HOW YOUR HORSE JUMPS

Understanding his jumping mechanics can make you a better rider and trainer—and help him stay sounder.

By Dan Marks, VMD, with Elizabeth Iliff Prax

All great jumpers have two qualities. First is the physical ability to get their bodies up into the air. Second is the mental combination of courage and a great desire to be careful—reluctant to touch, let alone wallop, a rail. In this article, I'll

Different Jumping Styles

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ABOVE: Olympic silver-medal winner Gem Twist, ridden by Greg Best, had the most remarkable front end of any horse I'd ever seen. He would thrust his front legs off the ground over jumps so forcefully that when the ground was hard, it sounded like a gunshot.

LEFT: In comparison, John Whitaker's two-time FEI World Cup winner Milton, whose scapula was much more sloping than most top jumpers, did not push off as much with his front feet but relied more on his powerful hind end and extremely flexible back to compensate for his weaker front end.

address the first of these two qualities, but this is not meant to diminish the second. No matter how much physical ability a horse has, if he is not careful and brave, he'll have little success in the show ring. As six-time Olympic show jumper Frank Chapot says, there is a delicate balance between being chicken and being brave, which all good trainers have to solve.

Trainers—and riders, too—must also understand the basic biomechanics of jumping—the rules of physics determining what a horse does mechanically with his body to generate the force to propel it up and over a fence. These are generally the same for all horses. How well each horse works with his biomechanics depends on his conformation, how much he weighs and how strong and coordinated he is. All of the levers in his body (the bones) need to be constructed and connected in such a way that he can most effectively convert his forward momentum and muscle shortening into upward momentum. For jumps that are both high and wide, he needs to propel himself vertically and horizontally. This requires either speed or scope—the ability to jump wide without much speed.

What makes a horse a world-class jumper? You might be surprised to learn there's no ideal formula. The best jumpers possess a combination of great strength

The Approach

PHOTOS COURTESY DAN MARKS

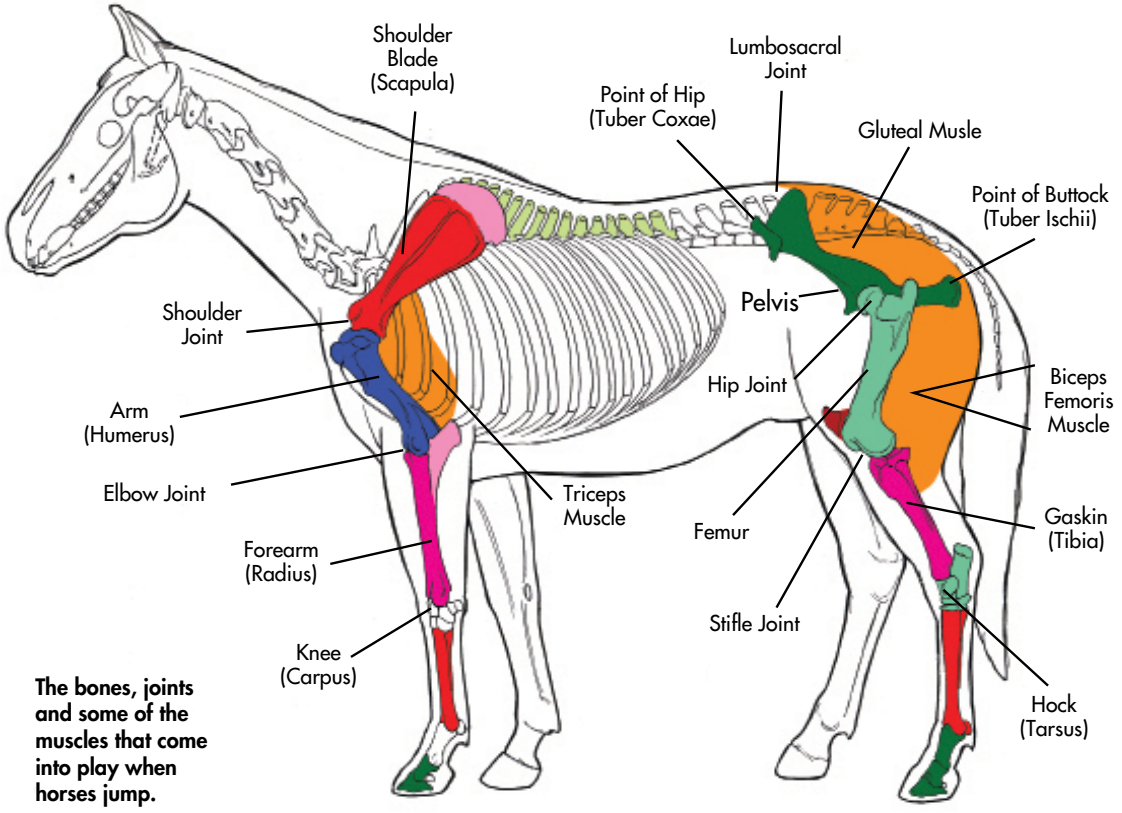
Here are Germany's 1978 World Champions Roman and Gerhard Wiltfang in an approach gallop, which is a four-beat gait. The hoof sequence is similar to a racing gallop, except the weight is shifted back. This gait has more support on the hind legs than a three-beat gait.

