The Horizontal Jumps

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Introduction

This article aims to provide a summary drawn from the current literature of the main aspects of the horizontal jumping events in track and field athletics as a general guide and a starting point for further study.

The horizontal jumping events can be defined as those disciplines where the athlete tries to jump as far as possible, whereas in the vertical jumps the athlete aims to jump as high as possible. Although this definition may seem trivial, it is important to point out that, from a purely technical or biomechanical point of view, the jumping action in the pole vault is not so much vertically directed but rather it is horizontal into the bending pole, as it were, giving the event a common characteristic with the two disciplines that will be covered below – the long jump and the triple jump. But because the goal of the pole vault to clear as great a height as possible it is classified as a vertical jump.

In the sections below we will look first at the most important commonalities between the two horizontal jumps and then at the two disciplines in some detail including basic descriptions, technique, teaching procedure and training.

Common Characteristics

The basic physical qualities required for success in either the long jump or the triple jump are:

- high sprinting speed or acceleration ability;
- above average eccentric and reactive strength;
- high take-off ability, i.e., the ability to convert forward velocity to vertical lift, or the ability to use explosive power at high horizontal velocity to create vertical lift;
- very good rhythm ability (see HILLIARD et al., 2004).

In all the jumping disciplines in track and field, there is a strong relationship between the execution of the approach run and take-off on the one hand and the jumping performance on the other hand. The more consistent and more technically correct the approach run and take-off, the better the jump performance (see TELLEZ & JAMES, 2000).

This leads JACOBY & FRALEY (1995) to regard the approach as the most important concern for all jumping events. They even state that the approach alone dictates the success or failure of the entire jump. All the power, velocity, impulse, and direction are developed during the approach run. Once airborne, other than controlling rotations, the athlete cannot contribute to the effectiveness of the jump. The athlete must be in contact with the ground to have any effect on the performance of a jump.

For this reason, with the exception of the pole vault, more than 90% of the work of a jumper should be directed at the approach and take-off.

The Long Jump

One could say, that, from a technical point of view, the long jump is the simplest of the field events. Its approach is from a single direction and the transition from running velocity to an optimum height in the jump and the most effective way of landing in the pit present smaller problems in body mechanics compared with the other three jumps. Against this background, it is not surprising that, until about 1950, long jumpers were usually "sprinters-on-holiday", doing a second event for fun or team points, with almost no emphasis on special training for the event (see DOHERTY, 1985).

According to HILLIARD (2007), the ability to jump is an innate skill and is easily identified. Therefore, they regard it as unnecessary to embark on an exhaustive series of talent identification tests to determine long jumping capabilities. Coaches should rather look for athletes who possess:

- a sound, rhythmical running action,
- a high degree of speed,
- spatial awareness,
- a natural spring and elastic energy,
- coordination in a range of activities.

It is common practice to break the long jump down into four elements:

1) The approach

2) The last two strides

3) The take-off

4) Th action in the air and landing

Long-jump Technique

The approach

If one compares the long jump approach with sprinting, the "techno-motor" differences do not seem to be very significant. At most, variations in three elements could be mentioned (see TIDOW, 1989):

- the knee lift in the forward swinging phase is normally more pronounced;
- the subsequent extension of the knee joint and plant of the foot (support on the ball of the foot) should, according to the Soviet philosophy of long jumping, resemble "slipping into slippers" (see ROSENTHAL, 1988);
- during the last third of the approach run, many long jumpers try to emphasise the stride rate.

The approach should be consistent and allow for gradual acceleration, beginning with the first stride and ending with maximum controlled velocity at the take-off (see TELLEZ & JAMES, 2000).

Although, in general, the approach should be as long as possible, depending on the jumper's experience, sprinting technique, and conditioning level, its length is usually between 12 and 22 strides. Since the longer the approach, the more difficult it is to develop a consistent stride pattern, inexperienced jumpers should begin by using an approach of 12 strides. A successful approach depends on the consistency of the first two or three strides. It is here that the rhythm of the run is developed. Check marks can help determine the consistency of a jumper's approach run (see TELLEZ & JAMES, 2000).

JACOBY & FRALEY (1995) state that the sole purpose of the approach is for the athlete to reach the take-off point at the greatest possible velocity. The basic rule is: Set the approache to fit the individual's acceleration curve; the acceleration curve should not be dictated by approach length.

It is also important to stress that it is not raw speed that is crucial in the long jump, but maximum controllable velocity. This means that the approach should be made at the maximum velocity at which the jumper can complete a successful take-off. However, the acceleration during the approach must be gradual. Accelerating too soon or too quickly can lead to deceleration toward the end of the approach going into the take-off, resulting in a poor performance (see TELLEZ & JAMES, 2000).

As far as body position is concerned, there is a slight inclination of the whole body from the ground at the start of the approach. However, as the jumper accelerates, the body gradually straightens up into an upright position by the end of the fourth or sixth stride (see TELLEZ & JAMES, 2000).

The last two approach strides

The main objective in the last two strides of the approach is to prepare for the take-off while conserving as much velocity as possible. During the penultimate stride, i.e., the next to the last stride from the take-off, there is a lowering of the jumper's centre of mass (CM). The penultimate stride is normally the longer of the last two strides because of the lowering of the CM and the flexion of the knee and ankle of the supporting leg. There is a noticeable "gathering" of the jumper's body during the penultimate stride. The rear support during the penultimate stride is performed with only an incomplete extension. This conserves energy in the take-off leg and introduces the lowering of the hip and CM. The trunk is also straightened. In addition, the foot is placed flat on the ground, which leads to what is called the "swing leg squat" (see TELLEZ & JAMES, 2000 and TIDOW, 1989).

From the swing leg squat, the jumper, through an incomplete extension of the knee of the swing leg during the support phase, applies a more horizontal impulse leading to a comparatively flat trajectory for the final stride (see TIDOW, 1989).

Because of the raising of the jumper's CM, the last stride is shorter than the penultimate stride (see, however, JONES, 2008, who shows that the two longest jumps in the history, by Mike Powell (USA) and Bob Beamon (USA), were made with penultimate strides that were shorter than the last stride). As the take-off foot makes contact with the ground, it is placed flat and in front of the jumper's body. In addition, there is a slight flexion of the joints of the take-off leg during which the muscles are forced into an active stretching phase or eccentric contraction. Immediately following this active stretching, there is a shortening, or concentric contraction, of these muscles. When a concentric contraction is preceded by a phase of active stretching, elastic energy is stored and the muscles are "loaded up," as it were (see TELLEZ & JAMES, 2000).

