

# The high jump

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### Introduction

**T**he purpose of this paper is to provide an overview of the main aspects and discussion points of the high jump as a general guide and as a starting point for further study. The topics covered are:

- history,
- development of high jump technique from the Eastern style to the Straddle,
- the Fosbury Flop,
- teaching the Fosbury Flop,
- training for the high jump,
- a model high-jump training programme,
- high jump psychology.

### History

The high jump has been contested since the Olympic Games of ancient Greece and the first recorded high jump event in modern times took place in Scotland in the 19th century. Early jumpers used either an elaborate straight-on approach or a scissors technique from a diagonal approach. Around the turn of the 20th century, techniques began to modernise, starting with the so-called Eastern Cut-off, which was followed by the even more efficient Western Roll. This technique predominated through the Berlin Olympics of 1936, where the event was won by Cornelius Johnson (USA) with a jump of 2.03m.

American and Soviet jumpers dominated the high jump scene for the next four decades, and they led the evolution of the Straddle technique. Straddle jumpers rotated their (belly-down) torso around the bar, obtaining the most economical clearance up to that time. The first straddler to achieve a world record was Dave Albritton (USA), who cleared 2.07m in 1936. Charles Dumas (USA) broke the 7-foot (2.13m) barrier in 1956, and John Thomas (USA) pushed the world mark to 2.23m in 1960. By 1960, 99% of high jumpers were straddlers.

By radically increasing the tempo of his approach run, Valeriy Brumel (URS) took the record up to 2.28m, and won the Olympic gold medal in 1964. Brumel was physically very strong, which is a prerequisite for a good straddler. However, most of the young jumpers who emulated Brumel did not have the same leg strength, and injuries to the knee became frequent (JACOBY & FRALEY, 1995).

The limits of the Straddle technique having been clearly set, the back-layout technique came along in the late 1960s, pioneered most notably by Dick Fosbury (USA). Taking advantage of the raised, softer landing areas by then in use, Fosbury directed himself over the bar head and shoulders first, sliding over on his back and landing in a fashion that would likely have broken his neck in the old, sawdust landing pits. By “backing” over the bar to an Olympic gold medal in Mexico City in 1968, Fosbury triggered a major revolution in the event. His technique began to spread around the world, and soon floppers were dominating international competitions. The last straddler to set a world record was Vladimir Yashchenko (URS), who cleared 2.33m in 1977 and then 2.35m indoors in 1978.

The current world records in the high jump are men: 2.45m by Javier Sotomeyor (CUB) and women: 2.09m by Stefka Kostadinova (BUL) (see Table 1).

*Table 1: Recent world record progression in the high jump*

**Men**

1985 – Igor Paklin (URS)	2.41m
1985 – Igor Paklin (URS)	2.41m
1987 – Patrik Sjöberg (SWE)	2.42m
1988 – Carlo Thränhardt (FRG)	2.42m
1988 – Javier Sotomayor (CUB)	2.43m
1989 – Javier Sotomayor (CUB)	2.44m
1993 – Javier Sotomayor (CUB)	2.45m

**Women**

1984 – Tamara Bykova (URS)	2.05m
1984 – Lyudmila Andonova (BUL)	2.07m
1986 – Stefka Kostadinova (BUL)	2.07m
1986 – Stefka Kostadinova (BUL)	2.08m
1987 – Stefka Kostadinova (BUL)	2.09m

**Development of high jump technique from the Eastern style to the Straddle**

*The approach run*

Prior to about 1940, most jumpers favouring a faster run performed some variation of the Eastern style, with its outside-foot take-off and forceful swing-up of the inside leg. The Irish-American Mike Sweeney, who set a world record by clearing 1.97m in 1895, was the first jumper to achieve a full layout from an outside-foot take-off:

“Sweeney started his run in the middle of the runway (about 15 feet back), and swung slowly towards the right edge of the cinder track, turning sharply to the left at an exactly fixed point. He then took three strides as rapidly and with as much force as he could compel. This brings his left foot on the takeoff, and gives his body a sort of twist that aids greatly in getting over the bar.” (Harper’s Round Table, 1896)

Clint Larson, who jumped 2.02 m in 1917, made an even greater use of speed in the run

and described his variation of the Eastern style as a “face-upward, back-to-the-bar position.” (LARSON, 1926)

The emphasis on a forceful approach run gradually faded as the Eastern style lost favour (DOHERTY, 2007). The Western roll and its variations had, unlike the Eastern style, a built-in tendency to slow the run in an attempt to ensure a maximum spring and efficient clearance style. George Horine (USA), who is credited with inventing this technique, used it to increase the world record to 2.01m in 1912. He approached the bar on a diagonal, but used his inner leg for the take-off while he thrust his outer leg up to lead the body sideways over the bar. He described his approach to the bar as “a short preliminary run – actually a walk – except for the last three or four steps” (HORINE, 1926).