The suspension noted in this photo results from great impulsion. The speed for big jumps is faster than usual, even if it is only generated in a few strides.

Melanie Smith Taylor and Calypso are in the final approach stride, where the horse's weight is shifted back. The shoulder blade has rotated back under the saddle flap, enabling foreleg extension, which facilitates front leg push-off.

and coordination, but exactly how they use their bodies to get from one side of a fence to the other varies from horse to horse. In some cases, they compensate for a weakness with a different strength. In others, training and good riding help them overcome weaknesses.

In this article, I'll explain how your horse uses his various body parts when he jumps so you can help him as a rider—by being aware of how your weight and position affect him at different phases of the jump and how your own flexibility and coordination can make you a better partner. As a trainer, understanding jumping biomechanics helps you determine what you can and can't improve in a horse's technique. It also can be a useful tool for diagnosing and preventing soundness problems.



The bones, joints and some of the muscles that come into play when horses jump.

I begin with the example of an elite jumper going over a very high fence, such as a puissance wall, because it's easiest to observe technique in such an exaggerated effort. Even at the grand-prix level, most horses are jumping appreciably below their maximum abilities. Most of those competing in the 1.55-meter (about 5 feet) classes have the potential to clear 2 meters (about 6-foot-7). The indoor puissance high jump record is 7-foot-10. Later, I'll point out ways in which a horse's technique might be slightly different over smaller obstacles. I'll also offer some conditioning and training tips for maximizing your horse's performance and soundness.

The Approach

When approaching a big jump, a horse gathers energy in preparation for the coming effort. He rounds his back to bring his hind legs farther underneath his body with each stride. This creates more impulsion (energy) and suspension in his gait. During the last few strides, he shifts his balance backward, concentrating the power in his hindquarters. Imagine coiling a spring before releasing it. The more he coils his body, the more forcefully he can take off over the jump.

To maximize this weight shift, the diagonal legs that work in unison in a three-beat canter separate as the hind legs reach farther under the body, supporting more of its weight. The result is an extremely collected gait with a four-beat, rather than a three-beat, rhythm. The footfall sequence is the same as that of a full gallop, but the speed is much slower—although not as slow as a dressage collected canter.

Contrary to common belief, a horse does not take equally measured strides all the way to the jump. He compresses the final stride before takeoff by several feet. So, for example, if he's averaging 13-foot strides in between the jumps, he'll shorten this last approach stride to about 9 feet. By doing so, he decelerates his body, transferring his forward momentum into energy for the vertical push-off. This energy is stored in his muscles, tendons and ligaments, which stretch so much that his front fetlocks sink almost to the ground.

Although the hind legs furnish the main power on takeoff, the forelegs are more significant at this moment than many people realize. The horse uses them similar to the way a pole-vaulter uses the pole. In the last approach stride, he lowers his withers and rotates his scapula (shoulder bone) backward under the flap of the saddle, extending his front legs in front of his body, preparing to plant them on the ground the way the pole-vaulter plants the pole in the box.

Meanwhile, to best judge the fence he's approaching, the horse looks down his nose at it. If his head carriage is in a more dressagelike, flexed-poll position in between the fences, he'll have to raise his nose at the last minute to get a better view of the jump.

