

# Individual approach in improving the technique of triple jump for women

By Ognyan Miladinov, Peter Bonov

*Most, if not all, elite women triple jumpers use opposite arm movements, known as the single arm technique, with individual peculiarities between athletes. After analysing 54 jumps by 23 top female jumpers, the authors conclude that even the current best jumpers have some 'improvement reserve' because of weaknesses in the 'hop-step' link related to this technique. The main purpose of this study was to determine the effect of 'mixed arm movements', a combination of single and double arm techniques, in which the "hop" and the transition to the "step" are performed with opposite movements of the arms and legs and then, during the "step", the arms are returned back together so that the "jump" is performed with both arms swinging forward. A one-year long pedagogical experiment with a female triple jumper (personal best of 13.78m) to introduce the change in technique is described, including the special exercises used and details of the applied training load. The authors conclude that the change led to a significant improvement in performance (to 13.98m) and predict the technique will be more widely used in the future. They also conclude that the approach used for introducing the change was efficient. This paper was awarded equal third place in the 2004 European Athletic Association Science Awards.*

## ABSTRACT

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## Introduction

**T**he women's triple jump is recognised as one of the most attractive disciplines in the athletics programme. Competition in this event is extremely tough and this has led to continuous improvements in the results. At the time this article was written, there were at least three athletes capable of improving the world record at almost any opportunity.

Performance in the triple jump is a quantitative expression of factors of both primary and secondary importance. The mastering of a rational and effective technique is a precondition for the greatest realisation of the motor potential of a particular jumper. Studies by many authors<sup>1, 2, 3, 9, 10</sup> have shown that the movements of the swinging parts of the body are among the most important factors in successful jumps. Studies proving the mechanism and the efficiency of the swinging movements have been conducted<sup>4, 6, 8</sup>. The contribution of the separate swinging parts in accelerating the body and the effect of the support in performing the triple jump have been calculated. It is proved that to be efficient the swinging movement has to be with high amplitude and there has to be a sudden stop of the swing at the end of the movement.

In the men's triple jump, we see two classic techniques:

1. With a simultaneous movement of the arms in one or more of the phases (the 'hop', the 'step' and 'jump'), known as the double arm action or double arm swing technique. Typical representatives of this technique include Michael Conley (USA), Christian Olsson (SWE) and Demitriy Valyukevich (BUL);
2. With opposite movements of the arms, known as the single arm action or single arm technique. One of the brightest representatives of this technique was Khristo Markov (BUL).

In some of his jumps, the current world record holder, Jonathan Edwards (GBR) per-

forms opposite movements with the arms in the 'hop' phase, returns both arms down and back in the 'step' and swings them simultaneously in the "jump".

Our preliminary observations have shown that only the single arm technique is currently used in the women's triple jump, but there are slight differences in the performance of this technique by the different jumpers.

## Purpose of the study

The main purpose of our work is to study the effect of the application of methods for studying and improving the women's triple jump by using mixed arm movements.

## Tasks

To realise our main purpose we have set the following tasks:

1. Analysis of the performance technique of elite female triple jumpers (54 competition jumps by 23 competitors, the analysed jumps were between 13.52m and 15.36m).
2. Analysis of the performance technique of a female triple jumper using mixed arm movements.
3. Conduct of a pedagogical experiment for studying and improving technique in the triple jump by using mixed arm movements on a highly qualified female jumper.

## Methods

The following methods have been used in the study:

1. Literature Analysis - data on the problems of technique in the triple jump.
2. Videometry - Complete training jumps and special exercises for studying and improving triple jump technique were recorded with a "SONY" video camera (at 25 frames per second).
3. Computer Analysis - Processing of the video materials with specialised software, gave us the opportunity to:
  - analyse the technique of performance in a dynamic regime using slow-motion replay and studying the jump frame by frame;
  - produce cinegrams of the jumps and special exercises;

- process the separate frames in a respective scale by placing markers and calculating some kinematic parameters: length of the separate parts of the jump, speed of movement, angular parameters.
- 4 Pedagogical Experiment. To study the effect of applying special exercises for improving triple jump technique we applied special exercises with mixed movement of the arms for the duration of a sport-competition year (September 2003-June 2004).

### Subject

The subject of the study was Nina Serbezova (BUL), whose personal best at the beginning of the experiment was 13.78m. Before the experiment, she performed the triple jump with the single arm technique.

