Seven Key Positions to Assess Jumping Mechanics

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This document provides seven key positions during a jump that can provide a lot of valuable information about how a horse utilizes its body to execute the jumping movement. Each horse is an individual and will utilize different strategies based on its conformation, velocity, rider inputs, past experiences, strengths and weaknesses, and so on.

This article covers seven key positions that can provide critical insights about the strategies a horse is using to jump as well as help to diagnose performance issues. I collected videos of the two horse-rider combinations back in 2015 (FEI 1.45m speed class).

The coloured lines indicate the approximate trajectory of each horse/rider's center of mass as they complete the jump. I selected this comparison because of the different approach strategies for the bay horse (blue line) vs the grey horse (red line), which ultimately impact the jump trajectory and associated mechanics.

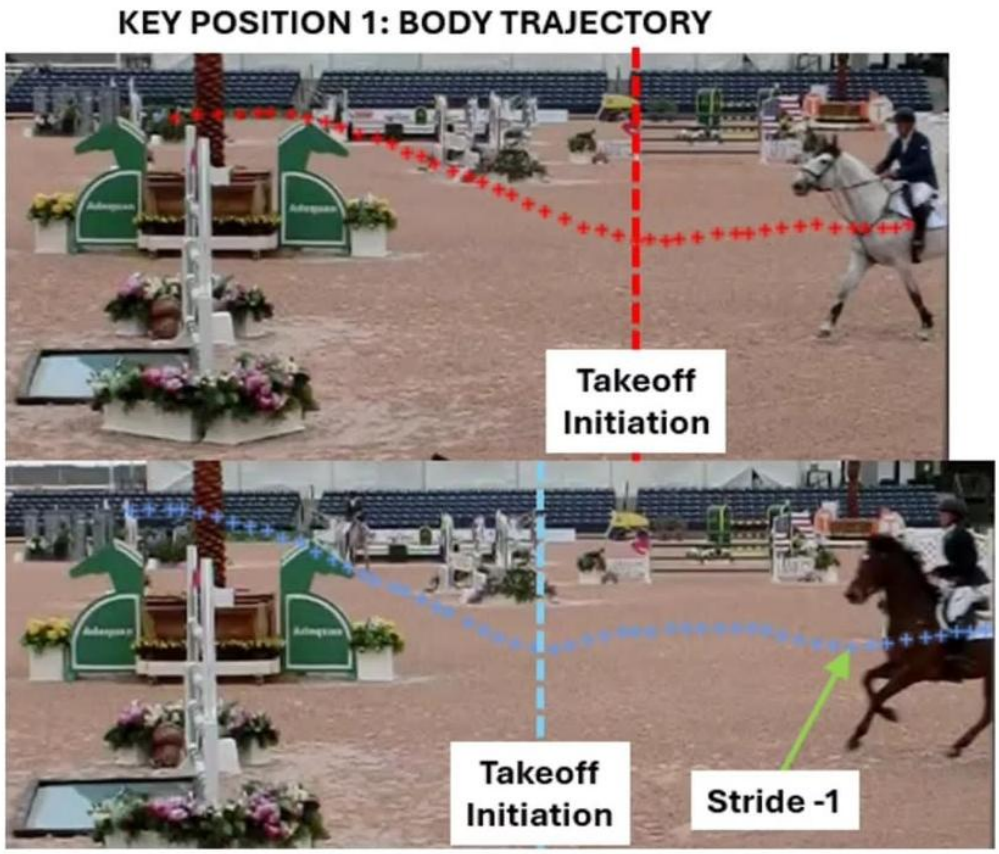
This is just one jump, with two very different rides/approaches, so it is impossible to draw conclusions about each horse's preferred jumping mechanics. However, this comparison does highlight the key positions that I find valuable when assessing a take-off as these moments in time provide a lot of detail about the horse's strategy to 'solve' the jump in front of them.

This is a simple overview and does not touch on many important topics (the rider's mechanics, the horse's head & neck and their role in amplifying or attenuating vertical forces, the transfer of force from the front to hind end, pretension and stiffness, etc). I hope to touch on these topics in the future. For a more in depth look at jumping biomechanics I would suggest "Biomechanics and Physical Training of the Horse" by Dr. Denoix.