Since the last stride is generally shorter than the penultimate stride, jumpers should think of the last two strides as long-short. They must avoid reaching on the last stride, because placing the take-off foot too far out into the front of the body will result in a braking or stopping effect and poor jump performance (see TELLEZ & JAMES, 2000).

The board contact, which is characterised by a pronounced front support, a slight backward inclination of the trunk and a slight twist towards the side of the take-off leg, marks the finish of the take-off preparation phase (see TIDOW, 1989).

The maintenance of velocity through the last two strides is also helped by continuing the arm swing of the running action (see TELLEZ & JAMES, 2000).

The take-off

The take-off, which is the most essential part of long jump technique, can only be successful if its preparation is performed correctly, so that the loss of horizontal velocity is minimised. This means that the jumper's CM should reach its lowest point at the moment the take-off foot hits the board and when the trunk has a slight backward inclination. If this happens, the CM's forward and upward directed path of acceleration will be as long as possible. This means that the redirection from the horizontal to the vertical begins immediately after the foot plant. Prerequisites for this are a pre-tension of the take-off leg, from the muscles of the sole of the foot up to the hip extensors at the backside, and an actively pawing foot plant (see TIDOW, 1989).

According to TELLEZ & JAMES (2000), coaches should encourage jumpers to think about jumping first and then running up and out off the ground. Focusing only on running

up and out off the ground tends to cause the jumpers to not load up the take-off leg and thus bypass a vertical impulse.

TELLEZ & JAMES (2000) also emphasise that the take-off foot is placed flat and directly in front of the jumper's body to allow for maximum vertical lift. If the jumper places the foot heel first, it will cause a braking or stopping effect. On the other hand, if the jumper places the take-off foot high up on the toes, there will be little stability on impact, causing the leg to buckle or collapse.

An optimal position at take-off is characterised by the jumper's body being upright to the ground. Assuming this posture is easier if the eyes are focused up and out when leaving the ground. Looking down at the sand or the take-off board should be avoided (see TELLEZ & JAMES, 2000).

However, jumpers should not over emphasize jumping up high at take-off. A high angle of take-off usually causes jumpers to slow down considerably to achieve the height, thus losing critical velocity. Long jumpers should jump for distance, not height, which means that the optimum take-off angle is roughly around 20°, implying a vertical velocity about 40% of the horizontal velocity at the end of the take-off (see DAPENA, 2005 and TELLEZ & JAMES, 2000).

Action in the air

The objective of the flight phase is to rotate the body into an efficient landing position that maximises jump distance. Once contact with the ground is broken, the jumper can do nothing to alter the flight path of the CM. However, the jumper moves his or her arms and legs about the CM to counteract forward rotation and assume an optimal position for landing (see TELLEZ & JAMES, 2000).

The hitch-kick style, which is described as a continual running action during the flight phase of the jump (see JACOBY & FRALEY, 1995), allows the jumper to counteract the forward rotation developed at the take-off. By cycling the legs and arms through the air, the jumper is able to maintain an upright body position and set up for an efficient landing position. If the jumper did not counteract forward rotation by cycling the arms and legs, the body would continue to rotate forward into a face-down position in the sand (see TELLEZ & JAMES, 2000).

Other techniques for long jumpers in the air are the hang and the sail. Each of these styles accomplishes the same task as the hitch-kick, counteracting forward rotation in the air in order to achieve an efficient landing position. In the hang technique, the jumper extends his or her body in a long, outstretched position and holds that position momentarily so that he or she appears to be hanging. Then, upon descending, the jumper snaps the legs to a forward landing position. The hang is beneficial in that the long position of the athlete as he or she rises in the air retards the tendency to tumble forward and lose extension (see TELLEZ & JAMES, 2000).

A detailed analysis of the hang and hitch-kick, or running-in-the-air, styles of long jumping is presented by TIDOW (1989). He states that after the take-off, both hang and running-in-the-air style jumpers show a release of the take-off posture leading to the so-called "first step", which is characterised by an opening of the knee joint angle of the swing leg. While, in the case of the hitch-kick, this is done in a thrusting way, the movement is active in the running-in-the-air style and tends to be smoother and more passive in the hang style.

The heel of the take-off leg (which is behind the body) is slightly kicked up at the back in a similar action to the backward swinging phase of sprinting. Although the leg posture is very similar, there are great differences as far as the arm action is concerned. In the running-in-the-air style, the arm on the side of the swing leg begins a forward "windmilling" movement. At the same time, the opposite arm performs a forward and downward movement parallel to the swing leg (which is still in front of the body). Thus both arms rotate in the same direction, but the leading arm is 180° ahead of the following arm.

In comparison, the arm action in the hang style is quite different. Since here the jumper must perform a double-arm swing, the counter-swinging arm movement realised in the take-off posture must first be eliminated. Correspondingly, the opposite arm locked in front and above must be lowered towards the swing leg. At the same time, the arm on the side of the swing leg is moved towards the trunk where it virtually "waits" for the opposite arm.

Then, the long jumper, for a very short time, reaches a "one-leg stand" in the air, the longitudinal axis of the body being vertically aligned. In the running-in-the-air style, the one-leg stand is caused by the active, backward movement of the (almost) extended swing leg, being overtaken by the take-off leg as it is brought forward for compensation. Parallel to this, the arms, which are as extended as possible, continue their forward windmill-like action.

In the hang-style, this "swing-leg stance" is achieved through a passive lowering of the swing leg and not through the use of the hip-extension muscles, as is the case in the running-in-the-air style. Since the flexed take-off leg, which is still backward, performs no active forward movement, the lowering brings about a parallel position of the longitudinal axes of the thighs. The arm on the side of the take-off leg, which is simultaneously lowered or moved backward, now also reaches a position parallel to the "waiting" opposite arm in the one-leg stand. Thus, during the hang style, the one-leg stand is that phase starting from which legs and arms can be used jointly and parallel to one another.

When, in the running-in-the-air style, the leading arm as well as the (opposite) take-off leg, which has been brought forward and is extended, have again reached an almost horizontal position, they are locked for a very short moment in a parallel position. Here, the 180° angle between the arms is reduced to approximately 90°, so that the "following" arm is directed vertically upward. Since the swing leg moved backward is flexed again behind the trunk in order to prepare the subsequent forward movement, the result is very similar to the hurdle seat, which is characteristic of what is known as the "second step".