Unlike Horine, who never measured his run or marked his take-off, Harold Osborne (USA), who cleared 2.03m in 1924 with his own back-to-the-bar version of the Western Roll, was very exact in his way of running:

“I measure my approach with a great deal of care, allowing 24 feet between my takeoff and first check mark, and 12 feet to the second mark. I take three steps to the middle mark and four more to the takeoff – about three feet from the crossbar. I approach from an angle of about 45 degrees and use a long easy bounding step, a little faster than a dog trot. On the last step I settle for the spring, then swing the outward leg up and over the bar with considerable force.” (OSBONE, 1926)

Straddle-style jumpers initially followed the minimal speeds in the approach as established by Horine and Osborne. However, this changed with the arrival of Lester Steers (USA), who jumped 2.10m and then 2.11m in 1941. Although Steers said that he ran without any special emphasis on speed, he actually ran much faster than his contemporaries.

In 1956, the Olympic champion, Charles Dumas (USA), who was the first man ever to clear seven feet (2.13m), reduced the run to its minimal values again. From an angle of 43°, he took eight strides to the take-off, almost walking the first few and accelerating rapidly only on the last three, much as Osborne had done in 1924.

The conscious use of the modern longer and faster approach runs probably originated with the great Swedish jumpers of the 1950s. For example, Bengt Nilsson, who cleared 2.11m in 1954, used a 13-stride approach in which he accelerated through the last seven or eight steps to produce greater force at take-off (DOHERTY, 2007).

All aspects of the Straddle were most perfectly developed by Brumel, who after having raised the world record from 2.13m to 2.27m (1962) in less than one and a half years cleared 2.28m in 1963. Perhaps Brumel's greatest contribution was that he contrived the means for making a fast run of practical use in increasing upward force. He took seven strides plus three or four preliminary steps, with full acceleration on the first stride beyond his check mark, a total run of 50 feet (15m). Brumel's coach, Valdimir Dyatchkov, reported that Brumel's speed at the next to last stride was over 25 km/h.

### *Bar clearance*

DOHERTY (2007) distinguishes nine bar-clearance techniques and, except for the first, the athlete credited with pioneering each:

1. Scissors
2. Modified Scissors (Page, 1987)
3. Eastern Cut-off (Sweeney, 1895)
4. Eastern Trail-leg Shift (Oler, 1914)
5. Eastern Back-to-the-bar (Larson, 1917)
6. Western Roll (Horine, 1912)
7. Straddle (Stewart, 1930)
8. Dive-Straddle (Cruter, 1938)
9. Flop (Fosbury, 1968)

While in the scissors first the inside leg is swung upward and then the outward leg up

and over the bar, the modified scissors is characterised by a slightly backward layout. Sweeney changed this technique used by fellow American W. Byrd Page by reducing the high throw of the second and pulling it under the lead leg (the cut-off) and landing on it.

Sweeney's technique was improved by another American, Wesley Oler, who in his Eastern trail-leg shift whipped the almost straight take-off leg as high and forcefully as possible while twisting the shoulders down and in the opposite direction, then brought it down quickly for the landing.

Throughout the 1930s, almost all the jumpers in the Eastern states and in other countries of the world used the Eastern style. Even as late as in 1948, John Winter (AUS) used the Eastern style in winning the Olympic title in London

Larson's face-up, back-to-the-bar style can be regarded as a variation of the Eastern style. This technique can also be seen as the predecessor of the flop technique. In fact, Fosbury initially used the Scissors style with a body angle of 45° to the crossbar and by laying out more and more he ultimately crossed the bar flat on his back. Only by his senior year at university had he rotated to the full 90 degrees during clearance (DOHERTY, 2007).

However, this was a later development. The immediate successor of the Eastern style high jump was Horine's Western Roll. Horine took off from the inside foot and cleared the bar in a side-to-the-bar position, and landing on the take-off foot.

The belly roll was first successfully used in major competitions by Jim Stewart (USA). The changeover from the roll to the straddle also took place gradually. Most roll-style jumpers felt that the Straddle created a tendency to dive and so lose vertical force during the take-off. Therefore, they continued to practice the roll and in competition shifted to the Straddle only at the highest heights.

Although the first high jumper to use a Dive-Straddle was Gil Cruter in 1938, this style of high jumping was perfected in Sweden. Between 1952 and 1961, at least four Swedish jumpers (Svensson, Dahl, Nilsson and Petterson) all used a pronounced dive while attempting world record heights. DOHERTY (2007) points out that they also introduced two important innovations:

1. A longer, faster and more forceful approach run.
2. The two-arm thrust along with a flexed lead leg to convert the running force upward.

