Sprint Mechanics
All sprinters need to understand and develop solid running mechanics that allow them to use their
talent to the fullest. Good running form is the foundation of track and field.

Body Mechanics While Sprinting
The primary areas that the sprinter needs to focus on are stride length, stride frequency, head
position, arm carriage, leg movement, foot plant, foot action, and pelvic alignment:

Stride Length and Frequency: A predominance of fast-twitch muscle fibers is essential for top-level
sprinting. A combination of optimal leg power, stride length, and stride frequency produces the best
sprinting times. Power, good reactions, and excellent flexibility are all essential. Stride length
depends on hip flexibility, leg length, muscle power, and range of movement. Training optimizes the
forward thrust that occurs at each stride. Training also brings more muscle fibers into action and
teaches the sprinter to relax opposing muscle groups. Leg drive is improved by related power
training.

Leg Movement: A powerful leg extension via the hip, knee, and ankle joints provides the athlete with
optimal thrust in the direction of the sprint. Thrust backward and downward at 50-55 degrees
produces an equal and opposite reaction from the earth, which drives the athlete in a predominantly
horizontal direction along the track. Flexion of the legs reduces their rotational inertia and makes
their recovery and forward movement easier for the muscles involved. After thrusting backward and
downward, the driving leg flexes at the knee and is brought directly forward and upward so that the
thigh swings to just below horizontal. The swing and upward thrust of the driving leg as it is brought
forward is counterbalanced by the action of the opposing arm. Forward thrust of both arm and leg
generates momentum transfer. This helps produce a greater thrust back at the earth with the driving
leg, and in response, from the earth propelling the sprinter’s body along the track. When the
sprinter’s driving leg is recovered and becomes the supporting leg, it flexes slightly on landing. This
flexion extends the time on impact that force is applied to the sprinter’s body and so cushions the
landing. Flexion stretches the leg muscles, ready to extend the driving leg backward and downward
against the earth. When the supporting foot lands vertically below the sprinter’s center of gravity,
it eliminates deceleration that would occur if the foot was placed ahead of the sprinter’s center of
gravity.

Head Position: The head should remain in neutral position, with thin chin level and the jaw relaxed.
The sprinter’s head is held in a natural alignment with the torso. Vision is horizontal and directly
ahead. The proper position of the head and vision assists in maintaining the stability of the sprinter’s
torso. Tilting the head back increases tension and restricts stride frequency and stride length. There
should be no horizontal or vertical movements.

Arm Carriage: The arms should maintain a 90-degree angle at the elbow throughout the forward
upswing as well as the backward backswing. They should not elongate or shorten. The hands
should be relaxed and swing hip high to the rear and shoulder high in front. The forward and
backward arm swing counter balances the twisting motion produced by each leg thrust on either side
of the sprinter’s long axis. Flexing the arms at the elbows reduces their rotary inertia and makes their
pendular movement easier for the muscles involved. A vigorous forward swing of each arm transfers
momentum to the sprinters body as a whole. This adds to the sprinter’s leg thrust and helps drive the
athlete forward. Forward and backward arm swing parallel to the direction of sprint (rather than
across the body) helps hold the torso and the shoulder girdle steady. This aids balance and
relaxation and assures that the sprinter runs a straight line toward the finish. Flexibility in the
shoulder girdle promotes good arm swing.

Foot Plant: The foot should always be in a toe-up/heel-down position to allow for the clawing effect.
This plant helps prevent a breaking effect that results when the toe is pointed downward during running. By keeping the toe up and the heel down during the recovery of the stride, the length of the lever is shortened, resulting in the fast motion.

Foot Action: The clawing action that results from a toe-up/heel-down foot plant is critical. As the foot strikes the ground during the plant, the sprinter should hear a scraping sound on the ground. The heel-down aspect assists in the foot plant, but it is also important in the recovery of the run. The fist contact of the foot with the ground is on the outside edge of the foot. The heel is lowered but does not contact the track.

Pelvic alignment: To assist with the lower body action, the pelvis should be tilted in an upward direction. Flexibility in the hip and pelvic area is particularly important. An ability to rotate the hips around the long axis of the body helps produce an optimal stride frequency and stride length.