During the hang style the typical hang phase is created: While the arms perform their backward and upward directed "double-arm circle", the previously extended swing leg is flexed at the knee joint up to an approximately right-angled position. This leads to a "knee stand" in the air. All the following leg and arm actions of the hang style are performed parallel and simultaneously.

The sail technique is the simplest because it involves no complex movement: The athlete immediately lifts his or her legs up into a toe-touching position upon rising up from the take-off. This makes it easy for the novice to get into a landing position early. However, the sail technique is seldom used by successful jumpers because of the difficulty of keeping the body balanced through the entire flight parabola. The jumper is likely to begin a premature rotation, and the weight in front of the hips adds impetus to his already problematic forward rotation. This large amount of total weight moves the CM out in front of the hips, and the jumper's legs quickly drop into the pit before the flight curve is completed (see JACOBY & FRALEY, 1995 and TELLEZ & JAMES, 2000).

Landing preparation

In the descending segment of the flight curve, both the second step of the running-in-the-air style and the hang phase of the hang style inevitably lead to the preparation for landing. In order to achieve this, in the running-in-the-air style, the rear arm catches up to the leading arm waiting in front of the body in a horizontal position. The flexed swing leg, which has been kept behind, also joins the take-off leg locked in front of the body. The results of these synchronous actions are a parallel position of both the arms and legs and a trunk that is pressed slightly forward.

TIDOW (1995) emphasises that, to minimise landing loss, the legs should be kept approximately horizontal, which means that the feet

should be a little higher than the flight curve. From the point of view of forward rotation, it is then easier to achieve an optimal "diving into the sand angle" by a slight opening of the hip angle.

In the case of the hang style, the jumper forms a bundle by actively flexing at the hip joint, actively swinging through (or forward circling) both arms and bending the trunk forward. Here, the knee joints remain flexed. The position achieved during the preparation of landing, therefore, is very similar to the flight phase of the sail style (see above).

If one compares the resulting initial positions of both techniques, it becomes clear that, in the case of the running-in-the-air style, only a slight opening of the hip angle is necessary for "gaining space" when landing, whereas, in the case of the hang style, a relatively wider opening of the hip angle and an extension at the knee joints are needed.

The landing

According to TIDOW (1995), the analysis of the landing technique of long jump specialists reveals four variations, which can be differentiated according to the behaviour of the arms:

- the arms are parallel in front of the body when breaking the sand,
- the arms are laterally beside the body,
- the arms are behind the trunk,
- a "counter-arm landing" is performed.

Since, from a biomechanical point of view, the flight curve should be utilised to the greatest possible degree, which would automatically result in a deep sinking of the CM, a landing with the arms held beside the trunk would be optimal. If the arms are held that way, their partial CMs are maximally low. The lateral position of the arms, however, means that – in comparison with the "arms-behind-position" – the horizontal distance to the point of breaking the sand is smaller. From this follows a relative equality of the landing postures with the arms kept beside or behind the trunk.

As the jumper makes contact with the sand, the knees bend and flex to cushion the impact. In addition, the arms are brought forward to assist the jumper's forward momentum and avoid falling back (see TELLEZ & JAMES, 2000).

Teaching the Long Jump

When teaching the long jump, the main emphasis should be on the approach and the take-off, whereas the flight phase deserves less attention (see FRANZ, 1986).

According to TELLEZ & JAMES (2000), when establishing an approach for beginning jumpers, it is best to do so without jumping. This way, the jumpers can isolate the approach run and develop a consistent acceleration, stride pattern and rhythm of the run through repetition. In addition, even with experienced jumpers, it is beneficial to practice the approach run without jumping to develop the consistency and rhythm of the run.

To work on the technique of the last two strides and the take-off, a short approach run of eight strides should be established. Short-run jumping allows the jumpers to isolate and emphasise the proper technique. In addition, jumpers can take more jumps, since short runs reduce the fatigue during training (see TELLEZ & JAMES, 2000).

As far as flight technique is concerned, one of the most common methods is to establish the basic elements leading to the single-stride technique, universally accepted as the most suitable for young athletes (see JARVER, 1988). This technique provides an excellent base for further technique developments. It is easy to learn and combines all essential elements without distracting the learner with complicated movements (see LOHMANN, 1997 and HILLIARD, 2007).

The long-jump teaching method proposed by WENSOR (2010) consists of the following steps:

- **Standing long jump into the pit** (aims: to give the athletes confidence in safely landing in the pit, to teach a safe two foot

landing, to teach the athletes how to use the arms to assist the distance of the jump);
- **Jump into the pit from a short approach – one to two feet** (aim: to introduce the basic long-jump action using a one-foot take-off and two-feet landing);
- **Long jump for distance from a longer approach** (aim: to allow he athletes to attempt the full long jumping action from a longer approach).

Training for the Long Jump

Apart from the development of running speed for the approach, the development of strength, specifically jumping power, is crucial to a long jumper's success. In developing strength, the emphasis should be on the specific qualities needed in jumping. According to TELLEZ & JAMES (2000), these qualities are:
- **Power** - the maximum available ability of the leg and back muscles during approach and take-off;
- **Jumping Endurance** - the muscular ability to withstand multiple bounding and jumping;
- **Special Strength** - bridging the gap between sheer strength and explosive power, it gives the jumper control over all mechanics of the back and leg muscles used in horizontal jumping.

When preparing young athletes, coaches should focus on the following areas:
- running mechanics and speed development;
- postural strength, body weight, strength and power activities;
- balance, coordination and agility activities;
- leaping, jumping, hopping related activities and drills;
- general conditioning.

As long jumping is a single-leg skill, a number of activities and drills must be rehearsed on a regular basis and the muscles and tendons and ligaments surrounding the feet, ankle, knee and hip joints must be sufficiently strengthened and mobilised to withstand the forces involved and constant loadings. The primary focus of all take-off drills is to develop the capacity to run at a rhythmical, optimal speed and experience the unloading during the take-off. This is achieved by modifying the running action by way of lowering the CM into the penultimate stride before converting this into an active, upward and forward take-off. However, it is critical that these actions are not overemphasised as they must be part of the whole movement pattern and should be as natural as possible (see HILLIARD, 2007).

As far as special strength training is concerned, the most productive and prominent strength training method used by elite jumpers today is plyometrics in conjunction with weight training (see TELLEZ & JAMES, 2000).