### The Fosbury Flop

Almost all serious high jumpers now use one of the versions of the Fosbury Flop technique. HUMPHREY & NORDQUIST (2000) give the following reasons for its popularity and success:

- it enables high jumpers to utilise the speed that can be generated in the curved approach run to a greater extent than the straddle technique;
- it allows the rotations developed in the take-off to be used to the jumper's advantage;
- it enables an easy and efficient bar clearance;
- it can be mastered with relative ease for early success.

In the following sections the elements of the technique are examined.

#### Approach

In the beginning, Fosbury did not produce a lot of speed because he used a constantly curved approach of eight strides. Although this approach allowed him to lean away from the bar and be vertical at the instant of take-off it prevented him from achieving consistency of momentum from one jump to another or from one facility to another (JACOBY & FRALEY, 1995).

HUMPHREY & NORDQUIST (2000) emphasise that consistency in running mechanics, stride length and frequency, the shape of the curve, and the acceleration pattern is one of the most important aspects of the approach. The touchdown foot, too, should be in the same place in relationship to the near standard every time.

In order to achieve a higher velocity and consistency of the approach, the constantly curved approach run was replaced by the so-called "J" approach. All flop-style jumpers now use this approach, as it allows them to run at greater speeds than those used in the Western or Straddle styles. However, the primary advantage of the "J" approach is that it has a constant, predetermined pattern starting a specific distance measured out from the standard. In addition, momentum is easily established during the straight portion of the run, so acceleration should definitely occur (JACOBY & FRALEY, 1995).

For the approach to be consistent, even the first step must be so. If this step is a solid, deliberate, upright, and powerful running stride, it will set up a dynamic pattern of stretch reflexes in the muscles, which allows for more powerful contractions, and thus a more forceful take-off.

The last four steps in the approach are on a curve, which, if properly run, enables the following:

- it increases the force that the athlete applies on the ground;
- it helps the athlete to lower the body's centre of mass (CM) prior to the jump;
- it generates rotations through the jumper's body, which assist with proper bar clearance;
- it allows the jumper to jump vertically and still land safely in the pit.

The total length of the approach is usually eight to 12 running strides. Although a ten stride approach is probably the average, the approach can be as short as seven strides, with a run-in, or as long as twelve strides from a standing start.

Phase one of the approach starts with the first three or four strides in a straight line, followed by a three to four stride transition to the last four strides, which curve gradually toward the near standard. The transition from the straight to the curve should be smooth. Any cutting, stepping out, or other improper transition into the curve effectively eliminates much of the curve, as well as its associated benefits. Most high jumpers touch down on the fifth step with the right foot turned inward slightly. The curve then is initiated on the sixth stride.

The smooth transition into the curve is dependent on two prerequisites: momentum and anticipation. Jumpers who fail to develop momentum during the first few strides of the approach often use the transition as a chance to compensate, usually by cutting and pushing hard off the fifth stride. The fact that they develop momentum late leads to poor jumping postures. The slight turning in of the fifth step is a result of a slight turning of the pelvis, which can only be accomplished by modifying the push-off from the previous stride. This means that the jumper must initiate the curve as early as in the fourth stride. Waiting until the fifth stride to initiate the curve will result in failure to perform these early modifications. These must be anticipated early in the approach to be performed correctly. Since anticipation and early initiation of the curve are so important, it is questionable whether placing a checkmark at the location of curve initiation is useful. According to SCHEXNAYDER (1994), cues formed to teach the transition into the curve should be anticipatory in nature.

When running the curve an inward body lean is developed. The degree of inward lean is dependent on the approach velocity and can be greater than 30° (TIDOW, 1993). The outside arm works somewhat across the body, and the inside arm drives backward a bit further than before in opposition. Most importantly, the feet must be applying the force outwardly (as opposed to a downward direction) as the body assumes its inward

lean. Another important consideration is elastic energy conservation. That is why oscillations of the hip axis in the transverse plane and free elastic movements must continue as the curve is initiated and run. On the other hand, actions like tightening up, drawing the arms into the sides, and assuming sitting postures greatly inhibit the creation of stretch-shortening cycles in the spinal, pelvic and shoulder musculature. The results would be inefficient take-offs and difficulty in presenting the back to the bar (SCHEXNAYDER, 1994).

Once into the curve, the jumper should find the top of the far standard. This will provide an erect object by which body lean may be gauged and the location of the crossbar may be cognitively established early so that clearance movements can be efficiently performed.

SCHEXNAYDER (1994) recommends that the approach should be laid out so that the tangent to the curve at the point of take-off is roughly in the direction of the far back corner of the pit. This ensures that the jumper will not travel too far along the bar but will have adequate time to execute clearance movements.

