NORTH AMERICA, CENTRAL AMERICA AND CARIBBEAN TRACK & FIELD COACHES ASSOCIATION

NACACTFCA BULLETIN Vol. 7 Number 5 – July 2010

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Published quarterly by

North America, Central America and Caribbean Track & Field Coaches Association

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Neuro-Biomechanics of Maximum Velocity

Loren Seagrave (Summary by Richie Mercado)

Loren Seagrave has coached several world class sprinters and hurdlers over the past decade and a half. Recently he took on the task of training Donovan Bailey. His company, Speed Dynamics, has sold volumes of videos and equipment designed to enhance speed, sprinting, and hurdling through a system he calls ''speed dynamics.'' He made this presentation to a group of eighty coaches at the NACACTFCA Congress in Costa Rica in October 1998, and he focused his remarks on both the importance of coaching skills and attitude, and the specific neuro-biomechanical principles that coaches must take into account when training their athletes to develop speed.

Loren Seagrave began by describing his recent experiences as the national sprints/hurdles coach in Thailand. In his time there he gave six coaching seminars. The question asked most by coaches was: What about sports psychology? He would respond, ''Psychology for the athletes or the coaches???'' The beliefs a coach has are often imparted to the athlete, and while this should be a good thing, too often it is just the opposite! In Thailand, the coaches have always said that Thai runners are too short to run fast, the athletes are lazy and the facilities are poor. That is exactly what Thai athletes learn! No wonder they continue to have low goals and little success. The coaching philosophy must be positive! Then you can get athletes to have and attain specific skill goals and enhance their performance.

He posed the question: how many people can wiggle your ears? Who taught them? No one - they are self-taught! A person probably did not set out with the goal of ear-wiggling, but accidentally discovered this talent, as do many people who learn particular skills. Seagrave's belief is that most of the fastest people in world have accidentally discovered how to be fast, and very few have been taught to be fast! Many coaches believe that an athlete cannot improve speed (Football coaches especially), but he believes that everyone can be taught how to run faster! In this respect, Track & Field coaches can be so valuable to other sports with their special expertise.

Seagrave then called on audience participation: in a seated position he had the participants place their feet flat on the ground, place their hands on their knees, and tap their toes on the floor together in rhythm as fast as they could for 10 seconds. (The audience then performed this task). He then described what the coaches were feeling: at ''go'' they were busting it, but before 5 seconds, they lost some coordination or slowed down to keep both feet tapping together; at 7-8 seconds the speed really slowed down, and before the 10 second signal, there was some shin tightness or pain! The point? It does not matter how strong one is, no strength would help to do that skill faster or better. So strength is not the key.

Speed is a skill: just like any other skill, it can be improved. Any coach can make you tired - but that is not the purpose of training for speed; the purpose is to become faster! A coach must apply a systematic approach to improvement. There is also a profound difference between coaching and training.

Coaching vs. Training

Perhaps if the word ''Teaching'' is substituted for ''Coaching'' the important differences will become more clear. Training is developing the physiological qualities through work. Coaching is teaching! But coaches cannot just teach during certain times of the training. Coaches must be present during all of the preparation, drills, and training to ensure that the athlete is performing them well at a very high level. The coach should empower the athlete with the knowledge and the tools to become more self-sufficient as they develop.

Seagrave said that he has four new athletes with an average age of 33 years. He tells them that if they do not understand why they are doing something in training, they are a fool not to ask! An athlete should understand how every component of training is going to help them achieve their ultimate goal! The more they understand, the better the compliance with the training program, and the likelihood of excellent training is increased! Athletes also make excellent peer coaches in a group!

It is a total reclamation project when a coach starts with a new athlete: the coach must help the athlete unlearn old bad habits and relearn proper patterns from scratch! He noted that his recent experiences as the speed development coach for the Atlanta Falcons of the National Football League have demonstrated this clearly. Football players, like any athletes, go through four stages when learning a new skill:

1st Stage: Unconscious Incompetence - The athlete is not thinking because they have never been told to think about anything, and is not very good at new skills. He said that he tells the football players that it is better to look foolish in front of your teammates in practice and get better at the skills than to get embarrassed on Sunday in front of 80,000 people and a TV audience! In this stage, the coach must convince the athlete to lose the inhibitions to looking foolish.

2nd Stage: Conscious Incompetence - The athlete knows what to do but has not mastered the skill; they consciously try to execute it, but are not very good at it yet.

3rd Stage: Conscious Competence - Athletes very quickly progress to conscious competence, where they are skilled but only with conscious effort; they cannot do it automatically and mindlessly. In this stage, unconscious action returns one to previous bad habits. The example Seagrave gave was someone trained in the martial arts would, when confronted by an attacker, most likely revert to ugly, unskilled fighting habits when in this 3rd stage.