KEY POSITION 1: BODY TRAJECTORY

The grey is approaching at a greater velocity, much longer stride length (note the last stride is not fully visible in the shot), shallower drop of the body, and will ultimately take off further from the jump.

The bay is approaching at a slower velocity, on a shorter stride, and with the body going through a greater vertical range of motion.



KEY POSITION 2: FRONT TRAIL LEG CONTACT

All horses will decelerate at the base of the jump to some extent (as demonstrated by placing the hooves out in front of the body and a more acute angle of the third metacarpal bone). This deceleration is necessary as it takes time to get the body into the correct position and to 'load' the tissues to produce the large forces needed to convert horizontal velocity into vertical velocity and project the body into the air.

The grey does not decelerate aggressively (indicated by a moderate third metacarpal contact angle) as the goal for this horse will be to i) minimize speed loss to cover the width of the jump (taking off further away) and ii) to prioritize force generation through the stretch and then rapid shortening of muscle and tendon in the front legs/shoulders.

Conversely, the bay, due to the closer positioning to the jump necessitating a steeper takeoff angle, will need to decelerate the body more aggressively (as indicated by a more acute angle of the third metacarpal bones relative to the ground) to provide more time to i) rotate the body back and away from the jump and ii) to provide muscles and tendons in the front end more time to generate the required forces.

