bounding, multi-jump training, multi-throw train-

SPRINT PERFORMANCE INGREDIENTS



ing, therabands and plyometrics. Your strength and conditioning program should be based on exercises and drills involving multiple joint actions and movements. Sport skills require multiple joint actions timed or fired in the proper neuromuscular recruitment patterns.

6. **SPEED ENDURANCE** Anaerobic endurance is a key ingredient needed in order for a sprinter to stay at maximum speeds longer and cover longer distances (7-20 seconds, 60-150m). This can be accomplished through interval/repetition training. Example: 2 X 3 X 5 reps with 2-5 minutes recovery/rep/8-10 minutes recovery/set

7. **ACCELERATION** Developing proper leg angles and training an acceleration pattern are essential to speed development. Acceleration mechanics in their purest form involve falling and recovery action with every movement affected by the previous one. The goal is to reach maximum stride with an efficient trained pattern in a minimum amount of time.

8. **BREATHING PATTERNS** Specific, rehearsed breathing patterns have a significant impact on sprint performance. It has been proven that acceleration and explosion improve when an athlete uses a pattern of inhaling/exhaling. Soviet research has long shown that more force can be produced when the athlete holds his breath. (Valsalva Maneuver)

9. **RECOVERY/REGENERATION** Athletes who are involved in regular regeneration/recovery treatments are able to increase the volume of high intensity work by as much as 40%. Many coaches/athletes do not understand that it can take up to 48 hours to recover from a high intensity CNS/power workout. Sauna, pool, massage, ice bath, massage sticks and form rollers are all useful recovery means. Athletes and coaches should understand too that nutrition, hydration and sleep can play a large role in recovery.

MARAUDER SPEED PRINCIPLES

1. Sprinting is the result of **neuromuscular coordination**; a motor learning process.

   a. Force production and movement and velocity have to be optimal rather than maximal.

   b. With higher speeds, the time frame becomes smaller for muscle contraction and relaxation. Thus, it is more difficult for the CNS to distinguish and coordinate the driving forces of extension with antagonistic actions of flexion in leg recovery. It is very important that the agonistic and the antagonistic muscle activities not hinder one another.

   c. **Repetition** of this neuromuscular facilitation in the correct firing sequences seems to establish an automatic response in performance**. Only through repetition at high speeds can an athlete educate the proper muscles to be used and the order to be fired.**

   d. The neuromuscular recruitment and activation of motor units (skill) is most effectively developed only during fatigue-free seconds of anaerobic alactic work. A sprinter does not only improve performance by activating bigger motor units in greater quantities but by synchronizing their activation to produce a greater rate of force development.

2. The base training for speed is **SPEED**. Thus, it should be trained year-around. Intensity is increased as competitive performances are required, but to neglect speed and technique for several months of the year is a serious mistake. This was often done in the past to obtain so-called “base work” prior to training speed. “If you train slow, you will be slow.” **If you want to be fast, train FAST!**

3. No fatigue can be present when speed training is being implemented. Athletes must have complete or near recovery if the athlete is to receive the maximum training effect. An elite level athlete needs 24-36 hours of rest or very low intensity work prior to a maximum speed training session.

4. Develop speed before speed endurance in any session or cycle.

5. Increase and decrease intensity to continually stimulate the CNS and avoid the movement stereotype. In other words, vary speeds and train at different intensities. Remember that practice does not make perfect, it makes **permanent.**

6. Emphasize neuromuscular coordination over strength and conditioning.

7. Speed should always be trained before strength in any session.

8. Acceleration and stride frequency do not develop without strengthening associating muscles to be fast and powerful.

9. Always choose exercises that are **specific** to sprinting and train for performance and not work capacity.

10. It is important to stimulate the CNS on a daily basis.

11. Medium loads with a fast series of repetitions are typically what are needed for the sprinter. Heavy loads, however, will be needed to aid in the improvement of the acceleration phase where power is needed. Remember, however, that too much work with maximum loads and slow speeds will develop muscle memory that is non-productive for the sprinter.

12. Choose multi-joint exercises over part movement exercises and optimally in the same firing sequence that a sprinter would employ.

13. Train for muscle balance and amplitude of movement. Programs must address all muscle groups and balance in strength development. Many injuries are the result of an imbalance in the antagonist muscles.

14. Address postural needs first and foremost. The **CORE** of the body is critical to performance.

15. Employ the same group of exercises long enough for a positive training effect (4 weeks). But not too long to cause a dynamic stereotype or staleness. Athletes and muscles need variety and varied stimulus.

16. Don't think that strength work has to be done in the weight room. Sled pulls, tire pulls, hill running, hurdle hops, multi-throw/jumps and circuits can produce some significant functional strength gains.

17. Training can have a huge effect on fast/slow-twitch muscle fibers. Although to a degree this is genetic, training can have a huge effect on the recruitment and utilization of the correct fibers. Too much slow endurance work will recruit the intermediate fibers to assume properties of slow muscle fibers. On the other hand, more high intensity training can train the intermediate fibers to take on the properties of fast-twitch muscle fibers.

ACCELERATION

Acceleration (defined) the rate of change in velocity. It allows the sprinter to reach maximum speed in an efficient, minimum amount of time. Most sprinters reach maximum speed between 30-60 meters. Very seldom in team sports do athletes go beyond the acceleration phase. They are constantly stopping, starting and changing directions.

Acceleration may be the most trainable of the speed components.

MECHANICS OF ACCELERATION

Posture The alignment of the body is critical, with posture being dynamic—constantly changing with every step. Remember the so-called lean comes from the **ankle** and not the waist.

Arm Action The arms assist to produce force and aid in balance so that forces can be applied toward the ground.

Arms/Charlie Francis All sprinting is controlled by the arms according to the late Canadian sprint coach, Charlie Francis. **When neurological pattern was researched it revealed that the arms do precede the legs and the faster the arms move, the faster the legs will in return.**

Leg Action The emphasis is on the backside mechanics—the legs are pushing back behind the body during the first steps/strides. The pushing action begins in the first 4-6 steps, after which a sprinter is attempting to get into the "hips tall" sprint position.

Acceleration Pattern It is necessary in order to obtain the correct force application and proper transition to top speed to have the proper acceleration pattern. The pattern typically sees each step increasing until full speed is achieved. *Many athletes take steps that are too long, hoping to achieve top speed quicker. Typically this causes just the opposite effect.*

Force Application The goal in applying force is to create a positive shin angle so that the foot initially contacts the ground behind the center of gravity. Quite often the opposite occurs, thus a braking action when the foot gets out ahead of the center of gravity and causes a braking action. A coaching cue

Marauder Speed/ Sprint Warmup Series — "A" Day

Circle Flexibility Exercises

1. Prisoner Squats
2. Front Lunge
3. Front & Back Eagles
4. Donkeys
5. Hip Raisers
6. 1 Foot Squares (eyes closed)
7. Inverted Bicycle
8. Inverted Scissor
9. Inverted Crossovers
10. 2 Foot Squares
11. Cone Hops (front & back)
12. Fire Hydrant
13. Knee Circles
14. Head Circles/Trunk Circles
15. Arm Circles
16. Leg Swings
17. Stationary Tuck Jumps
18. 25 Sit-ups (crunches)

Dynamic Exercises 25m

1. Regular High Knees (March)
2. Jog
3. High Knees Backwards
4. Jog Backwards
5. Carioca (down & back)
6. Walking Lunge (eyes closed)
7. Crane (ankles) (eyes closed)
8. Jog
9. High Knees with Skip
10. Bounding (big bounds)
11. Backwards Skip
12. Jog Backwards
13. Goosestep (March) x 2
14. Jump Rope (backwards & forwards)
15. Jog Backwards
16. Straight Leg Bounding
17. Frogs x 2
18. Hang
19. Bounding (big bounds)
20. Fast Leg/ Fast Arm
21. 40m High Knees Backwards
22. Fast Leg Series (1) Single (2) Alternate
23. A-B-C's (shin splint drills)
24. 25 Sit-ups (crunches)
25. Hurdle Drills
26. Accels (4x50-60m)

* Your last stride should be as FAST as anything you will do in the entire workout or track & field meet.
"Remember you are only as fast as your mechanics will allow."

is to have the sprinter get the foot down as quickly as possible—you can only apply force if the foot is on the ground.

Acceleration Training Improvement in acceleration is closely linked to gains in power. Gains in power will result in the ability to produce higher amounts of force more quickly, thus decreasing ground contact time. **Power** (defined) is the rate at which work is done. Work divided by time = Power.

Acceleration Breathing Pattern The athlete will typically hold his breath (the in if you are working in and out breathing) during the acceleration phase before breathing out during the transition to the maximum velocity phase.

Acceleration Drills There is no substitute for the real thing. Therefore, the best way to train acceleration is to do just that and do not deviate very much from true acceleration work (drills). An example of acceleration work just using the body would be simple Falling Starts.

DRILLS:

1. Stick drills (experiment with spacing)

2. Harness Sprints (moderate resistance))

3. Sled Pulls (Always use the 10% rule—the resistance of the sled should not slow the runner down more than 10%)

   a. React and Go drills
   b. From a 180-degree turn
   c. From back lying prone

Marauder Speed/ Sprint Warmup Series—“B” Day

Circle Flexibility Exercises

1. Prisoner Squats
2. Front Lunge
3. Front & Back Eagles
4. Donkeys
5. Hip Raisers
6. 1 Foot Squares (eyes closed)
7. Inverted Bicycle
8. Inverted Scissor
9. Inverted Crossovers
10. 2 Foot Squares
11. Cone Hops (front & back)
12. Fire Hydrant
13. Knee Circles
14. Head Circles/Trunk Circles
15. Arm Circles
16. Leg Swings
17. Stationary Tuck Jumps
18. 25 Sit-ups (crunches)

Dynamic Exercises 25m

1. Regular High Knees (March)
2. Jog Backwards
3. Skip with Arm Circles
4. Backwards Skip
5. Jog
6. Carioca (down & back)
7. Frogs
8. Hang
9. Jog
10. High Knees with Skip
11. Goosestep (March)
12. Jog Backwards
13. Bounding
14. Frogs
15. Jog Backwards
16. Jump Rope
17. Straight Leg Bounds
18. Fast Leg/ Fast Arm
19. 40m High Knees x 2
20. 40m High Knees Backwards
21. Fast Leg Series (1) Single (2) Alternate
22. A-B-C’s (shin splint drills)
23. 25 Sit-ups (crunches)
24. Hurdle Drills
25. Accels (4x50-60m)

* Your last stride should be as FAST as anything you will do in the entire workout or track & field meet.
“Remember you are only as fast as your mechanics will allow.”

d. On stomach
e. Drop and go

BALANCE

Balance may be the most neglected component in training. Yet, it is the most important component in athletic training because it underlies all *movement.* It is a very simple task, but is highly complex when it comes to sprinting.