The Takeoff

PHOTOS COURTESY DAN MARKS

The larger the fence, the more important the front-end push-off. The forward momentum carries the horse over his front legs, and the fetlocks are loaded. The hind legs are starting to move forward together. The back muscles are stretched to add thrust to the push-off.

Each horse has an ideal takeoff distance combined with an ideal speed and balance that enable him to successfully jump his highest. This is ascertained by experimentation. Here, Gerhard Wiltfang has intentionally left from a longer spot on Roman.

The Takeoff

The front feet arrive at takeoff separately, with the nonleading foreleg absorbing most of the force. So, for example, if the horse is on his left lead, his right foreleg will contact the ground at the takeoff spot first and push off first. As both front feet are grounded, he lowers his head and bends his shoulder, elbow and fetlock joints, essentially shortening his front legs and bringing his body closer to the ground, storing elastic energy for the jump.

His momentum then carries his body weight over his front legs, just the way a pole-vaulter swings over his planted pole.

Strength/Soundness note: *When a horse prefers to approach jumps more on one lead than the other or jumps considerably better off one turn than the other, it may indicate a weakness or soundness problem in one front leg. He may even swap leads in front of a jump to ensure that his stronger leg is the nonleading leg, which bears more of the force on takeoff. Like people, horses develop habits and preferences that may not have anything to do with pain. It takes a clever trainer and vet to differentiate between painful and nonpainful sources of the problem. If putting a horse on NSAIDs (nonsteroidal anti-inflammatory drugs), such as phenylbutazone (bute), or blocking or treating an area changes this unevenness, there is likely a painful component.*

> If a rider makes the mistake of getting ahead of her horse, she adds her weight to his forehand just as he's trying to push off the ground.

As the front legs leave the ground, the loaded muscles, tendons and ligaments release their stored energy, much the way a stretched rubber band snaps back into place when it is released. The faster and more powerfully a horse loads his front legs, the greater the vertical slam off the ground on takeoff. He coordinates the release of the elastic rebound with the muscle contractions that straighten his front legs, extending his shoulder, elbow and fetlock joints. The most important are the triceps muscle, located behind and above the elbow, which straightens the elbow joint (this is the same muscle on the back of your arm), and the muscles that rotate the top of the shoulder blade forward.

Much of the trajectory of the jump is set by the front legs before the hind feet even touch down at their takeoff spot. The higher the jump and the closer the horse gets to it on takeoff, the steeper he needs to make this trajectory.

Some horses push off with their front feet more than others, even at the very top levels. Silver-medal Olympian and three-time American Grandprix Association Horse of the Year Gem Twist had the most remarkable front end of any horse I'd ever seen. He would thrust his front legs off the ground over jumps so forcefully that when the ground was hard, it sounded like a gunshot.

In comparison, the 1989 European champion and two-time FEI World Cup winner Milton, whose scapula was much more sloping than most top jumpers (see "The Role Conformation Plays," opposite page), did not push off as much with his front feet. Eventually, he learned to use his front legs more effectively, but he still relied much more on his powerful hind end and extremely flexible back to com-

pensate for his weaker front end. His rider, John Whitaker, used extreme skill to keep him beautifully balanced and avoided getting him too close to the jumps on takeoff.

At the same moment a horse pushes off his front feet, he may also lift his head and neck, much the way you might throw your hands upward to help yourself jump off the ground. The amount of head movement during this phase varies considerably among horses. Some make a pronounced motion while others push their withers upward with less head and neck lift.

Good riders know how important it is to keep their own balance from tipping forward before the horse's front legs push off. If a rider makes the mistake of getting ahead of her horse, she adds her weight to his forehand just as he's trying to push off the ground. To help your horse maximize his vertical lift, it's important to keep your weight back at this moment.

As the horse's front legs are pushing off, his back is flexing like a bow (particularly the lumbosacral joint, which connects the loin to the croup), allowing his hind legs to sweep forward under the body. Unlike the front legs, the hind legs unite during this phase of the stride so they hop forward onto the ground simultaneously, usually just behind the hoofprints of the front feet. The more pace the horse has in the approach, the closer his hind hoofprints are to the jump.