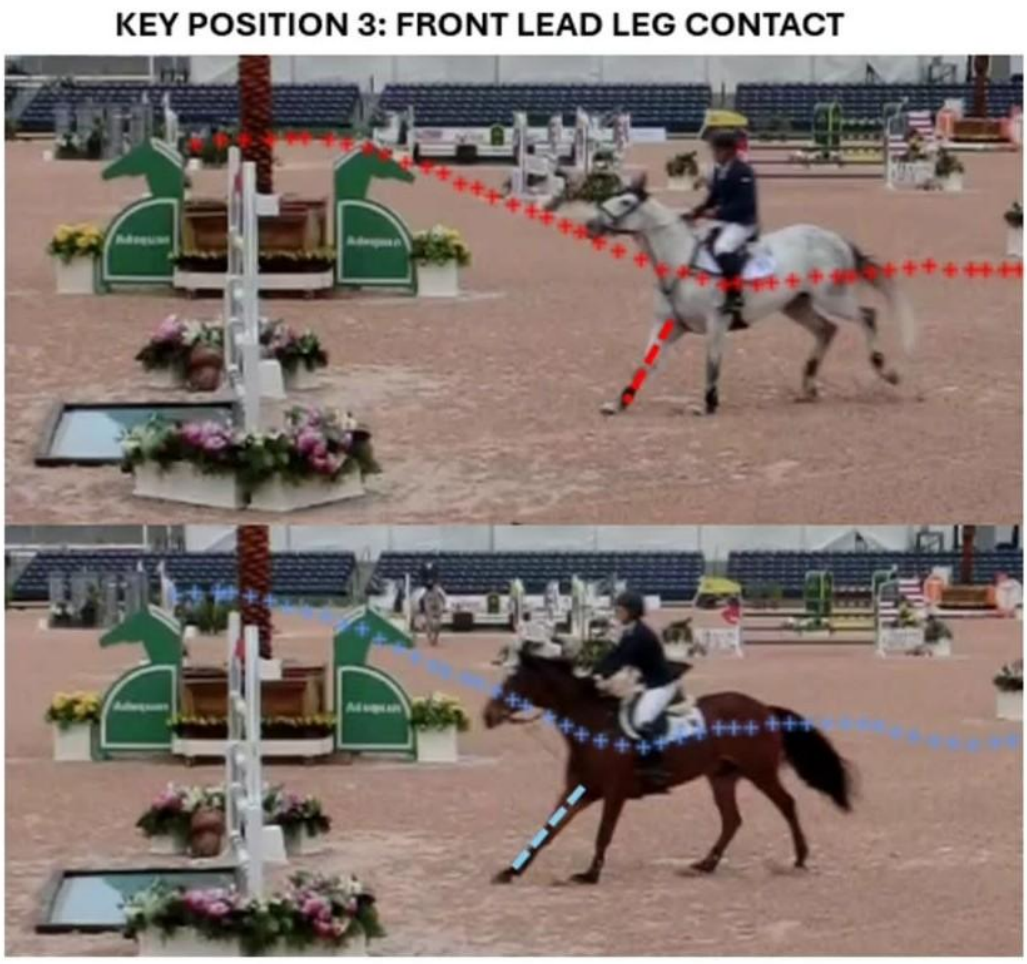
KEY POSITION 3: FRONT LEAD LEG CONTACT

Similar trends for the leading front limb.

A note on jumping ‘styles’:

Horses that prefer a ‘SPEED’ style of jumping tend to ‘attack’ the ground with a faster lowering speed and amortization, in concert with a higher approach velocity. Usually there is a moderate to shallow amount of flexion from the hind end. Anatomically, they should possess stiffer tendons and utilize faster ground contact times as they rapidly store maximal strain energy then release it to generate high impulse.