**Inertia**

Think of inertia as an enemy when an athlete wants to get moving. To defeat this enemy, it’s good if the sprinter’s mass is made up of powerful muscles that are able to generate the required amount of force. Once on the move, inertia can become a sprinter’s friend because the mass wants to keep the sprinter going. The difference between resisting inertia and moving inertia causes sprinters to expend much more energy at the start of the race than when sprinting in the middle of the race. Sprinters use short quick strides as they accelerate from the start. Once moving at high speed, they reduce their stride rate but each stride is longer. Because great force applied quickly and repeatedly over a short distance, or a short range of motion, is the most efficient way of overcoming inertia. It’s the best way for a sprinter to accelerate and get up to top speed as quickly as possible.
Unfortunately, a high stroke or stride rate burns up a lot of energy and, although efficient when accelerating, is inefficient once moving at high velocity. Once up to speed, sprinters reduce their stride rate and extend more fully with each leg trust. So even though stride rate and stroke rate may be reduced, great force is applied over an increased range of motion at a lower cadence. This “change-down” in cadence helps the sprinters maintain their velocity without running out of energy.

**Speed and Acceleration**

If a sprinter runs 100m in 10sec, we know that the athlete has run a certain distance in a certain time. From this information you can work out the sprinter’s average speed, which is 22.36 mph, or 36 km/hr, (Note: 22.36 mph = 10.9 yd/sec). These numbers don’t tell you the sprinter’s top speed, (which could be as high as 26 mph), and they don’t tell you anything about the sprinter’s acceleration or deceleration, which is the rate that speed changes. Immediately after the starter’s gun goes off, the athlete is gaining speed and for a while runs much slower the 22.36 mph. The sprinter then has to run faster somewhere else in the race to average 22.36 mph over the whole distance. Rates of acceleration vary dramatically from one sprinter to another. Some sprinters rocket out of the blocks and have tremendous acceleration over the first 40m of a 100m race. Thereafter their rate of acceleration drops off, and close to the tape they may even decelerate. A strong sprinter that is in extreme shape may have an acceleration less than his/her opponents at the start of the race, but his/her acceleration continues longer into the last 30m, catching up and passing the athletes who were “tying up” (i.e. breaking proper form because of fatigue), and decelerating. Note: It’s also possible for athletes to reduce their rate of acceleration and still increase speed due to fatigue.

**Newton’s Laws at the Sprint Start**

In a sprint start, sprinters aim to get out of the blocks as fast as possible. After the issue of “on your marks” command, each sprinter is positioned in the blocks with the body weight resting equally on the rear knee and the hands. Arms are shoulder-width apart, and the hands are just to the rear of the
line. The fingers and thumb form a V. Shoulders are rotated forward, 7-8 cm ahead of the hands. The sprinter's stronger leg normally drives from the front block, because contact with block is longer. The forward foot on the blocks is commonly 2 of the athlete's foot lengths from the starting line. The rear foot on the blocks is usually 1 ⅛ of the athlete's foot length behind the front foot. On the "set" command, they shift their line of gravity forward so that it is very close to their hand positions on the track. The athlete's seat is raised up and moved forward so that the angle of the leading leg is approximately 80-90 degrees at the knee. The rear leg is 110-130 degrees at the knee. This highly unstable position satisfies two requirements. It extends the sprinters' legs into a powerful thrusting stance. Second, prior to the start, it moves the athletes as far as possible in the desired direction—toward the finish line. In this set position, the athlete is like a coiled spring. The athlete's back and head for a straight line. Vision is forward and toward the ground. The athlete holds the shoulders in a position that is slightly ahead of the vertical plane of the hands. On the set command, the athlete inhales and holds the breath. Most sprinters use one of three basic block positions. These positions vary in the distance between the front and rear block and in the distance that the blocks are set from the line. The different block positions depend upon the athlete's body length, leg length, leg power, and coordination. The elongated start position is frequently used by athletes with long legs. The bunched or bullet start position is used by athletes with shorter legs. The most common used stance is the medium start. When exploding out of the blocks, the force that the sprinter applies against the blocks is the action. The reaction (the push back) comes from the earth pushing equally and in the opposite direction by way of the blocks against the sprinter. The force produced by the sprinter's muscles overcomes the inertia of the athlete's mass and the sprinter begins to accelerate. The acceleration of any sprinter's body mass is proportional to how much muscular force the athlete applies and the time frame in which the force is applied. It is also inversely proportional to the athlete’s mass. This means that if two sprinters apply the same muscular force to their bodies for the same amount of time, the less massive of the two athletes accelerates more. Likewise, if two sprinters have the same mass and apply force for the same amount of time, the athlete who applies more force within that time frame will accelerate more. (Note: When exploding out of the blocks, a sprinter should work their arms and legs as vigorously as possible to drive themselves 4 or 5 strides forward out of the set position. A sprinter shouldn't lift his/her head upward or jump straight up at the explosive stage). In the longer sprints, the athletes start on a curve. They need to adjust the starting block so that the outside hand is just behind the line and the inside hand is about four inches behind the line. Once the gun is fired, the athlete runs to a point on the inside of the curve, leaving the blocks in a straight line. The left shoulder should lean in slightly, and the right arm should just drive across the midline of the torso. As the runner comes out of the curve, he or she must not float to the outside of the lane but must instead maintain the line established in the turn.
**Centrifugal Force on the Curve**

