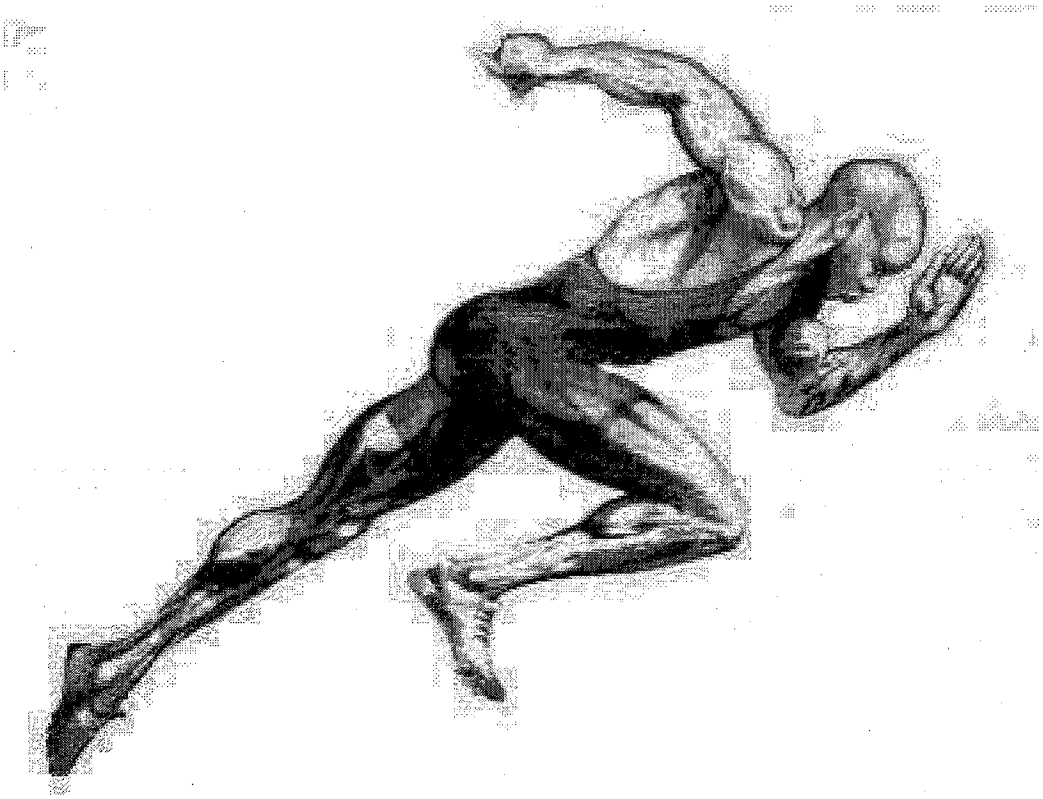
SPEED IS OF THE ESSENCE



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Introduction
SPEED & ITS RELEVANCE TO SPORT

Speed, the ability to move rapidly over a given distance, has been redefined many times over the past 40 years due to improvements in the application of sports science to coaching and training. It is not only applied to the act of running fast, but also to throwing, hitting, striking and jumping, which all require speed and quick reaction time.

The ability to move rapidly has been an integral part of the great success many athletes have achieved in their chosen sport. Leyton Hewitt (*Tennis*), Sherelle McMahon (*Netball*), Jason Robinson (*Rugby Union*), Michael Jordan (*Basketball*), Marion Jones (*Track and Field*) and Michael Klim (*Swimming*) are all examples of successful athletes who have had the ability of great speed. The athlete who is able to out-sprint an opponent, throw a ball faster and further, hit faster and harder, and jump longer or higher has a distinct advantage over their fellow competitors.

Less than 20 years ago, many coaches believed that great speed was a natural gift and that the key to a good team, for instance, was the recruitment of naturally fast players. It has now been shown that with the correct training programme, any athlete can achieve a significant improvement in speed performance, be it in sprinting, throwing, or jumping. It is through the long-term planning of correct speed training methods that athletes can reach their speed potential in their chosen sport. These training methods require only minor changes to the athletes' current training programmes, but the results can lead to enormous gains in field, track or on-court performance. Many current training programmes unfortunately lead to a decrease in speed of movement - this is obviously not a desirable outcome. It is essential that athletes at least maintain their current speed levels so as not to decrease their playing or performing potential.

This manual has been written to demystify the development of speed and speed strength (power) attributes in athletes in all sports. I have attempted to put together a *training manual* that will serve coach and athlete alike as a reference guide to the many components of training that should be addressed if greater speed and power performance is required.

It is my hope that you, the reader, finds this manual a comprehensive and practical reference for essential drills and exercises, and that it stimulates the development of new exercises to create a programme which is more effective at developing speed in the short term and long term.

The New Biomechanics of Sprinting

Athletes like Marion Jones and Maurice Greene display the latest technical model of sprinting. It should be every athlete's goal to gradually develop the most effective technique. So what are the latest ideas?

To increase any athlete's maximum speed means improving at least one of the following two things:

1. The number of steps the athlete makes per second (their cadence).
2. The effectiveness of ground contact.

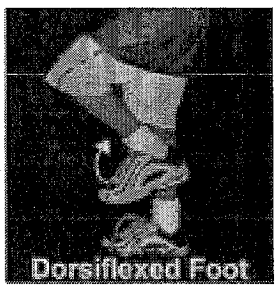
Improving cadence is very much related to decreasing recovery time (the time it takes to get the foot off the ground and back on the ground). Having a foot that hangs way out of the back of the body after ground contact is a common problem that increases recovery time. It is often caused by the athlete dropping their hips, which causes a noticeably increased lower back curve (a butt out position). This creates a situation where the athletes compensate for their lack of knee lift by pushing more out the back. There are a number of problems associated with this excessive rear-side running action:

- Increased recovery time, which results in a slower step-rate.
- Increased load on the hamstrings, which have to assist in the recovery action. Greatly increasing the risk of hamstring injury.
- Decreased knee lift because knee lift is inhibited when hips are low and there also isn't enough time for them to be lifted higher with the late recovery. This consequently results in less powerful foot contacts.

Many of the world's top athletes are now trying to decrease rear-side mechanics. The plan has been to prevent the thigh from swinging back any further than just 20 degrees behind the plane of the trunk. (Note the Marion Jones photo, she is in maximum hip extension). To do this requires that the athlete maintain high hips. Therefore minimizing the increase in lower back curvature. To do this the athlete needs a high level of strength and control of the muscles that maintain good pelvic stability particularly the lower abdominals. To develop this strength takes a few years of training in the right way.

It is important that the leg folds up close to the butt on recovery *but* in an athlete that is recovering early enough the foot should be closest to the butt when the thigh has already swung forward. Athletes that are recovering late have thighs that are vertical when the foot is at its closest to the butt. Performing butt kickers drills with a vertical thigh is very counterproductive in developing good recovery mechanics. It is best to make sure that the drills are always done so that the knee is forward when the foot is at its closest point to the butt and also fully dorsi-flexed almost all the time.

Good leg recovery involves a cyclic action where the athlete strives to keep their big toe as close as possible to their shin (dorsi-flexion), high hips, early recovery and recovers their foot over the height of their opposite knee. The action looks and feels like "stepping over long grass". This cyclic recovery action allows the athlete to develop a much more powerful acceleration of their lower leg moments later. Many athletes run by recovering their foot by pulling it through low and straight up. This is much more energy costly and slower.