Horses with a ‘PATIENT’ style will have a slow to moderate lowering speed and amortization, in parallel with slower approaches, and prefer more hind end flexion at the base. Theoretically, they will have more compliant tendons and need longer ground contact times to build up maximal strain energy to generate impulse to jump up into the air.



KEY POSITION 4: LEAD LEG VERTICAL POSITION

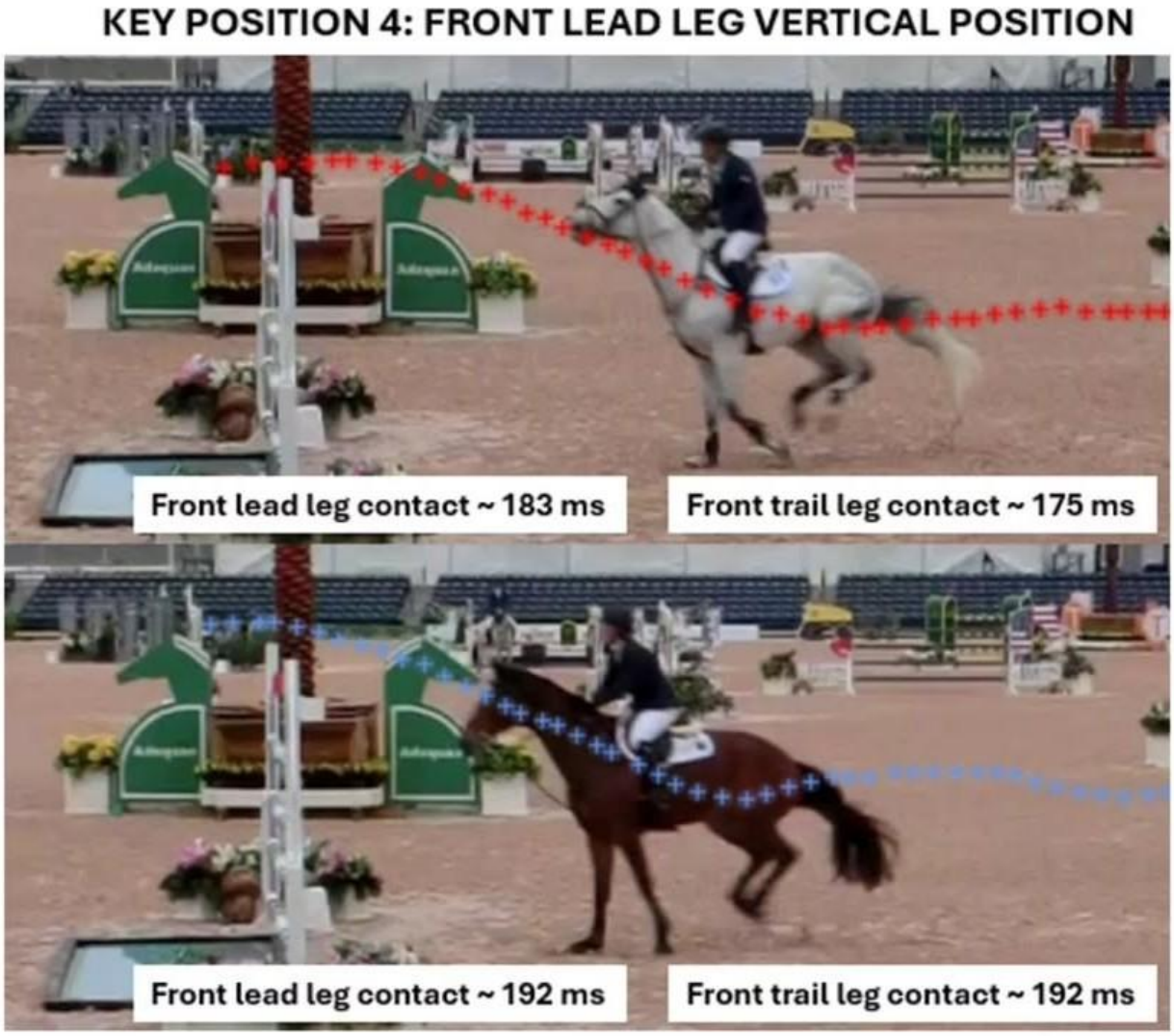
The front end has worked to set the takeoff angle for both horses.