### Analysis of the results

#### Analyses of the performance technique of elite female triple jumpers

The analysis of the literature and our expert judgment of the technique of almost all contemporary triple jump competitors (men and women) shows that the performance of the 'jump' from the board is the same in all styles of movements, namely with opposite arm

movements. However, the connection between the 'hop' and the 'step' is a crucial moment in a jump and for this reason we made a detailed analysis on the link 'hop-step'.

Tereza Marinova (BUL) is a typical representative of the classical performance of the triple jump using opposite arm movements (Figure 1). The 'hop' is characterised by an active take-off from the board and very high amplitude of the arms and legs in the flight stage after the legs pass each other (Frame 7). When performing the 'step', the right leg is actively moved forward together with the left arm. In our opinion, the left arm is not extended enough at the elbow joint (Frames 11-13) and is lifted higher than the head, which we consider an error. In performing the third takeoff (for the 'jump'), the arms pass each other slightly flexed at the elbow joints, and their movement is similar to the movements in the first takeoff.

The jump of Tatyana Lebedeva (RUS) is performed with very high speed, which gives her a great advantage (Figure 2). As in the previous example, Her arms and legs pass each other with very high amplitude during the 'hop' phase. However, in her second takeoff (for the 'step'), she flexes her arms at the elbow joints (Frame 8) and this flexed posi-



Fig. 1: Tereza Marinova

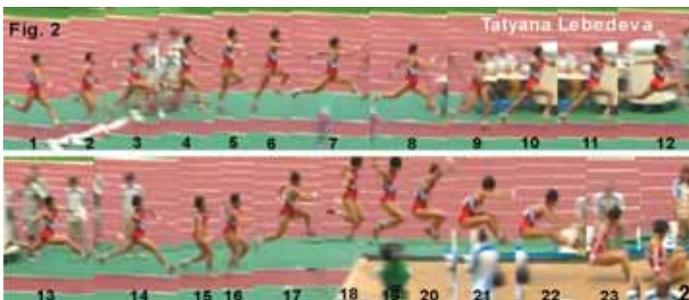


Fig. 2: Tatyana Lebedeva

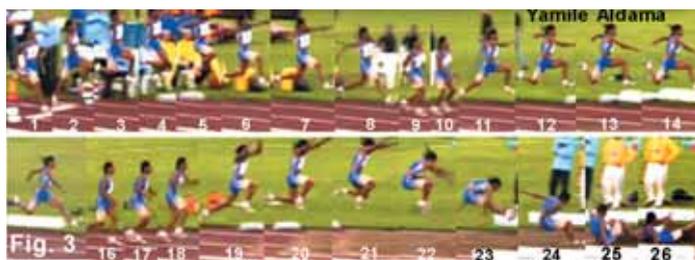


Fig. 3: Yamilé Aldama

tion continues in the flight phase of the 'step' (Frames 11-14). The arms swing flexed and in the third takeoff, and afterwards, the right arm goes back (Frames 17-19), and the body remains in a flexed position.

The performance of the 'hop' by Yamilé Aldama (SUD) is distinguished by its exceptionally active pass through the board (Figure 3). When the arms pass each other in the flight phase, the left arm goes up, to the side and forward, while the right arm goes to the side and back. Both arms are extended at the elbow joints (Frames 3-6). The activity in passing each other and the legs is lower and, as a result, the amplitude of the arms in Frame 7 is greater than of the legs. In the next takeoff, for the 'step', (Frames 9-11) the arms make a very sudden swinging movement (left arm down and back, right arm down and forward).

The difference between Aldama on the one hand and Marinova and Lebedeva on the other, is that both Aldama's arms are almost fully extended at the elbow joints. Later, in the flight phase of the 'step', Aldama tries to hold the position of the arms and legs longer (Frames 11-13). However, the body loses its balance, its stability is disturbed and the right arm goes passively down while the left arm manages to stay extended back (frames 12-15). As a result of this loss of balance, the takeoff for the 'jump' is performed almost without any swinging movement of the right arm.