Balance does not work in isolation when it comes to athletics. Things such as coordination and agility depend on a well-developed sense of balance. The ability for the sprinter to produce force at the right time, in the right plane, and in the right direction, is highly dependent on balance.

Balance and actually sprinting and running involve the body repeatedly losing and regaining control of its center of gravity because a runner (sprinter) is always moving. Balance can be improved through a variety of different sensory exercises.

A mini tramp, K-board, foam blocks or other means of equipment can certainly be used to train balance. But always remember the best equipment is the body itself.

Examples of balance training activities:

1. Hurdle Walk/Hurdle Walkovers (Regular and with eyes closed)

2. 180 and 360-degree turns/jumps (regular and eyes closed) Also called Half Turns/Full Turns. Respond to caller’s signal

3. Green Light/Red Light—Stop on one leg each time and hold in a balance position in response to a caller's signal

Nearly any type of dynamic warmup drill can be used as balance training by merely having the athlete close eyes. Athletes will discover an entirely new sensory experience when drilling with eyes closed.

WARMUP

The warmup prepares the body for the training session, both from a physical and mental standout. It basically reduces the number of muscles that can be strained or hurt along with preparing the body to perform. It can be highly important in rehearsing the specifics of the event if structured and done properly. Skill development can and should take place in the warmup. Proper warmup not only prevents injuries and prepares the body, but improves sprint mechanics, flexibility, power, balance and strength. Thus, the warmup is a speed development improvement tool in itself.

Different types of Warmup:

1. Dynamic Continuous Movement
2. Static Flexibility (Research has shown that static stretching should be for the most part done at the completion of the workout)
3. PNF
4. Medicine Ball
5. Skipping Rope
6. Games (Tag, Relays)

SPRINT MECHANICS

A sprinter is only as fast as his mechanics will allow!

The principal mechanics keys/ points:

1. The head is held high and level with the eyes looking straight ahead. No rotation of the head with a loose jaw and chin down (head steady).

2. The torso is erect and in a position of "good" posture. Instruct athletes to run tall with chest up. The body will be nearly vertical at high speeds (slight forward lean in some cases).

3. The hand of the driving arm comes up shoulder level (front-side mechanics). Arms should be bent at 90-100 degrees. Hands should drive back 6-8" behind the hips on the backside. Remember that all sprinting is controlled by the arms and that the arms precede the legs. Arms drive the legs!

4. The shoulders are relaxed, with the thumbs up and the elbows turned in toward the body. The arms should not cross the mid-section. The shoulders are down—not hunched causing tightness in the upper body.

5. The hips are high enough above the ground to allow the driving leg to extend fully to the ground.

6. The ankle fully extends at the end of the leg drive. Good knee lift is essential—thigh should be parallel or horizontal with the ground.

7. Concentrate on running smooth—no bouncing.

8. Ground contact should be with the ball of the foot, behind or slightly underneath the body's center of gravity with an active foot strike. The goal of the athlete should be to impact the ground with a foot that is moving backward—think of a child riding a scooter or skateboard. The foot should be pushing backward before it impacts the surface. Sprinting is a pushing action and not a pulling action. Ground contact for 100-200m athlete should be ball of the foot, 400-800m runner the arch. By contrast, the 1500 meter runner will have ground contact with the entire foot.

9. Feet should be straight ahead during foot contact and in the dorsi-flexion position (toes as close to shin as possible—cocked)

10. Avoid excessive rear-side mechanics (actions). Stress high hips. Problems associated with excessive backside actions:

    a. Increased recovery time which results in slower step-rate (stride frequency)

    b. Increased load on the hamstrings which have to assist in the recovery process. Greatly increases the risk of injury!

    c. Decreased knee lift (front-side mechanics) because knee lift is inhibited when the hips are low and there isn't enough time for them to be lifted higher with the late recovery. This results in less powerful foot contractions.

11. Relaxation: All athletes should be striving for relaxation. Focus on using muscles that are required for running and stabi-

lization. Even the face should be relaxed. More importantly, learn to switch off all muscles that are not required as much as possible.

SPRINT MECHANICS TEACHING CUES

1. Cocked foot (dorsiflexion) no dangle

2. No butt kick

3. Tight back, stomach and butt

4. Run tall, Chest up (aids in keeping hips tall)

5. Knee up, Toe up, Heel up

6. Speed up the arms (Arm Speed)

7. Close the angle on the arms (short levers are fast levers)

8. Thumbs up and turn elbows in with arms

SPEED DEVELOPMENT EXERCISES/WORKOUTS/ SAMPLES

1. Maximum Velocity Training
   a. 3 X 30 m with blocks/spikes (4 min recovery)
   b. 2 X 3 X 50m with blocks/ spikes (4 min recovery/8 min/Set)
   c. 2 X 20m, 30m, 40m from 3 point/spikes (4 min recovery/(8 min/ Set)

2. Speed Endurance
   a. 4 X 150m @ 98% w/spikes (5 min recovery)
   b. 2 X 2 X 150m @98% w/ spikes (5 min recovery/10 minutes/Set)

3. Acceleration Training
   a. 4 X 40m with standing start (3 min recovery)
   b. 4 X 50m Hill Sprints (3 min recovery)

4. Ins and Outs (Breathing pattern work over different distances)
   a. Block Starts
   b. Flying 30's

4. Resistance Training
   a. Weight vest sprints
   b. Uphill Sprints
   c. Sled/Tire Pulls
   d. Stairs
   e. Parachute

5. Assisted Training
   a. Downhill Sprints
   b. Towing (Tube/Cord)

The **10 % rule should be in effect for both assisted and resistance training. No more than 10% of the athlete's body weight should be used when providing overload for resistance. And the time should not be slowed by more than 10%. The same is true of assisted training: the athlete should not increase speed by more than 10%.

CONTRAST TRAINING

This is one of the best ways to develop pure acceleration and maximum speed. It involves combining resistance training and assisted running followed by the actual race model run ("the real thing" over acceleration or velocity distances).

POOL TRAINING

Pool workouts and hydrotherapy have long been used for rehabilitation. They also can be used for recovery and become a part of regular training programs. The pool can be used for strength gain improvement, skill development, and flexibility employing deep water intervals and regular swimming.

MENTAL/PSYCHOLOGICAL ASPECTS

One of the trademarks of successful coaches is their relationships with their athletes. Successful coaches understand that coaching at the end of the day involves people, that it involves relationships.

1. The goal is to have athletes feel fast and successful

2. Create training that has positive outcomes

3. Have a **passion** for athletes and training (Display that)

4. Care!! Show athletes you care about them—on the track and off!

5. Develop trust and respect with athletes

6. You need to develop the ability to work with athletes that "operate outside of the box." Understand that not all athletes will march to "your drum."

7. Create a positive atmosphere with positive energy

8. Make athletes believe that anything is possible and that the key to obtaining goals is proper preparation (PP).

9. You as a coach should have goals and they should closely correlate with the athlete's goals. Understand and communicate with each other!!!

OBJECTIVE

The objective of this speed presentation is to provide a practical and simple guide to speed and speed development. It is our goal that we can provide both coaches and athletes alike a basic, yet somewhat technical understanding of speed and what is required to develop and enhance it.

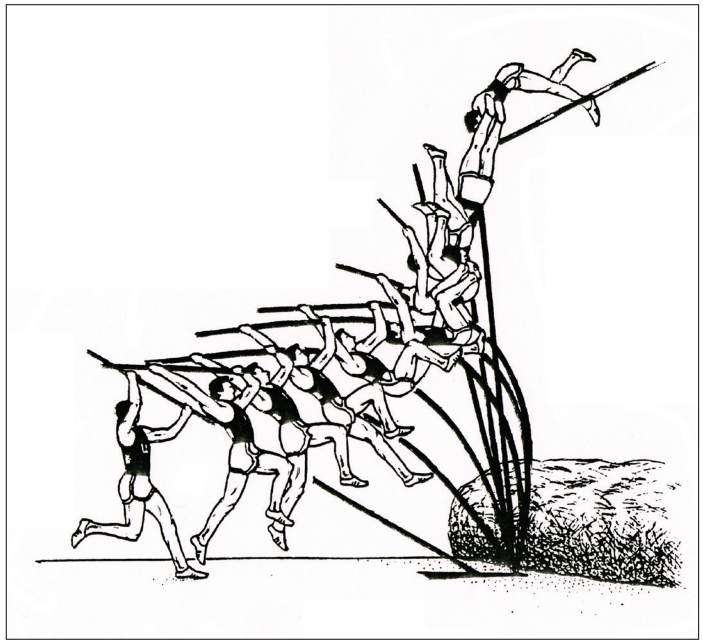
For more information and questions: Mike Thorson—mthorson@bis.midco.net (701.426.3080)

REFERENCES

1. Francis, Charlie, T*he Charlie Francis Training System* E-book
2. Gambetta, Vern , *Gambetta Method,* 2nd Edition, 2002
3. McFarlane, Brent , *The Science of Hurdling and Speed,* 4th Edition, Canadian Track and Field association, 2000
4. Pfaff, Dan, Conversations, Handouts, Clinic
5. Seagrave, Loren, Speed Dynamics, Conversations, Handouts, Clinics
6. Winckler, Gary, University of Illinois, Handouts, Clinics, Conversations

THE DOUBLE PENDULUM PRINCIPLE IN POLE VAULTING

Continued from page 7163



G: John Pennel (USA) over 15'5"/4.70, 1964

than the next fastest 6m vaulter. Shawn Barber (Can) uses a variation of the penetration style takeoff, and has the highest hand grip for a 6m vaulter at 17-4½. WR holder Renaud Lavillenie (Fra) has the most pronounced penetration style takeoff the writer has ever seen and at 5-9 with only 11 second 100m speed his hand grip is about the same as Bubka's.

EDITORIAL COLUMN

Continued from page 7160

One needs to resolve to make a personal change. The use of study, observation or consultation with someone more experienced are paths that may help mitigate and even reverse a situation. One needs to remember the old cliché that health is a journey, not a destination.

This should all fit seamlessly into one's philosophy of coaching. No doubt one of the core values of all successful programs is that of self-responsibility. This is an ever-evolving process as one learns to pack a travel bag as a Junior Olympian through the juggling act of the professional Olympian who deftly manages marriage, shoe deals, training, travel, the media and competition.