The hindquarters then go through a similar compression process, crouching low to the ground to coil maximum energy. In general, the deeper the horse flexes his hind legs during this support phase, the more power he stores in his hindquarters and the bigger the jump he produces. Over a very big jump, his hocks lower so much that the cannon bones in his hind legs are parallel to the ground.

The lowering and loading of the hindquarters on takeoff steepen the trajectory set by the front legs even further, essentially tilting the body upward. Then, just as the front legs did, the hind legs extend vertically (in particular, the lumbosacral joint, hips, stifles, hocks and fetlocks), releasing their stored elastic rebound by uncoiling the support structures that stretched while the feet were grounded and the joints flexed.

The angle at which the hind legs push the body at this point varies from horse to horse, depending on conformation and the size of the jump. When a horse uses most of his power to push vertically, he counts on his forward momentum to get him over the width of the jump. He also needs enough coordination to synchronize the elastic rebound with the muscle firing on takeoff. Some horses can do this automatically, but most need to learn this coordination through practice and exer-

The Role Conformation Plays

Most of a horse's natural physical talent depends on his conformation. The best jumpers are usually balanced (withers and croup relatively level, not noticeably "downhill"—croup-high) and well proportioned when comparing his height to his length. When his height at the withers is compared to his horizontal length from point of the shoulder to point of the buttock, the two should be approximately equal, or "square." A little discrepancy one way or the other—either slightly rectangular or oversquare—is fine. But you don't want extreme disproportion.

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Dr. Dan Marks evaluates a horse at the George Morris Horsemastership Training Session.

Good jumpers do not have low-set, short necks. The best ones have more upright scapulas (shoulder blades) with an angle ranging between 67 and 70 degrees relative to the ground. This is hard to measure accurately without palpating the actual bone underneath the muscle. All elite jumpers have very well developed triceps muscles in the front legs. The scapula is long relative to the humerus, which runs from the point of the shoulder to the elbow. A top jumper's humerus typically measures about 66 percent of the length of his shoulder blade. The angle of the shoulder joint—where the scapula connects to the humerus—should be no less than about 45 degrees. The elbow joint should be positioned on a vertical line drawn from the very front of the withers.

The hind end should have large biceps femoris and hamstring muscles. The croup, from the top of the point of the hip to the point of the buttock, should not be very sloping. Many of the scopiest jumpers have fairly flat croups with the point of the hip quite forward and the point of the buttock high and prominent. The femur (thigh), which runs from the hip joint to the stifle joint, should be longer than the tibia (gaskin), which runs from the stifle to the hocks. It is frequently said that the hocks should be low, but this is not a feature of most elite jumpers.

In Midair

COURTESY, D. WINKLER

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ABOVE: Not all top horses jump with a pronounced bascule. Shutterfly, with whom Meredith Michaels-Beerbaum won three World Cup Finals, had very little bascule in his technique over fences. He simply jumped higher over them to make up for that.

LEFT: Halla, ridden by Hans Winkler, demonstrates a beautiful bascule, or rounding of the neck and back, over a puissance wall at Aachen in Germany.

cises, such as gymnastics.

The gluteal (croup) muscles and hamstring group (biceps femoris, semitendinosus and semimembranosus) are the powerhouses creating this propulsion. In fact, the biceps femoris muscles, which run down the backs of the hind legs, originating at the pelvis and attaching across the stifle joints, do the majority of the work in straightening the hind legs. These muscles are especially well developed in a top jumper. When you view him standing still from behind, they often bulge out noticeably to the sides. Horses with these prodigious muscles can power off the ground with little momentum. I compare them to weightlifters who don't need as much technique as other weightlifters to pick up impressive amounts.

Strength/Soundness note: *If your horse begins to refuse fences, he may be experiencing muscle pain. While most horsemen are adept at checking the legs for signs of tendon and ligament soreness, some forget the muscles. Horses who refuse a day or so after their first experience jumping puissance, for example, may be suffering from sore hamstring muscles. Deep soreness in the medial gluteal muscles (the croup muscles) can also make it uncomfortable for horses to jump even low crossrails. Ask your veterinarian to show you how to check your horse's muscles, including those in the back and neck. This takes only two or three minutes to do and should be a part of your daily routine.*

> In the air, the rider has little effect on the jump and simply needs to avoid interfering with the horse by pulling on the reins, sitting down heavily or radically shifting her balance.