Plyometrics

Plyometric drills and exercises combine endurance, coordination, and pure strength training, through which jumpers can produce better explosive reaction movements. However, the biggest benefit of this type of training is the development of stretch reflex in the muscles involved during take-off and flight.

The goal of jumping drills is to develop the neuromuscular system so that strength gains can be incorporated into speed movements. Two methods of plyometrics are used: long jumping and short jumping. Long jumping takes place during the first six weeks in order to condition the athlete and build speed endurance. These jumps can be subdivided into low-intensity long jumps and high-intensity long jumps. Both types of jumps are done over a distance greater than 30m, but they are done at a lower amplitude or as quickly as possible, respectively. Short jumping is done over a shorter distance (less than 30 meters) very explosively. Plyometrics should be done two times per week, allowing several days rest in between. Mondays and Thursdays or Mondays and Fridays before weight training is preferable.

Plyometric jumping exercises include:
- **Long-jumping exercises** - at low intensity (e.g., high skips, alternate bounding, single- and double-leg hops, gallops, bound-

ing up a hill or stairs, straight-leg jumps up a hill or stairs, double-leg jumps up a hill or stairs, ramps and/or hill running, jump rope, jumping or hopping over seven or more cones, alternate step-ups on bench, box, or step for 30 secs or more), and at high intensity (same as low-intensity exercises but performed as quickly as possible);

- **Short-jumping exercises** - any of the long-jumping exercises but performed with greater amplitude and fewer repetitions: standing triple jump, standing long jump, jumping over hurdles [about one meter apart], jumping over boxes 30-45 cm high, 60-90cm apart], jumping in place from half-squat, jumping from half-squat up a hill (half the distance of long jumping but faster) or steps, any jumps in place (double-leg tuck, single-leg tuck, pike, split-squat, squat jumps, forward and backward over cone, side to side over cone, box/bench jumps, timed jumps of 10-30m, single- and double-leg bounding holding an to a partner's shoulders or to a railing).

The incorporation of these exercises into three four-week periods can be done as follows:

Period 1:

Week 1: Long jumping (low intensity): 4 x 100m (four exercises are chosen)
Week 2: Short jumping: 2 x 6 reps per exercise
Long jumping (low intensity): 3 x 50m (1 exercise) + 3 x 50m (1 exercise)
Long jumping (high intensity): 2 x 30m (1 exercise) + 2 x 30m (1 exercise)
Week 3: Short jumping: 2 x 6 reps
Long jumping (high intensity): 3 x 30m + 3 x 30m + 3 x 30m
Week 4: Active rest: Sprint drills

Period 2:

Week 5: Short jumping: 2 x 6 reps + 2 x 20m
Long jumping (high intensity): 2 x 30m
Week 6: Short jumping: 2 x 6 reps + 2 x 20m + 2 x 10 sec.
Long jumping (high intensity): 2 x 20m
Week 7: Short jumping:
4 exercises x 3 sets of 6 reps each
Week 8: Sprint drills: 2 x 25m

Period 3:

Week 9: Short jumping:
3 x 2 x 6 reps or 3 x 2 x 30m
Week 10: Short jumping:
4 x 4 x 6 reps or 4 x 4 x 30m
Week 11: Short jumping:
5 x 4 x 6 reps or 5 x 4 x 30m
Week 12: Short jumping: 2 x 6 reps

Free-weights, medicine-ball exercises, running

The development of a jumper's explosive strength, or power, can be supported by the following free-weight exercises:

- **Squat movements** - back squat (full, half-jump, static, dynamic), front squat (full, static, dynamic);
- **Pull movements** - cleans (mid-thigh pull, below-knee pull, full pull, clean from mid-thigh, clean from below the knee, full clean), snatches (mid-thigh pull, below-knee pull, full pull, snatch from mid-thigh, snatch from below the knee, full snatch);
- **Press movements** - bench (incline, behind-the-neck-press: seated, push), jerk (split, power).

The jumper's body can also be effectively developed by medicine-ball exercises:

- **Upper body** - chest pass, overhead pass, underhand pass, seated rotations, kneeling pass, seated roll back-and-up pass, seated cross-body scoop, side-overhead-extension pass, bend over between-legs pass (for details see TELLEZ & JAMES, 2000);
- **Lower body** - thigh bounces, foot passes, heel passes, leg-raise rollover – put back, seated squad lifts, lying hamstring lifts, "fire" balls, ninety-degree "drives" (for details see TELLEZ & JAMES, 2000).

The following types of running workouts should also be a part of the long jumper's training schedule:

- **Speed Endurance** - 5 x 100m with 5-10 min rest, 3 x 150m with 5-10 min rest, 2 x 200m with 10 min rest, 1 x 400m with 10 min rest;
- **Tempo Endurance** - 6 x 200m with 2 min rest, 4 x 300m with 2 min rest, 50m-100m-

150m-200m-250m-300m walking the same distance for rest;
- **Strength Endurance** - 6 x 100m hill, 6 x 15-20 sec resistance running, 2 x (4 x 15-20 sec) jump rope;
- **Power Speed** - 6-8 x short hill runs 50-60m, 6-8 x 30m assistance running, 6-8 x 10 sec fast rope jumps;
- **Endurance** - 15-45 min of running at a steady pace.

Sample training programme

With all the above listed types of workouts in mind, TELLEZ & JAMES (2000) propose the following training programme for long jumpers:

Weeks 1-4: Technique, Speed and Strength

Monday: 3 x 300m with 200m of walk or jog recovery, drills: 3-6 x 60m of A-skip the free leg swings up until the thigh is parallel to the ground and the heel of the free leg meets the hips then extends down to meet the ground), and B-skip (same as A-skip, except that the free leg extends straight forward before landing), 3-6 x 60m of high knees, event-specific drills, weights.

Tuesday: Tempo runs: set 1 – 100m + 100m + 100m, set 2 – 100m + 200m, set 3 – 100m + 100m + 200m, set 4 – 100m + 200m, set 5 – 100m + 100 m + 100m (50m jogging between reps, 100 m walking between sets).

Wednesday: Power Speed (progresses to power technique): 6 x 20m of A-skip into 20m sprint, 6 x 20m of B-skip into 20m sprint, 3 x 60m of running bounds, 6-10 x 50m, event-specific drills, weights.

Thursday: 6-8 x 200m, with 200m of walk or jog, drills: same as Monday.

Friday: 8-10 x 150m, with 150m of walk recovery, weights.

Weeks 5-12: Speed, Strength and Endurance

Monday: 2 x 300m + 1 x 200m with 10 min recovery, technique drills, weights.