For the true procrastinators in the crowd, the one's with their heads perpetually in the sand, there is some good news here. If you read the last line of Kirkilday-Willis's cascade you'll see "fibrosis, spondylosis and stenosis"—all conditions where things shrink, degenerate or stop moving. It is a decrepit state that most don't live long enough to achieve. No doubt some solace there for some, I guess.

Negative Cascade of Kirkilday-Willis

Hypertonic muscles

↓

Muscular dysfunction or myofascial trigger points

↓

Faulty movement/alignment

↓

Joint dysfunction

↓

Excessive strain on joint capsule or disc

↓

Capsular laxity or disc herniation

↓

Instability

↓

Osteophyte formation and/or facet hypertrophy

↓

Stabilization

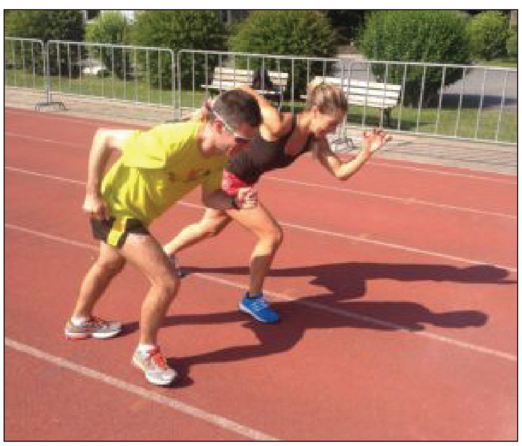
↓

Fibrosis, spondylosis or stenosis

HOW TO DO INTERVAL WORKOUTS CORRECTLY

A quick guide to interval training, with some sample workouts.

BY JASON R. KARP, PHD



Once the training secret of the world's best runners, interval training is now done by everyone, from competitive athletes to grandma next door.

Emil Zatopek of the former Czechoslovakia, who won the 10K at the 1948 Olympics and 5K, 10K, and marathon at the 1952 Olympics, was the first athlete to popularize interval training. However, it wasn't until the 1960s that famous Swedish physiologist **PerOlaf Åstrand** discovered that breaking up a set amount of work into smaller segments enables individuals to perform a greater volume of work at a high intensity. Sounds obvious, but Åstrand's simple observation is the basis for interval training. For example, you can run 5 x 1,000 meters faster than you can run 5,000 meters; you can run 10 x 500 meters faster than 5 x 1,000 meters; and you can run 20 x 250 meters faster than 10 x 500 meters. However, this is where a lot of coaches and runners make mistakes. We'll get to that in a minute.

When interval training was first studied in the 1930s by coach Waldemar Gerschler and physiologist Hans Reindell of Germany's Freiburg University, they focused their attention on its cardiovascular aspects and believed that the stimulus for cardiovascular improvement occurs during the *recovery intervals* between work periods rather than during the periods of activity, as the heart rate decreases from an elevated value. Thus, the emphasis of the workout was placed on the recovery interval, prompting Gerschler and Reindell to call it an "interval workout" or "interval training." Gerschler and Reindell's original interval training method consisted of running periods ranging from 30 to 70 seconds at an intensity that elevated the heart rate to 170 to 180 beats per minute, followed by sufficient recovery to allow the heart rate to decrease to 120 beats per minute, signifying the readiness to perform the next work period.

During the recovery interval, the heart rate declines rapidly, but there is a lot of blood returning to the heart from the muscles, which leaves more time for the left ventricle to fill with a lot of blood, and subsequently eject a lot of blood with each beat (called the stroke volume). The increase in stroke volume places an overload on the heart, which makes the heart stronger. Since stroke volume peaks during the recovery interval, and because there are many recovery intervals during an interval workout, stroke volume peaks many times, providing a stimulus for improving maximum stroke volume and thus the capacity of the oxygen transport system. Pretty neat, huh?

Also during the recovery intervals, a significant portion of the muscular store of quick energy—creatine phosphate (CP)—that was depleted during the preceding work period is replenished via the aerobic system. During each work period that follows a recovery period, the replenished CP will again be available as an energy source.

Interval training manipulates four variables: time (or distance) of each work period, intensity of each work period, time of each recovery period, and number of repetitions. With so many possible combinations of these four variables, the potential to vary training sessions is nearly unlimited. Possibly the greatest use of interval training lies in its ability to target individual energy systems and physiological variables, improving specific aspects of your fitness level.

Back to the mistakes that coaches and runners make with interval training, and how to do interval workouts correctly.

(1) Know the purpose of the workout and match the pace to the purpose. If the purpose is to improve VO_2max, then run at your VO_2max pace, which you can determine from a recent race, from heart rate, and eventually by feel as you gain experience with these workouts. Do not run workouts at arbitrary paces, which is what most runners do. Always match the pace of the workout to its purpose.

POSSIBLY THE GREATEST USE OF INTERVAL TRAINING LIES IN ITS ABILITY TO TARGET INDIVIDUAL ENERGY SYSTEMS AND PHYSIOLOGICAL VARIABLES, IMPROVING SPECIFIC ASPECTS OF YOUR FITNESS LEVEL.

(2) Run only as fast as you need to meet the purpose of the workout. If the purpose of the workout is to improve VO_2max, then run at your VO_2max pace, no faster. Make the workout harder by doing more volume at the right pace (or decrease the time of the recovery interval between reps) rather than run faster than the right pace. Just because you can run faster doesn't mean you should. To stress the system, run at the upper limit of that system; there is no reason to run faster because that confers no greater benefit.

(3) Design interval workouts correctly, with an understanding of Åstrand's research: *By breaking up a period of work into periods of work and rest, you can perform a greater volume of work at a high intensity.* For example, if you run 10 x 400 meters at 5K race pace, that workout doesn't adhere to the purpose of an interval workout. It's actually too easy a workout because 10 x 400 meters is only 4,000 meters, which is less than the 5,000 meters that you could have held the pace for without any recovery intervals. So if you're going to run 400meter reps at 5K race pace, you need to run enough reps such that the total distance of the workout exceeds 5,000 meters, which is at least 13 reps. And since the reps are only 400 meters in length, which is only 8% of the distance that you can hold the pace, you should do many more than 13 reps at that pace to stress the system.

(4) Don't run (or at least limit how much you run) at 5K, 10K, or half marathon race pace, unless you are specifically trying to practice running at race pace. These race distances don't correspond to any specific physiological factor that influences performance. For example, 5K pace is too slow to achieve the benefits of a VO_2max workout and too fast to achieve the benefits of a lactate threshold workout. It's much better to design workouts that specifically target the physiological variables that dictate your race performance. If you improve lactate threshold, VO_2max, running economy, anaerobic capacity, etc., your races will get better even without running at race pace because you will have improved the specific factors of your physiology that make you a better runner.

AEROBIC POWER (CARDIOVASCULAR) INTERVALS

One of the best methods to improve the capacity of your cardiovascular system— specifically, your heart's ability to pump blood and oxygen to the active muscles—is interval training using work periods lasting 3 to 5 minutes and recovery periods equal to or slightly less than the time of the work periods. The cardiovascular adaptations associated with interval training, including hypertrophy of the left ventricle and a greater maximum stroke volume and cardiac output, increase your VO_2max (the maximum volume of oxygen muscles consume per minute), raising your aerobic ceiling. Since VO_2max is achieved when maximum stroke volume and heart rate are reached, the work periods should be performed at an intensity that elicits maximum heart rate during each work period. This type of interval workout, which is very demanding, is one of the best workouts you can do to improve cardiovascular conditioning.

ANAEROBIC CAPACITY (SPEED ENDURANCE) INTERVALS

Anaerobic capacity refers to the ability to regenerate energy (ATP) through glycolysis. Work periods lasting 30-seconds to 2-minutes target improvements in anaerobic capacity by using anaerobic glycolysis as the predominant energy system. These short, intense work periods with recovery intervals 2 to 4 times as long as the work periods increase muscle glycolytic enzyme activity so that glycolysis can regenerate ATP more quickly for muscle contraction and improve the ability to buffer the muscle acidosis that occurs when there is a large dependence on oxygen—independent (anaerobic) metabolism.

ANAEROBIC POWER (SPEED) INTERVALS

Anaerobic power refers to the ability to regenerate ATP through the phosphagen system. Work periods lasting 5 to 15 seconds target improvements in anaerobic power by using the phosphagen system as the predominant energy system. These very short, very fast sprints with 3-5 minute recovery intervals that allow for complete replenishment of creatine phosphate in the muscles increase fast-twitch muscle fiber activation and the activity of creatine kinase, the enzyme responsible for catalyzing the chemical reaction that breaks down creatine phosphate.

SAMPLE INTERVAL WORKOUTS

Make sure you warm up and cool down before and after each workout.

AEROBIC (CARDIOVASCULAR) INTERVALS (AEROBIC POWER):

- 5 x 3 minutes @ VO_2max pace (95-100% max HR) with 2½ - 3 minutes jog recovery
- 3 x 4 minutes @ VO_2max pace (95-100% max HR) with 3½ - 4 minutes jog recovery
- 3, 4, 5, 4, 3 minutes @ VO_2max pace (95-100% max HR) with 2½ - 3 minutes jog recovery

VO_2max pace = 3K (2mile) race pace or slightly faster for good runners; about 1½ mile race pace for recreational runners

ANAEROBIC CAPACITY (GLYCOLYTIC) INTERVALS (SPEED ENDURANCE):

- 4 to 8 x 30 seconds at 95% all-out with 2 minutes jog recovery
- 4 to 8 x 60 seconds at 90% all-out with 3 minutes jog recovery
- 2 to 3 sets of 30, 60, 90 seconds at 90-95% all-out with 2-3 minutes jog recovery & 5 minutes rest between sets.

Anaerobic Capacity pace = Mile race pace or slightly faster for good runners; about ½ mile race pace for recreational runners

ANAEROBIC POWER (PHOSPHAGEN SYSTEM) INTERVALS (SPEED/ POWER):

- 2 sets of 8 x 5 seconds all-out with 3 minutes passive rest & 5 minutes rest between sets
- 5 x 10 seconds all-out with 3-4 minutes passive rest
- 2 to 3 sets of 15, 10, 5 seconds all-out with 3 minutes passive rest & 10 minutes rest between sets

Jason Karp, PhD, is the 2011 IDEA Personal Trainer of the Year, founder and coach of REVO$_2$LUTION RUNNING ELITE, and creator of the REVO$_2$LUTION RUNNING™ certification for coaches and fitness professionals. He has more than 400 published articles in international running, coaching, and fitness magazines, is the author of eight books, including *The Inner Runner, Run Your Fat Off*, and *101 Developmental Concepts & Workouts for Cross Country Runners,* and speaks at conferences and coaching clinics around the world.