An effective transition to the take-off, i. e. one that causes little or no slowing, is dependent on the development of adequate speed to lower the CM so the hips can be redirected from horizontal to vertical. Analysis of many high jumpers shows the take-off angle to be around 48° for the good jumpers and 52° for the really great ones.

A low hip position without slowing is enabled by two factors:

1. During the penultimate step, flexion of the knee and ankle occurs. Foot contact must be directly under the hips and not out in front. The good penultimate stride is initiated by an incomplete leg push off the third stride out from take-off. During this foot strike, ground contact is flatter than normal. The result is a subtle lowering of the hips but without any slowing.

2. The athlete's lateral lean naturally causes the hips to lower with no undue slowing. The greater the lateral lean, the lower the hip position, creating more time to impart vertical impulse at take-off.

According to JACOBY & FRALEY (1995), the most important factor in high jumping is leg loading. The stretch reflex should be caused to occur over the shortest possible time. This means as little knee flexion as possible and a solid flat-footed take-off with the CM (hips) slightly behind the take-off foot. The arm motions and the foot strike of the free leg should take place simultaneously with the extension of the take-off leg. This timing of the free-moving limbs transfers additional force into the ground and, due to the action-reaction principle, the ground returns equal force back into the jumper's hips.

HUMPHREY & NORDQUIST (2000) recommend the touchdown, or plant, to occur at the near standard to provide a solid, visible, and consistent landmark for the placement of the touchdown foot.

From the beginning of the run until take-off, there should be a constant acceleration. Stride frequency must increase constantly up to and through the take-off phase of the jump while stride length should gradually progress through the penultimate stride. The longer stride allows the jumper to begin making the transition from horizontal to vertical velocity. Here, the jumper's goal must be to develop maximum vertical velocity without losing velocity in the horizontal direction.

### **Take-off**

When projected into flight, the high jumper's CM follows a predetermined, predictable, and unalterable parabolic curve. Thus, establishment of the proper flight path is totally dependent upon proper force application during ground contact (SCHEXNAYDER, 1994).

The maximum height of the jumper's CM has also been determined once the jumper

has left the ground. Therefore, the isolation of the touchdown in preparation for the take-off is quite important. The foot should touch down about 90cm outside the near standard at an angle of approximately 30° to the plane at the uprights (TIDOW, 1993).

If the jumper is in proper position at touchdown, he or she will be able to efficiently transfer this horizontal velocity to vertical velocity. This speed conversion is where the Flop has the advantage over the other styles. Basically, the faster a Flop jumper can run and transfer that speed, the higher he or she will jump. The horizontal velocity is converted to vertical velocity by body lean. There are actually two angular components to the proper lean at touchdown: backward lean and inward lean. Lean creates the three rotational forces at the take-off, which move the body around its CM once the jumper has left the ground:

1. The first rotation is the result of the backward lean (into the centre of the curve and away from the bar). This backward lean component happens naturally and creates a forward somersaulting rotation.
2. The second component of the lean is the inward lean, which is the result of running the proper curve and creates a lateral somersaulting motion. The inward lean allows the athlete to jump straight up and not into the bar. It also brings about the forces that allow the body to rotate over the bar.
3. The third rotation is the transverse rotation, which is caused by the blocking action of the jumper's knee and helps the jumper to get his or her back to the bar.

When these three rotations – forward somersaulting, lateral somersaulting, and transverse – are combined, the result is the jumper's resultant rotation over the bar.

In order to jump vertically, the jumper's CM must be directly over the touchdown foot at

the point of take-off. This means that at the start of the take-off phase the CM should be behind and inside the approach circle. This allows the CM to continue directly over the foot to the take-off point, allowing the jumper to jump vertically. Without the lean, the CM would pass by the vertical take-off position, causing the jumper to jump into the bar. The jumper who stays in the curve and hits the vertical at take-off will get the maximum height over the bar, and still land safely in the pit.

The use of the arms and free leg is also an important aspect of the take-off phase. These three limbs combined produce the so-called blocking action, which is a stopping of one or more body parts to accelerate another. The more efficient and aggressive the block, the more force is applied and the higher is the jump.

The free leg should move through as fast and as high as possible. The thigh should finish parallel to the bar. The knee should not be driven across the body to rotate the back to the bar because enough transverse rotation has already been created by running the curve properly and moving the free leg from behind and inside the touchdown foot in a circular path around the touchdown leg.

