Conditions Under Foot

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First Published: 16 July 2009 - Issue Number: 13

Since the untimely and high-profile deaths of George Washington and Eight Belles in America, research has stepped up a gear in an attempt to understand what causes horses to break down.

It's a Tuesday afternoon in August in Saratoga Springs, New York. They call it "dark" Tuesday because there's no racing. Most trainers and track workers have gone south to The City for a 36-hour hiatus during America's premiere boutique race meet.

But today there's some activity inside the Fasig-Tipton sales arena. Speakers file up to the podium, one after another, instead of sleek yearlings. Slides change on a giant screen instead of seven figure bids.

The emptiness in the huge arena is palpable. Trainers and owners sit in the fan-shaped theater, one or two to a row. No one is really looking at the stage. No one is looking at the others. They glance at watches, check cell phones, shift in their seats.

This may be the darkest Tuesday of the race meet.

The speakers are a star-studded cast of veterinarians, researchers, and track experts. They are briefing a state-appointed task force that is assigned the protection of the welfare of the state's Thoroughbreds. Included in the to-do list is a preliminary exploration of possibly converting New York's Thoroughbred tracks from dirt to synthetic.

The committee members know how tough their assignment is. They are in the difficult position of possibly asking the racing universe to change.

Change is a four-letter word at the racetrack, no matter how you spell it. Training racehorses is about routine, about keeping the horses on a schedule, about meeting your owner's expectations. It's about standard excuses, common injuries, predictable winnings. For a sport supported by gambling, the sure-thing routine of the backstretch is a stark contrast.

When it's over, the trainers and horsemen file out. Only then do their eyes meet. They acknowledge each other as if just waking from a nap. One chuckles. Another laughs out loud, “Hey, Dan,” he grins, grabbing another trainer’s arm. “They don’t know anything more about this artificial track business than we do.”

Farrier Mitch Taylor is used to carrying a shoeing box in one hand, his apron slung over his shoulder. Today he is also lugging a camera, and behind him trails a crew of technicians, a couple of horses, an exercise rider and an equine motion-analysis software developer. Their goal is not to shoe the horses, but to watch them run and catch it on tape. But first they must convince the exercise rider that only the strides caught by the camera count, and that the horse needs to maintain the same speed.

Working with the support of the Grayson Jockey Club Foundation’s Welfare and Safety of the Racehorse Summit, Taylor has set out not to do research, but to collect simple video footage that real people – trainers, owners, racetrack officials, veterinarians, farriers – can understand. He needs to make the footage so simple, that the point is obvious.

But what, exactly, is the point?

Welcome to American horse racing. Since the public outcry over the tragic deaths of Eight Belles, George Washington, and other stakes horses on national television, racing is on the defensive, but not on the run. Like a fairgoer caught in a hall of mirrors, racing looks one way, then the next, and sees a distorted picture of itself, partly because the very things it knows to be true, may not be anymore.

So it was in 2006, when the first Welfare and Safety Summit tackled the isolated topic of the possible ill effects of toe-grabs on raceplates. Certainly doing away with toe grabs would make racing safer, they thought. What they couldn’t have known is that the picture would grow darker, and darker still. Toe grabs, steroids, whips… would there by anything left to ban?

Building a case to ban toe grabs required Taylor to head out to the track with a camera and record the difference in foot action between different types of shoes. It was a simple variable and his WSS Shoeing and Hoof Care Committee built a case that, when presented to the Association of Racing Commissioners International, brought about a swift model rule change adopted by several state jurisdictions to reduce the height of toe grabs to a miniscule 4 mm.

Pandora’s Box creaked open. A breeze ruffled through a house of cards. A traveler made it half way around the world without a passport; can he make it home?

The entire 20th century was a grand era for horse racing, but a tough time for improvements to our base of knowledge about the horse. In the 1800s, the Science of Speed occupied the minds of men who tinkered with shoes, harness, saddles, track designs, and whatever else they could think of as a variable. Their goal was a faster horse, a better horse.

But in the 20th century, in spite of improvements in racetrack maintenance, lighter shoes and therapeutic medications, the curiosity about speed and efficiency of motion calmed to a status quo. Late in the century, the new science of biomechanics spilled over from human sports, bringing leading minds like Drs. Doug Leach, Hilary Clayton, James Rooney, George Pratt, and others to examine the motion of the horse and the role of the surface through new technologies.

Their detailed PhDs, papers and reams of data met with murmurs of, “How interesting,” as horsemen went back to their daily routines, doing what had always worked for them, running horses on the surfaces that suited them, at the distances that suited them, over intervals that suited them, injuries permitting.