4th Stage: Unconscious Competence - The skill is automatic and performed perfectly with no conscious effort. Attainment of this level takes not only practice, but mental imagery and rehearsal. It can take up to 500 hours of practice to achieve unconscious competence with a skill!

With amputees there is something called the Phantom Limb Phenomenon. Someone who has lost a limb feels as if it is still there; all sensory receptors are still connected to the brain despite loss of the limb; it can take up to 500 hours before the brain figures out that these are false receptions! What this means for coaches is not necessarily 500 hours of skill work on the track, but mental rehearsal and imagery practice of a skill counts to help reduce the time to attain unconscious competence!

With respect to skill development and ultimate performance enhancement, Seagrave stressed that coaches must develop a mission statement for their athletes. This statement should pinpoint what the athlete must try to do every day to reach intermediate and long range goals. An example of a mission statement for a Sprinter / Hurdler might be:

Sp/HH Mission Statement:

1. Reduce the time needed to put the required force into the ground by 0.005 seconds
2. Reduce the time needed to recover the leg through the required range of motion by 0.005 seconds

These may sound like modest goals, but saving 0.005 seconds on the ground and 0.005 seconds in the air

saves 0.01 seconds per stride in a 50 stride 100 meter race! That means the athlete has saved 0.5 seconds! What athlete would not want to drop 0.5 seconds off their 100m, 100 Hurdle or 110 HH time? If one computes this out for other distances, here are the results:
0.2 seconds in the 40 yard dash (distance most used in Football)
0.5 seconds in the 100 meters
2.5 seconds in the 400 meters
Marathon - 3-5 minutes!

The big question is: How can this be accomplished? There are four different ways: 1. Apply greater force; 2. Apply force in less time; 3. Apply force in the proper direction; 4. Apply force through the proper range of motion.
Objectives –
1. Apply greater force. Should this be done simply by hypertrophy or non-traditional recruitment of greater number of motor units? Remember the toe-tapping principle? Motor unit recruitment and inhibiting the inhibitors is the answer - coaches and athletes must get rid of the speed governors! This is just like the little old lady stories about grandmothers who lift the car off of the person who is trapped: all of the inhibitory overrides through the Central Nervous System (CNS) have been removed and all muscle fibers are recruited! Massive injury may and probably will occur to the little old lady, though! Coaches can teach athletes how to reach deeper into their power stores and allow them to feel competent and that they have a high level of ability!
How competent do young hurdlers feel staring down that long line of 10 hurdles? They will be guarded and reserved. Training must allow them to develop a competence above their performance: teach for success

2. Athletes must learn how to apply the force in less time! An example was demonstrated by Seagrave: place the hand palm down on the table and raise and tap the index finger on the table as hard and as quickly as possible one time. Then pull the index finger back with the other hand and let go! The stored elastic energy - stored in muscle and tendon & fascia surrounding muscle - provides a greater force in less time. This is the stretch-reflex principle of muscular contraction. Muscle contraction alone is severely limited due to restraints of speed of contraction, but this elastic stretch-reflex helps make up for lack of fast twitch fibers, too.

3. Athletes must apply force in the proper direction. Forces must be forward and backward, not side to side, but without the braking forces that are often applied by athletes reaching with the touchdown too far forward of the center of gravity, resulting in loss of velocity and force.

4. Athletes must apply the force through the full or optimal range of motion. As speed increases, force on the ground is applied over a smaller range of motion than during acceleration.
Mann pointed out that the angle on knee and hip extension at maximum velocity is smaller in elite class sprinters. The goal is to apply the necessary force in as small a time as possible and a thus the range over which it is applied is reduced at maximum velocity.

If Maximum Velocity = Vmax; Stride Length = SL; and Stride Frequency = Sf, then: Vmax = SL x Sf
Perhaps it would read better as: SL = Vmax / Sf

In other words, the faster one travels, the further one flies through the air! The traditional focus was on stride length and the concept that more strength = a longer stride. But it is coordination that is the limiting factor, and more strength does not necessarily do it, as demonstrated by the toe-tapping. SL is concrete as a value, so coaches have liked to use it, but Sf is very nebulous, confusing, and more abstract to many coaches. Mann and other researchers and coaches feel that stride frequency is the more important component.

Stride Length
Take a young Costa Rican sprinter and say, ''Run with long strides for coaches.'' She would probably exaggerate her strides to please the command of the coach. She would increase her actual SL from the toe of the right foot at takeoff(t.o.) to the toe of the left foot at touchdown(t.d.). This is the simplistic concept many athletes have of stride length. But SL is better understood in relation to the athlete's Center of Gravity (COG), and the distance the COG travels from t.o. to t.d. is used to figure the actual SL.