OLYMPIC WEIGHTLIFTING FOR THROWERS

SNATCH, CLEAN AND JERK IN THE TRAINING OF YOUNG ATHLETES.

BY ANTONIO SQUILLANTE, CSCS*D, USAW

Throwing is a fundamental motor skill that consolidates during the first decade of life. Learning how to throw represents a fundamental milestone in the cognitive and physical development of children, especially between the age of 4-5 years old and the age of 8-9 years old, a narrow window of time also known as the golden age of motor learning (Thelen, 2000). Overarm throwing mechanics improve throughout childhood and can soon evolve into more advanced skills such as throwing a javelin or putting a shot. Youth athletes age 9-12 practice basic throwing drills with 6-pound shots and 300g mini javelins, with no difference between boys and girls. It is not until the onset of puberty—between the age of 11 and 13 years old for the female athlete and between the age of 12 and 15 years old for male athletes—that implements progressively become heavier and young athletes start throwing the discus and the hammer.

According to the most recent long-term athlete development (LTAD) model described by Lloyd and Oliver (2013), the circa-pubertal phase, represents a relatively common landmark for sports specialization among strength and power athletes. As young throwers become faster and stronger, their throwing mechanics change to accommodate more speed.

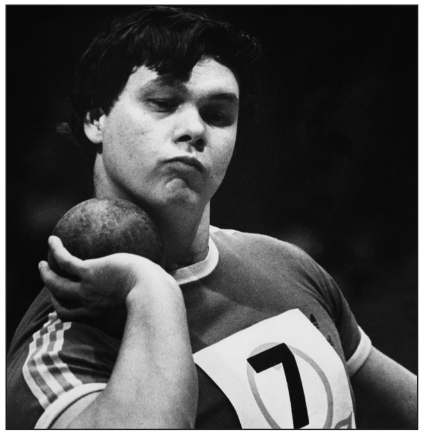
Strength—relative strength, a better estimate of the change in the rate of force development occurring during early adolescence—does, therefore, become a limiting factor in developing elite level throwers, as stronger and more powerful athletes can better handle linear and/or rotational speed.

Increasing speed of release represents, however, the very last step in a progression that goes from basic overarm throwing drills mostly oriented toward skill development and accuracy (age 4-6) to more advanced bilateral and unilateral drills where distance, and therefore rate of force development, comes into play (age 9-11).

It is not usual for young and adolescent throwers to practice with lighter and/or heavier implements in the effort to improve speed and strength. Although valuable, there is only a limited amount of time that can be spent working with overweight and underweight throwing drills—10-15% heavier and/or lighter than a regular discus or shot—10-14 pounds for a 14-15 year-old boy and 6-10 pounds for a girl—and only a limited amount of weight that can be used before throwing mechanics starts deteriorating. Longer periods of time practicing with overweights can make athletes, especially young athletes, slower by affecting timing and coordination to the point that speed or release starts to decrease (Verkhoshansky, 2011). Similarly, a higher volume of training with the use of underweight can limit the ability of an athlete to increase strength, simply because of lack of necessary overload. It is, therefore, necessary to implement age-appropriate general and special strength training exercises in the effort to increase speed of release and improve overall throwing mechanics.

Young athletes can benefit from strength training as soon as they are capable of understanding and relate proper lifting mechanics with some of the basic skills in sports. This stage is also known as the formal operational stage—see Jean Piaget (1896-1980) and his theory on cognitive development—and it precedes by a few years the onset of puberty. Between the age of 7 and 12 years, young athletes are capable of processing information at a higher level (organized and rational thinking), developing logical connections between different experiences.

The same way young athletes learn how to throw a shot from the power position before learning the art of gliding and spinning, they can also learn how to snatch, clean and jerk after they practice pulls and high pulls. Their ability to relate these similar experiences represents a prerequisite for them to be able to learn and master sport-specific skills (SSS).



This positive carry-over between similar movements—lifting and throwing, but also similarities between many different fundamental motor skills (FMS)— is also known as positive transfer of learning and it represents one of the most valuable assets in the training of young athletes. By learning skills that are so similar in nature—the triple extension of hips, knees and ankles, also known as the “pull” in Olympic weightlifting (Enoka, 1979) or the “thrust” in throwing mechanics (Garhammer, 1978) share important similarities in terms of joint angular displacement, peak power output, peak vertical velocity and rate of force development. Young athletes can improve performance in sport to a much greater extent than what numbers seems to suggest. Transfer of training only takes into consideration the quasi-algebraic relationship between strength, speed, power, and performance in sport. However, the positive carry-over between similar drills and exercises can further support the development of sport-specific skills, creating a solid foundation of general athleticism.

Weighted pulls and basic overarm throwing drills—the foundation in the training of young and adolescent throwers—are nothing but different examples of advanced body transport, object manipulation skills—according to Antoinette Gentile (1936-2016)— involving a higher degree of in-motion regulatory conditions and intertrial variability such as throwing a shot or snatching a bar overhead. Because of their similarities in terms of invariant features (a term that according to Schmidt’s original general motor pattern theory [1975] describes the permanent traits among variations of similar movements such as relative timing, relative force and movement sequence), pulls and high pulls provide the opportunity to increase positive transfer of learning between general and sport specific skills. Weighted pulls represent, therefore, a valuable asset in the training of young throwers as they are taught how to overcome inertia with speed as they develop proper mechanics in the triple extension.

As young athletes learn the basics in Olympic-style weightlifting they learn how to exert vertical force against the ground and transfer it to the implement (the bar) in the effort to increase its momentum. This summation of force via the triple extension of ankle, knees and hips also provides the prerequisite to learn how to convert linear speed into speed of release in some of the basic throwing events (Lanka, 2000).

Weighted pulls—pulls and high pulls—provide the opportunity for young throwers to improve some of the most fundamental aspects of throwing mechanics while developing strength, speed and power. Learning the basics in Olympic weightlifting begins at a very young age and represents, therefore, a fundamental milestone in the training of elite level throwers. As athletes become faster and stronger, heavy snatch, clean and jerk should be incorporated into their training in the attempt to prioritize peak vertical bar velocity over weight, namely power over absolute strength.

Male and female athletes between the ages of 7 and 11 years become capable of developing more complex and coordinated movements by rationally assembling fundamental motor patterns into more sophisticated skills. A 14-year-old thrower who has already learned how to snatch, clean and jerk and has been back squatting and front squatting for more than two or three years has, therefore, much better chances of becoming a stronger, more powerful athlete after the onset of puberty. Today we consider this carry-over between fundamental and sport-specific skills as the most elementary example of transfer of learning (Seidler, 2010). Piaget's formal operational stage, the circa-pubertal phase that immediately precedes and follows peak height velocity (PHV)—represents undoubtedly the most appropriate time to introduce young and pre-adolescent athletes to the skill of lifting weights.

After the onset of puberty, the discrepancy between male and female athlete in terms of absolute strength becomes, indeed, more significant. However, if properly trained, pound per pound females should be no more than 12-15% behind male males with similar training experience when it comes to relative strength. Young throwers age 15-16 with three or more years of experience in strength training should be able to squat anywhere between 1.1 and 1.5 times their body weight (respectively, female and male athletes), snatch between 0.5 and 0.7 times their bodyweight and clean and jerk 20% more (Keiner, et al., 2013). At this age, lack of absolute strength usually results in a snatch to clean and jerk ratio of 78% or lower, as a consequence of a much heavier clean and jerk and a relatively slow pull in the snatch. Faster athletes—more efficient, better throwers—on the other hand, tend to have a higher snatch to clean and jerk ratio (82% or higher) with peak vertical bar velocity in the pull approaching 1.98 m/sec (Takano, 2012).

AFTER THE ONSET OF PUBERTY, THE DISCREPANCY BETWEEN MALE AND FEMALE ATHLETE IN TERMS OF ABSOLUTE STRENGTH BECOMES, INDEED, MORE SIGNIFICANT.

"Numerous studies and review articles have reported evidence and logical arguments for the use of explosive exercises for throwers" explains Dr. Lawrence Judge from Ball State University (Indiana). Heavy strength training and absolute strength are without a doubt of paramount importance in developing elite level throwers. Brute sheer strength, however, is meant to be the consequence and not the main reason why athletes squat, bench press and power clean. "Elite athletes should strive to improve vertical bar velocity as they manage to move submaximal weight at maximal speed" (Poprawski, 1987); explosive in nature, the snatch, clean and jerk are meant to develop speed over sheer brute strength, representing the core exercises in the training of elite level throwers. Some of the unique aspects of competitive weightlifting (Storey and Smith, 2012), can, indeed, improve general athleticism, creating the foundation for throwers to develop the necessary skills and physical attributes to compete in sport.

REFERENCES

1. Enoka, R. M. (1979). The pull in Olympic weightlifting. *Med Sci Sports*, 11(2), 131-137.
2. Garhammer, J., & Gregor, R. (1992). Propulsion forces as a function of intensity for weightlifting and vertical jumping. *J Appl Sport Sci Res*, 6(3), 129-34.
3. Gentile, A. M. (1972). A working model of skill acquisition with application to teaching. *Quest*, 17(1), 3-23.
4. Judge, L. W., Bellar, D., Thrasher, A. B., Simon, L., Hindawi, O. S., & Wanless, E. (2013). A pilot study exploring the quadratic nature of the relationship of strength to performance among shot putters. *International Journal of Exercise Science*, 6(2), 171.
5. Keiner, M., Sander, A., Wirth, K., Caruso, O., Immesberger, P., & Zawieja, M. (2013). Strength performance in youth: trainability of adolescents and children in the back and front squats. *The Journal of Strength & Conditioning Research*, 27(2), 357-362.
6. Lanka, J. (2000). Shot putting. *Biomechanics in Sport*, 435-457.
7. Lloyd, R. S., & Oliver, J. L. (2012). The youth physical development model: A new approach to long-term athletic development. *Strength & Conditioning Journal*, 34(3), 61-72.
8. Piaget, J. (1970). Piaget's theory.
9. Poprawski, B. (1987). Track and field: Aspects of strength, power and speed in shot put training. *Strength & Conditioning Journal*, 9(6), 39-43.
10. Seidler, R. D. (2010). Neural correlates of motor learning, transfer of learning, and learning to learn. *Exercise and Sport Sciences Reviews*, 38(1), 3.
11. Schmidt, R. A., Lee, T., Winstein, C., Wulf, G., & Zelaznik, H. (2018). Motor Control and Learning, 6E. *Human kinetics*.
12. Storey, A., & Smith, H. K. (2012). Unique aspects of competitive weightlifting. *Sports Medicine*, 42(9), 769-790.
13. Takano, B. (2012). Weightlifting programming: A winning coach's guide. *Catalyst Athletics*.
14. Thelen, E. (2000). Motor development as foundation and future of developmental psychology. *International Journal of Behavioral Development*, 24(4), 385-397.
15. Verkhoshansky, Y., & Verkhoshansky, N. (2011). Special strength training: manual for coaches. Rome: Verkhoshansky Sstm.