Soon after the turn of the 21st century, American racing turned back the clock 100 years and people began asking questions. The main question was “WHY?” Why did that horse take a bad step? “That’s racing” just wasn’t enough of an answer after a switch to the so-called safety option of an artificial track failed to reverse the breakdown trend.

Fanned out across the country and around the globe is a growing cadre of researchers and analysts who are ready and willing to study the surface, the shoes, the shape of the hoof, the humidity in the air, the angle of the sun in the sky – whatever it takes to unlock some clues.

So here comes Mitch Taylor with his entourage and his high-tech slow-mo camera. He's not going to explain much, he's going to show you.

Stride length and stride frequency are the key factors in determining speed, but the New Reality puts more emphasis on shear force, friction and the horizontal movement of the foot after it touches the ground. The goal is an efficient stride. And a safe step.

According to mechanical engineer Dr. Mick Peterson of the University of Maine, working in tandem with Dr. Wayne McIlwraith of Colorado State University, the additional variables are how quickly the foot stops when it hits, how hard the landing is, and how much resistance the ground provides for the hoof to push off against as the horse's weight passes over the hoof.

The task of relative shock absorption is assigned to the fetlock; it flexes relative to the hardness of the track. A fetlock is under more stress on a hard surface, Peterson and McIlwraith tell us. The more the fetlock flexes, the more return spring is released as the horse is propelled forward off that foot.

Peterson applies the one-two punch to understanding stress on the foot. The hardness effect on the fetlock's flexion on landing is the right jab, but the shear strength of the track is the left hook.

Shear strength, quite simply, determines the pressure that will be on the front of the hoof when it impacts the track, and that pressure will stop the hoof; the higher the shear force, the faster the stop. It will also assist (or handicap) the push-off factor.

A track with low shear strength will allow the hoof to slide several inches before it stops. A track with high shear strength will snap it to a quicker halt. The sliding may be kinder to the landing, but it makes pushing off more difficult – there's nothing to push off against.

Whether researching a riding arena for show jumping or a racetrack for Thoroughbreds, biomechanists want to know the shear strength of the surface. While for years video was used to determine if horses were landing flat or not, the new, more sophisticated video can at least compare the relative horizontal motion of the hoof after it disappears into the surface.

It was not until 1995 that Professor Willem Back at the University of Utrecht determined that there was a measurable difference in the horizontal movement of the front and hind hooves on landing. The normal hind foot slides more than the normal front, Back showed.

To understand what is really going on in the hoof, strain gauges and accelerometers are the new buzz words, but the true key may be in the study of the moving hoof through the use of finite element (FE) analysis, or a computerized simulation of running hoofs interacting with the ground.

Leading researchers in this field include Dr. Jeff Thomason at the University of Guelph in Canada, Dr. Simon Collins at the Animal Health Trust in Newmarket, England, and Dr. Christine Hinterhofer at the University of Vienna in Austria. Only Thomason is currently applying his analytics to the racehorse but the research of all are applicable in describing the action of tendons and determining the functions of a normal foot under different shear conditions.

It's understandable to focus on the landing of the hoof. According to landmark research conducted by Professor George Pratt at Massachusetts Institute of Technology in 1981, the horse does not pull itself forward as it gallops. The horse may be moving forward at 55 feet per second, but the hoof is moving downward at 20 feet per second, as well; the hoof is actually moving faster than the horse's body. Even 28 years ago, Pratt preached against toe grabs, calks, and stickers, which he felt would interrupt the foot's ideal contact

with and departure from the ground.
“It is imperative that the hoof be allowed to slip forward,” Pratt wrote in 1981.
But, he would have added, not forward too much.
Did the Welfare and Safety Summit select a tree instead of the forest when it decided to recommend a national ban on toe grabs? The intense light that the group shone on one shoeing modification opened Pandora’s Box, to be sure, but concurrent events showing that artificial surfaces were not a one-stop solution to end breakdowns helped temper the apprehension that banning toe grabs wasn’t enough – but what’s left?
Peterson, Clayton, Thomason and their students and supporters are left. While researching racetrack surfaces and shoes is not easy, it will become easier with guidance that will place researchers into a concerted effort rather than isolated stabs at data collection.
“We need to measure what the horse feels,” says Peterson, who has become a de facto spokesman for the new spirit of proactive research and collaboration in racing science. “We need to change some things.”
There’s that four-letter word again.
Look closely and you’ll see the word “can” inside “change.”

