

2D AND 3D MOTION ANALYSIS

Analysis of the movement

Pole vault

María Sánchez Aranda

2013

MASARYK UNIVERSITY

DISTANCE

Taking as a reference the height of the bar (5m, pink line) we will calculate how many pixels correspond to this distance.



We will use this equation to know the distance between two points:

$$|\overline{AB}| = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$$

First we calculate the distance in pixels of the height:

	x	y
Point 1	25	-1570
Point 2	25	-260

Distance xy = 1310

5 meters → 1310

Once we know the relation between pixels and meters we can calculate the distance of the step of the jumper:

	x	y
Point 1	2675	-1950
Point 2	2120	-1945

Distance xy = 555,022

Now with the rule of 3 we can calculate how many meters are those pixels:

$$\begin{array}{l} 1310 \\ 555,022 \end{array} \begin{array}{c} \longrightarrow \\ \longrightarrow \end{array} \begin{array}{l} 5 \\ x \end{array} \left. \vphantom{\begin{array}{l} 1310 \\ 555,022 \end{array}} \right\} x = (5 * 555,022) / 1310$$

Distance of step (x) = 2,118

SPEED

Now, knowing the distance of step and the time spent on those steps we can calculate the velocity of the entrance to the last step)

$$\begin{array}{l} \text{Time} = 1,20 \text{ seconds} \\ \text{Distance} = 6,354 \text{ meters (3 steps)} \end{array} \left. \vphantom{\begin{array}{l} \text{Time} = 1,20 \text{ seconds} \\ \text{Distance} = 6,354 \text{ meters (3 steps)} \end{array}} \right\} v = e/t = 6.354/1.20 = 5,295 \text{ m/s}$$

Velocity = 5,295 m/s

ANGLES

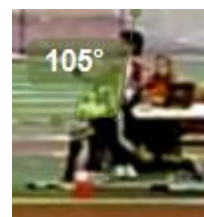
To calculate the angles I have used the program Kinovea, which helps you to realize good video analysis. It can calculate the angles, you just have to point the centre of the angle and it gives you the number.

I have calculated the angles in the moment of the running, of the last step and of the invert.

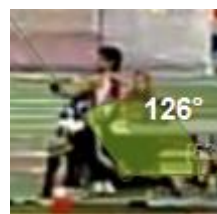
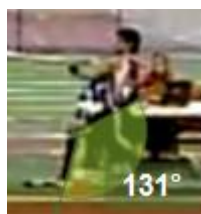
Running

Here we can see the different angles during the running in the step before the last one.

First of all, we can observe that the angle of the trunk is more than 90°. If it was a speed running like 100m it would be a bad measure because the trunk would be too backwards, but in the pole vault it is perfect because we are talking about the previous step to the last, so you have to open a space between your hands and your trunk to have a better position during the last step.



Next two photos are about the legs. We can say that their position is quite good because the front leg, the knee, is quite up, so it is perfect to have more space to push for the next step, and in the back leg we can see that has finish the impulse and it is starting to go forward.



Last step

Here we can see the position of the athlete at the moment of the jump. We can observe that the back leg is quite stretched. This is good because it means that he has pushed at the right moment to go forward. The front leg is also in a very good position because it helps him to go forward. On the other hand, the angle of the arms should be a little bit more wide, because it would help more to the athlete.



Invert

The angle of the perfect invert is 180°, here this athlete just arrives to 155° but it is also quite good, because it will help him perfectly to go very high. We can also see that he is inverted in the perfect moment, just a little bit before the pole is completely straight. Being in that position at that time is great because when the pole goes straight he will start to help with his arms and start turning to go the bar in ventral position.