YEAR-ROUND INDIVIDUALIZED RESISTANCE TRAINING FOR COLLEGIATE TRACK & FIELD EVENT GROUPS

A look at recent research regarding resistance training and its application to each event group in each season of the year.

BY SARAH E. MURPHY, ASSISTANT TRACK AND FIELD COACH, WINTHROP UNIVERSITY, AND SETH E. JENNY, PH.D., USATF LEVEL 1 COACH, SLIPPERY ROCK UNIVERSITY OF PENNSYLVANIA

ABSTRACT

The purpose of this paper is to provide a year-round resistance training guide for all track and field athletes. Evidence-based resistance training research for sprinters, throwers, and distance runners as well as more specific information for jumpers, pole vaulters, middle distance runners, and javelin throwers is provided. The information will follow the periodization for the typical track and field training year and provide detailed information on training techniques, recommended intensities, and various goals for each event group and training season. While many track and field teams are not equipped with a strength and conditioning coach, this guide will assist any track and field coach to incorporate resistance training into their general training for the entire track and field team.

INTRODUCTION

Resistance training is defined as "a specialized method of conditioning whereby an individual is working against a wide range of resistive loads to enhance health, fitness, and performance" (Haff & Triplett, 2016, p. 136). Resistance training does not only occur in the weight room, it can happen in various locations—including beyond weight machines to free weights, band exercises, parachute runs, sled pulls, and various plyometrics like bounding, hops, and medicine ball throws.

Many coaches see the importance of resistance training but lack the knowledge to apply it to their athletes. Bolger, Lyons, Harrison, and Kenny (2016) interviewed seven expert track and field coaches all of whom used resistance training for their athletes. Their findings concluded that utilizing and applying recent research on resistance training for track and field athletes is difficult for the average coach. Therefore, the purpose of this paper is to provide research-based year-round resistance training programs for all collegiate track and field athletes.

LITERATURE REVIEW

This paper will follow the outline of off-season, preseason, in-season, and post-season with research-based evidence regarding resistance training recommendations for sprinters, throwers, and distance runners explained across each season. More specific evidence geared toward jumpers, pole vaulters, javelin throwers, and middle distance runners will also be included for each within their respective groups.

OFF-SEASON

The off-season should be considered as a preparatory period for the upcoming season. For the collegiate track and field athlete, this begins around June or July and carries them through the end of the summer into the start of the school year. The main focus for this stage of resistance training is hypertrophy and strength endurance (Bompa & Buzzichelli, 1994). Essentially, athletes should be increasing muscle fibers that will allow them to continue to build more strength in the proceeding seasons of training.

In the off-season, the intensity of training should be at a low-to-moderate level and weight should be lifted at 50-75% of the athlete's one repetition maximum (1RM) (Haff & Triplett, 2016). At the beginning of this phase of training, weight and intensity should be at their recommended lowest to boost muscular strength endurance as well as hypertrophy. The weight and intensity should then gradually rise to 80-95% of the athlete's 1RM to increase basic strength in the athlete (Haff & Triplett, 2016). By the end of the off-season, the athlete should have made strides in muscle size, endurance, and overall strength. See Table 1 for a summary of training recommendations across all seasons.

Sprinters. The off-season for sprinters (including hurdlers and jumpers) should aim to develop basic muscular strength that will prepare them to sprint, hurdle, jump, or vault. Delvecchio, Korhonen, and Reaburn (2015) reviewed the effects of resistance training on masters athletes in sprint events. They reported that resistance training increased muscle fiber size, muscle size, and neural activity to improve the sprinting abilities of the participants. Types of exercises performed were leg curls, half squats, bench press, upright rows, bicep curls, and crunches. Using these exercises to develop a basic strength within the sprinter is ideal for this season.

Distance Runners. During the off-season, the distance runner should focus on muscular endurance both in running and in the weight room. To develop muscular endurance, the recipe is a high volume of 15 to 20 repetitions with low intensity of about 67% or lower 1RM (Haff & Triplett, 2016). Performing this formula of resistance training will prepare the muscles of the runners to withstand their long upcoming races.

Because not all distance coaches understand the value of resistance training for their runner, Berryman et al. (2018) conducted a meta-analysis of studies containing strength training in addition to aerobic training and its effects on runners in a multitude of physiological characteristics. The analysis found a trend that the addition of strength training for distance runners can improve overall running performance through enhancements in running economy (i.e., amount of energy used at a given speed and distance) and maximum force and power capabilities. Having distance runners participate in strength training in addition to running will be beneficial leading into the subsequent training phases.

Throwers. Resistance training and practicing technique with the throwing implements (i.e., shot put, discus, etc.) are the main training techniques for this group. Effective use of time in the weight room is essential for throwers. Some may mistakenly believe that throwers only need to be strong (i.e., how much total weight one can lift) and not powerful (i.e., how quickly one can lift that weight). The more you can bench press, the farther you should be able to put the shot, right? Not necessarily.

Judge et al. (2013) found mixed results when they compared elite throwers' farthest distance thrown with their 1RM bench press, 1RM power clean, and 1RM back squat. A significant linear relationship was found with the farthest distance thrown and the 1RM power clean, while no significance was found with the 1RM bench or squat, which are strength exercises. Thus, power exercises like the power clean are an essential portion of a resistance training program for power/strength athletes like throwers. Certainly, throwing technique may also have been a factor too.

However, Zaras et al. (2013) reported significant findings for both strength and power training with throwers. Seventeen novice male shot putters were split into two groups: a strength training group and a power training group. The participants were tested in shot put throws, 1RM strength, jumping abilities, anaerobic abilities, and muscle fiber growth before and after the six-week training program. Results indicated that both groups significantly improved in throwing capabilities, with the strength group demonstrating greater muscle fiber growth and 1RM gains while the power group improved jumping and anaerobic capabilities. Zaras et al. (2013) concluded that shot putters can benefit equally in throwing abilities following either a strength or power training program. Of note, the power training group demonstrated greater growth within Type IIx muscle fibers, which are the fibers that can produce the highest force in the body.

AFTER BASIC STRENGTH HAS BEEN ESTABLISHED IN THE ATHLETE, RESISTANCE TRAINING SHOULD THEN SHIFT TO FOCUS ON DEVELOPING POWER

Basically, the off-season for the thrower should consist of strength building exercises that will transition to include power exercises leading into the upcoming preseason.

PRESEASON

The preseason is the preparatory period that occurs directly before the competition phase. For collegiate track and field, this begins around September to October and lasts until the first indoor meet. During this time, athletes should begin to be more specific in their technique training and in their resistance training (Haff & Triplett, 2016). Rather than focusing on strength in the whole body, specific body regions are stressed, as they are key factors in performing individual events.

In the beginning of preseason, the intensity of training should be high and athletes should be lifting 80-95% of their 1RM (Haff & Triplett, 2016). After basic strength has been established in the athlete, resistance training should then shift to focus on developing power (Stone, O'Bryant, & Garhammer, 1981). During the power phase, weight and intensity should drop to 30-85% 1RM depending on the exercise (Haff & Triplett, 2016). When lifting lighter weights, the athlete must focus on speed of the movements. In exercises focusing on strength, the athlete should be lifting 87-95% 1RM to continue the development of basic strength (Haff & Triplett, 2016). At the end of the preseason, track athletes should be strong, powerful, fast, and well prepared for their first competition. Again, see Table 1 for training season summaries.

Table 1: Summary Prescriptions for Resistance Training across Seasons

Season	Subperiod	Phase	Intensity (1RM)	Volume
Off-Season	General & Specific Prep	Hypertrophy/Strength Endurance	75%	3-6 sets 8-20 reps
Preseason	Specific Prep/Precompetitive	Basic Strength/Power	30-85% 85%	2-4 reps 2-5 reps
In-Season	Main Competitive	Maintaining	93%	2-5 sets 3-6 reps
Peaking	Main Competitive	Peaking	93%	1-3 sets 2-6 reps
Post-Season	Post-Competitive	Active Rest	-	-

Note: 1RM = 1 maximum repetition. Peaking is a sub-phase of In-Season. Adapted from Haff and Triplett (2016).

Sprinters. During the preseason, sprinters should be undergoing a multitude of resistance training exercises to develop strength and power. To accomplish this, training sessions must be organized in a way to set the athlete up for success. Hartmann et al. (2015) studied the effects of undulating periodization (i.e., nonlinear training where strength and power sessions vary throughout the week) versus strength-power periodization (i.e., linear training where one week focuses on strength and the next focuses on power).

Results indicated that both periodization methods can be effective, but undulating periodization created larger strength and power gains. Thus, coaches should understand how to space out power and strength workouts during the preseason to allow for optimum recovery between sessions while possibly favoring undulating periodization formats.

In addition, Balsalobre-Fernandez, Tejero-Gonzlez, Campo-Vecino, and Alonso-Curiel (2013) researched seven male high school hurdlers who participated in ten weeks of power specific training. These participants performed loaded jump squats two days a week while performing "normal" sprint training the other days—none of which consisted of strength building exercises. With a power training emphasis, the participants demonstrated significant improvements in 30-meter sprint, maximum strength, and maximum jumping abilities. Therefore, the implementation of power-specific exercises, like loaded squat jumps, can lead to significant improvements for sprinters during this precompetition phase of training.

Jumpers. While keeping the base training of speed and power, jumpers also benefit from different plyometric exercises. In a study by Misnova and Luptakova (2017), a group of female athletes participated in a 30-week plyometric training program and showed significant increases in jumping ability and power. The types of exercises performed were jump rope, squat jumps, one-leg jumps, repeated jumps, and jumping races. Having triple, high, and long jumpers perform plyometric exercises in the preseason can increase their jumping capabilities and make them more powerful as they approach the competition season.

Pole Vaulters. While the vaulter must be proficient in both speed and power, he/she must also acquire a significant level of strength in the upper body, lower body, and core. The pole vault is a whole-body effort with the help of coordination, flexibility, balance, and accuracy (Dusan & Milenko, 2015). In addition to sprinting training, extra efforts should be made during preseason training for pole vaulters to enhance these features, such as hand and grip exercises, to produce a well-rounded athlete who is strong in all parts of the body.