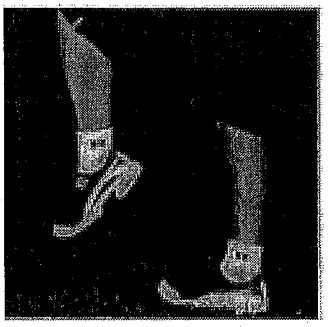
When an athlete is in the position of their highest knee lift and they are maintaining high hips as well as a dorsi-flexed foot, they are in a situation where they can generate using the gluteus maximus muscles a large amount of vertical force resulting in an explosive acceleration of the knee downward. If they have a dorsi-flexed foot their lower leg can swing freely (without contraction of the hamstrings). The result is a rapid flinging backward of the foot, this is often called negative foot speed. It has been reported that elite sprinters can swing their feet backwards at speeds in excess of 50kph (30mph). Maintaining dorsi-flexion until the foot hits the ground increases the quickness of ground contact and also helps contact to occur further underneath the body minimizing breaking forces. Some athletes have incorrectly developed a technique that produces high negative foot speed but they do not maintain appropriate dorsi-flexion of their foot until ground contact. These athletes are a great risk of hamstring injury because they strike too far forward in front of their body, which severely loads their hamstrings.

Active Foot Strike

Athletes should be aiming to impact the ground with afoot that is moving backwards. This is not unlike the impact when a youngster is riding a scooter or a skateboard. The ground is moving backwards at a fast rate and when the foot first makes contact with the ground there is usually a jolt of deceleration before there is any propulsive force applied. This braking force can be decreased by creating a technique that has the foot moving backwards before it impacts and also making contact far enough back under the body.

Dorsi-flexion

For the athlete to make an active foot strike and have a quick contact with the ground. It is essential that the athlete maintains dorsi-flexion of the ankle (keep toes as close to the shin as possible). This pre-stretches the calf muscles and prepares them for a much quicker more elastic impact. Maintaining dorsi-flexion also causes foot strike to occur later under the body.



A common (sometimes taught) error is for the athlete to point their toes away from the shin in an attempt to run on their toes. This method has a variety of negative consequences:

- Usually unless the athlete is super strong they will increase contact time because their foot will be forced into maximum dorsi-flexion after contact anyway. As a consequence controlling this rapid forcing back of the foot on impact puts a tremendous extra load on the anterior tibialis that often leads to lower leg injuries like shin splits, tibia stress fractures and even Achilles tendonitis.
- The athlete running up on their toes (attempting not to let their heel hit the ground) is in much more of a pushing position. This means they will need to lean further forward to get maximum power out of an action that is more dependent on muscles in the front of the thigh. By leaning forward the athlete will also minimize the effects of over-striding that they have because running with a pointed foot will cause foot contact to occur further forward.
- The forward lean usually is accompanied by an increased lumbar curve in the lower back. This often causes a situation where the athlete's pelvic position will make it less possible to have muscular activity from the important Gluteus Maximus muscles due to inhibited activation. The Gluteus Maximus in Elite athletes works very powerfully in concert with the hamstrings to create the backward sweeping action of the thigh and result in a fast backward "flinging" action of the foot. If the Gluteus Maximus is inhibited and/or weak, the hamstrings then are forced to take over the load. Often this means athletes that run in this way have lots of problems with their hamstrings accordingly.

Arm Swing

Arm swing should involve having the elbows swing in front of the plane of the trunk. Not swinging them far enough forward limits knee lift and results in greater rear-side mechanics to compensate. The angle of the arms should be mostly about 90 degrees at the elbow. The only time this angle should increase is when the hands are behind the body and then they may open up to no more than 120 degrees. The opening up of the angle makes it easier for the athlete to have a more relaxed arm action and also allows the legs to complete the cycle of movement.

Forward Lean

Athletes should aim to run at maximum speed with a very slight forward lean that is evident throughout the whole body. They need to keep their hips up and have the right balance of front-side and rear-side running action. Leaning too far forward will result in the athlete increasing the rear-side action and introducing all the associated problems.

Head Position

Athletes need to keep their chins down. Having a head that tilts backward often is accompanied by an increased lumbar curve and lower hips. This will decrease knee lift and negative foot speed.

Running Tall

Athletes need to aim to run tall. This means they keep their body long, their hips up and can have a high knee lift. Many athletes run low and have legs that are quite bent as they pass under the body. This causes them to have effectively shorter legs and a shorter stride. The key to improving tallness of the runner is to develop more strength and to always practice running tall.

Relaxation

All athletes should aim to develop relaxation. This means focusing on using muscles that are required for running and stabilization. It importantly means learning to switch off all un-required muscles as much as possible. There are many situations where athletes can practice relaxation and seek to develop a good feeling when running, that many athletes call *rhythm*. Young athletes particularly need to develop this skill because it is common for people to equate running at maximum speed with maximum tension. This is why this area needs careful and regular attention. Tempo sessions aim to develop endurance and desirable movement habits while relaxed. Relaxation is much more easily attained during Tempo sessions because all running is done at lower intensities.

Sprinting Mechanics and Technique

Many athletes run with poor technique, which hampers their speed. Energy is wasted and progress forward is too slow relative to the effort expended. For example, one very basic element of proper running form is to point the feet straight ahead during foot contact with the ground. To demonstrate the loss of distance with each stride, try this. Place your foot straight ahead on the ground with the toes even with a line that is perpendicular to the foot. Now pivot the foot on the hell so that the toes move twenty-five or twenty-seven centimeters outward. Notice the loss of distance from the line to the toe. This 0.5 to 1 centimetre is lost on every stride when a runner toes out, which results in slower running speed.

Proper running form requires the bodily movements be used to propel the runner forward in the most efficient manner. Muscular forces used during running should be applied in a backward direction. The runner moves forward with no counter productive actions, if force is applied straight backward. Excess up and down, sideways, or rotational movements all waste energy, slow the runner, and cause premature fatigue.

The key to good sprint running form is to eliminate unnecessary muscular actions that do not contribute to movement forward and to maximize those, which do. This is the art of learning to relax while sprinting at maximum speed. The relaxed athlete applies great muscular force directly backward to move forward at the fastest possible speed.

Many times the development of proper running form is difficult for an athlete because of poor flexibility. The athlete must be able to easily move his or her body parts through the full range of motion to achieve correct sprinting form and high speed. Limited flexibility shortens stride length and increases energy requirements of sprinting as one muscle group works needlessly against another. Stretching to enhance running form will be discussed following a description of proper sprint running form.