Tuesday: 8 x 100m at 80-90% speed, light technique drills.

Wednesday: Jog and stretch, weights, event technique.

Thursday: 3 x 200m, light technique drills.

Friday: 5 x 150m with full recovery, weights.

Weeks 13 and on: Competitive phase

Monday: 2 x 200m fast, with full recovery, light technique drills.

Tuesday: Full technique drills, weights, 6 x 60 m at 60-70%, with full recovery.

Wednesday: Jog and stretch.

Thursday: 3 x 150m fast, technique drills, weights.

Friday: Rest.

Saturday: Competition.

Although the various drills and workouts presented above can enhance the long jumper's performance, TELLEZ & JAMES (2000) hold that the majority of training time for the long jump should be devoted to developing a technically correct approach and take-off. This is because of the strong correlation between correct technique or execution of the approach run and take-off and jumping performance.

The Triple Jump

The triple jump is the only jumping discipline in track and field that does not require a big explosive effort, but is actually a continuous sequence of movements, with each phase dependent on the preceding one. Although each element can be isolated, it is important to keep the total activity in mind. This means that the three distinct jumping phases – the hop, the step and the jump - must flow into one another.

To be successful, triple jumpers must possess above-average ability in sprinting and jumping, and at the same time possess powerful muscles and good motor skills (see HAYES, 2000).

Each of the three jumping phases includes a take-off, flight and landing. In the hop, the take-off and landing are performed on the same foot, in the step the landing takes place on the opposite foot, and the jump is performed simi-

lar to the long jump. While the hop and jump are relatively easy to master, the step is a more difficult skill (see HAYES, 2000).

Since the three jumping phases form a unit, understanding the later phases requires going back to the hop phase, and especially to how the landing occurred at the end of the hop – as it almost totally dictates what can and cannot occur in the step and later in the jump. As with other jumping events, the height of the hips into the hop and then into each succeeding phase will create efficiency of distance. The higher the hips, the greater the flight curve. The angle of the hips going into each flight phase must be as low as possible. As the jumper's velocity diminishes through each phase, the take-off angle will automatically increase through the step and jump phases. Elite triple jumpers will average under 14° for the hop and step and then move up to a little under 22° for the jump phase.

Balance and rotations are always a product of forward rotation at the take-off of each jump phase. Here angular momentum is in a frontal or horizontal direction. Lateral rotations are generally caused by an uneven arm thrust or by landing with inappropriate foot support or placement. Finally, an efficient landing in the jump phase is achieved by keeping the hips on the flight curve as long as possible. Good landings are a product of the take-off from the step phase. The objective is to reduce forward rotation as much as possible (see JACOBY & FRALEY, 1995).

Triple-jump Technique

Approach and take-off

The triple jump approach should be long enough to allow the jumper to accelerate to nearly full velocity. At the same time, the approach must be relaxed so that the jumper is under control. If the approach is too slow, the jumper will lose momentum in the later phases of the jump. If it is too fast, the jumper will be unable to control the legs and keep them from collapsing. The length of the approach run should be 30-40m with beginning jumpers using the shorter end of the range (see HAYES, 2000).

HUTT (1989) divides the triple-jump approach into two phases. The first, or acceleration phase, consist of 8-16 strides. The second phase, the take-off preparation, begins between 6 and 4 strides out from the take-off board. This phase is characterised by an increase in stride frequency and a straightening of the trunk. During the final strides, the knee lift is higher. Both the increased stride frequency and higher knee lift lead to an approach rhythm that prevents a lowering of the CM.

The triple jumper should not, as in the long jump, prepare for a high-angle take-off from the board, but instead should concentrate on accelerating well past the board. Any loss in velocity at the take-off board should be kept as small as possible since a low velocity at this point has negative effects on the initial velocity of the two subsequent take-offs.

The final approach velocity significantly contributes to performance. However, the statistical correlation between the two is not as great as in the long jump. Jumping power and technique have considerably greater influence on final performance in the triple jump than in the long jump (see HUTT, 1989).

Following the take-off preparation phase, the triple jumper begins the jump by planting the foot of the take-off leg flat on the take-off board. Since for the triple jump, the horizontal speed component ratio is 3:1, a good performance requires a very low take-off angle, well under 16°. According to JACOBY & FRALEY (1995), there is little need for a complicated transition from horizontal velocity to lift. The planting foot is more directly under the hips than in other jumping events. During the take-off, the trunk is kept upright while the arms are moved as in sprinting. A double arm action should be avoided at this point since it would result in a reduction of horizontal velocity (see HUTT, 1989).

The hop

The objective in the hop is to go forward and up (not up and forward as in the long jump), i.e., the emphasis should be on forward motion rather than vertical. Vertical forces occurring at

this time would cause a reduction of speed on landing. The parabola for the hop should be low going up and consequently low coming down (see JACOBY & FRALEY, 1995). The aim should be to keep the body upright and rotate the heel of the hop leg high up under the buttocks and then extend it as far forward as possible. The athlete should feel that he or she is running off the board (see HAYES, 2000).

The swing leg is brought forward quickly as a short lever, the knee joint forming an acute angle. At the moment of take-off, the knee of the swing leg should have reached hip height where it is held momentarily. When changing the position of the legs, the swing leg is pulled backward as a long, almost extended lever. Simultaneously, the take-off leg is brought forward as a short pendulum (with an acute knee joint angle) all the way to a high, "reaching out" position (see HUTT, 1989).

To minimise any possible braking effect, the jumper must make ground contact just ahead of the CM (hips). To do this, the jumper must be patient, waiting for the ground to come up to the foot rather than reaching for the ground. The athlete should not rush the extension of the knee and hip (see JACOBY & FRALEY, 1995).

Landing on the toes interrupts speed and flow, whereas landing on the heel can cause heel bruises. Also, a heel landing makes it more difficult to control the forward movement. The landing should therefore be very slightly on the heel, followed by a "rolling" action of the foot (see HAYES, 2000).

The grounding foot must be very active. This foot should move backward as rapidly as possible in a short downward and backward "pawing" motion (see JACOBY & FRALEY, 1995 and HUTT, 1989). Foot contact with the ground should be minimised, i.e., the jumper must get onto and off the ground in the shortest possible time. HUTT (1989) recommends to visualize the ground moving backward underneath the athlete and then to aim at bringing the foot down to the ground moving faster than the ground is moving in order to maintain as much horizontal velocity as possible. He also points out that the foot of the take-off leg is better prepared for the high impact with the ground if the sole of the foot is tensed by drawing the big toe towards the body.