Strength/Soundness note: *Since both of a horse's hind legs push off together, if one is weak or painful, the other will exert a stronger push on takeoff, causing the horse to drift in the air toward the side of the lame/weak leg.*

To add thrust to the push-off, the horse also now straightens his back. In many top jumpers, the powerful forces of the musculature contractions of the back and legs combined with the suspensory structures' elastic rebound feel like a rocket ship. Even the best riders have trouble flexing their own bodies enough to stay with the motion. Frank Chapot had retired by the time he bred Gem Twist. When he tried to jump him, the horse's powerful efforts hurt Frank's back.

The hindquarters' explosive force on takeoff not only propels the horse's body vertically and horizontally over the jump, it also tips his hind end upward relative to his forehand, beginning a rotation around his center of mass. Imagine the horse as a seesaw, with his head on one end and his hindquarters on the other. His front end tips upward in the beginning of the takeoff, then becomes level with his haunches over the top of the jump before lowering relative to them on landing. The shape of the horse's trajectory through the air is the accurate translation of the word "bascule." (Bascule is also used to describe the shape a horse's body makes when he curves his neck and back over a jump.) The rotational force helps his hind legs clear the jump. As I'll explain later, though, the horse must stop this forward-rolling motion when he lands; otherwise he'll fall.

Horses' jumping trajectories generally get flatter as they get faster. That's why steeplechase horses typically have flatter arcs over their fences. Some horses, however, can convert speed into lift more

The Landing

PHOTOS COURTESY DAN MARKS

After Fleet Apple, ridden by Kathy Kusner, rounded his back over the jump, he reverses the direction of bend in his back—and especially his lumbosacral joint—to pull his stifles and hind legs upward to clear the jump.

When landing, the first leg to touch down is the nonleading leg, which absorbs about 20 percent more force than the leading leg. San Lucas, ridden by Frank Chapot, will depart on his left lead. The front landing legs reverse the rotary motion of the body.

quickly than others. These unique individuals can stand off from the fences—take off from farther away—and still jump high enough to clear them safely. By doing so, they leave out more strides than other horses and can thus save time.

In Midair

Once the horse is in the air, the most important thing he can do is get his legs out of the way of the jump. He bends his elbows and uses the long brachiocephalicus muscle, which runs along his neck from the top of his head to his forearm, and the trapezius muscle, which runs from the top of his neck and withers to his shoulder blade, to pull his forearms up and forward. Then he tightly folds his lower forelegs.

Most horses also curve their backs and necks around the fence into the round bascule shape considered so desirable in jumping horses. Contrary to common belief, a good bascule may not make more than a 2-inch difference in the height a horse achieves. Not all top horses jump with a pronounced bascule. One of the world's best grand-prix horses, Shutterfly, with whom Meredith Michaels-Beerbaum won three World Cup Finals, had very little bascule in his technique over fences. He simply jumped higher over them to make up for that.

Midway over the jump, the horse has to invert his back and lumbosacral joint again to flip his hind end so his stifles and hind legs can clear the fence. Most upper-level jumpers do this well.

Strength/Soundness note: *Because jumpers flex and extend their backs so dramatically over big fences, they're more prone to back problems than horses in other disciplines. If your horse's scope deteriorates—if oxers he once jumped easily feel a foot wider—and there's no sign of lameness, have your vet check him. Sacroiliac soreness is one common cause for this scenario. (The sacroiliac is the joint between the backbone and the pelvis.)*

In the air, the rider has little effect on the jump and simply needs to avoid interfering with the horse by pulling on the reins, sitting down heavily or radically shifting her balance to one side or the other. In rare cases, for example, when a horse is reaching to clear a very wide jump, his rider may help slightly by shifting her weight farther forward.

The Landing

Riding a horse landing from a big effort, such as a puissance jump, is like zero-gravity freefall. For a moment, there's no weight in your stirrups—until your horse completes the parabola of the jump by touching down with his front feet. Once again, the nonleading foreleg lands first, absorbing 20 percent more force than the leading leg.