The arms can be used in two ways to bring about the blocking action. In the double-arm block, at the touchdown both arms are as far back as possible and move through together and stop abruptly, with the forearm at shoulder level and the hands high. Getting the arms back with a minimum amount of effort and disruption to the approach is important. There are two effective methods of achieving this:

1. The least disruptive but not so powerful way is to keep the inside arm (the left arm for the left-footed jumper) moving normally throughout the approach and hold the outside arm (the right arm for the left-footed jumper) back on the penultimate step.
2. The more dynamic but most disruptive method of getting both arms back is the

“swim” method. Here, the arms are both together in front of the body on the penultimate step then they are pulled back together in preparation for take-off, similar to the breaststroke.

With the single-arm block, the arms do not stop moving throughout the approach. On the penultimate step, the inside arm is forward and stays forward reaching high as the outward arm continuing forward through the take-off. The advantage of this method is that there is no change in the approach-running mechanics, which makes it easier to maintain the approach acceleration through the take-off. However, the disadvantage is that the inside arm is usually stretched out toward the bar, causing the athlete to miss the vertical take-off position and to jump into the bar. According to TIDOW (1993), the dynamic double arm swing is most effective with regard to transfer of momentum.

HUMPHREY & NORDQUIST (2000) hold that during the take-off the shoulders should be at least at a right angle to the bar but better turned slightly away, showing the back to the bar slightly. This will not only help the jumper to attain a vertical position at the take-off but it will also aid in the rotation over the bar.

#### *Bar clearance*

Since the flight path of the jumper's CM has already been determined once he or she has left the ground, the body's rotations around the CM can only be influenced by moving the limbs. Shortening the levers, i. e., moving the arms and legs closer to the CM, will speed up the rotation and lengthening the levers, i. e., moving the arms and legs away from the CM, will slow down the rotation.

TIDOW (1993) holds that by an optimal positioning of body segments and simultaneous shifting of partial masses on both sides of the bar it is, at least theoretically, possible to have the CM “sail through” below the level of the bar.

As the jumper leaves the ground, the take-off leg is kept low, and the blocking knee stays up. The head is balanced on the shoulders and not tilted into the bar to avoid a drop of the shoulder and hip on that side.

The head and back should pass the bar first, with the back flat to the bar and the shoulders approaching parallel to the bar. Again the head should be balanced on the shoulders, looking up.

Immediately after having passed the bar, the shoulders should be lowered ("Head back!"), causing the hips and buttocks to rise as they approach the bar. The result of this movement is the arch over the bar. During this phase the rotation must be the fastest, so the jumper should keep his or her feet as close to the buttocks as possible and his or her arms at the side. This combination of the short-lever, tight-body position (arch) and the rotation generated through the take-off phase will allow the jumper's hips to rise sufficiently to clear the bar. If the athlete has the proper rotation, the hips will continue to rise as the athlete clears the bar.

As the hips clear the bar, the hamstrings must be raised, which is done by lowering the hips. The athlete should bring his or her chin to the chest, thus lowering the hips and so raising the hamstrings. This will simultaneously raise the knees, putting them in the proper position to clear the feet. With the knees up, straightening the legs will clear the feet. As the athlete continues to descend toward the pit, the rotation is slowed by keeping the legs straight and extending the arms from the body (HUMPHREY & NORDQUIST, 2000)

If the take-off spot has been correct and if the rotation about the longitudinal axis is sufficient, the longitudinal axis of the body is at a right angle to the plane of the uprights during the landing, which takes place near the upright farthest away from the take-off. The upper part of the back and the arms, which are spread at both sides, of the body, hits the landing mat first.

In order to avoid injuries to the face, the "landing" angle at the hips should be maintained during this process. Parting the legs at the moment of landing is another method that helps to avoid injuries that might be caused by the "follow through" of the legs or knees (TIDOW, 1993).

### *The speed and the power flop*

Keeping in mind the principle that power equals strength x velocity, power floggers tend to emphasise the strength factor in their approach to jumping whereas speed floggers focus on the velocity factor. According to OZOLIN (1981), in the power-oriented jump the take-off leg is placed further forward and the angle of backward body lean is increased. This puts a much greater load on the muscles of the support leg and usually requires a greater bending of the leg. The muscles have to be very strong in order to complete the take-off effectively.

In the speed-oriented flop, which OZOLIN considers more efficient, horizontal speed must provide sufficient kinetic energy to the take-off leg to react in the shortest possible time and with optimal effect. To achieve this, the foot cannot be as far forward, the backward body lean must be less, the support leg less bent, and the take-off phase shorter.

REID (1984) listed the significant differences between the speed and the power flop (see TABLE 2).

### **Teaching the Fosbury Flop**

A model teaching sequence for the flop high jump is presented by BOURNE (1992):

#### *Step 1: Bent leg scissors*

With appropriate curves and run-ups marked on the ground and the take-off safety markers in place, the athletes run in from a six-stride approach and jump onto the mats (no bar at this stage), using a scissors technique which is modified with the lead leg being bent to at least 90° at the knee.