Our calculations for some jumps by Aldama and Lebedeva have shown the following:

With an exact step on the board, Aldama had a measured result of 15.11m. The distance between the takeoff point for the 'jump' and the sand was 0.44 m (Figure 4). In other words,

the sum of the length of the 'hop' and the 'step' was 10.56m. This means that the length of the 'jump' was 4.55m, which is very short for a competitor of Aldama's calibre (only 30.11% of the result). For most contemporary triple jumpers, the 'jump' is 34%-36% of the total distance covered. In our opinion, more efficient performance of the swinging movements in the transition 'hop-step' (namely - actively returning the right arm forward in Frames 12-15 of Figure 3)

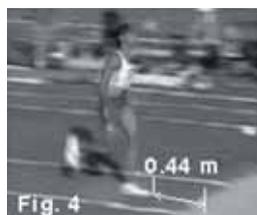


Fig. 4: Yamilé Aldama

in the 'jump', which would make it possible to extend its length to 5.00-5.10m and give an overall result better than the current World Record.

The analysis of a competition jump of Lebedeva has shown the following:

Again, with an exact step on the board and a measured result of 15.18m, the distance between the takeoff point for the 'jump' and the sand was 1.12m (Figure 5). The sum of the length of the 'hop' and 'step', therefore, was 9.88m and the length of the 'jump' was 5.30m, which is 34.91% of the overall result. We think that with a more rational performance of the swinging movements in the 'step' phase



Fig. 5: Tatyana Lebedeva

(namely extending the left arm forward in Frames 10-14 of Figure 2), its length could be increased significantly. This would have a positive effect on the

length of the link 'hop-step' and on the overall result, which would bring it very close to or even beyond the current World Record. This could be achieved by performing a swing with a fully extended left arm in the takeoff for the 'step' and keeping the arm in an extended forward position longer.

### Analysis of the performance technique of a female triple jumper using mixed arm movements

Analysis of the cinegrames of multiple recorded jumps by the subject of our study Nina Serbezova has shown the following:

The performance of the jump from the board (the 'hop') is characterised by active movement forward (Figure 6). The following pass of the arms and legs is with a high enough amplitude and a not bad synchronous movement of the jumping (right) leg and the left arm. The position of the body parts on Frames 6-8 is demonstrative, as the thigh of the right leg is moving parallel with the left arm, and the leg makes a pawing movement forward and down. The problems in the performance of the overall jump appear in the 'step'. The right arm swings flexed at the elbow joint and is lifted higher than the head (Frames 9-12). As a result of this, and despite the right arm being lifted actively back and up, the takeoff is troubled and the knee and pelvis joints of the jumping leg (the right leg) are not fully extended (Frames 9-10). Furthermore, the body is losing stability and the left arm is starting to fall passively down earlier (Frames 12-15). At the same time, because its position is too high, the right arm is slowing its active downward

swinging movement. Frame 15 shows the left arm already at the thigh of the left leg, while the right arm is still in front of the body. At this moment, the angle between the right arm and the middle vertical axis of the body should be equal to the angle of the left arm and the middle vertical axis of the body. The takeoff for the 'jump' is practically without the active participation of the arms. This increases the load on the swinging (left) leg in the takeoff and leads to an early lowering of both legs in the preparation for landing (Frames 23-24).

We should note that no special exercises or instructions related to technique tried could help and these negative peculiarities appeared in almost every attempt.

We suggest that the right arm should not be lifted so high as shown on Frames 11-13, and that the takeoff for the 'step' (Frames 8-10) would have a much more explosive character if we could find a way to stop the arm from suddenly moving forward at the moment it reaches the horizontal position. This can happen only if we establish the motor task to return the right arm back after it finishes the swinging movement.

This radical change of such an important element of triple jump technique is risky. From both the theory and the practice, it is known that it is much easier to learn a new motor ability than to replace a motor habit with another. Despite this, we decided to conduct the experiment described below.



Fig. 6:  
Nina Serbezova

## Pedagogical Experiment

The pedagogical experiment took place in the period of September 2003 to June 2004. We decided to make the following change in the technique: After the opposite movement of the arms and legs in the 'hop' and after the arms pass each other in the takeoff for the 'step', the same arm as the jumping leg (right), instead of holding its position forward, should return down by the side and back in such way that before the takeoff for the 'jump' both arms would be back, down and extended in the elbow joints.

The new feature in the technique led to significant change in the methods for studying and further improving the overall jump and its separate elements. Firstly, we began to do horizontal multiple jumps exercises (multiple jumps) with opposite movement of the arms (Figure 7) and with double arm swings (Figure 8). Until the beginning of the experiment, the multiple jumps were performed only with opposite movement of the arms. The main task in horizontal multiple jump exercises with double arm swings is to avoid lifting the arms forward above the horizontal position after the body leaves the ground on each takeoff.