Sprinting Form with Biomechanical Analysis

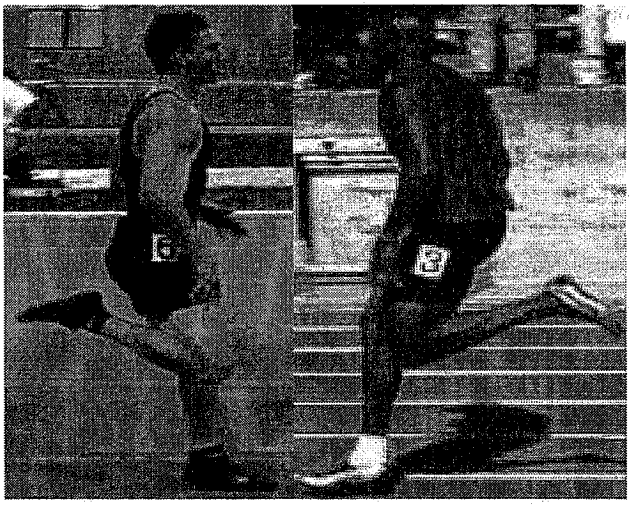
- The forward moving foot staying high under the hips with the toes pulling forward or dorsi-flexing. This keeps the pendulum of the forward moving leg short and moving quickly.
- The shoulders staying relaxed and down. This increases the range of motion and conserves energy.
- The head remaining steady with the eyes focused straight ahead.
- The shoulders and hips are perpendicular to the direction of the run.
- The pelvic girdle is tucked under the torso. (In the picture that would be in a counter-clockwise direction). This allows the foot to stay high as it passes under the hips.

- The forward moving foot staying high as it moves to a position under the lead knee.
- The pelvic girdle remains tucked under the torso. (In this picture that would be in a counter-clockwise direction). This allows the foot to stay high as the knee rises.
- VERY IMPORTANT: If the pelvic girdle is rotated in the opposite direction (clockwise in the left picture), that would shorten the range of motion of the knee trying to rise.

- The angle from the toe coming off the ground to the hips should be a 45 degree angle. This maximizes the distance traveled until the next foot hits the ground. The parabolic curve (that is the flight pattern of an object in flight from takeoff to landing) is the same for all sprinters, and the angle of takeoff should be the same. With this in mind **two sprinters traveling at the same speed with the same mechanical movement, no matter what their height is, should have the same stride length.**
- The shoulders and torso remain balanced above the hips.
- The forward foot should be directly under the lead knee.
- The lead toe is up but not higher than the heel.
- The back arm should be directly under the elbow.
- At this point the back hand can stay relaxed and can swing back.
- The angle of the forward arm at the elbow is closing.
- The forward elbow is in front of the torso.
- The forward hand moves to a position above the elbow.
- The forward hand remains steady here. The hand balanced above the wrist and elbow.
- The shoulders stay down and relaxed.

- The lead foot does not pass does not pass the knee until the knee starts to move downward.
- The forward leg extending forward as the knee drives down and back.
- The lead foot toe stays up or dorsi-flexed.
- The back arm and hand starts to move forward counteracting the lead knee moving backward.
- The forward arm starts to rotate at the shoulder with the angle staying closed at this point counteracting the back knee moving backward.
- The back leg flexes raising the foot as it drives forward.
- **VERY IMPORTANT:** The back foot never rises higher than the crotch.
- Keep the twisting action of the shoulders and hips to a minimum.
- **NOTICE** how high the forward foot is before it starts its down and back action. This maximizes the speed of the foot and leg before it hits the ground.

- **VERY IMPORTANT:** The forward moving back foot never gets as high or directly behind the butt. This will cause the forward moving foot to snap down as it passes the hips.
- After the forward moving elbow passes the torso, the hand can begin to swing up adding to the drive of the lead knee and foot.
- After the backward moving elbow passes the torso, the hand can begin to drive back.
- **NOTICE** that the foot touching the ground is making contact just in front of the body. This tells is that sprinting is a pulling action as much as a pushing or jumping action.
- **NOTICE** the heel of the foot touching the ground is just off the ground. The sprinter is on the balls of his feet NOT on his toes.



Body Mechanics

In outline there are 2 key aspects to consider:

1. Strong stable chassis (body).
2. Fast efficient moving parts (arms and legs).

1. The Chassis must be powerful and stable so that it is able to withstand the fatigue and torsion brought about by the moving parts. It must also be capable of channelling the various forces that are generated within it to bring about the desired momentum.
2. The Moving Parts – free limbs – must be rangy and well co-ordinated (between arm and arm, leg and leg, and between arm and leg). Continuity of rhythm is essential, with a skill based action that must be taught to ensure that the correct foundations are laid for future development.

How should the Chassis hold itself together?Key Thoughts

–Run tall

–Low shoulders

–High hips

Teaching Points –Trunk fairly erect

–Eyes looking ahead

–Long relaxed neck and facial muscles

–Shoulders square to the front**Technical Aspects** –Transfer of power from legs to body

–Free range of hips/legs**How about the Moving Parts?(a) Upper motor/limbs = arms**

Key Thoughts

–Shorter means faster

–Fast arms lead fast legs

–Rhythm and relaxation

Teaching Points

–Backward and forward pendulum action of arms

–Arms work of low shoulders

Technical Aspects

–Flexed elbow (90°) – fingers lightly folded

–Thumb on top of hand

–Inside of wrists lightly brushing hips

(b) Lower motor/limbs = legs

Key Thoughts

–Down and extend

–Strike and push

–Up and fold

Teaching Points

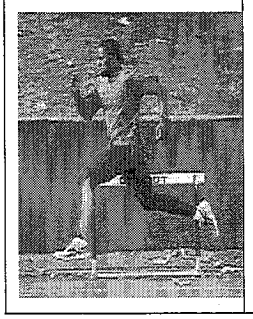
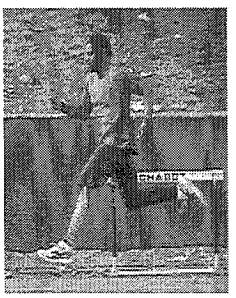
–Cyclic rhythm with continuous movement of arms and legs

–Flexed hip/knee/ankle----->Extended hip/knee/ankle----->Flexed hip etc **Technical Aspects**

–Active strike of ground with ball of foot —— *Support phase*

–Push ground down and away – long lever movement ——*Drive phase*

–High fast recovery – short lever movement —— *Recovery phase*

Front Side Ground Phase	**Back Side Ground Phase**	**Residual Phase**	**Recovery Phase 1**	**Recovery Phase 2**
				
Transition Phase	**Ground Preparation Phase**	**Watch the Left Leg** (one with the white stripe to see the Phases) **Front Side Preparation Phase** - Instant of touchdown of foot until the Centre of Mass is over the base support (hips). **Backside Preparation Phase** - From mid stance of support over the foot until take off in the next Residual Phase. **Residual Phase** - Moment the toe leaves the track until the thigh begins to move forward in recovery **Recovery Phase** - Moment the thigh begins moving forward until the thigh stops and blocks. Two pictures to show how long the Recovery Phase is. **Transition Phase** - Moment the thigh blocks until the thigh begins to negatively accelerate back towards the ground. **Ground Preparation Phase** - From negative acceleration of thigh until touch down of foot.			
				

Key Points

- The **LEGS** propel the body forwards through the following phases

SUPPORT
DRIVE
RECOVER

- The **ARMS** synchronise with the legs but work as opposites
  – as the left leg is in its driving phase the right elbow is driving backwards
  – as the left leg recovers, so the right arm recovers to a position in front of the trunk.
- The **ARMS** also balance the body, by absorbing the strong drive of the legs. Try running with arms clasped behind the back or across the chest.
- The **ARMS** should rotate on the shoulders in a backwards/forwards movement.
- The **ARMS** should swing parallel to the lane lines on the track, sometimes slightly across the body
- The **ARMS** also aid the force of the legs, when the foot is in contact with the ground. The emphasis in the arm action should be driving **BACK** the elbow. As the elbows drive backwards, ask for a ninety degree angle to be kept at the elbow joint. Actually, the angle at the elbow opens out beyond ninety degrees at a certain stage in the running action, but asking for a ninety degree angle will produce the correct effect.
- The **SHOULDERS** should be kept still and square to the lane lines on the track.