Distance Runners. Resistance training for distance runners can improve the energy cost of locomotion, maximal power, and maximal strength (Berryman et al., 2018). For example, Karsten, Stevens, Colpus, Larumbe-Zabala, and Naclerio (2016) tested 16 distance runners in a 5K (3.1 miles) time trial before and after a resistance training program. Following this program, those participants reduced their 5K trial time by 3.62% while those whom did not partake in a strength training program showed no difference in their 5K trial times. The study concluded that resistance training can decrease 5K times in distance runners.

Additionally, Mikkola, Vesterinen, Taipale, Capostangi, and Nummela (2011) split male recreational distance runners into three test groups: a heavy resistance group, an explosive resistance group, and a muscle endurance training group. Before and after eight weeks within their specific training regimens, the participants were tested in maximal strength, vertical jump, maximal endurance treadmill running, maximum anaerobic velocity, leg extensor activity, VO_2max (maximal oxygen uptake), and running economy. All three test groups improved maximal endurance treadmill running, but the heavy and explosive resistance training groups were the only ones to also demonstrate improvements in neuromuscular functions.

Additionally, the heavy resistance group had the highest improvement in anaerobic running. Therefore, the study concluded that endurance runners should incorporate heavy resistance exercises in their training to improve their overall running capabilities and especially the sprint at the end of a distance race. Hence, a distance runner's preseason should begin by incorporating heavier resistance training exercises in order to increase neuromuscular functions leading into the competition season.

Middle Distance Runners. Training for middle distance is a mix between both endurance and speed, as races are longer than a sprint, but shorter than "long" distance. Alotaibi and Mahmoud (2016) tested middle distance runners in three different test groups: an endurance group, a strength group, and a concurrent endurance/strength group. The groups participated in their respective exercises three times a week for eight weeks.

The concurrent endurance/strength group demonstrated significant increases in grip strength compared to the other two groups, greater leg and back strength compared to the endurance group, and greater maximal oxygen uptake compared to the strength group. The researchers concluded that incorporating both strength and endurance training results in higher strength and aerobic gains in middle distance runners, rather than just performing strength or endurance exercises only. Thus, middle distance runners should perform concurrent endurance and strength-based resistance training in the preseason to help them make gains both aerobically and anaerobically.

Throwers. During the preseason, throwers should have a solid strength base and should transition to more power-enhancing sessions while also working with throwing event implements. Linder (2010) advocates three elements that make for a successful thrower: technical form, resistance training, and power development. Judge et al. (2013) also notes that power development in the thrower is crucial and can be developed through various exercises like Olympic lifts and medicine ball throws. Therefore, throwing coaches should take special consideration to incorporate power exercises in the preseason to ensure their athletes are sufficiently explosive coming into the competitive season.

Javelin Throwers. Javelin differs from other throwing events in that it requires a semi-running approach and is particularly stressful on the shoulder and the arm (USATF, 2015). For javelin throwers, Burgyone (2007) recommends resistance training which emphasizes flexibility, speed, and strength for javelin throwers. He further advocates that javelin training be divided into a conditioning phase, strength and hypertrophy phase, a force development phase, and a speed phase. Burgyone (2007) also notes that when performing explosive exercises, the movements should be emphasized to increase maximum power in the athlete.

POWER DEVELOPMENT IN THE THROWER IS CRUCIAL AND CAN BE DEVELOPED THROUGH VARIOUS EXERCISES LIKE OLYMPIC LIFTS AND MEDICINE BALL THROWS

When working on power, intensity should be dropped to 20-40% of an athlete's 1RM and the actions should be done as fast as safely possible with correct form with three to five minutes of rest between sets. It is also suggested that exercises that aim to strengthen the hands and fingers should be performed. Exercises that are encouraged include the Russian twist, side slings, rebound rotational medicine ball throws, pulley throws, and Olympic explosive lifts. With preseason training focused on speed and flexibility in addition to power and strength, the javelin thrower will be well prepared coming into competition.

IN-SEASON

The in-season phase can be very long for the collegiate track and field athlete. With a two-month indoor season followed by a two- or three-month outdoor season, tapering and maintaining fitness must be timed appropriately. According to Bosquet, Montpetit, Arvisaid, and Mujika (2007), "the taper is a reduction in the training load of athletes in the final days before important competition, with the aim of optimizing performance" (p. 1358). Additionally, because the season is five months or more, a coach cannot expect the athlete to maintain the same level of fitness through the entire season without keeping up similar workouts done in the preceding seasons. The overall goal of the in-season is to maintain and taper athletes appropriately so they can perform their absolute best at the championship or goal meets.

During the first indoor meets, resistance training should be geared toward maintenance with intensity moderate to high and volume 85-93% 1RM (Haff & Triplett, 2016). Towards the end of the indoor season, one to two weeks leading into the championship indoor event, a mini-taper can occur that will test how the athlete responds to an altered training stimulus (USATF, 2015).

At this time, intensity should vary depending on the exercise. Volume should drop and speed should increase to prepare the athletes to compete at the highest possible level (Bosquet et al., 2007). Following this reduction in volume, the athlete should resume maintenance training at 85-93% 1RM one or two weeks after the indoor championships to carry into the outdoor season (Haff & Triplett, 2016). One or two weeks before the outdoor championships, a second more pronounced tapering should take place. With a large drop in volume and 50-93% intensity, the athlete will be fresh and fast coming into the outdoor championship events (Bosquet et al., 2007). Again, see Table 1 for a concise summary.

During the in-season, training sessions must be spaced appropriately to maximize potential advances that can be made as well as having the athlete physically prepared for any upcoming competition. Howatson, Brandon, and Hunter (2016) tested ten track and field athletes in a series of power or strength exercises and measured strength, power, and total work capabilities following each session. The results indicated that the athletic abilities of the athletes were reduced following a strength session versus a power session. Therefore, care should be given when placing a strength-focused resistance training session during the in-season, allowing ample time for athletes to recover and rest.

Sprinters. During the in-season, the sprinter should maintain a level of power and speed in order to carry him throughout the season. There are several resistance training exercises that are beneficial for this goal. Toma, Corin, and Cartojan (2011) found a significant correlation between 100m times and standing long jump, semi-squats, and squats in male athletes. Exercises that develop force for a sprinter create faster 100m times and should be used throughout the in-season to maintain sprinter speed.

As previously mentioned, plyometric exercises have been shown to increase jumping abilities in athletes (Misnova & Luptakova, 2017). Similarly, Lehnert, Lamrova, and Elfmark (2009) tested the effects of plyometrics on speed and power in athletes. The plyometric program lasted eight weeks and included various hops, tuck jumps, medicine ball drills, bounding, and box jumps. The participants tested their vertical jumping abilities along with their running speed before and after the program and found that both variables had improved over the eight-week period. Thus, plyometric exercises can increase explosive power and speed in athletes (Lehnert et al., 2009). Of note, while it is apparent that plyometrics can lead to drastic improvements for jumpers, this form of resistance training can also be of value to sprinters and the inclusion of plyometrics within training can be beneficial within the competition season.

CARE SHOULD BE GIVEN WHEN PLACING A STRENGTH-FOCUSED RESISTANCE TRAINING SESSION DURING THE IN-SEASON, ALLOWING AMPLE TIME FOR ATHLETES TO RECOVER AND REST

Jumpers. Plyometric exercises of differing intensities can significantly increase high jump performance as they influence explosive power and other kinematic variables. For example, Ghareb (2014) tested two groups in a 12-week plyometric training program, where one group trained at a fixed intensity and the other trained at varying intensities. The group with varying intensities demonstrated higher vertical jump, increased kinematic variables (including takeoff velocity, center of mass position, and takeoff time), and an increased high jump performance. Therefore, high jumpers may benefit more from plyometric exercises that vary in intensity rather than working at a set intensity.

Pole Vaulters. As mentioned before, pole vaulters must train the whole body in order to be fast, powerful, and strong all at the same time. Cissik (2015) explains the various biomechanical movements that go into this technical event. He describes the two phases of the vault that must be acknowledged during resistance training: the approach and the swing up. The ultimate goals for the approach phase are to teach the athlete to exert force quickly and in the correct direction. Suggested resistance exercises include bounding, squats, power cleans, medicine ball throws, and hip extension exercises.

Next, the ultimate goals for the swing up phase include teaching the athlete to make the muscles of the body work in unison and to increase strength in the upper body and the trunk. Different resistance exercises that are suggested for this phase include overhead squats, good mornings, presses, rows, and Romanian deadlifts. Because the pole vault event requires the entire body to be strong, powerful, and fast, resistance training for vaulters should be focused to meet these needs during the in-season phase of training.

Distance Runners. During the competitive season, it is important for endurance athletes to maintain and even gain in athletic ability during the season. Bauman and Wetter (2010) studied the changes in anaerobic power for distance runners from the beginning of a competitive season to the end. Their findings showed that anaerobic power decreased in the distance runners at the end of the season compared to the beginning. While anaerobic power is not the primary energy system used in distance running, it is still used secondarily at key parts of a race including during surges and the final "kick" (Mikkola et al., 2011). Therefore, it may be necessary to maintain or increase anaerobic power through resistance training during the competitive season or the progress made during the preseason will be lost, ultimately effecting the success of the runner. However, this should not be to the detriment of negatively impacting aerobic running training.

Middle Distance Runners. Strength training is beneficial to the endurance athlete, particularly those racing the 800m and 1500m. A study by Beattie, Carson, Lyons, Rossiter, and Kenny (2016) found that 40 weeks of strength training resulted in significant improvements in maximal and reactive strength, running economy, and VO_2max in competitive endurance athletes. While it is a common stigma that distance runners should not perform resistance training exercises in order to avoid adding excess weight to the body, this study also found that there was no significant increase in body composition following the strength training program. However, this may depend on the type of resistance training performed (e.g., high repetitions, low weight, etc.). Therefore, participating in strength training exercises may help physiologically to achieve faster running times in middle-distance runners during the in-season competition phase.

Throwers. During this time, the needs of throwers are similar to that of endurance and sprint athletes in that they need to maintain or increase muscular strength and power. Because throwers do not run competitively, weightlifting and other resistance training techniques are a vital part to their practice. In a case study one of the best hammer throwers Romania has produced, Ursanu (2016) reported many factors that are relevant to training throwers during the in-season part of the year. He states that intensity and volume need be adjusted throughout the mesocycles to achieve the greatest success from the thrower. Volume should be at its highest during preparation periods and intensity should be the highest during in-season competition periods. Using this information, coaches can strategically make strength and power gains in the throwers while allowing them to rest and recover for competitions throughout the season.