The longer the distance the athlete's body travels while on the ground, the more time is spent, and the slower the Vmax. The relationship between ground and air distance for COG should be long air distances relative to ground distances! Change how the athletes look at SL, maybe by utilizing the concept of effective SL: the distance the hip travels through the air in a stride. The goal is big air distance and small ground distance. Therefore, during acceleration runs and buildups, force should be applied into the ground with the goal of projecting the hips forward as far as possible.

Stride Frequency
Ground Time (GT) + Air Time (AT) = Stride Time (ST), or the time it takes to execute one stride. Here is the data for elites: it is not uncommon for GT to be 0.09 seconds and AT to be 0.11 seconds = ST of 0.20 seconds.
Therefore: 1 second / 0.2 = 5.0 strides per second.
4.8 - 5.2 strides per second is the range for elite sprinters. Young athletes' values are:
GT = 0.12 seconds

In other words, the force applied into the ground at Vmax is virtually identical in relationship for a slow High School boy and an elite male sprinter, so what is the difference? Time! Elites put the same force into the ground in less time and the hips project forward a farther distance.
AT = 0.13 This is lower due to lack of skill and motor coordination.
Sf = 4.0 strides per second. It is not strength which distinguishes elite sprinters from average ones, but efficiently reduced ground times due to enhanced skill and motor coordination.

Videos of High Level Sprinting
Loren Seagrave then showed some video of sprinters to focus on aspects of sprint mechanics. The first example was of Andre Cason one week prior to 1992 Zurich meet. He said that most people would see a little short guy running fast! Coaches and observers do not have their minds ready to analyze and break down the key components at regular speed, so he froze certain frames and slowed down other parts. Important in understanding sprinting are the Cyclical Movement Phases: these occur over and over and over again throughout the course of a race! This is much different from an acyclical movement; the quality of each one of the phases of the movement depends on the quality of the phase that precedes it. The ground phase is the most important, yet the quality of the ground phase is determined by all phases that come before it!

1. Residual Phase - from the moment the toe leaves the track (T.O.) until the thigh begins moving forward in recovery.
2. Recovery Phase - from the moment the thigh begins moving forward until the thigh stops (blocking.
3. Transition Phase - from the moment the thigh blocks until the thigh begins to accelerate in a negative direction.
4. Ground Preparation Phase - from the acceleration of the thigh in a negative direction until touchdown (T.D.).
5. Frontside Ground Phase - From the instant of T.D. until the COM is over the base of support (contact point of foot).
6. Backside Phase - from the midstance of support over the foot until the Takeoff (T.O.) into the next Residual Phase.

Vital to the development of maximum velocity sprinting skills is a proper understanding by coach and athlete of the following: there is a big difference between quality and intensity. Intensity is the % of maximum, say 90% of Vmax (90% of 10meters/second = 9meters/second). Quality is a measure of the % of perfection - even if not done at 100% of intensity! There is no excuse to do any work at less than 100% of quality, no matter what speed or intensity.

The practical applications for coaches and athletes developing the appropriate skills in each of these phases include neuro-biomechanical cues to allow for proper positioning and muscular response in the cyclical phase. The prime example comes in the transition into the Residual Phase, where the brain must send the message to dorsiflex the foot before T.O. into the Residual Phase. German studies have shown EMG messages occurring while the foot is still in contact prior to T.O. At T.O. there is stored elastic energy if the foot is dorsiflexed, thus reducing the amount of time required to recover the leg (i.e. get the thigh and leg moving forwards sooner after T.O. to save time in the Recovery Phase.

The cue for therapists when reteaching someone to walk is not to lift the knee, but lift the top of the foot! This evokes the ''triple response'‘; by curling the toe up (lifting the top of the foot) the knee and hip also respond! Those with too pronounced backside mechanics and slow recovery do not send this message of dorsiflexion soon enough. Since recovery requires velocities of over 400 degrees / sec, the smaller muscles must do it, not the larger ones. The Gastrocnemius (begins above the knee and goes down to achilles) becomes an extremely fast knee flexor!

Joint position dictates muscle recruitment (this is the Speed Dynamics principle), with dorsiflexion of the foot and other joint movements. If one raises their arm and holds their biceps, then rotates the palm, it is obvious that pronation turns on, and supination turns off the biceps (this is why it is easier to do closed-grip rather than open-grip pullups). In cyclical motions, part of time muscles must contract, and part of the time they must relax. Hip extension from ground contact through the Drive Phase is vital, and requires hamstring contraction. If the hamstring contracts during the Recovery Phase then it does not have time to relax, and the result is either premature fatigue or worse, injury! By reducing the moment of inertia through dorsiflexion of the toe, then Recovery is quicker and allows the hamstring to relax and recover for the next contraction during the Drive Phase.