Posture

Although there have been notable exceptions, most good runners have an erect posture with the head held in natural alignment with the spine. All extraneous head movements must be discouraged. The muscles of the face, jaw and shoulders must always be relaxed.

- The athlete should always concentrate on *running* tall – with eyes looking directly forward, chin down – never up! The trunk, then, is fairly erect, with the crown of the head reached upwards, not the forehead.
- The shoulders should remain square to the direction of the run. There should be no shoulder rolling, or twisting of the trunk.
- The hips should feel raised or 'lifted' – and never low, because this will lead to a 'sitting' action in running.
- This 'strong' posture gives a sound 'chassis' for the 'motor' of arms and legs to work on.

Coaching advice may be "run tall" and "run with a glass of water on your head", "run light and lifted", "run your hips high", "run as if pulled by an invisible cord straight down the track", "straight back, chin down".

It is important that there is no distortion of trunk/hips, as this will lead to absorption of energy rather than its transference to the track for propulsion.

Arm Action

"Fast arms lead fast legs"

"Fast arms mean short levers and relaxation".

Maintaining the arm action as a short lever movement should be thought of as an attempt to move the upper arm through its wide range, with the elbows always flexed.

The athlete should feel that the hand comes no higher in front than the shoulder.

The athlete should also feel that the elbows brush his or her vest in moving forwards and backwards – and that they are not sticking out to the side like wings!

The arm action must be well drilled, with the movement 'coming from the shoulder'.

Leg Action

The leg action might be best described as a 'striking and pushing' the ground from under to behind the athlete.

The 'striking' action is very active and commences the moment the thigh is driven downwards and backwards from its high recovery position, parallel to the track. In other words, the foot is not laid on the track, it is almost 'thrown' at the running surface.

The 'pushing' action is felt by the athlete to be as if the foot has stuck to the ground behind the body. The thigh's action in the 'strike' continues as the hip completes its extension. The next joint to extend is the knee – and finally the ankle, as the foot 'flicks away' the track.

Another sensation with which the athlete will become familiar is one of bouncing from the ball of one foot onto the ball of the other. In fact, acceleration will be felt as a greater sensation of pressure on the balls of the feet.

The recovery should be thought of as 'high and fast'.

Sprint Drills Drills aim to specifically strengthen the muscles in postures and actions that are similar to those that occur during the sprint action. They are posture drills, specific strength drills and functional flexibility drills all at the same time (Gambetta et al.). It is very important that correct execution of the drill be trained carefully with coach feedback essential. This is because drills performed incorrectly can ingrain bad habits that will result in the opposite of the intended effect. Bad drills are much worse than not doing drills at all. Athletes should never perform them as relaxed warm-up activities unless they are done perfectly. They are as serious a business as a concert pianist practising piano.

I have the young athletes in my squad concentrate on the following drills before progressing onto the more established drills:
Sprint Running Form Some experts believe that the preschool and early elementary school years are the most favourable for learning correct sprinting form. After age 7 or 6 children may have lost a unique opportunity to learn to sprint correctly. Although you can "teach an old dog new tricks", it is much more difficult to eliminate faulty form after bad habits have been used for so many years. The preadolescent and early adolescent period is an ideal time to develop proper form and correct form errors that will hinder their speed in the future.

Although ideal form will be described, be aware that each athlete may have small deviations from the ideal because of individual differences in body build and structure. Minor faults in form will have little or no affect on running speed and need not be of great concern, but one or more major faults will result in slower speed. These faults must be corrected if the athlete is to achieve his or her speed potential. Proper sprint running form includes:

1. The feet are pointing straight ahead during foot contact with the ground.
   Faults: a. Toeing out excessively
   b. Toeing in excessively

   These faults may be difficult to correct if they are caused by body structure. Improved flexibility in the hips, calves, and ankles might help, along with concentrated practice running on the line with the toes pointed straight ahead.

2. Initial ground contact is with the ball of the foot. The foot then drops slightly to the ground due to the force of landing, thereby stretching the leg muscles and subsequently providing power for the following push off.
   Fault: Making initial contact with the heel or flat-footed.

   These faults can be corrected by having the coach observe and provide feedback while the athlete concentrates on correcting the fault during running form drills and repeated sprints.

3. The body's centre of mass should be directly above or just slightly ahead of the ball of the foot at the time of initial contact with the ground.
   Faults: a. Over-striding with the centre of mass behind the ball of the foot
   b. Under-striding with the centre of mass significantly ahead of the ball of the foot

   Over-striding can be corrected with observation by a coach or video-tape analysis. Concentration on correcting this fault will be necessary during practice drills. One drill is to place markers on the running surface which are slightly closer together than the runner's normal stride. The athlete then sprints alongside the markers and maintains a stride length equal to the distance between them Under-striding would be corrected in the same manner, but the markings are placed further apart. Flexibility improvement as well as strength/power training techniques are also advised for someone with a small short stride.

4. Full leg extension at the time of push-off.
   Fault: Prematurely lifting the foot from the ground at the time of push-off due to incomplete extension of the hip, knee, and/or ankle

   The hip, knee, and ankle must be fully extended at the time of push-off from the ground. Maximal force can only be applied backward against the ground when full extension occurs. Prematurely lifting the foot from the ground reduces push-off power, lessening stride length and speed. To utilize the strength and power developed in a speed programme, full leg extension must be an integral part of the sprint running technique.
   Observation by the coach and videotapes analysis can identify the fault of limited leg extension. The athlete must constantly think while working on sprint form to maximize the push-off backward to move forward the fastest. The verbal cue of "push-off" should become synonymous with the act of applying maximum force backward by fully extending the hip, knee, and ankle.
   The hip flexors may also need to be stretched because tight hip flexors prevent full hip extension causing premature flexion of the knee and ankle.

5. Knee lift should be as high as possible.
   Fault: Knee lift, which is too low shortens the stride length

This may be due to a lack of flexibility in the hamstrings and buttocks. Specific stretching exercises should be incorporated into the training programme. Weak hip flexors also cause low knee lift. The hip flexors are strengthened with uphill sprints and the hip flexor exercises

6. The heels should kick high toward the buttocks after each push off.
   Fault: Low heel lift.

   Low heel lift while sprinting results in greater effort to bring the leg forward following the push off. Tight quadriceps muscles on the front of the thigh will limit heel lift. Quadriceps stretching will help to eliminate this fault.

7. The elbows are bent near 90 degrees.
   Faults: a. Elbows too straight
   b. Elbows bent to excess.

   Elbows, which are too straight and result in wasted energy and slow arm action may be the more common of the two faults. Elbows bent too much limit the transfer of momentum from the arms to the body and contribute little to speed. Concentrate during form drills and sprints to correct this problem.

8. Forward arm action brings the hands to shoulder height and backward arm action takes the hands just behind the hips.
   Fault: Arm action through a shorter range of motion.

   Arm action must be vigorous during sprinting. A short range of arm action limits the transfer of momentum from the arms to the body. Arm action counteracts leg action and must be great to balance the equal and opposite movements of the legs.

9. The hands do not cross the midline of the body. The head is parallel to the ground without rotation. Shoulder and pelvic girdle rotation is minimal.
   Fault: Excessive rotation of the arms, head, or hips.