Due to approach velocity and distance from the jump, the grey requires a shallower takeoff angle vs the bay.

To set a steeper takeoff angle, the bay's front end actively 'punches' the ground and spends a longer time pushing against the surface to first decelerate in the horizontal direction and then to generate vertical impulse (as shown by contact times).

*This is the ideal time to identify 'issues' in the front end of horses. The power generated should be proportional to how the front end 'attacked' the ground. You are looking for a "leakage of power", which can indicate a lack of core strength, timing issues, soreness, etc.

** If the horse continues to extend the neck up and backward at this stage it indicates the horse is searching for more vertical 'lift'. This is a good way to determine if the horse is reading fences correctly but is struggling to generate the vertical force needed to achieve the correct trajectory.



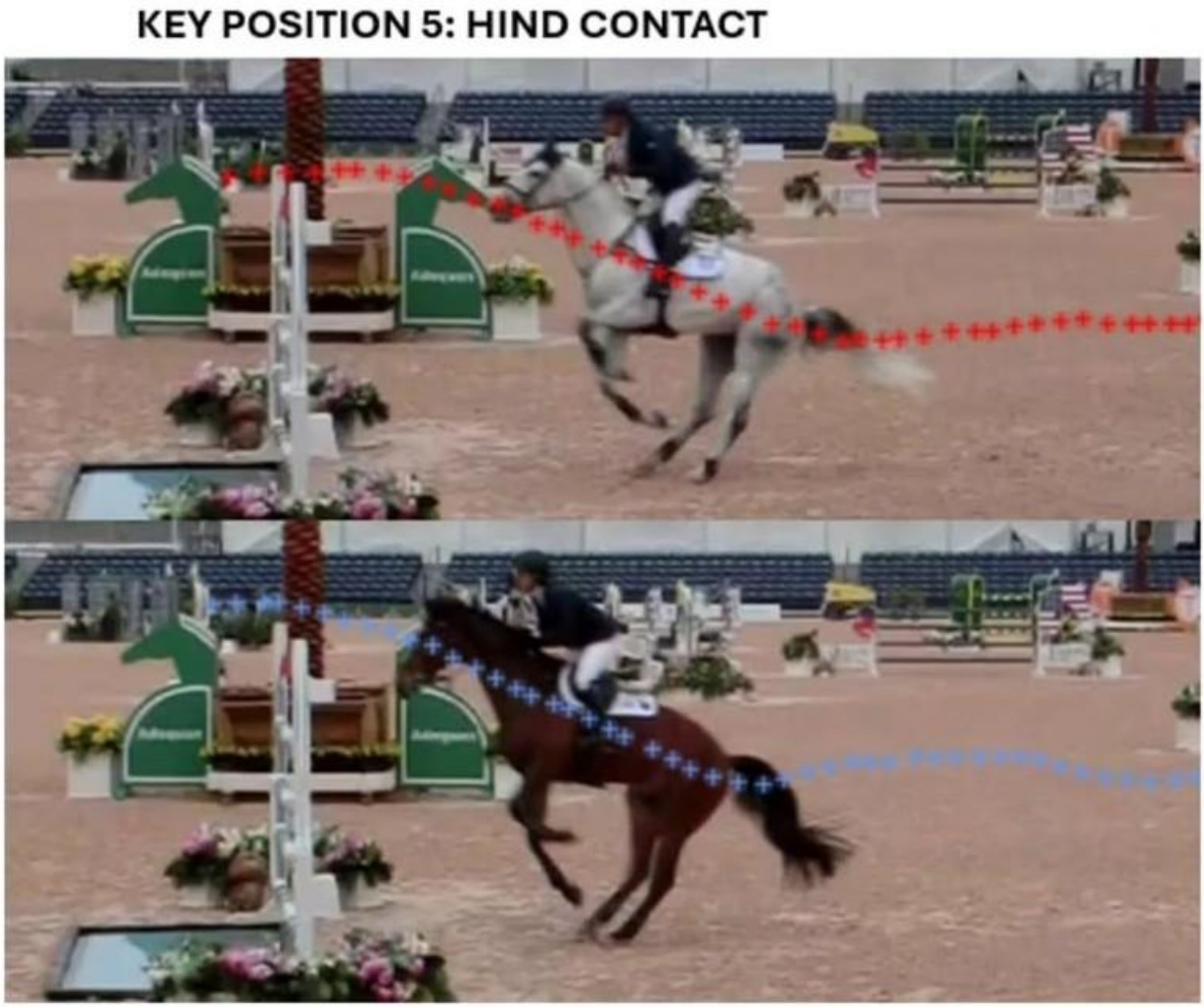
KEY POSITION 5: HIND CONTACT

Postures for both horses at hind end touchdown.

The grey is still travelling faster in the horizontal direction here, so this horse must really stretch to place the hind end as far forward beneath the body as possible. This placement is required so that force can be effectively applied underneath the body. If the hind end was slow to rotate through, it would not touchdown close enough to the body's center of mass and would not effectively apply force (it would lead to reduced force and over rotation in the air).

Due to the bay's slower speed, the horse has more time to properly place the hind end and does not need to rotate the pelvis/hind end as far forward beneath the body.

Whether the hind hooves are placed in or out of alignment will depend on numerous factors, including the distance from the jump, approach speed, a horse's preferred technique, anatomy, soreness, etc.