Table 2: Characteristics of the Speed and Power flop techniques

Speed flop	Power flop
Approx. approach velocity of 7.7-8.4 m/sec	Approx. approach velocity of 7.0-8.0 m/sec
Approx. approach length of 8-9 strides	Approx. approach length of 10-12 strides
Approx. take-off time of 0.13-0.18 sec	Approx. take-off time of 0.17-0.21 sec
Approach run on the toes until last (plant) step	First half of the approach on toes, second half flat-footed and even on heels, incl. plant
Usually controlled, fast, single arm action in the last two steps and take-off	Usually sustained wide double-arm action with arms very active on take-off
Small loss of velocity in the last step (plant), CG stays relatively forward and high	Greater loss of velocity in the last step (plant), CG sinks more and is back, or on top of plant foot, usually not forward
Usually further away from the bar on take-off	Usually slightly closer to the bar on take-off
Usually less arm and leg action in the air	Usually more active in the air with the pulling up of the trail leg (heels to buttocks) and more active arm movements
Trail leg (after take-off) seems to come up (level to buttocks) close to the body automatically and very quickly	Trail leg (after take-off) tends to be slow and has to be forcefully (consciously) pulled up (heel to buttocks) to continue the activity that results in the back arch
Tend to show less "head throwing", jumpers tend to look down the bar for feedback more naturally	Tend to show more "head throwing", no feedback of seeing bar has to be taught
Speed floggers usually have low body weight and tend not to do much weight training	Power floggers usually have higher body weight and tend to do more weight training
Speed floggers do a lot of speed work	Power floggers do not do so much speed work

Coaching points:

- athletes should be asked to jump tall towards a point directly above their heads;
- The lean-back and extended leg kick-up should be eliminated because they will limit the ability to rotate about their longitudinal axis.

### Step 2: Lead knee and arm drill

The athletes are asked to stand on a line and, using a fast four-stride running approach, execute a vertical take-off straight down the line. In doing so, they must drive the lead knee as quickly and forcefully as possible upwards, trying to attain maximum knee and hip flexion. In sequence with this drive comes the vertical drive with the arm on the same

side of the body as the lead knee. These actions will produce the eccentric torque required to generate the desired amount of rotation about the vertical axis which is essential to turn the jumper back-on to the bar at the peak of bar clearance.

Coaching points:

- the drill should be executed at maximum speed to be successful;
- the knee should not be driven across the body to achieve rotation, but should follow the natural inclination of the hips.

### Step 3: Vertical take-off and hold drill

The athletes are required to run on a curved approach using six strides. The take-off and

in-flight movements are identical to those practised in Step 2, except that in this instance the take-off is from a curved approach and the take-off position is held in flight and allowing the athletes to rotate around their vertical axis to fall backwards onto the mats.

Coaching points:

- the movements must be executed at maximum speed;
- again, the knee should not be driven across the body to achieve rotation, it should follow the natural inclination of the hips;
- the athletes should jump vertically without a lean-back during the take-off.

#### ***Step 4: The lead arm exercise***

The athletes are now told to move their lead arm at the completion of its vertical drive down and around the body during the flight phase to point at the far upright. The goal of this exercise is to prevent the head being thrown back at, or just after, the take-off and to provide a focus point for the lead arm to prevent it being thrown out across the bar in the latter stages of the take-off.

Coaching points:

- to provide a point of focus, a brightly coloured T-shirt should be placed on each upright;
- the coach should stand behind the far upright as the athletes complete the exercise to observe their focus;
- the lean-back and extended leg kick-up should be eliminated because they will limit the jumper's ability to rotate about his/her longitudinal axis.

#### ***Step 5: The lead knee exercise***

The athletes are required to try to point at the far upright with their well-bent lead knee throughout the flight phase of the jump in order to produce the necessary hip elevation during the clearance phase.

Coaching points:

- the athletes should be asked to turn the foot of their lead leg toward the far upright, as this will assist them in pointing

the knee toward the upright during the ascent and clearance;

- to ensure that the athletes hold the vertical position during the ascent and undergo rotation about their vertical axis, they should try to hold the fully extended take-off leg drive position during the ascent, aiming to achieve a clear separation of the take-off and lead leg during this phase;
- a low elastic bar may be introduced part of the way through this drill to provide a focus for hip elevation. However, the introduction of this focus should not lead to the athletes anticipating their clearance during the take-off by leaning in toward or doing a backward dive at the bar.

#### ***Step 6: Bar clearance movements***

After having become proficient in the take-off movements, the ascent and the peak height position, the athletes can be introduced to clearing the bar. This involves bringing the head toward the chest at the point of time when they observe their hips passing over the bar. The result of this action will be a drop of the hips with the thighs, lower legs, and feet being elevated rapidly, taking them up and away from the bar. The arms remain by the side and drop below bar level.