   Muscular forces should be applied forward and backward during the sprinting to move forward without wasted energy and counterproductive motion.

10. The fingers are loosely cupped.
    Faults: a. Fists held tightly.
    b. Hands held straight.

    Both of these faults create unnecessary tension in the arms and shoulders. Concentrate on keeping the hands and fingers loose, the elbows bent to 90 degrees, and the shoulders moving the arms forcefully backward and forward.

11. The jaw and shoulders are relaxed.
    Fault: Tightness in either area.

    Relaxation is the key factor to enhance running form and speed. Tightness inhibits freely moving arms and legs and results in a loss of speed.

12. Body lean is high during the start of a sprint and nearly vertical while maximum speed is maintained.
    Fault: backward lean during sprint.

    Speed will be slower if backward lean occurs during a sprint. The forward lean is directly proportional to acceleration. Therefore, lean is high at the start and minimal top speed. If the head is lifted excessively, this is likely to cause a backward lean of the trunk. Correcting the head position should bring the trunk to the proper position. A backward lean occurs while slowing down and stopping.

Any faults in sprint running form can be improved by using the following sequence:

1. Identify faults through observation or videotaping the athlete while sprinting.
2. Identify specific drills, which emphasize correcting this fault.
3. The athlete must concentrate on correcting these faults during sprint running form drills and when sprinting.

Continued observation by the coach or analysis of videotape will assist in improving and maintaining good sprint techniques.

Drills for sprint running form should be done as part of each sprint workout warm up routine. I believe that if we spend time of about ten to fifteen minutes of quality work with athletes concentrating on perfect form during these few drills, it will greatly assist toward proper sprint form. Once these are properly mastered, then we can take athletes on towards the more regular drills, which I will outline later. The following drills are recommended to develop proper form:

1. High knee lift while standing in place.

Start with athlete standing on balls of the feet.

Alternately lift the knees straight up to hip height. Land on the ball of the foot.

Emphasize toe up to achieve the dorsi-flexion that we require.

2.High knee lift while slowly walking forward.

As above, but slowly move forward as if marching.

3. High knee lift while running slowly.

Continue to accentuate high knee lift to hip height while slowly running.

4. Arm action while standing in place.

With hands loosely cupped, bring them forward to shoulder height and backward to about fifteen to twenty centimetres behind the hips.

5. High knee lift with arm action while remaining in place.

Combine proper knee lift and arm action.

6. High knee lift with arm action while running slowly.

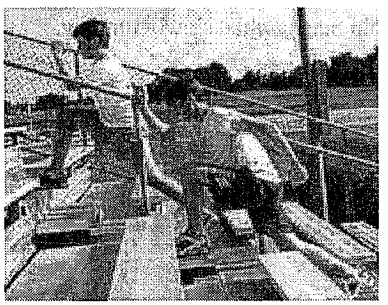
As the leg and arm actions are combined while running it is essential that the athlete concentrates and performs the drill perfectly, if form is to improve.

7. Skipping emphasizing high knee lift and vigorous arm action.

Skipping with an emphasis on achieving maximum height requires a powerful push-off, high knee lift, and forceful arm action. Be sure the knees are coming straight forward and the feet point straight ahead.

8. Running steps one or two at a time.

Begin with one step and emphasize good knee lift and arm action. When two steps are taken maximal push-off, high knee lift and strong arm action will be required to accomplish the task.



Each of the above described sprint running form drills should be performed from 25 to 50 times or 25 to 100 metres for one to three sets. An athlete with a specific fault in an area will need to perform two or three sets of a particular drill or series of drills. Other athletes should perform one set of each exercise to maintain excellent sprinting technique.

We must take time to ensure that young sprinters master each of these form drills. These drills will help establish a basic sprinting form that eliminates the wasted energy that does not contribute to forward movement. Although this will be difficult and require weeks of practice, you will be able to take the important step of getting sound technique before moving on to the more specific sprint drills.

A relaxed sprinting style is essential to fast speed. Relaxation can be learned by performing repeated half and three quarter speed runs of 50 to 100m while concentrating on key areas including loose jaw, relaxed neck and shoulders, and loose hands. Another technique, after achieving maximum speed during a sprint, is to maintain speed for an additional 20 to 25 metres while consciously relaxing all the body parts not directly involved in generating maximum force for the sprint. These relaxation runs should be done before beginning the sprint phase of the session.

As coaches we should observe each athlete to correct faults and the athlete must concentrate on proper form during all sprint running sessions. How is the head position, the jaw, shoulders, elbow angle, arm movement backward and forward, trunk lean, knee lift, and foot contact with the ground?

More Established Sprint Technique Drills Sprint or technique drills are used to break the sprinting motion down into more manageable components. This is important because breaking down the skills into their parts and mastering them first at slow speed and then at faster ones makes them easier to learn. Eventually, the athletes can transfer the techniques of the parts (i.e. the drills) to the whole (i.e. sprints at maximum speed). There are several categories of drills that are used to teach aspects of the sprinting motion. These include (a) arm-swing drills, (b) ankling, (c) heel kicks, (d) high-knee drills, (e) A drills, and (f) B drills.

Arm Swing Drills

The arm swing is an important and often overlooked aspect of technique training. During sprinting, the arms act in opposition to the legs serving to prevent upper body rotation, which could lead to a loss of balance and timing. When coaching the arm swing, the emphasis should be on avoiding the arms crossing the midline (which would contribute to upper-body rotation), having the hands travel from the hip to the height of the shoulder, driving the arms back forcefully. If the arms are driven back forcefully, the stretch reflex at the shoulder will recover the arms forward – which will also serve to reduce the number of things the athlete will have to think about when running at high speeds. In elite sprinters, the elbow angles will vary from 60 degrees in front of the body to 140 degrees in back.

Arm drills have the objective of developing a relaxed, powerful and efficient arm action.

There are several progressions for teaching the arm swing. First the drills are performed in a seated position. Sit on the floor with the legs straight out in front and swing the arms in a sprinting motion. Each arm should move as one piece with the

elbow bent at about 90 degrees. Keep hands relaxed. Hands should come up to about shoulder height in front and should pass the gluteus at the back. The arm action should be forward and back without crossing the main line of the body. This drill will help train the correct position of the arms as the hands pass the lowest of the swing by avoiding contact with the ground. Once mastery of the seated drill has occurred, the athlete is ready to perform the same drill standing, then walking, and then jogging.

There are several common errors seen with the arm swing. First, athletes may not swing the arm from the shoulder – they may swing by locking the upper arm into place and only moving the lower arm. This is called "beating the drum" or "milking the cows" and does not allow the athlete to move his or her arm quickly enough during high-speed sprinting. Athletes should be encouraged to move the arms from the shoulders. Second, athletes may allow their arms to cross the midline of the body while running. This is called "running like a chicken". Athletes should be reminded to drive the arms backward while running. Third, athletes may swing the arms too high (i.e. hand over the shoulder) or may not swing back far enough (i.e. hand does not reach the hip). This can affect arm speed negatively. Coach athletes to move the arms 'hip to shoulder'.

Ankling

Ankling teaches how to lift the feet off the ground and how to put them down during sprinting. This is an important skill as proper positioning of the foot will minimize the amount of time spent on the ground, minimize power lost into the ground by providing a more rigid ankle joint, and minimize injuries that could be caused by incorrect foot placement.