Javelin Throwers. Burgyone (2007) suggests that weight training take place twice a week for javelin throwers during the in-season competition period. Breaks in the schedule should include training that focuses on power and speed, rather than muscular endurance. As opposed to the average thrower, efforts to maintain flexibility and range of motion (ROM) should also be a priority during the in-season for the javelin thrower. Stoikov, Karapetrova, and Stoykov (2010) recommend the following lifts to be the most beneficial to the javelin thrower: barbell snatch, hang clean, power clean, and squat.

POST-SEASON (ACTIVE REST)

The post-season is the shortest of all seasons. It occurs after the final outdoor meet for the track and field athlete and continues one to four weeks into the summer. The main purpose of this season is to rest and recover from the preceding long competition in-season. The post-season oftentimes will not include resistance training for the athletes and will mainly consist of active rest recreational activities. Examples of active rest activities that an athlete can do is walking, tennis, bicycling, or swimming (Haff & Triplett, 2016). Table 1 summarizes this phase.

PARTICIPATING IN STRENGTH TRAINING EXERCISES MAY HELP PHYSIOLOGICALLY TO ACHIEVE FASTER RUNNING TIMES IN MIDDLE DISTANCE RUNNERS DURING THE IN-SEASON COMPETITION PHASE

Balsalobre-Fernandez, Tejero-Gonzalez, and Camp-Vecino (2015) studied the changes in force production in elite middle and long distance runners from the beginning of in-season to the end of the post-season. Their findings indicated that an active post-season resulted in higher force production during the competition season compared to those with a passive post season. As a coach, it is important to instruct athletes on how to actively recover from the previous season to be well prepared to begin the next.

SUMMARY

According to Bolger et al. (2016), some track and field coaches lack the knowledge and ability to apply evidence-based research within their resistance training practices. Therefore, the purpose of this review was to gather and present empirically-based research regarding appropriate resistance training guidelines for track and field athletes. Broken down across four training seasons (i.e., off-season, preseason, in-season, and post season) and across varying track and field event groups, this paper provides general year-round resistance training guidelines for all track and field athletes. To conclude, a summary of main suggestions for each event group are provided in Table 2 below.

REFERENCES

Alotaibi, S. A. & Mahmoud, N.G. (2016). Effect of concurrent training on certain pulmonary, physical variables and record level of middle distances for young athletics. *Science, Movement, and Health, 14*(2), 247-254.

Balsalobre-Fernandez, C., Tejero-Gonzalez, C. M., & Camp-Vecino, J. (2015). Seasonal strength performance and its relationship with training load on elite runners. *Journal of Sports Science and Medicine, 14*, 9-15.

Balsalobre-Fernandez, C., Tejero-Gonzalez, C. M., Campo-Vecino, J., & Alonso-Curiel, D. (2013). The effects of a maximal power training cycle on the strength, maximum power, vertical jump height, and acceleration of high-level 400-meter hurdlers. *Journal of Human Kinetics, 36,* 119-127.

Baumann, C. W. & Wetter, T. J. (2010). Aerobic and anaerobic changes in collegiate male runners across a cross-country season. *International Journal of Exercise Science, 3*(4), 225-232.

Beattie, K., Carson, B. P., Lyons, M., Rossiter, A., and Kenny, I. C. (2016). The effect of strength training on performance indicators in distance runners. *Journal of Strength and Conditioning Research, 31*(1), 9-23. doi: 10.1519/JSC.0000000000001464

Berryman, N., Mujika, I., Arvisais, D., Roubeix, M., Binet, M., & Bosquet, L. (2018). Strength training for middle and long distance performance: A meta-analysis. *International Journal of Sports Physiology and Performance, 13*, 57-63.

Bolger, R., Lyons, M., Harrison, A. J., & Kenny, I. C. (2016). Coaching sprinting: Expert coaches' perception of resistance-based training. *International Journal of Sports Science & Coaching, 11*(5), 746-754.

Bompa, T. O., & Buzzichelli, C. A. (1994). Periodization: Theory and methodology of training. *Human Kinetics, 6*, 1-381.

Bosquet, L., Monpetit, J., Arvisaid, D., & Mujika, I. (2007). Effects of tapering on performance: A meta-analysis. *Official Journal of the American College of Sports Medicine,* 1358-1365.

Burgyone, L. (2007). Weight training for javelin throwers. *Modern Athlete and Coach. 45*(3), 26-27.

Cissik, J. M. (2015). Pole vault. *Modern Athlete and Coach, 53*(1), 12-15.

Delvecchio, L., Korhonen, M. T., & Reaburn, P. (2015). The effects of resistance training on sprint and endurance performance in master's athletes: A narrative review. *Journal of Fitness Research, 5*(1), 5-13.

Dusan, S. & Milenko, J. (2015). Kinanthropology analysis of pole vault. *Research in Physical Education, Sport and Health, 4*(1), 87-93.

Ghareb, E. F. (2014). Effect of plyometric training with different intensities on kinematics variables in Fosbury-Flop high jump. *Science, Movement and Health, 14*(2), 135-139.

Haff, G.G., & Triplett, N. T. (2016). *Essentials of Strength Training and Conditioning.* Colorado Springs, CO: National Strength and Conditioning Association.

Hartmann, H., Wirth, K., Keiner, M., Mickel, C., Sander, A. & Szilvas, E. (2015). Short-term periodization models: Effects on strength and speed-strength performance. *Sports Medicine, 45,* 1373-1386.

Howatson, G., Brandon, R., & Hunter, A. M. (2016). The response to and recovery from maximum-strength and power training in elite track and field athletes. *International Journal of Sports Physiology and Performance, 11*, 356-362.

Judge, L. W., Bellar, D., Thrasher, A. B., Simon, L., Hindawi, O. S., & Wanless, E. (2013). A pilot study exploring the quadratic nature of the relationship of strength to performance among shot putters. *International Journal of Exercise Science, 6*(2), 171-179.

Karsten, B., Stevens, L., Colpus, M., Larumbe-Zabala, E., & Naclerio, F. (2016). The effects of sport-specific maximal strength and conditioning training on critical velocity, anaerobic running distance, and 5-km race performance. *International Journal of Sports Physiology and Performance, 11*, 80-85.

Lehnert, M., Lamrova, I., & Elfmark, M. (2009). Changes in speed and strength in female volleyball players during and after a plyometric training program. *Acta Universitatis Palackinae Olomucensis Gymnica, 39*(1), 59-66.

Linder, T. (2010). Athletic power development: A critical component for throwers. *Track Coach 190,* 6062-6072.

Mikkola, J., Vesterinen, V., Taipale, R., Capostango, B., Hakkinen, K., & Nummela, A. (2011). Effect of resistance training regimens on treadmill running and neuromuscular performance in recreational endurance runners. *Journal of Sports Sciences, 29*(13), 1359-1371.

Milsnova, G. & Luptakova, J. (2017) Influence of plyometrics on jump capabilities in technical and aesthetical sports. *Acta Facaultatis Educationis Physicae Universitatis Comenianae, 57*(1), 76-88.

Stoikov, S., Karapetrova, R., Stoykov, G. (2010). The power and power changes in qualificational aspect for competitors in javelin throw. *Transilvania University of Brasov, 3*(52), 165-170.

Stone, M. H., O'Bryant, H., & Garhammer, J. (1981). A hypothetical model for strength training. *Journal of Sports Medicine and Physical Fitness, 21*(4), 342-351.

Toma, P., Corin, G., & Cartojan, N. (2011). Study on power/performance ratio in the men's 100m event. *Annals of the University Dunarea de Jos of Galati: Fascicle XV: Physical Education and Sport Management, 1,* 143-147.

USATF. (2015). *Track and Field Coaching Essentials eBook* [Kindle DX version]. Champaign, IL: Human Kinetics.

Ursanu, G. (2016). Optimizing performance capacity in women's hammer throw, based on a just scheduling of action means and a rational dynamic of training effort parameters—case study. *Sport and Society International Journal of Physical Education and Sport, 16,* 123-130.

Zaras, N., Spengos, K., Methenitis, S., Papadopoulos, C., Karampatsos, G., Georgiadis, G.,…Terzis, G. (2013). Effects of strength vs. ballistic-power training on throwing performance. *Journal of Sport Science and Medicine, 12*(1), 130-137.

Sarah E. Murphy
Email: murphys11@winthrop.edu

Seth E. Jenny
Email: dr.sethjenny@gmail.com

Table 2: Summary of Key Resistance Training Points for Each Track and Field Event Group

Event Group	Key Point(s):
Sprinters	Benefit from various forms of resistance training, including plyometrics and power exercises where power and strength sessions vary throughout the week.
Jumpers	Benefit from plyometric training that varies in intensity.
Pole Vaulters	Benefit from whole body training including the core, upper body, hands, and wrists.
Distance Runners	Benefit from muscular endurance resistance training that transitions into heavy resistance training leading into the competitive season.
Mid-Distance Runners	Benefit from concurrent resistance training.
Throwers	Benefit from emphasis on power training where volume is high in the off-season and intensity is high in the competition season.
Javelin Throwers	Benefit from strength and power training that focuses on speed and flexibility.

USATF COACHING EDUCATION

2018 CALENDAR OF SCHOOLS

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

Level 1

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. 16-18	Life University — Marietta, GA
Nov. 17-18	Allen High School — Allen, TX
Nov. 17-18	Wellesley College — Wellesley, MA
Nov. 24-25	Virginia Wesleyan University — Virginia Beach, VA
Nov. 24-25	The Armory — New York City, NY
Nov. 30-Dec. 2	Greater Columbus Convention Center — Columbus, OH (in conjunction with the 2018 USATF Annual Meeting — special rate for Annual Meeting registrants)
Dec. 7-9	St. John's School — Houston, TX
Dec. 8-9	Pine Crest School — Ft. Lauderdale, FL
Dec. 8-9	Cerritos College — Norwalk, CA
Dec. 14-16	University of South Carolina — Columbia, SC
Dec. 15-16	Tennessee State University — Nashville, TN

Level 2

Dec. 27-31	USATF Level 2 School IMG Academy — Bradenton, FL Sprints/Hurdles/Relays or Endurance

Level 3

Dec. 2-8	USATF/IAAF Academy IMG Academy — Bradenton, FL Sprints/Hurdles or Endurance

**Locations and dates for 2019 Level 1 Schools will be available by October 31 on the Calendar of Schools.*

SPACE FILLING IN THE USATF LEVEL 2 SCHOOL FOR SPRINTS/HURDLES/ RELAYS OR ENDURANCE

Join an elite group of coaches in the USA and around the globe at IMG Academy, Bradenton, Florida, **December 27-31, 2018 at the USATF Level 2 School for Sprints/Hurdles/Relays or Endurance**. 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 a program manual dedicated to the individual events comprising the event discipline, Level 2 provides a coach with the knowledge to greater implement individualized, sophisticated training, and enable them to explain the “why” to the athlete.