Having your lower leg in a solid position (underneath your body and not slipping behind you) will help you absorb the landing force—and avoid being slung forward onto your horse's neck. This stable position also keeps you in a better balance to signal your intentions to him on landing. Leaning to the side to signal a turn on landing will cause the horse to land on the opposite lead. If you load one side, he will first land on that foreleg to balance himself, thus producing the other lead. It is important, therefore, to keep your weight in the middle of your horse and not weight the inside stirrup.

Strength/Soundness note: *As the fence gets bigger, more strain is put on the superficial digital flexor tendons on landing. This explains the increase in bowed tendons in horses jumping very big fences. The strain on the suspensory ligament and the deep digital flexor tendon and its check ligament doesn't increase as dramatically as the fences get bigger. Drop jumps, however, are particularly taxing on the suspensory ligaments because the horse's hind legs take longer to reach the ground. This delay means that the front legs can't unweight as quickly as in a normal landing. Hard ground aggravates this problem.*

Jumping off a bank onto hard ground may also sting the horse's feet enough so that he is reluctant to make a big effort over the next jump or two. This is why you often see horses knock rails down the fence after a bank when the footing is hard.

Strength/Soundness note: *A horse with a sore front leg may try to minimize the concus-*

ABOVE: Practicing riding turns at home helps your horse to coordinate his various body parts.

LEFT: To maximize his thrust during the critical moment of takeoff, your horse must minimize the delay between stretching the support structures (muscles, tendons and ligaments) and push-off. Gymnastic exercises are the best way to shorten this delay.

sion on it by landing on the opposite foreleg. This will usually cause him to angle away from the sore leg.

One of the critical functions of the forelegs during the landing phase is to stop the rotation of the horse's body. Without this stopping force, he would continue to somersault forward onto the ground. Known as a rotational fall, this is considered one of the most dangerous types of falls for both horse and rider. It sometimes occurs in timber racing and on cross country in eventing when a horse hits a fixed obstacle with his forearm. If he can't extricate his leg quickly, he won't be able to plant a front foot on the ground in time to stop the rotation. Fortunately, this is rare in show jumping.

Once the horse has landed, he needs time to regain his forward momentum to canter away from the jump. The first move-off stride, therefore, is generally slightly shorter than the subsequent strides. A jumper with an average stride of 13 feet will usually cover only about 12 feet in this stride. By the next stride, he's recovered from the jump and has resumed his original canter.

How effectively you can influence your horse in the recovery strides following a jump may depend somewhat on your rein release in the air. In olden times, when the distances inside combinations were much more challenging, it was critical to be able to signal the horse during the landing to shorten or lengthen immediately and significantly. A following hand (automatic release) in the air facilitates this much better than a crest release because it provides seamless contact with the horse's mouth from takeoff to landing.

One extreme example was in the 1960 Rome Olympics. There was a triple combination, the second part of which was 30 feet out over a big oxer. It was an impossibly long one stride or an impossibly short two, even for these top horses. It was very tricky to ride, and quite a number of rails were broken. Those who cleared it successfully had to make dramatic changes to their horses' strides the moment they landed from the second jump. We would never have such a difficult combination in today's shows. But this may partly explain today's controversy over crest releases versus automatic releases.

Over Smaller Fences

The differences in a horse's biomechanics over a puissance jump versus smaller fences (for example, under 4 feet) are mostly a matter of degree. The extremely collected four-beat canter is not so necessary over small fences—although many good horses approach jumps of any size in a collected balance. Placement of the forelegs on takeoff is similar to the one I described previously, although their thrust off the ground is smaller. The head and neck movements are also less noticeable, and the body doesn't crouch so low prior to pushing off the ground. The hind legs do not have to push off together, and the hocks and stifles bend much less in the takeoff.

Riding the approach with the horse very straight (balanced, with the hind feet tracking directly behind the front feet) is important, however, because he'll need to know these basics when he learns to take off with his hind feet together. Almost all good riders do this well.

Over smaller jumps, the speed in the approach and precision of the takeoff distance are less critical. Whereas success over a puissance fence can hinge on the difference of a mere 4 inches in takeoff location—and this is highly dependent on the individual horse's jumping style—there is more leeway over smaller fences. Even so, knowing your horse's strengths and weaknesses is valuable at any level. Some horses jump best at a specific speed over certain types of fences, while others have a broader range. To jump well from closer distances, for example, a horse must have a quick, powerful front end. To stand off from a longer distance, he needs to have

more speed or more scope. Teaching a horse who is a bit short on scope to jump with more speed or momentum can compensate, but if his scope is really deficient, he is unlikely to improve enough to become a big-time jumper.