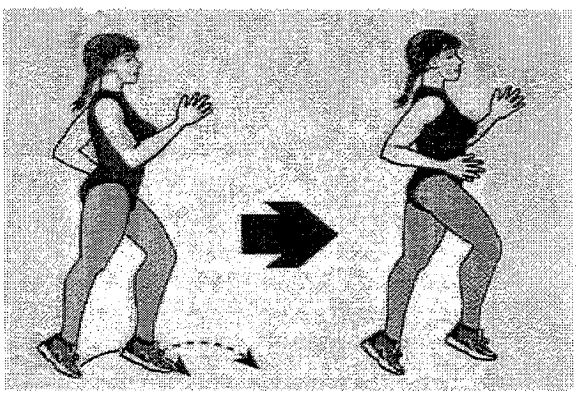
When coaching foot action during sprinting, emphasize plantar-flexion as the hips pass over the foot to push the body forward. When the back foot breaks contact with the ground, it should immediately be "cast". Casting refers to dorsi-flexing the ankle to approximately 90 degrees while pulling the big toe up. The foot should remain in the cast position until it is again on the ground and the hips are passing over it. In ankling, the foot will be driven forward from the hips, and the outside of the forefoot will make contact with the ground and will pull the body over it.

There are several progressions for teaching ankling. At first, the drill is performed walking, focusing on one leg at a time (i.e. only the right leg performs ankling). With the legs stiff, move forward until the hips have passed over the right foot. As this happens, the right ankle will go into plantar-flexion before the foot breaks contact with ground. When the right foot breaks contact with the ground, it should be cast and driven forward from the hip. The outside of the right forefoot will contact the ground (cast position, big toe up) and will pull the body over it. When the desired distance is covered, switch legs. After the athlete is proficient performing this drill with one leg at a time, have the athlete alternate the legs. Note that the walking versions of ankling are meant to be slow technique drills. To work on speed and explosive power, these drills can be performed as straight leg bounding exercises; focusing on correct ankle mechanics while trying to get off the ground as quickly as possible.

Besides having difficulty achieving and maintaining the cast position, the most common errors with foot placement involve running on the toes or running heel-to-toe. Running on the toes is a frequent problem when one attempts to teach the cast position and having the forefoot contact the ground first. If the toes contact the ground, it could actually make the athlete have balance problems while running, which is undesirable and also act as a breaking action. To correct, emphasize a pawing motion where the forefoot strikes the ground and then pulls the body along. Running heel-to-toe is problematic because often the structures of the lower limb are unable to absorb the forces, and this can lead to hamstring injuries over time. Athletes need to be encouraged to cast the foot, "stay of the heels", and allow the forefoot to contact the ground.

The drill involves a good range of movement of the foot and ankle joints from the ball of the foot (heel low but not quite touching the ground) to the extension of the ankle. The foot moves forward a short distance (the toes barely leaving the ground) almost by pushing the knees forward. The hips should be lifted and remain in the same plane throughout the drill. The arms are active. The head looks forward. Emphasis is on the use of the foot and calf muscles only.

The purpose of this drill is to increase foot speed and elastic ankle strength



Heel Kicks or Butt Kickers

Heel kicks are designed to build upon the mechanics taught by ankling drills. Heel kicks teach the athlete to bring the heel to the hip immediately following plantar-flexion. This serves to "shorten the lever" so that the mass of the leg is closer to the axis of rotation; allowing the leg to be cycled forward more quickly during sprinting.

Heel-kicks or Butt Kickers that are performed for sprinting are slightly different than what most of us are used to. The goal of the drill is to teach the athlete to lift the heel up to the hips quickly during the recovery phase of sprinting. The athlete should step forward with his or her right leg with the foot dorsi-flexed and big toe lifted up, and proceed through the driving phase as was discussed in the ankling drill above. As the right foot leaves the ground, it should immediately be dorsi-flexed and the big toe should be lifted up. The heel should quickly be brought up to the athlete's hip. Note that as this is done the right knee will be lifted up. Unlike the more traditional butt kick drills, the goal here is not to stretch the quadriceps, it is to practice getting the heel to the hips as quickly as possible.

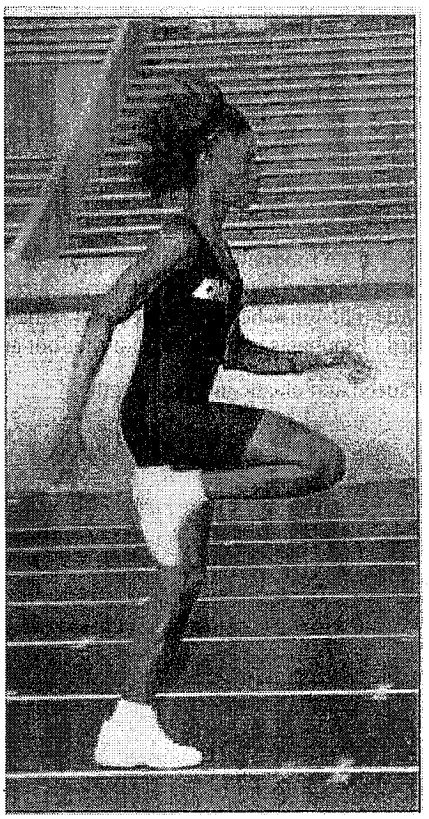
Heel-kick drills begin at a walking pace (like ankling) and begin by focusing on one leg at a time (e.g. the right leg). Keep the left leg stiff and step forward. As the hips move over the right foot, the right ankle should plantar-flex as it breaks contact with the ground. When the foot breaks contact with the ground, it should be "cast" and immediately lifted up to the right hip. As the heel is lifted up, the right hip will flex to approximately 45 degrees. Repeat until the desired distance is covered, then switch sides. Once proficiency is achieved in this drill, perform it by alternating between the right and left sides.

Athletes that lack good flexibility will have trouble bringing the heel to the hip during this drill, which will make correct technique difficult to visualize. To help solve this problem, the advanced versions of this drill are performed at a jogging pace. The increased speed will enable the athlete to bring their heel to their hip during the drill.

There are two frequent errors seen during this drill. First, many athletes will perform this drill by pointing the knee down toward the ground. It should be emphasized that the hip will flex during this drill, and this is important for the sprinting motion. The goal is not to stretch the quadriceps; it is to teach bringing the heel to the hip during the sprinting motion. A second error is that the athletes will lose the cast to their foot while it is brought to the hips. Remind athletes that they should not allow their foot to "dangle" and that the ankle must remain rigid.

From a jog, pull the heel of the lower leg up to the gluteus, with the thigh coming up to a parallel position. Imagine a pane of glass running down the back, and do not allow the heel to break the glass. This action will produce knee lift without forcing the action. The arms are active.

The purpose of this drill is to increase foot speed and reduce the time necessary for recovery and create a tight short lever.



High-Knee Drills

High-knee drills help to teach front-side mechanics while reinforcing casting the foot and also help to condition the hip flexors. These are initially taught at walking speeds, focusing on one leg at a time. To perform the high-knee drill with the right leg, the right ankle will plantarflex as the hips pass over it. As the foot leaves contact with the ground, it should be cast as the right knee is lifted high (parallel to the ground). Keeping the foot cast, place it on the ground slightly in front of the hips so that the outside of the forefoot contacts the ground. The foot should be driven to the ground from the hips. Repeat for the desired distance, and then switch sides. Initially, the arm swing is not emphasized during this drill. However, after the athlete has perfected the hip and ankle motion, the arm swing can be introduced.