Keep in mind that there is a battle between inertia, (a pull towards the outside), and centripetal force, (friction towards the inside), for a sprinter rounding the curve in a 200m or 400m sprint. Compared with running on a straightaway where all the sprinter’s effort can be spent driving toward the tape, running a curve makes the athlete spend some precious energy thrusting outward to get around the curves. An indoor banked track pushes the athlete inward, allowing the sprinters to run flat out without fearing that their inertia will cause them to fly off the track or lane. Outdoor tracks are not normally banked, so the tight inside lanes can be difficult to negotiate and have a slight disadvantage. This is particularly the case for heavier sprinters who have more inertia and must push outward more vigorously to get their extra body mass around the curve. A sprinter should lean inward as he/she sprint around the curve and swing their right arm more powerfully than the left.

**Relative Motion to Airflow**

Suppose a sprinter is sprinting at 20 mph into a headwind of 5 mph. The athlete move on direction at 20 mph and airflow is in the opposite direction at 5 mph. The relative velocity of airflow past the athlete in this situation is 25 mph. Suppose a sprinter is sprinting at 20mph but with a tailwind of 5 mph. The relative velocity of airflow past the athlete is now 15 mph. Suppose a sprinter is sprinting at 20 mph but with a tailwind of 20 mph. The relative velocity of airflow past the athlete in this situation is zero, because both athlete and airflow are traveling in the same direction at the same velocity. In these three examples, the frictional forces acting on the sprinter occur maximally in the first case and minimally in the third case. Friction-reducing running tights and slick body suits help minimize drag from the air. Headwind add to the sprinter’s fight against air resistance.

**Center of Gravity of the Sprinter**

A sprinter’s body should rise and fall very little when running at full speed. A sprinter’s center of gravity follows a low wavelike pattern as it travel forward. Slightly more time is spent in the air than in a support position. Too much time in the air is time wasted and indicates that too much thrust is directed in a vertical direction. The forward thrust of friction only applies while the sprinter is on the ground.

**Relax with Impulse**

Good sprinting combines power with relaxation. Face, neck, shoulders and hands are relaxed. Tension in the body reduces the velocity of muscle contraction and reduces sprinting velocity. Good sprinting requires a rapid change from muscle contraction to relaxation. A technically superior sprinter is mechanically efficient. Unnecessary tension needs to be avoided, and in this way the sprinter uses energy efficiently.

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**Finish with a Lean**

An athlete should sprint through the finish tape as though the finish is at the second line. Sprinters
should try pushing their chests forward at the tape. When practicing a lean, a sprinter should drive the chest ahead of his/her arms and lean toward the tape when approximately one full stride away. Don't jump at the tape or lean too early, or the athlete will stumble.