The step

The step is the most troublesome and difficult to manoeuvre and the most difficult to integrate into the overall jump. It is a combination of a supported landing and then a jump, with the athlete moving from one foot at take-off to a landing on the opposite foot (see JACOBY & FRALEY, 1995).

Just before the hop is finished, the arms are pulled back again in preparation for the step (see HUTT, 1989). At the take-off into the step, the ground is "kicked backward" with the extended leg while the swing leg (opposite of the hop leg) is being brought forward quickly and powerfully, the knee angle being more obtuse than during the take-off into the hop. At the moment of take-off, the thigh should have reached a horizontal position and formed a right angle with the lower leg. The trunk is kept upright (see HAYES, 2000).

During the flight phase, the thigh of the swing leg should be locked beyond the horizontal and form a right angle with the lower leg. When the arms reach backward in order to perform a double-arm swing, the trunk, because of the law of action and reaction, is inclined slightly forward. This inclination can be avoided by moving the arms in a sprinting action (see HUTT, 1989).

The leg that has been the take-off leg during the hop and step is bent at the knee and moved far backward in a relaxed way. The triple jumper should take care that the foot of the take-off leg is not swung backward and upward beyond hip height as this would cause a forward rotation at the moment of the reversing movement (when the leg is brought forward quickly to function as the swing leg during the jump). A forward rotation at this point would have a negative influence on body posture and the potential jumping distance (see HUTT, 1989).

Following HAYES (2000), there are two methods of executing the step:

1) The body is kept upright and the upper body is basically perpendicular to the ground. The upper leg is parallel to the ground, and the lower leg is positioned so that the toes are just ahead of the knee. This is done so the jumper can "ride" the leg, or hold it up. At the last instant, the jumper extends the leg and reaches out as far as possible. This extension is aided by pulling the arms back to prepare for double-arm action in the jump phase. Again, the foot should hit the ground almost flat-footed. The heel "barely" leads the action.

2) The jumper lets the lower leg extend ahead of the knee during the step. This requires the upper chest and head to be stooped slightly forward in an effort to hold the foot up. As the foot is extended, or held forward, the arms are drawn behind the back to pre pare for the jump phase.

As the body begins to descend, the lead leg, which has been held at 90°, begins to extend out in front of the jumper. At the completion of this extension, the leg is actively pulled down and back so there is an active foot plant (see JACOBY & FRALEY, 1995).

The jump

The take-off for the jump is introduced at the end of the flight phase of the step, by placing the foot of the swing leg (which now becomes the take-off leg) on the ground with an active downward and backward pawing motion, the knee and hip joints of the take-off leg being extended. The swing leg forms a right angle at the knee joint and is brought forward quickly and powerfully as a long lever (see HAYES, 2000).

At the moment of take-off, the thigh of the swing leg should have reached the horizontal position. This is only possible if, during the step, the swing leg has not been kicked up too high at the back. Also at this moment, the body is straightened, which is a prerequisite for performing a hang-style jump. Many triple jumpers perform a float-style jump, which is particularly useful if the flight phase is short. The running-in-the-air, or hitch-kick, style is very rare since, in most cases, the horizontal velocity at the take-off for the jump is too low (see HAYES, 2000 and HUTT, 1989).

In the jump, the horizontal speed of the support phase of the step must now be converted into a much more vertical component than was present in either the hop or the step (see JACOBY & FRALEY, 1995). This means that the jumper should try to get as high as possible, with his or her arms (both of which are used in the hang style) reaching up and then extending forward. The feet are extended so that the heels lead the way into the pit (see HUTT, 1989).

By the time of the jump, the majority of the jumper's horizontal velocity build up in the approach has been lost through the hop and step phases. To counteract this, the jumper's emphasis must be on vertical velocity. The impulse at take-off is provided by the swinging free leg, with special attention to the motion of the double arms, which are pulled through with a punch (see JACOBY & FRALEY, 1995; HUTT, 1989).

No matter which technique is used during the jump phase, it is important that a "distance-gaining" landing is well prepared for. Shortly before landing, the arms are swung far backward so that the feet can be simultaneously lifted higher. At the moment of breaking the sand both arms are swung powerfully forward to counter the tendency to fall backward. A variation of landing technique is characterised by the movement of only one arm backward and upward. This is to introduce a sideways landing. Here the athlete's trunk is inclined far forward. After completing the landing the athlete leaves the pit towards the front (see HUTT, 1989).

Hop, step and jump ratios

The breakdown of the triple jump performance into hop, step and jump phase distances has helped to examine how an athlete distributes his/her effort and to identify areas of strength and weakness. The contribution of each phase to the overall performance is determined by ex-

pressing each phase distance as a percentage of the effective distance. The three phase percentages form a phase ratio that describes the athlete's distribution of effort in any given jump (see GRAHAM-SMITH & LEES, 2000).

The ratio between the hop, step, and jump phases in the triple jump has been dealt with in quite a number of articles (see ECKER, 1987 and HAY, 1994, 1995, 1996, 1997, 1999). This is not surprising because success in the triple jump depends very much on how the athlete distributes his or her effort over the three phases (see HAY, 1997). While normally there is an equal number of triple jumpers using a hop-dominated or a jump-dominated technique, there is also the case for the jump-dominated technique (see HAY, 1999).

It is widely agreed that there is no single optimal distribution of effort that suits all triple jumpers. Research indicates that individual athletes have their own optimal phase ratios dependent on factors such as speed, strength, technique, anthropometric measures and psychological profile. As these factors can also be related to temporal changes, i.e., training age, growth and experience in the event, there may well be a dynamic nature to the optimal distribution of effort. For example, novice athletes may have an optimum phase ratio that is likely to be different from that of an elite athlete jumping in excess of 17m.

GRAHAM-SMITH & LEES (2000) conducted a study to investigate developments in approach speed and phase distances with respect to increases in performance and to examine the existence of "dynamic" optimal phase ratios. The approach speed and phase distances data from all triple-jump performances at major domestic competitions in Britain from June 1991 to August 1996 were examined (343 jumps, 156 by female athletes and 187 by male athletes). The levels of ability ranged from Junior and Senior British National squad members to world-class performers. Among the women, the effective distance ranged from 11.73 to 14.94m, while the men's performances ranged from 14.44 to 17.43m. As with other studies examining wide ranges of performance, strong positive relationships were found between speed and phase distances on the one hand and the effective distance on the other. However, noticeable stepwise developments were observed as distance increases. This supports the notion that an "optimal" phase ratio is a dynamic phenomenon and will change with respect to developments in speed, strength, and experience in the event.