SIDEBAR 1
TRYING TO IRON OUT THE VARIABLES
American racing is faced with tough variables to analyze the reasons for breakdowns or to optimize the equipment on horses. Racehorses train at training centers with sand, or dirt, or artificial surfaces. They migrate between tracks that, again, have different surfaces. Half a field in any given race may be artificial veterans, while the other half are running for just the first or second time on it.
Other horses are switching from the artificial training tracks like the gallops at Fair Hill Training Center in Maryland, straight to a dirt or turf course set of races.
As long ago as the 1980s, racehorse lameness experts in the United States like Dr. William Moyer (pictured), now of Texas A&M University College of Veterinary Medicine, were pointing to the fallacies of shoeing horses with cookie-cutter aluminum shoes that spread all too easily and all too soon. Moyer and others called for new shoe designs, a better mousetrap to replace the status quo.
At the other end of the university campus, soil scientists called for better racetrack design, banking of turns, and more studies into how horses run.
That left the anatomists and motion analysts in the middle. And when they spoke, no one liked what they said. The late brilliant researcher Doug Leach felt compelled to postpone any true research into the injuries and foot problems plaguing the racehorse. “We don’t even know what’s normal,” he declared, and set out to see if a norm could be established.
The loss of a key researcher like Leach, who died in 2008 after a long illness, was a blow. Clayton’s migration to sport horse medicine from racing is less critical; much of her research is applicable to both sport and race horses and the research done in the US and Europe on sport horse competition surfaces will help with understanding racing surfaces.
Leach’s seat at the table has been ably filled by a newcomer, Dr. Mick Peterson of the University of Maine, a soil scientist with an interest in understanding the characteristics of an ideal racetrack, and developing protocols to measure and define the parameters needed to get horses around the track safely. Peterson uses a dual-axis drop-hammer system to test both the impact of a simulated hoof and also the horizontal movement of the hoof within the surface.

SIDEBAR 2

Synthetic vs Dirt

What's the difference to the average hoof?

Mitch Taylor filmed high speed video (2000 f/sec) of the same horses on both surfaces and recorded subtle locomotion changes are evident between the two surfaces and visible to the naked eye.

Synthetic racing surfaces (SRS) characteristics:

• A decrease in the slide phase of the stride
• Increased flexion of the pastern joint
• Decreased penetration into the cushion upon impact
• Decreased shear and penetration into the cushion at breakover
• Decreased kick back

Speaking in Saratoga Springs in August 2008, Taylor noted, "High speed video indicates that, at midstance, feet do not penetrate into the cushion as much as on traditional dirt surfaces; therefore, one can assume that the toe is less able to penetrate the surface during the breakover phase and the limb has to rotate over the toe instead of the toe rotating into the surface as in dirt.

The result of such an alteration would be that stabilizing muscles are being asked to function as propulsion generating muscles. This theory is strengthened by the observation that there is less kick back on SRS.

Because of the fibrous make-up and more resilient characteristics the foot would logically have a harder time breaking through the surface, unlike sand, which shears away easily.

Now you see it, now you don't

The depth of racing surface conceals the actual movement of the foot. With normal slow-motion video, emphasis was always on impact and landing. Is he landing flat? Toe first? Heel first? Which heel?

SIDEBAR 3

VIDEO RESEARCH

The reality of the racetrack brings us repeatedly back to Taylor and his high-tech camera. At conferences and seminars across the United States, his video clips show trainers, veterinarians, farriers and racing officials what they have been looking at, in some cases, all their lives. But they are seeing it for the first time.

Slow motion has always fascinated, but the new slow motion of high speed video (which offers many more frames per second, making even the most minute movement of the hoof or kickup of dirt observable) raises the bar. While it is not practical to use such an expensive piece of equipment regularly on the track, seeing clips of different horses – or even the same horse on different surfaces – has shown that there is tremendous variation in how horses run and what happens to the foot under the surface.

Taylor is not conducting research, but rather recording variations. He speaks repeatedly of the "snowplow" effect, referring to the cloud of dirt kicked up by the hoof's braking action. The more immediate the slowdown of the hoof, the more snowplow.

Taylor repeatedly recorded the toe grab impeding the sliding motion on landing; he and others contend that the grab required more fetlock angulation to push the hoof back off the ground. This is easy to see with the video, but hard to explain in scientific terms to trainers and farriers.

An immediate distinction visible in all Taylor's videos is that the synthetic track, in this case the surface at Keeneland, also impedes the sliding action of the hoof, but with a slightly different aspect but, perhaps more strikingly, shows that the hoof does not penetrate as deeply into the surface.

Taylor's videos also show a decrease in fetlock joint flexion on the synthetic track, but a concurrent increase in pastern joint flexion.

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