Applications will be accepted through November 1, 2018 or until capacity is reached. Complete program information, including featured instructors, is accessible at the link below.

http://www.usatf.org/Resources-for---/Coaches/Coaching-Education/Calendar-of-Schools/Level-2/2018/IMG-Academy.aspx

LINEUP OF INSTRUCTORS CONTINUES TO GROW FOR THE 2018 USATF/IAAF ACADEMY

Earn the highest certification level from USATF and the IAAF at the **USATF/IAAF Academy for Sprints/Hurdles or Endurance**. The Academy encompasses the scientific base included in the previous levels, while providing coaches with comprehensive knowledge in a specific event group and prepares an individual to coach at the national and international level. The week-long course will be conducted December 2-8 at IMG Academy, Bradenton, Florida, and again boasts some of the world’s best instructors.

Featured Instructors:

Ralph Mann: One of the world’s premier biomechanists and a USATF National Track & Field Hall of Famer, Dr. Mann has been a longtime contributor to the USATF sports science and high-performance programs, focusing on using biomechanical analysis of elite sprinters and hurdlers to evaluate and improve their performances.

Jeremy Fischer: USATF Lead Coach at the Chula Vista Olympic Training Center and specialist in the horizontal jumps, Fischer coached Brittney Reese and Will Claye to silver medals at the Rio Olympics.

Mike Holloway: Head Coach, Men’s and Women’s Track and Field at the University of Florida, where he has led the Gators to eight NCAA team championships. At the 2016 Rio Olympics, Holloway coached Gator alums Kerron Clement and Arman Hall to gold medals in the 400mH and 4x400 relay, respectively.

Robert Chapman: USATF Associate Director of Sports Science and Medicine; Assistant Professor of Kinesiology, Indiana University. He currently leads USATF’s high performance sports science programs.

Gunter Lange: IAAF Senior Manager of the Development and Member Relations department. Lange oversees all aspects of the IAAF Coaching Education Program and is a recognized endurance specialist throughout the world.

Andreas Behm: Recruitment and Education Director and sprints/hurdles coach at elite training group ALTIS. Behm’s athletes include 110m hurdler Aries Merritt, whom he coached to an Olympic gold medal and 110mH world record in 2012.

Jim Radcliffe: One of the most acclaimed and innovative strength and conditioning coaches in the world, Radcliffe works with all athletes at the University of Oregon and oversees strength programs for the Oregon Elite Track Club.

Ulrich Hartmann: Professor in the Movement and Training Science Department, University of Leipzig, Germany, Hartmann speaks around the world on performance training and human physiology and has consistently lectured for IAAF in their CECS courses.

Anne Shadle: Specialist in coaching theory and holds a Ph.D. in Health Education with an emphasis in Sport Psychology. Her research focus has targeted understanding the psychosocial challenges, preparations and responses of Olympic gold medal-winning athletes.

Complete program and application information is accessible at the link below.

http://www.usatf.org/Resources-for---/Coaches/Coaching-Education/Calendar-of-Schools/Level-3/2018/IAAF-Academy.aspx

REMINDER: NEW EDUCATION STANDARD FOR USATF COACHES REGISTRY EFFECTIVE JANUARY 2019

To further elevate the professional credibility of the USATF Coaches Registry and its members, USATF has established a new **Education Standard** for qualification into the **USATF Coaches Registry**. The Education Standard provides for a baseline standard of professional education or coaching accomplishment in the sport of track and field for coaches seeking admission to the Registry.

By establishing a baseline standard of professional education or coaching experience, the Education Standard aligns with the best practices for professional certifications in other fields, within the coaching industry at large, and with licensing protocols of other Olympic family national governing bodies.

Overview: To be part of the USATF Coaches Registry, an individual must, currently, be a USATF member, undergo a background screen from approved screening agency, and have completed USOC Safe Sport training. This Education Standard is a one-time requirement. Once a coach has met the Education Standard, he or she has fulfilled the requirement for as long as the coach is part of the Registry.

Timeline: The Requirement of the Education Standard to receive benefits of the Coaches Registry will take effect beginning January 2019**.** USATF coaches may begin adding their Education Standard to their Coaches Registry profile beginning fall 2018. Instructions to complete the process will be provided prior to the start of the enrollment period. Coaches should be prepared to produce proof of qualification if so requested.

Eligibility: Any person who has completed one of the approved coaching education courses for track or field or who qualifies based on career accomplishments as a track and field coach is eligible.

Meeting the Education Standard: There are two different paths to meet the Educational Standard for the Coaches Registry: Complete a verified educational course, OR achieve a specified coaching accomplishment.

Path 1: Complete a verified course of education. *Complete any one of the following courses:*

a. Level 1, 2, or 3 of the USATF CE Professional Pathway of Coach Certification
b. USATF Cross Country Specialist Course
c. Completion of a USATF Event Skill Specialist Clinic (Learn By Doing)
d. NFHS Coaching Track and Field (online) AND any approved sports science course on USATF Campus (online)
e. Technical Basic course of the USTFCCCA Academy or any advanced course (online or classroom)

Certificate of completion for any of the above courses serves as verification of Education Standard.

Path 2: Accomplish an Education Standard equivalency during one's coaching career, through a body of work, a career honor, or demonstrated professional coaching career. *Demonstrate any one of the following:*

a. Member of an international coaching staff selected by USATF over the last 5 Olympic quadrennials.
b. Primary coach of record of a medalist athlete on any one of the "big three" teams (Olympics, World Champs, Pan-Am Games)
c. Elite technical coach of USA National Team athletes over a 10-year period (coach must list athletes' names and contact information)
d. Hall of Fame Coach for USATF, USTFCCCA or National Scholastic Track Coaches Association
e. National Coach of the Year for USATF or USOC
f. USTFCCCA National Head or Assistant Coach of the Year for men's or women's (NCAA, NAIA, or NJCAA) cross country, indoor or outdoor track & field
g. Employment as a track coach at a scholastic or collegiate institution for a 10-year period verified by employers' information.

The USATF National Office staff will provide oversight of all components of the Coaches Registry. An oversight subcommittee from the Coaches Advisory Committee will review and evaluate any issue with a coach's education standard.

For more information, contact Terry Crawford, USATF Director of Coaching.

DEADLINE APPROACHING FOR 2018 USATF COACHING EDUCATION AWARDS

USATF annually recognizes coaching professionals for outstanding contributions and service to coaching education. If you know a deserving individual exemplifying the criteria below, please nominate him or her for consideration at the below link. Nominations are due **October 1, 2018**. Award winners will be recognized during the USATF Annual Meeting Awards Breakfast.

https://usatf.wufoo.com/forms/usatf-coaching-education-awards-nomination-form/

Awards

- Joe Vigil Sports Science Award
- Ron Buss Service Award
- Fred Wilt/Educator of the Year Award
- Vern Gambetta/Young Professional Award
- Terry Crawford/Distinguished Female in Coaching Award
- Kevin McGill/Legacy Award
- Level 2 Coaches/Rising Star Award

Examples of USATF Coaching Education organizational service that might qualify:

- A frequent speaker/contributor at USATF Level 1, Level 2, or Level 3 coaching education schools
- A history of service to USATF CE at the club/local, state or national level
- A frequent contributor of articles, videos or books that strengthen the professionalism of coaching, or point the way to new, creative approaches
- Working with beginning coaches/coaching students to provide inspiration and direction (mentoring, shadowing)
- Offering support to the CE Committee to strengthen curricula, outreach and public relations in our CE schools

2019/2020 NATIONAL TEAM COACHING STAFF APPLICATIONS NOW AVAILABLE

USA Track & Field (USATF) is now accepting applications for Head Coach and Assistant Coach positions for the following teams:

2019 Non-World Major Competitions Coaching Staff Selection

- 2019 IAAF World Relays — Location TBD (May)
- 2019 USA vs Europe — Minsk, Belarus (September 9-10)

2019/2020 World Major Competitions Coaching Staff Selection

- 2019 Pan American Games — Lima, Peru (August 4-10)
- 2019 IAAF World Championships — Doha, Qatar (September 28-October 6)
- 2020 Olympic Games — Tokyo, Japan (July 24-Aug 9)

Duties and application requirements for specified roles are outlined at the link below. Qualified individuals wishing to be considered for these national team staff positions should complete the online application no later than **October 15, 2018**.

http://www.usatf.org/Resources-for---/Coaches/Coaching-Education/2019-2020-National-Team-Coaching-Staff-Selecti.aspx

USATF/INDIANA UNIVERSITY CONTINUING EDUCATION UNITS (CEUS)

In partnership with the Department of Kinesiology, School of Public Health – Bloomington, Indiana University, earn continuing education units (CEUs) for completion of an approved USATF Coaching Education Program course. The CEU credit provides a higher education endorsement and can be applied to teaching license renewal and certifications from other national governing bodies. CEU credit is available for completion of the USATF professional pathway (Level 1, 2, 3), skill specialist courses and online USATF Campus coursework.

Click the link below to learn more about the program or to submit an application to receive CEU credit.

http://www.usatf.org/Resources-for---/Coaches/Coaching-Education/Earn-CEUs.aspx

TRACK & FIELD NEWS

www.trackandfieldnews.com

SERVING THE TRACK & FIELD COMMUNITY SINCE 1948

TRACK & FIELD NEWS (Digital Only) — *1 yr subscription — $79*

With subscribers in more than 60 countries, T&FN is the standard of accuracy and completeness for reporting of U.S. and worldwide track and field athletics. Published monthly. Call 1-800-GET-TRAK (1-800-438-8725) to subscribe.
T&FN became a digital-only publication in January 2018.
Subscribers get free eTrack (quick post-weekend results by email).

TRACK COACH (Digital Only) — *1 yr subscription — $19.95*

The official technical quarterly of USA Track & Field, *Track Coach* (formerly *Track Technique*) has been the sport's major technical publication since 1960.
TC became a digital-only publication in January 2015.

TOURS

Popular sports tours since 1952. Write for information about tours to the Olympics, Olympic Trials, World Championships, etc.

TRACK & FIELD NEWS
2570 W. El Camino Real • Suite 220 • Mountain View, CA 94022 • USA
Phone (650) 948-8188 • Fax (650) 948-9445
http://www.trackandfieldnews.com • email: subs@trackandfieldnews.com

USATF.ORG