When young people learn to bat in baseball and they swing the bat too slowly to hit the ball, the appropriate adjustment is to choke up on the bat and thus be able to swing faster. If the length of the leg is shorter, then it too can swing faster! The same principle also works in sprinting. Just before the Transition Phase - when the thigh blocks - coaches will often observe athletes floating in the air in a blocked motion. The legs work in concert and in opposition, so a blocked leg cannot go down until the opposite leg begins to move forward - in other words, they need to work on the Recovery Phase to enhance the Transition Phase! Coaches can drill athletes to use a maximum acceleration of the hip flexors and a maximum deceleration of hip extensors by means of a fast leg drill. Coaches and athletes must understand and identify key regulatory factors (Maraj) that are going to limit performance and develop learning and skill routines that will enhance sprinting skills. In this fast leg drill, the cues are for the athlete to get the ankle cocked and step over the opposite knee to thigh block, then accelerate the thigh backwards into extension. It must be a short lever: shorter = faster!

Athletes can control when they send the neurological message to the quadriceps to extend the knee. Insure that the quad muscles stay relaxed, and remember that the lower leg stays in the same position and neither adds to length or mass of the leg lever. Sprinters should first accelerate the long lever, then accelerate this long lever against the ground by contracting the quadriceps. According to Mann, top sprinters maintain a lower angle longer, thus maintaining greater speed at the knee and foot going backwards. There are also smaller distances from the COG to TD in elite sprinters; beginners have bigger distances, thus creating greater breaking forces and loss of Vmax with each TD.
The cue should be to keep the ankle cocked (dorsiflexed) thus preparing the Gastrocnemius and Soleus muscles for contact. This muscular resistance upon TD will reduce amortization (collapse and loss of energy) prevent the toe pointing down, which tends to place TD even farther in front of the COG.

The stretch reflex from dorsiflexion turns the ankle joint into a mechanism akin to the horse's fetlock joint: no muscles cross the joint, just a thick non-elastic ligament. The gastroc-soleus-achilles complex in humans stores energy and projects us forward more quickly, minimizing amortization.

Another cue to look for as a coach is the angle between the thighs at the moment the foot touches the ground. The knees should be at least together: an excellent measure of quality and perfection of leg recovery mechanics. If there is light, i.e. some angle between the legs at TD, then a forward TD and braking is occurring, thus Vmax is reduced. In drills, sprinters should shift the hip forward - this avoids stress on the ham from hip back. The shoulders should remain directly above the hips, and the athlete should use the lower two abdominals to stabilize the pelvis (the upper four are used for breathing). This is a skill, and like any it can be unlearned and overridden by bad technique!

The sprinting action can be practiced in a Whole Method by maintaining a stable and upright torso, then dorsiflexing the foot (thus initiating the triple reflex of the ankle-knee-hip joints), then drive the thigh down and grab back into the ground and end up tall with the hip over the knee. Excellent strength exercises that will enhance the specific strength of the sprint cycle are squats, lunges, stepups, and bounding.

In sprinting, arms are like operating a vehicle on a one way street - they only drive one way - backwards! The arm action should take place in a loose 90% angle, with the athlete driving the arm back to store elastic energy in the shoulder and biceps.
Do not paddle with the hand palm-down, because it will relax the biceps!
Some important drills to teach sprinting skills include:

continued…

Ankling - maintain body position (posture) and dorsiflexion(keep the bottom of the foot pointing down to the track and do not push from the ankle) while stepping over opposite ankle! Cue - tie your big toe up to your knee joint! use tape and FEEL the proper movement! There may be a problem: the new, more optimal way does not feel right, but it is vital to feel it anyway.

Butt Kicks - dorsiflex ankle, use gastrocnemius as the knee flexor (initiate the triple flexor response), preserve good body position and proper pelvic tilt, crash calf into ham and see knee move forward ever so slightly as knee is flexed. One athletes described it as trying to comb their hair with their spikes!

A Series - dorsiflex ankle (initiate the triple flexor response) and block thigh, then accelerate thigh back down towards the ground.

Training Power and Speed in the Jumping Events
Basic Outline

Irving Schexnayder

1. The Training Stimulus
- A. The Overload Principle
- B. Rest and Recovery Needs

II. Adaptation
- A. The Adaptation Process
- B. Specificity of Adaptation
- C. Adaptation Time Frames

111. Volume and Intensity
- A. Principle of Increasing Intensity
- B. Plotting the Intensity Curve.
- C. Plotting the Volume Curve

IV. Training the Neuromuscular Systems
- A. Electrical Concerns
- B. Intensity of Training
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V. Grouping of Training
- A. Neuromuscular Components and Training
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- C. Contrast in Training
- D. Comparative Power

Outputs and Recovery

VI. Power Output Concerns
- A. Power Output Levels
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VII. Set and Repetition Guidelines
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- A. General to Specific
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- C. Short to Long Power Output Times

Entrenamiento de Potencia y Velocidad en Saltos
Por Irving Schexnayder

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B. Necesidades de descanso y recuperacion

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