For studying and further improvement of the new features of the technique by our subject athlete, we used the following special exercises:

- Imitation exercises, while standing or walking, for memorising the movements of the arms in the performance of the link 'step-jump'
- 'Step-jump' from standing position or with 2-4 running steps for acceleration (Figure 9)
- 'Step-step-jump' from standing position or with 2-4 running steps for acceleration (Figure 10)
- 'Hop-step' with 2-4 running steps for acceleration (Figure 11)
- Triple jump from standing position starting with the both legs (Figure 12)
- 'Hop-step-jump' from standing position (Figure 13)
- 'Hop-hop-step-jump' from standing position or with 2-6 running steps for acceleration (Figure 14)
- Triple jump with mixed movement of the arms and acceleration from 4-16 running steps.

We have established the following main requirement for the technique of the special exercises: When performing a 'step' (i.e. when changing the right leg with the left) the right arm is to return actively backwards so the next takeoff is performed with a simultaneous swing of both arms. The lighter area of Figures 7-14 shows this exact part of the performance of the exercises.



Fig. 7: Multiple jumps with opposite arm movement



Fig. 8: Multiple jumps with double arm swings



Fig. 9: Step jump from standing position



Fig. 10: Step-step jump from standing position



Fig. 11: Hop-step with 2-4 running steps



Fig. 12: Triple jump from standing position



Fig. 13: Hop-step-jump from standing position



Fig. 14: Hop-hop-step-jump from standing position

The exercises were applied in 2-3 training session weekly during the autumn-winter and the spring-summer preparation period. In the competition period, the main exercises performed were whole triple jumps with different acceleration distances.

The volume of the different training means, applied in the period of the pedagogical experiment is shown in Table 1.

### Results of the pedagogical experiment

Analysis of the mixed arm movement triple jump technique by the subject athlete

The analysis of the movements of the whole triple jump after applying the selected methods for technique improvement has shown the following:

1. The performance of the 'jump' from the board is, in principle, the same as with the opposite movement of the arms - with a fast and active takeoff and high amplitude of the arms and the legs in the flight phase (Frames 3-7).
2. Just 4-5 months after the beginning of the experiment, there was a significant improvement in the dynamics of the second takeoff (the 'step'). This became significantly more explosive and the subsequent movements of the arms were ensuring more stability of the body and more efficient preparation for the takeoff for the 'jump'. In Frame 12, it can be seen clearly that shortly after the push from the support, the right arm is forward, almost fully extended at the elbow joint and the wrist is almost level with the shoulder. Right after

Training means	Number of repetitions
Imitation exercises	520
Step-jump	63
Step-step-jump	81
Hop-step-jump from standing position	127
Hop-hop-step-jump	47
Triple jump with 2 stride approach	32
Triple jump with 4 stride approach	50
Triple jump with 6 stride approach	56
Triple jump with 8 stride approach	29
Triple jump with 10 stride approach	16
Triple jump with 12 stride approach	27
Triple jump with full approach	39

Table 1: Volume values of the special exercises for improvement of triple jump technique using mixed arm movements

that, the right arm starts to move down, from the side and back, while the left arm tries to keep itself extended backwards as much as is possible (Frames 13-15). At the same time, the knee of the left leg remains flexed and the thigh is almost horizontal. Significantly positive, in our opinion, is the moment (Frame 15) when the left leg starts a pawing movement and is actively going down for the takeoff, and both arms are back and ready to begin accelerating in a swinging movement down and forward. All this helps the jumper to perform a very active takeoff for the 'jump'. Because the efficiency of

the 'jump' defines the efficiency of the landing in the pit, this explosive takeoff for the 'jump' is positively effecting the movement of the legs forward for the landing. Now the two legs have an almost horizontal position as the body prepares for landing (Frame 25). In this way the pelvis touches the sand at the place where the heels have already touched and no valuable centimetres are lost from the measured distance.