Training & Conditioning

Regardless of conformation (see "The Role Conformation Plays," page 39), most horses can improve their performances with correct training and conditioning. This means targeting muscle strength, coordination and fitness (to prevent tiring at the end of a course or fatigue on the next day). We know from human jumpers that a combination of strength training and plyometric exercises (repeated quick jumps, e.g., gymnastics) produces the best strength and coordination gains.

With horses, strength training produces more power on takeoff. This is best done by incrementally raising the fence height over time. According to human studies, strength training is most effective at 50 to 65 percent of maximum ability. Horses don't really start jumping until the fences reach about 3 feet (anything lower than that is more a matter of picking up the legs without any necessary vertical lift of the rest of the body). So we use that as a baseline. For a jumper who has the potential to clear 6 feet on his best day, we calculate 50 percent of his maximum ability by dividing his ability above 3 feet (another 3 feet) in two, then adding that result (1-foot-6) to the baseline 3 feet. Ideal strength training for this horse, therefore, would involve practicing over fences about 4-foot-6 in height.

To maximize his thrust during the critical moment of takeoff, your horse must minimize the delay between the stretching of the support structures (muscles, tendons and ligaments) and the push-off. Muscle fatigue contributes to this delay. Gymnastic exercises are the best way to shorten the delay. They teach a horse to coordinate his various body parts and to synchronize the elastic rebound of his muscles, tendons and ligaments with the muscle-contraction forces.

Galloping fitness is important, too, especially in large rings like Aachen, Germany. Having galloping as a regular part of training will improve this aspect of fitness and actually stretch and lengthen the stride. It also makes your horse more controllable and balanced going fast. Practicing jumpoff speeds and turns at home is wise as well.

The legendary rider Bill Steinkraus once compared jumping to a golf swing. He said that some very strong players can mishit a golf ball but still hit it a long way. Other golfers, who depend more on coordination, have to get everything just right, but when they do, they can also hit the ball a long way.

Interestingly, it's easier to improve a horse's front-end technique than his hind-end technique. However, if it is painful for him to use his hind end, this can be diagnosed, treated and hopefully corrected.

Jump practice is equally invaluable for riders. It probably takes about 1,000 to 2,000 reasonably sized, correctly performed jumps to develop an automatic muscle memory. Because top competitors jump many horses daily, they easily synchronize their bodies with the horse's jumping mechanism. That's why I think a jump simulator, like a mechanical bull, would be a great tool for amateur riders (all kinds, including eventers) who don't have the opportunity to practice daily over many fences.

Whether you're riding or watching jumping horses from the sidelines, observing different styles can be fascinating. The information I've shared here was derived through many decades of observation combined with insight from top riders and illuminating scientific studies. But we have a great deal more to learn!

To watch videos of Dr. Marks reviewing conformation and discussing how a horse jumps, go to *www.PracticalHorsemanMag.com*.

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A U.S. Equestrian Team veterinarian from 1971 to 1994, a founding partner in the Delaware Equine Clinic in Cochranville, Pennsylvania, and a former jumper rider, ***Dan Marks, VMD,*** *has had a lifelong interest in elite equine athletes. He has a wide range of experience, from riding at the Spanish Riding School of Vienna to timber racing, including in the Maryland Hunt Cup. His patients have included top-level show jumpers, dressage horses, steeplechasers and racehorses from many countries around the world. Among his surgical innovations is the co-invention of the standard method used today for "roarer" surgery. He also coined the term "prepurchase exam" and set the standards for the examination and reporting that are now used worldwide.*

Dr. Marks was the first to recognize and describe proximal suspensory desmitis, a common injury in performance horses. He writes and speaks extensively on lameness, competition injuries, prepurchase examinations and conformation. His published work includes a chapter on conformation of grand-prix jumpers in the book, Winning With Frank Chapot. *He has also worked to improve animal-cruelty regulations. Dr. Marks now has a consulting practice based in Santa Fe, New Mexico. He is presently working on an extensive publication about the conformation and biomechanics of elite dressage horses and jumpers.*