Teaching the Triple Jump

Introducing the movement

According to HAYES (2000), after studying triple-jump films and a brief demonstration of a standing triple jump with the emphasis on the leg movements only, prospective triple jumpers should be instructed to do a few standing triple jumps. Jumps should be done with each leg to decide which is most comfortable. Instead of going for distance, an even distance for each phase and learning the leg movements of each of the three phases should be emphasised.

Not trying to extend the reach too far can help in keeping the jump under control. It will also keep learners from leaning too far forward during the jump and give them time to have an active phase leg. The phase leg should be developed next, by having the jumper stand on one leg and jump up, making the standing leg rotate under the buttocks and reach out in front before landing. The athlete should alternate legs for this drill so that coordination is developed in both legs.

As mentioned above, the step phase is the most difficult to master. The hop is relatively easy to perform, but the recovery is difficult. The athlete usually will not have problems learning the basics of the jump phase. The greatest progress in triple jump training will come from improving the step. However, one must remember that each phase is dependent on the others.

Bounding exercises

The next stage of development comes through bounding exercises, which, in the beginning, should be done for control rather than for strength. Later, strength (endurance) can

be included. The main exercises used at this stage (see HAYES, 2000) are:

- **Hopping exercise** - This should be done with both legs (R-R-R-R . . . or L-L-L-L ...). In the beginning, it is done for about 25m with each leg. As the jumper grows stronger and more confident, the distance is increased. The jumper's body should be upright throughout the hopping. Beginners should do two sets of 25m of hopping on Monday, Wednesday, and Friday (three days a week).
- **Step exercise** - This is R-L-R-L-R. . . . Again, the upright body and bounce in the legs should be emphasised. The beginner just reaches out as far as he or she can, being careful not to lead with the toes. The landing is flat-footed, with a "pawing" action just before the foot strikes the ground.
- **Hop-to-step exercise** - This exercise helps the jumper in changing from the hop to the step. The drill is R-R-L-L-R-R. . . . It is beneficial if two or more jumpers work together, as the competition tends to make the jumpers run faster and stretch farther. The triple jumper works on the jump phase by doing pop-ups, just like the long jumper. The pop-up should be done from a short approach and using the hang style, since the time in the air is too short for a good hitch-kick.

Running and jumping exercises

The next step is to incorporate a short run with the jump. Exercises helpful here (see HAYES, 2000) are:

- **Running over low hurdles** - The hurdles should be spaced at high-hurdle distance and "three-stepped." This is done at least twice a week.
- **Jumping over low hurdles** – The hurdles should be spaced apart to allow an even distribution, or the hop, the step, and the jump. The athlete should use a three- or five-step approach. This gives some speed but not enough to cause a total breakdown of the step phase. The emphasis should be on a "level flight" during each phase, keeping the body upright. If the jumper gets too high in a phase, the landing leg will break down, which curtails momentum for the next phase.

Arm action

The next step is deciding what type of arm action should be used. Some jumpers use single-arm action in the hop to maintain speed, and use a double-arm action in the step and jump (see HAYES, 2000).

At this stage, the athlete should be ready to attempt the complete triple jump. To start, a seven-step approach should be used (under control) and the hop phase should be stressed, with an easy step and jump included. The hop should be relatively short so it does not cause the jumper to break down. Also, the jumper should avoid getting too much height, because this causes a jarring effect and can lead to a breakdown, too. The head should be level, with the eyes focused straight ahead. The athlete should attempt to go through the complete triple jump to learn extension in each of the three phases (see HAYES, 2000).

Lengthening the approach

The final phase of instruction is to lengthen the approach. A distance of about 35m should be adequate. To begin with, a controlled run should be used. As the athlete is able to use it, the speed should be increased (see HAYES, 2000).

Timing, rhythm and kinesthetic feel

TODD (1998) points out that important to the development of any triple jumper is an understanding of the feel or rhythm of the event. The athlete must clearly understand how the event flows from one segment to the next when done correctly. It is crucial that the coach begin instruction with a whole-part-whole teaching philosophy. The novice triple jumper must develop the kinesthetic awareness of the whole movement before instruction progresses to the individual parts. Without knowledge of the whole, the individual parts are meaningless. Hand in hand with developing a "feel" for the event is the need for the athlete to get accurate feedback from the coach and from his/her personal feedback system (i.e., the sensory perceptions of the in-

dividual physical movements). This feedback, or knowledge of response, is vital to the learning process. Accurate knowledge of response can cut the learning time in half. According to TODD (1998), technique should not be the only goal of triple-jump drills; there must also be a focus on timing, rhythm and kinesthetic feel.

Training for the Triple Jump

Triple jump drills

HAYES (2000) recommends the following drills to be used as part of an overall triple-jump training programme:

- **Standing triple jump -** The athlete faces the long jump pit and places a mark about 6-7.5m from the pit. From this mark, the jumper does a standing triple jump and lands in the pit. Next, the hop, step, and jump distances are marked. Concentration should be on knee drive for the hop and step, and arm action (both arms driving) for the jump. The distance should be 2.4-3m for the hop, 3.4-4m for the step, and 3.7-4.6m for the jump. Anything between 9 and 11m is a good distance for male beginners. Women's distance should be proportional.
- **Hurdle hopping -** Four to eight low hurdles are placed 1.5-1.8m apart. The jumper, with the aid of the double-arm upswing, leaps over the hurdles with both legs together and with the knees brought up to the chest in order to clear the hurdle. As strength increases, the height and the number of hurdles can be increased. Hurdle height and the distance between the hurdles should be adjusted for individual jumpers.
- **Split-squat -** This is a squat jump in which the legs are alternated. The arm action should be disregarded because this is not a triple jump action. The front knee should be brought up close to about a 90° angle, with a slight bend in the back leg. Then the legs should be alternated.
- **Double-leg jump -** The jumper should drive off both legs with the use of his or her knees and ankles. As soon as the jumper is off the ground, the left knee is driven up as high as possible, beyond parallel with the ground. Landing takes place on both feet. Then the athlete should settle down and drive right back up this time, lifting the right knee as high as possible. The foot should be kept under the knee while using arms vigorously.
- **Hopping drill -** The jumper should stay on the same leg, with a single-arm action (unless double-arm action is normally used). As the jumper lifts off the jumping leg, he or she brings the thigh to parallel and, as that leg returns to the ground, the opposite knee comes from the behind (split) position and forward as it would in the step phase.