Once the above drill is perfected, the athlete can begin to alternate between the two sides. Advanced athletes can perform the drill with a skip.

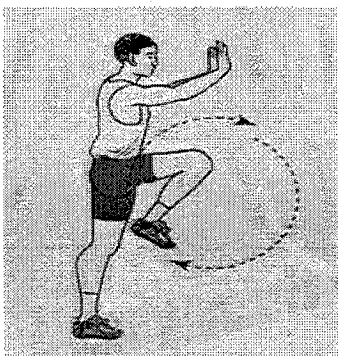
There are two errors commonly seen with this drill. First, an athlete with weak hip flexors and core muscles may have trouble staying tall while performing the drills. This will be seen as they will flex the trunk as they lift the knee. Coaches should emphasize that athletes must "stay tall" while performing these exercises. A second error is that the athletes will lose the cast to their ankle while the foot is brought to the hips.

A very useful introduction to this exercise is to have athletes perform the "Claw".

Claw

Start with the thigh in a parallel position, toe up, ankle cocked (dorsi-flexed) or cast. Always remain on the ball of the foot of the support leg. Drive the leg down as fast as you can and recover it up as quickly as possible. Knee joint remains loose to allow the lower leg to swing out naturally. Ensure the athletes set the correct position after each cycle.

The purpose of this drill is to allow you to break through old patterns of movement and create a new improved leg speed.



"A" Drills or High Knee Lift Marching

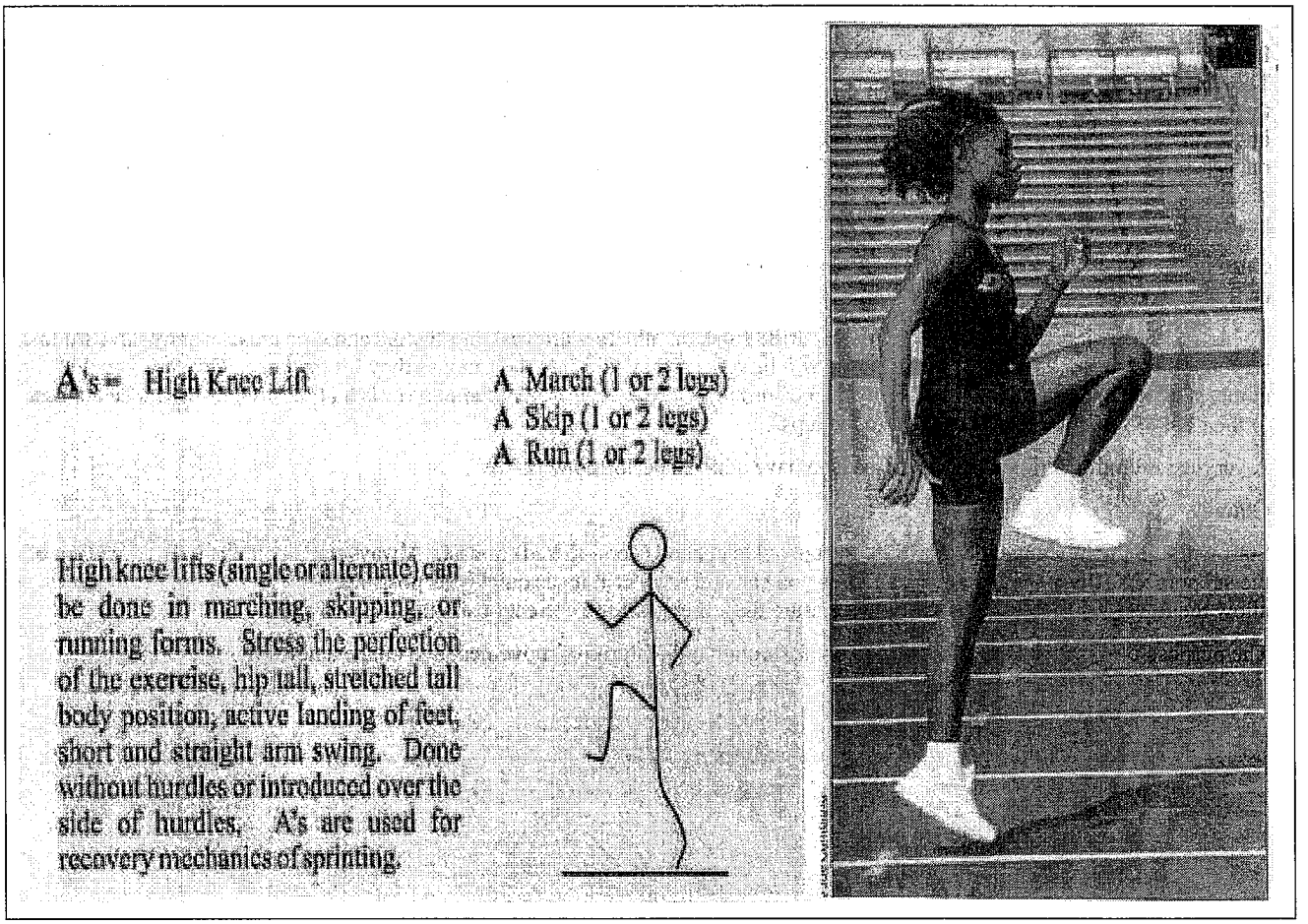
'A' drills combine high-knee drills with heel kicks. McFarlane feels that 'A' drills share many similarities with the sprinting motion (albeit at slower velocities than sprinting) and should be performed extensively in sprint training. Like many of the previous drills, a number of progressions are used for 'A' drills.

Initially, the drill is performed as a walk, focusing on the right leg, the right ankle will plantar-flex as the hips pass over it. As the foot leaves contact with the ground, the foot should be cast and immediately brought to the right hip (as in heel flicks). Keeping the heel in contact with the hip, the right leg should be cycled forward (the athlete should focus on "stepping over the opposite knee"). As the leg is cycled forward, the knee will be lifted high (as in the high-knee drill), and the leg will begin to unfold. From that position, the foot should be driven down from the hips as in the high-knee drills. Repeat for the desired distance, and then switch sides. Arm swing can be integrated into the drill as mastery is achieved.

Once the drill is perfected, the athlete can begin to alternate between the two sides. Advanced athletes will perform the drill with a skip

Marching is done at slow speeds. The athlete drives up high on the ball of the foot and straightens the drive leg. The knee of the lead leg is lifted as high as possible. The body leans slightly forward (not bent from the hips). The head is steady and looking forward. The shoulders are relaxed. There is no head or shoulder rotation. The arms are at 90 degrees at the elbows, working backward and forward and should not come forward higher than the shoulders. The hands are slightly closed.

This is a good teaching drill, producing basic technique in all aspects with good ankle extension, hips driven high, good knee lift, balanced body and head positions and the arms working.



"B" Drills or High Knee Lift Marching with Leg Extension.

'B' drills combine the 'A' drill with an active foot strike. They are an advanced sprinting exercise that teaches how to exert more force against the ground. Like 'A' drills, these exercises are frequently recommended for inclusion in a sprinting programme.