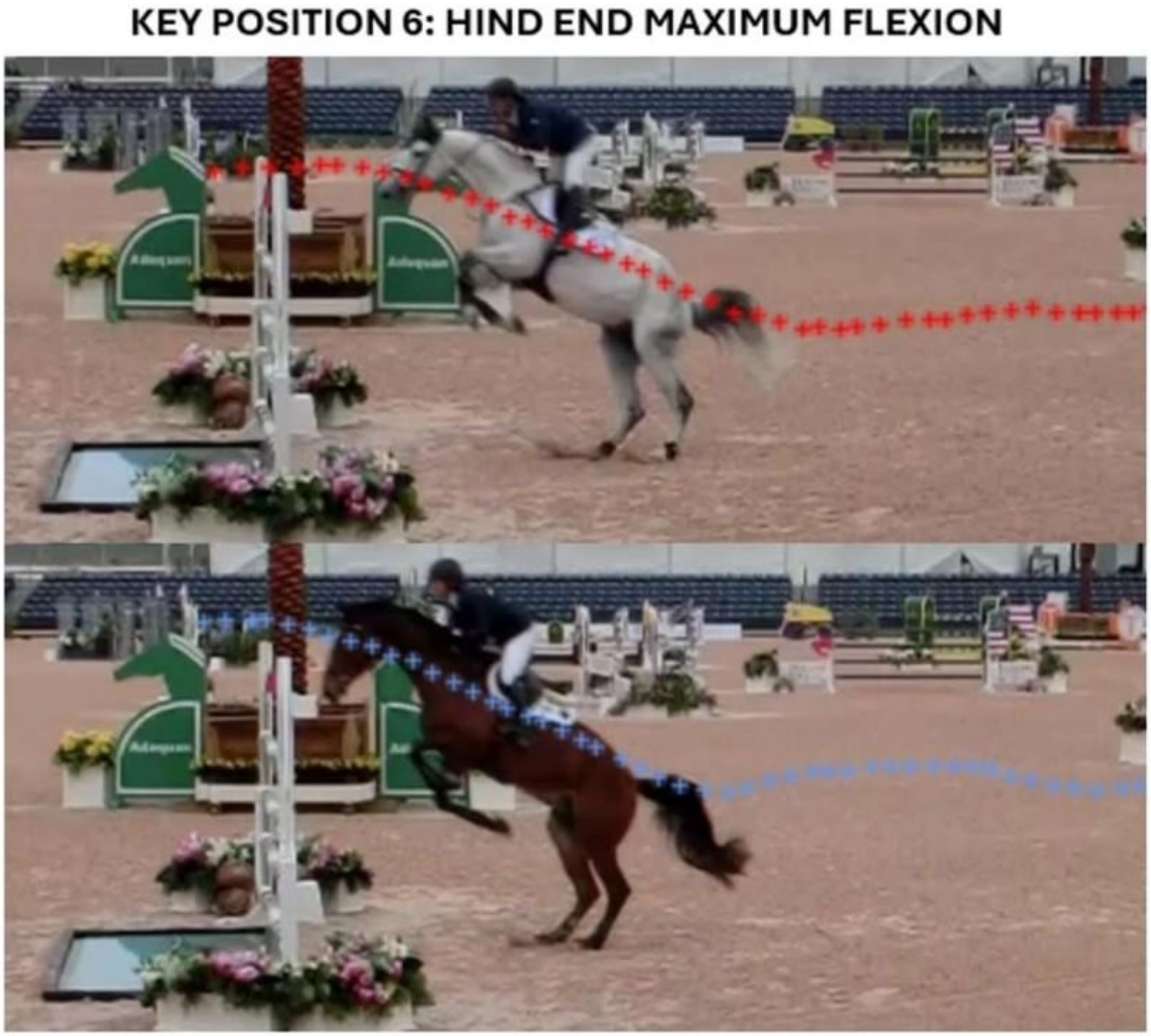
KEY POSITION 6: HIND END MAXIMUM FLEXION

The point of maximum flexion in the hind end for all joints (lumbosacral, hip, stifle, hock, fetlock).

From the touchdown of the hind hooves until this moment, powerful muscular contractions in the core and hind end, in addition to the stretch of elastic components, are generating high levels of stored energy.

Immediately after 'hitting' this position, the muscle-tendinous units that were elongated/stretched will rapidly shorten and provide a huge amount of force to push against the ground. For example, the hip and lumbosacral joint will be extended due to the shortening of the middle gluteal muscle as the horse propels up into the air.

The direction of force application from the hind end to the ground, in relation to where the body's center of mass is, will determine the trajectory of the body once it leaves the ground as well as the body's rotation.



KEY POSITION 7: TAKEOFF

Both horses leave the ground in similar postures, despite numerous differences at the start of the jump.

Due to differences on approach, the grey is prioritizing covering width at this point, while the bay needs to focus on maintaining a steeper takeoff trajectory to avoid contact on the way up. This impacts how long the hind hooves stay on the ground, and at which angle they apply force relative to the body. Horses that struggle to clear jumps may push against the ground for as long as possible in an attempt to generate more impulse, which presents as the hind end trailing out behind the horse and not snapping off the ground.

The apex of the grey's jump is in front of the jump, while the bay's trajectory reaches its' maximum behind the jump.