Coaching points:

- the athletes are asked to turn their head to their chest when they observe the bar about to pass under their hips.

#### ***Step 7: Establishment of the approach run***

To establish the length of the approach, the athletes should stand with the toes of their take-off foot on the take-off point, facing toward the curve. From here they must run out along the curve and then up the straight line for a total of eight strides. It is important that they run at the same speed and with the same rhythm they intend to use on their approach to the jump. The coach marks the position of their toes on the eighth stride. This then becomes the starting mark for the approach. This means that the athletes should "toe" this mark with their take-off foot before commencing the run.

Coaching points:

- the coach should make sure that the athletes do not accelerate too rapidly before reaching the curve, because this can hinder them to accelerate throughout the curve and into the take-off;
- beginners should be kept on an eight-stride approach while advanced or competent jumpers may be moved up to 10 or even 12 strides.

## Training for the high jump

### *Training contents*

Following DOHERTY (2007), a well-balanced high-jump training programme should contain the following elements:

- a related power programme designed to enable the jumper to both withstand and use effectively the great forces inherent in converting horizontal velocity to vertical lift. (A related weight-training programme that emphasises legs and torso is essential but should be supplemented by plyometrics and circuit training),
- high jumping to improve technique;
- a programme of related exercises to improve flexibility, agility, and body control while in the air;
- a programme of sprint running to increase running speed and endurance as related to high jumping.

According to the great West-German high jump coach TANCIC (1981 & 1985), basic training for high jumping should include the following contents:

1. Horizontal jumps:
  - bounding up to 40m;
  - single-leg hopping up to 20m;
  - standing 5-hops (left and right);
  - 5 hops from a 6- to 7-stride approach (left and right);
  - standing triple hop (left and right);
  - standing long jump.
2. Vertical jumps:
  - double-leg hurdle jumps (height 76-107cm, 6-7m apart);

- single-leg hurdle jumps (height 76-107cm, 6-7m apart);
  - vertical jumps from a 4-stride approach;
  - jumping on and off gymnastics boxes (height 61-107cm);
  - jumping up flights of stairs, jumping uphill, depth jumps.
3. Technique imitation:
    - bunched jumps over a bar from a straight approach (100cm to maximum).
    - curved approach scissor jumps over a bar (100cm to maximum).
  4. Sprinting:
    - 40m from a flying start (maximum speed);
    - accelerations over 100m;
    - starts;
    - uphill sprints.
  5. Running:
    - tempo runs over 150 to 400m;
    - technique-specific runs: a) Curved accelerations, slalom runs and b) approaches changing to increased stride frequency.
  6. General strength:
    - abdominal and back exercises;
    - leg exercises (full squats, half squats, leg presses, leg machine).
  7. Specific strength:
    - split jumps with a load;
    - full squats against the clock;
    - squat jumps with a load;
    - lead-leg exercises.
  8. Technique:
    - approach development (first part, accelerating part, full approach);
    - take-off development from shortened and full approaches.
  9. Other training and regeneration contents:
    - mobility exercises;
    - games;
    - psychological training;
    - sauna, massage.

## A model high-jump training programme

The training programme for the high jump devised by CHU (1980) includes two main elements:

1. Basic and related strength training
2. High jumping for technique, endurance and maximal height

On a year-round basis, the first element is given about 50% emphasis, jumping for technique about 25% and the remainder is devoted to related activities including jumping for endurance and height.

### *Basic and related strength training*

- a) Maximal loading base period (quantitative work – July to September)

This is an early pre-season period during which the jumper does a great volume of lifting. A large number of sets and repetitions at moderate weight are utilised, e.g., 4-6 sets of 10-15 repetitions at 60-70% of maximum.

- b) Power development period (October to January)

During this phase, emphasis is placed upon the maximal amount of weight that can be moved during a specific time, usually one second. The purpose of this is to enhance faster movement response. Lifting is interspersed with jumping (bounding and box drills) twice a week (e.g., Monday and Friday). Training is done three times per week (Monday, Wednesday, and Friday, with no jump training on Wednesday). Exercises used are: Half squat, inverted leg press, power clean, snatch, squat jump.

- c) Power transfer period (February to April)

The exercises used during this period are more specifically related to the jumping movements. They should be carried out at maximal speed. Jumpers should do 4 sets of 5 repetitions each at maximum intensity (85-95% of 1RM). Exercises: Double-legged jumps with barbell; inverted leg press; single-legged

jumps; shoulder and biceps curl; bounding split squats.