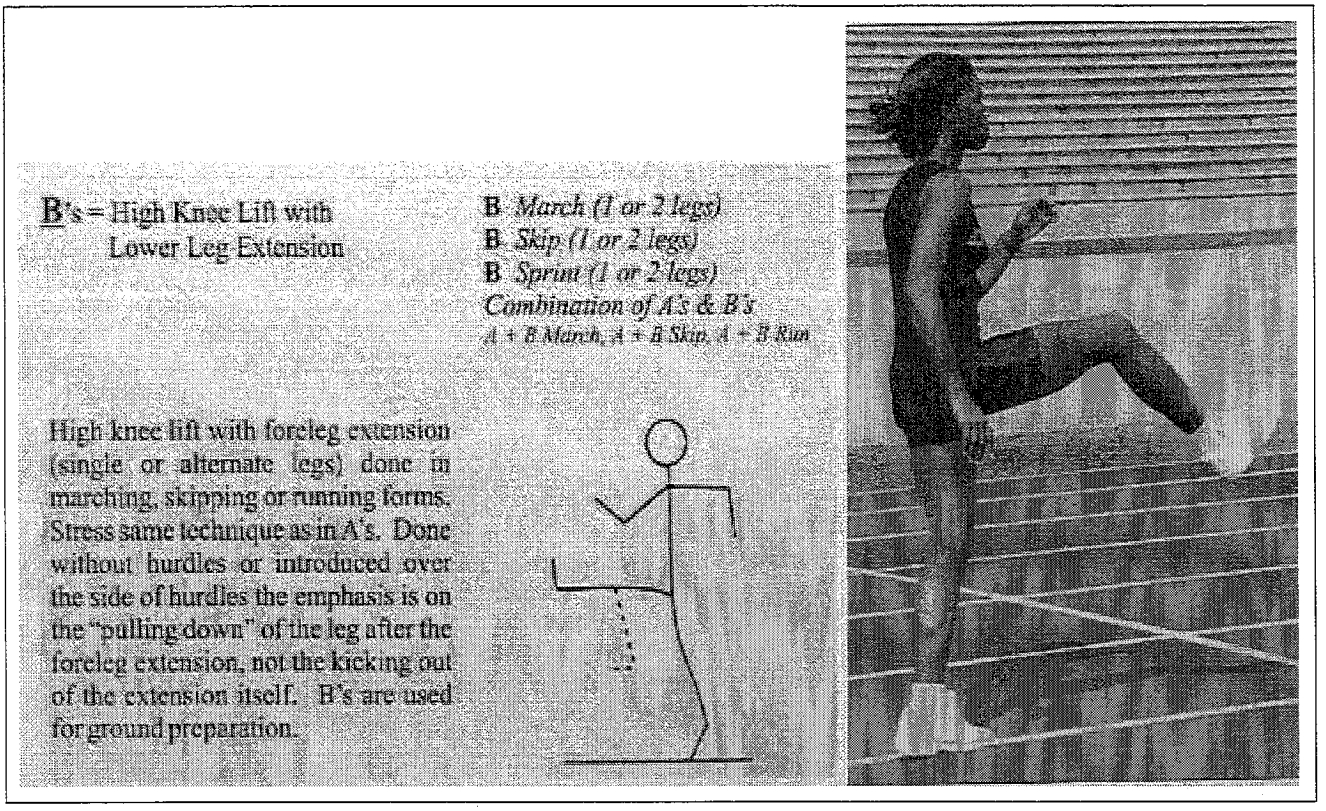
As with many of the drills, this drill is initially performed as a walk focusing on one leg at a time. Basically, the athlete will perform an 'A' drill. However, as the leg is cycled forward, the hamstrings are relaxed. The combination of the relaxation of the hamstrings and the driving forward of the knee will cause the leg to extend at the knee. The extended leg is driven down (from the hips) much like the other drills.

As with the other drills, the athletes can integrate arm motions, alternate between both legs, turn the drills into a skip. Advanced athletes can combine 'A' drills with 'B' drills (e.g. perform 'A' skips with a 'B' skip on the third step).

One of the most frequent errors seen when learning this drill is to lean backwards while extending the knee. This should not be encouraged because, if it is carried over to actual sprinting, it can result in "over-striding", which can cause the athlete to spend more time on the ground and brake while running. Encourage athletes to "stay tall" while performing 'B' drills.

From the high knee lift position of the marching drill the lead leg is extended outward and then brought down to the ground with an increasingly active "leg down" action as the technique of the drill is perfected. The leg extension has a number of benefits. Aside from reinforcing the technique in the marching drill it also:

- Strengthens the hamstrings,
- Is an excellent flexibility exercise which assists in obtaining an improved stride length,
- Places the foot into a position where it can be brought downwards and backwards, thus giving a faster foot action.



The Short Skip

This is really the marching drill in a skipping form, emphasising a faster rhythm. The skip is low to the ground but the knee is lifted high with a complete rear leg extension. Body, head, shoulders, arms and hands are as for the marching drill.

The short skip can also be performed with a leg extension of the leading leg with an active "leg down" action.

Learning Progressions

Normally, ankling and arm drills are learned first. Moderately skilled athletes can progress through many of the arm-swing and ankling progressions in minutes. Once ankling and arms are mastered, heel kicks and high-knee drills are learned simultaneously. Once heel kicks and high-knee drills have been mastered, athletes can progress to 'A' drills. After 'A' drills have been mastered, some athletes may benefit from performing 'B' drills. The following Figure presents a breakdown of various technique drills as well as progressions that may be followed for each category of drill.

Technique Drill progressions	
Types of Drill	**Progressions**
Arm swing drills	1. Seated 2. Standing 3. Walking 4. Jogging
Ankling	1. Walking, one leg 2. Walking, alternating legs 3. Straight leg bounding, one leg 4. Straight leg bounding, alternating legs
Heel kicks	1. Walking, one leg 2. Walking, alternating legs 3. Jogging, one leg 4. Jogging, alternating legs
High knee drills	1. Walking, one leg 2. Walking, alternating legs 3. Skipping, one leg 4. Skipping, alternating legs 5. Running, alternating legs * without then with arms
'A' drills	1. Walking, one leg 2. Walking, alternating legs 3. Skipping, one leg 4. Skipping, alternating legs * without then with arms
'B'drills	1. Walking, one leg 2. Walking, alternating legs 3. Skipping, one leg 4. Skipping, alternating legs 5. 'A' drills + 'B' drills (for example, 'A' drill for 20metres, 'B' drill every 3rd step) * without then with arms

Summary

It is important that the co-ordination drills are performed fast in order to be effective. However, in order to perform the drills correctly they must first be performed slower to ensure correct mastery. As the technique improves, so the drills become faster. Once the drills have been mastered and performed fast, they will give a feedback to the neuromuscular system.

Being able to sprint fast is extremely important. While many factors may be trained to help sprinting speed, technique is one of the most trainable and one of the most important. Solid technique will result in a faster, more efficient sprinter. Poor technique will limit an athlete's speed. To help an athlete master the skill, the sprinting motion is broken down into drills that train parts of the motion. Drills simplify a complicated skill, helping with mastery. They may also serve as warm up and conditioning exercises.

Practice makes perfect only if practised perfectly. To practice skills incorrectly is to rehearse them perfectly wrong....and to get really good at it. Athletes can only sprint as fast as technique allows, and the technique must be based on a sound Basic Technical Model