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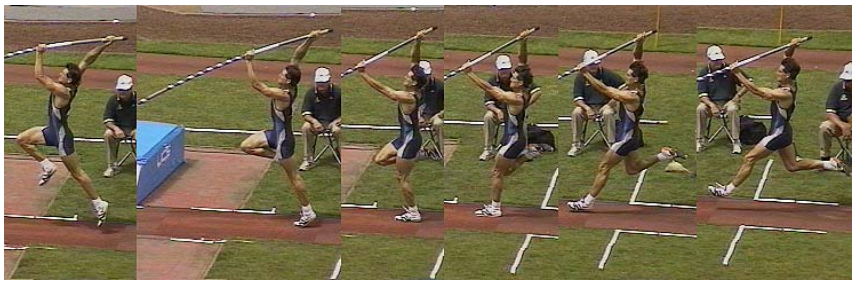

Eight Elements of an Effective Takeoff

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Eight Elements of an Effective Takeoff

The takeoff is the most important phase of the pole vault. The takeoff phase begins when the vaulter's takeoff foot strikes the runway at the end of his last step, and it ends at the instant of takeoff, the instant when the takeoff foot is no longer in contact with the runway. The vaulter's actions during the takeoff greatly affect the vaulter's actions during subsequent phases of the vault and ultimately affect the height achieved by the vaulter. The importance of the takeoff phase may be best illustrated by examining the factors that determine pole vault performance. Mechanically, work and energy principles can be used to derive an equation for the maximum height achieved by a vaulter:

$PE_{apex} = TE_{to} + U_{to\text{-}rel} - E_{lost} - KE_{excess}$

where,

PE_{apex} = potential energy of vaulter at the apex of vault

TE_{to} = total mechanical energy of vaulter and pole at takeoff

$U_{to\text{-}rel}$ = mechanical work done by vaulter from takeoff to pole release

E_{lost} = mechanical energy lost from takeoff to pole release

KE_{excess} = excess kinetic energy at apex of vault

This equation essentially states that the maximum height achieved by a pole vaulter (PE_{apex}) is determined by:

• how high his center of gravity is and how fast he is moving at takeoff (TE_{to});

• how much he pulls, pushes, and swings himself upward on the pole during the vault ($U_{to\text{-}rel}$);

• how much energy is lost or not converted to potential energy during the vault (E_{lost} and KE_{excess}).

An effective takeoff is one in which the vaulter maintains or increases the energy developed during the approach run while minimizing energy losses during this and subsequent phases of the vault. Additionally, at the end of an effective takeoff the vaulter is in a position which improves his ability to do work on the pole during the subsequent pole support phase. Four criteria thus determine whether an action contributes to an effective takeoff, does the action help to…..

…increase energy coming into the takeoff?

…decrease energy lost during the takeoff?

…increase work done (and thus increase energy) during the takeoff?

…increase the ability to do work following the takeoff?

The eight elements listed below each meet one or more of these criteria. The first two elements are really not part of the takeoff phase but are included in the list since they greatly influence the effectiveness of the takeoff.

1. RUN FAST

A fast approach run increases the energy the vaulter has to build on at the start of the takeoff phase. Elite male vaulters run faster than 9.0 m/s during the last five meters of their approach runs. There is a strong correlation between crossbar height cleared and approach run velocity.

2. TAKE A LONGER SECOND TO LAST STEP AND A SHORTER, QUICKER LAST STEP

The longer second to last step lowers the center of gravity slightly to set up for a jumping takeoff. The shorter and quicker last step reduces the downward velocity of the center of gravity when the takeoff foot touches down at the start of the takeoff phase. This in turn reduces the braking force which acts on the takeoff foot as it first hits the runway.

3. MOVE THE HANDS UPWARD THROUGHOUT THE TAKEOFF PHASE

This movement contributes to the vertical velocity of the vaulter at takeoff. It also increases the height of the vaulter's center of gravity. A faster velocity and higher center of gravity increase the total energy of the vaulter at takeoff. Finally, higher hands result in a higher plant and greater pole angle both of which are beneficial for getting the pole to rotate forward. Look at the positions of Jeff Hartwig's right hand in pictures 2, 3, 4 and 5. Throughout the takeoff his right hand is moving upward.

4. DON'T LET THE POLE STRIKE THE BACK OF THE BOX UNTIL YOU ARE ON YOUR TOES

Delay the pole strike (the instant the pole hits the back of the box) until just before the instant of takeoff. If the pole strikes the back of the box earlier you may be yanked off the ground by the pole before you have finished your jumping action off the ground. The work you are able to do by pushing against the ground during the takeoff phase is reduced and you will not have as much energy at the instant of takeoff. Look at pictures 2 thorugh 6. The instant just before the takeoff foot hits the ground is shown in picture 2. An upward but backward (braking) reaction force acts on the takeoff foot when it first touches down in picture 3. In picture 4 the reaction force acting on the foot is primarily upward. In picture 5, the reaction force on the foot is an upward and forward propulsive force and Jeff is now up on his toes. Pole strike occurs at or just before this instant.

5. PLANT THE POLE WITH YOUR TOP HAND DIRECTLY ABOVE THE TOES OF YOUR TAKEOFF FOOT

At the instant of pole strike, the top hand should be directly above the toes of the takeoff foot. This relates to the previous element. It allows you to maintain an upright posture throughout the takeoff phase and it will enable you to be on your toes when pole strike occurs. Look at picture 5.

6. START THE POLE BEND BY PUSHING AGAINST THE POLE AT A RIGHT ANGLE WITH YOUR LOWER HAND

This action occurs at pole strike and is just a continuation of the forward and upward movement of the hands which takes place throughout the takeoff phase. The force exerted by the lower hand greatly reduces the compressive force required to buckle the pole to initiate its bending. This buckling force is supplied by the top hand (it's the force exerted by the top hand and directed through the butt end of the pole towards the box). If the buckling force is too great energy will be lost. The lower hand only pushes against the pole for a short period following the takeoff. Do not prolong the pushing action of the left arm for too long.

7. MAINTAIN A TALL UPRIGHT POSITION THROUGHOUT THE TAKEOFF PHASE

The upright posture of the trunk helps to increase the height of the center of gravity and it increases the height of the pole at the instants of pole strike and takeoff. An upright position of the trunk at takeoff sets up the vaulter to do more work on the pole during the pole support phase following takeoff by enabling the trunk to swing through a greater range of motion during the vault. If the vaulter is leaning backward at takeoff, this range of motion (and thus the potential to do work and increase energy) is reduced.

8. JUMP OFF THE GROUND

Pole vaulting is a jumping event. The average takeoff angle of elite male pole vaulters is about 18°. This is slightly higher than the takeoff angle of elite male triple jumpers (~15°) and slightly lower than the takeoff angle of elite male long jumpers (~20°). Look at pictures 5 and 6. Jeff is not just running off the ground, he is jumping off the ground. To jump off the ground effectively, the body must move through a large distance while it is on the ground during the takeoff phase. Look at pictures 2 and 6 and see how far Jeff's body has moved forward (and upward) relative to his takeoff foot (or relative to the guy sitting in the chair behind him).