The following drills are the core of the triple-jump training programme. They help the jumper to learn to perform each phase of the triple jump correctly. At the same time, they give the jumper the thrill of competing. The drills emphasise each phase and the movement from one phase to the next.

- **Bench drill #1 -** The benches are about 30cm wide, so that good foot placement can be taught, and about 45cm high. The jumper bounces up on to the bench and then drives off. The sequence of this drill is hop-step-hop-step-hop-jump. The starting leg should be alternated so that both legs are developed equally. The sequence is: Right leg (take-off in front of the first bench) – right leg (landing on and take-off from the first bench) – left leg (landing and take-off from between the first and second bench) – left leg (landing on and take-off from the second bench) – right leg (landing and take-off from between the second and third bench) – right leg (landing on and take-off from the third bench) – both legs (landing after the third bench and take-off into the pit).
- **Bench drill #2 -** This drill develops the step phase and encourages a bounce action. It has the jumper stepping over the benches with another alternate step between the benches. The step between benches is a real jump step. The legs can be reversed in this drill, too. The sequence is: Left leg (take-off in front of the

first bench) – right leg (landing after the first bench) – left leg (landing and take-off in front of the second bench) – right leg (landing after the second bench) – left leg (take-off in front of the third bench) – both legs (landing after the third bench).

- **Bench drill #3 -** This is a pop-up drill. The athlete runs to and then jumps off of the bench into the pit. It requires only a short run and therefore does not fatigue the jumper. In fact, a five-step approach can be used for all the drills. The sequence is: Right leg (take-off in front of the first bench) – right leg (landing on and take-off from the first bench) – landing in the pit.

Each of the drills ends with the jump phase into the landing pit. The heels lead the jumper into the pit.

Weight training

Weight training is a major portion of the triple jumper's training routine. Weights should be lifted regularly – at least three times a week. HAYES (2000) proposes the following programme:

Knee extensions:	3 x 10 reps
Leg curls:	3 x 10 reps
Incline sit-ups:	3 x 15 reps
Leg presses:	4 x 10, 7, 4, 2 reps
Toe raises:	3 x 20 reps (using a 5 x 10cm board under the toes)
Half-squats:	3 x 8 reps (use one-half of body weight)
Split-squats:	2 x 10 reps (use one-fourth of body weight)
Knee raises:	3 x 15 reps
Step-ups:	3 x 10 reps (with heavy weight)

Developing a training programme

According to HAYES (2000), a training programme for triple jumpers could look as follows:

Early season (fall)

Monday:	Grass run (5-8km) + 100m-200m-300m-400m 200m-100m/jog same+ Weights
Tuesday:	10 x 200m, with 200 jog interval + Running stadium steps with weightjacket + Easy take-off drills (just to get the arm technique)
Wednesday:	8 x 300m, with 300m jog interval + 6 x 75m easy + Weights
Thursday:	Grass run + Running stadium steps + Take-off drill
Friday:	Grass run + Weights

In season

Monday:	Bounding: 3 x 25-100m of hopping (the regular hopping leg should be used twice and the other leg once; if an athlete is having trouble making the transition from one phase to the other, he or she should use 3 x 50m of R-R-L-L-R-R, as this incorporates the bounding and adds practice of changing from the hop to the step; also, this drill helps to improve the capabilities of each leg) + Running: 2 x 300m for endurance, 6 x 75m for speed + Weight lifting
Tuesday:	"Drill" day: Bench work (6 good drills of each of the 3 exercises) + Running 10 x 3 low hurdles set at high-hurdle spacing (10m between) + Running 6 x 100m or work on the actual approach + Running stadium steps (5 times wearing a weight jacket) + Practicing the actual triple jump take-off (at a reduced speed, correct technique is stressed, especially the correct arm action).
Wednesday:	The same basic workout as Monday, but running should be 5 x 25m, 5 x 35m, and 5 x 50m.
Thursday:	Same as on Tuesday.
Friday:	Same as Monday, except much more relaxed and easy.

Performance Development

Since the 1990s, performance development in the horizontal jumping events has stagnated. The current world record in the men's long jump (8.95m by Mike Powell (USA) in 1991) is over 20 years old and the world record in the women's long jump (7.52m by Galina Chistyakova (URS) in 1988) was set almost 25 years ago. Although the situation in the triple jump

is a little better, even here the current world records (men: 18.29m, Jonathan Edwards (GBR); women: 15.50m, Inessa Kravets (RUS)) were both set in 1995.

However, at least as far as the triple jump is concerned, OSOLIN (2001) thinks that considerable improvement is still possible. He holds that the potential of a triple jumper can be defined by doubling the athlete's long jump best and adding what he calls the athlete's PSP factor. This is calculated by doubling the athlete's long jump best and subtracting it from his/her triple jump best. For example: Jonathan Edward's PSP is arrived at by: 7.45m x 2 = 14.90m, 18.29m-14.90m = 3.39m.

According to this calculation, a top male long jumper with a best of 8.35m, would, given the correct training, be capable of 18.50m in the triple jump and thus achieve a PSP factor of 1.80m.

With a PSP factor of 2.60 m, which is an achievable target, 19m thus be reached by an 8.20m long jumper, if he can start the hop at a speed of 10.5 m/sec and limit the fall in acceleration to 9.5 m/sec for the step and 8.5 m/sec for the jump, producing increments of 7.22m + 5.60m + 6.18m (taking as ideal increments of 38% + 29.5% + 32.5%).

According to OSOLIN "it is universally known that an acceleration of 10.0 m/sec produces a long jump of 8m, of 9 m/sec a 7m, and of 8 m/sec a 6m result and that a triple jumper's hop should not be greater by more than one metre, theoretically, than his jump. The prime slot earmarked for improvement is of course the step; by equating its length with that of the jump even a 7m long jumper should be ideally capable of 19m, with increments of 7m + 6m + 6m. It's within the realm of an athlete's physical capabilities."

From the current point of view, OSOLIN's prognosis seems interesting on a theoretical level but there is nothing in practice to support his calculation. The last triple jump over 18m was achieved in 1996 (18.09m by Kenny Harrison (USA)). So, before thinking of jumping 19m, it would be more realistic to think about how to achieve more 18m+ jumps and to stabilise performances.

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