The positive tendency of the changed technique lasted throughout the whole competi-

Year	2002/03	2003/04
Training means		
1. 20-100m sprints (km)	6.89	8.47
2. Vertical jumps (number)	4554	5255
3. Horizontal multiple jumps (number)	7263	6918
4. 150-300m runs (km)	23.40	29.60
5. Approach distance runs (number)	102	82
6. Jump exercises for technique (number)	84	318
7. Triple jump from different approach distances (number)	374	197
8. Strength training (tons)	435	495

Table 2: Volume values of the preparation means in the year before and the year during which the pedagogical experiment was conducted

Year Indices	2002/03	2003/04
1. Triple jump from standing position (m)	8.40	8.70
2. Quintuple jump from standing position (m)	14.35	14.74
3. 30m from standing start (s)	3.78	3.78
4. 40m from standing start (s)	4.79	4.82
5. 60m from standing start (s)	7.23	7.10
6. Half-squat with weight-bar (kg)	190	140
7. Squat with weight-bar(kg)	100	110
8. Jumps from half-squat with both legs (kg)	100	90
9. Half-squat on one leg (kg)	140	120
10. Forward toss with shot (m)	13.68	14.80
11. Competition result (m)	13.78	13.98 (14.10)

*Table 3: Values of the indices for speed-strength preparation for the year before and the year during which the pedagogical experiment was conducted*

tion season and had a positive effect on the results achieved. The subject athlete's best result for the year was 13.98m, and the real measured distance (from the place of starting the "hop") was 14.10m, which is a high-class result.

#### Analysis of the data from the pedagogical experiment

Periodically during training, we set markers on the runway in order to determine the change in the proportion between the different elements of the triple jump ('hop', 'step' and 'jump'). After recording the training jumps, we calculated the length of each part. We have determined that most of the jumps had small differences between the 'step' and the 'jump' - 35% for the "hop", 31% for the 'step' and 34% for the 'jump'. For comparison, when performing a jump with opposite arm movement in the year before the experiment, almost all measured jumps were with proportions 35.5%-29%-35.5%. This shows that the whole jump became much more compact, which allows for the retention of more of the body's velocity.

To check if there is an explanation other than the change in jumping technique for the

improved performance, we made a comparison between the applied volumes of the main training means in the year before the experiment and the year during which the experiment was conducted. In planning the training workload for the year 2003/04, we were predicting an increase in the volume of the exercises for developing maximal running velocity and in the volume of the horizontal jump exercises. It was our opinion that there had not been enough quantity of these in the previous year.

The analysis of the data from Table 2 has shown the following:

During 2003/04, the volume of sprinting (1), vertical jumps (2), runs of 150-300 metres (4) and strength preparation (8) was slightly higher than the previous year. The volume of horizontal multiple jumps (3) was slightly less during 2003/04. In the year of the pedagogical experiment the number of special exercises for studying and improving the new way of jumping (6) was greatly increased. At the same time, the number of complete triple jumps from different acceleration distances (7) decreased. All this shows that the only significant increase in the volume indices for the two years in question is the larger number of special exercises for studying and improving the new features in the technique.

The high level of the indices for speed-strength preparation is a precondition for achieving good results. The analysis of the data from Table 3 has shown that in the control exercises representing the speed abilities (3 and 4) the results are the same in both periods. More significant is the improvement of the 60m time from a standing start in the second year (5). On the other hand, the indices for strength preparation (6, 7, 8 and 9) had lower values in the year of the pedagogical experiment. We should mention that during 2003/04 we intentionally decreased the weights of most of the weight training exercises and aimed to perform them more dynamically. The difference in the 'half-squat with weight bar' (6) was 50kg.

Performances in the control exercises triple jump and quintuple jump from a standing position (1, 2) and forward toss with shot (10) showed significant improvement during the second year. Our explanation is, that these exercises, including the improvement of the swinging movement with both arms when throwing a shot forward, are directly connected with the technique changes we introduced.

All this gives us reason to think that the improvement in triple jump performance is mainly because of the successful application of the methods for studying and improvement of the technique for jumping using mixed movements of the arms.

### Conclusions and recommendations

1. After the analysis of the technique of elite women triple jumpers, we concluded that all female competitors use opposite movements of the arms, the single arm technique, and that there are individual peculiarities in the performance by the different competitors. In our opinion, the best female triple jumpers in the world have some 'improvement reserve' in the 'hop-step' link, which gives us reason to predict improvements in the world-wide level of performance.
2. For the first time in our knowledge, we have applied a technique for women in

order to improve the link 'hop-step' in the triple jump with the following typical movements:

- When jumping off the board, the arms move opposite the legs and the pass of the arms and legs in the flight phase of the 'hop' is opposite;
  - When performing the 'step' the same arm as the jumping leg is returned back and the swinging move in the 'jump' is made simultaneously with both arms.
3. The results of the pedagogical experiment has proven the efficiency of the methods for studying and improving the technique for performing triple jump with mixed movement of the arms.

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