- d) Transition phase – Preparation for major competitions

This phase includes two weeks of circuit training: 6-7 stations, 30 sec work at 40-50% of 1RM – 15 sec rest, 3 circuits.

- e) Power retention phase

This helps to maintain gains made earlier and is used during late season championship meets. Training is done one day per week: 4 sets of 6 repetitions each for major muscle groups.

### *High jumping for technique, endurance and maximal height*

- a) Technique

This is the most common type of session, usually done twice a week. The bar is set 15cm below the jumper's maximum jump. 15-18 jumps are taken with adequate rest between the jumps. If all is going well, the bar is raised 2-5cm after the first jumps. The jumper must concentrate on the specific technique points to be stressed during this type of session.

- b) Endurance

Here, the aim is to take many jumps during a session – up to 30 if the athlete is well-trained. At the beginning, the bar should be placed 20cm below the best jump attained. The bar should be cleared three times at this height and then raised by 5cm. This process should be repeated until the jumper has missed twice. Then the bar should be lowered by 2-3cm and should be cleared.

- c) Maximal height

12-15 jumps should be taken at the jumper's personal best. Jumping should be continued regardless of whether the bar is cleared. The jumper should fully concentrate on each jump. He or she should try to relax and allow technique to remain.

High jumping for technique occurs during all five phases of the training year:

- Phase a): once in two weeks,
- Phase b): two times per week,
- Phase c): two times per week,
- Phase d): once two times per week,
- Phase e): once per week.

In addition, the following principles should be observed:

- when power training and high jumping occur on the same day, jumping should be done first;
- high jumping for technique and for either endurance or maximal height are done on separate days;
- during the maximal loading base period and the power development period (July to January), high jumping for technique should occur only once in two weeks.

### High jump psychology

The high jump poses unique psychological demands on the athlete. No world records are set in the qualifying round and best results cannot be achieved in the first round of the final. Athletes must successfully jump better and better as the bar is raised and even the winner will be out of competition when he or she is unsuccessful on three consecutive attempts. These unique circumstances illustrate why high jumpers train to be in competition against the bar instead of against other competitors. The fact that a high jumper is not so much beaten by his or her competitors but rather by the bar demands certain psychological training considerations not found in other sports (REID, 1984b).

### Mental imagery

Once the athlete has the proper technical mechanics in mind, mental practice can be used, with the jumper putting his or her body into a mental video that shows him/herself completing the 'perfect' jump. It is important that this imagery is as real as possible, including colour, crowd noises and scenes, sounds, and a picture of the athlete clearing the bar successfully.

The athlete should start the 'video' at the back of the approach, continue through take-off and actual bar clearance, and even include getting off the pit to waving at the cheering crowd.

The athlete must repeat this picture in his or her mind often, both at the high jump apron and away from the track, to reinforce the kinaesthetic patterns expected. All mental practice must be of successful attempts and techniques. The athlete should feel in charge of the situation and feel good about the progress being made.

### Affirmations

Affirmations are short, strong statements about the athlete or performance. They are phrased in the first-person 'I' and tie into the athlete's goals. For example, possible affirmations are: "I'm fast!" "I'm strong!" "Stay quick!" and "Jump high!" Affirmations can be written on cards and carried throughout the day and/or posted somewhere to be always seen. Negative thoughts should be avoided!

### Relaxation

Like other athletes, high jumpers, too, usually perform their best when they are relaxed. When in such a state, the athlete has the impression that even record performances are easy and nothing special. Things are not "made" to happen but "allowed" to happen – this type of relaxation is what athletes want to feel when competing.

There are many relaxation techniques that can be practised by high jumpers, for example:

- autogenic training;
- biofeedback;
- deep breathing;
- meditation;
- progressive muscle relaxation;
- visualisation;
- self-regulation techniques.

To get used to these routines, they should be practised on a regular basis, in various

training sessions and then in low-key competitive situations (HUMPHREY & NORDQUIST, 2000).

### *Coping strategies*

Psyching is perhaps more obvious in the high jump than in other events. The main psyching time is during the warm-up. Jumpers want to ensure that their approach is measured accurately and want to test themselves at relatively high heights. They should therefore try a relatively high height in the warm-up to see if everything is in order. It also gets them over the nervousness or even fear of heights that will be coming later in the competition. The key is for the jumper to tell the

official early that he or she wants to get an attempt at a certain height and then to ensure that he or she gets it.

During the event itself, the jumper needs to be in control and ready for the personal best result. As the bar is raised the athlete must repeatedly mobilise psychologically for yet another perfect jump. From previous meetings the jumper should know what to concentrate on at each height. In fact it can be written on a card the athlete can refer to. According to REID (1984a), this is one method of a coping strategy, ensuring focusing, concentration and that elusive state of 'oneness'.

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