PARADIGM FOR THE NATURALLY SHAPED HOOF

by Jaime Jackson

"Thus it appears advisable to me to look back from the perfect animal and to inquire by what process it has arisen and grown to maturity, to retrace our steps as it were, from the goal to the starting place, so at last when we can retreat no further, we shall feel assured that we have attained to the principles." (William Harvey, 1651)

"PARADIGM FOR THE NATURALLY SHAPED HOOF--A HOLISTIC VIEW"

by Jaime Jackson

Forward

I have travelled daily at my own expenses and time for weeks on end among hundreds of this country's feral horses. I have held in hand a thousand of their immaculate hooves. Looking back across to our domestic horse world, I can only conclude that we have much to learn still about what is right and wrong for our equine friends. Unfettered by the human hand, Nature's grand *design* for horse and hoof beckons us all.

First Session

Model for Excellence: The Wild, Free-Roaming Horse

- Video & Slides--Glimpses of the inner life of wild horse society
- The Significance of Habitat
- Conundrum of the Locomotive Force
- Summary--Matrix of the Naturally Shaped Hoof
- Questions/Answers

Second Session

Architecture of the Naturally Shaped Hoof

- "Video Round-up"--Close-up journey inside and around the naturally shaped hoof
- Statistical Evaluation--Size/Proportion
- Value of the naturally shaped hoof in modern farriery and veterinary care
- Questions/Answers

Display Table

Biospecimens--invitation to see and touch the naturally shaped hooves of wild horse society

- Contacts to visit wild horse country

- Copies--*The Natural Horse* (Northland Publishing, 1992) by Jaime Jackson
- Related Articles published by the American Farriers Journal: please contact Frank Lessiter, Publisher, AFJ, P.O. Box 624, Brookfield, WI 53008-0624; telephone 414-782-4480; Fax 414-782-1252.

DISCUSSION

Introduction

At every inch of the way of the domestic horse's life it is at the total mercy and whim of its human master. In this life, the horse has little or no say about the conditions it must endure or the future that lies ahead of it. As a captive, its diet, socialization, health, and hooves, are entirely governed by the regimen of care humans deem appropriate.

As a farrier, I have participated at the center of this care regimen, noting that the horse's life is complicated further by the fact that few humans agree on what is best or appropriate for the horse. This division is demonstrated in many ways--how the horse's hooves are managed, how the animal is trained and ridden, and even what is considered abusive or humane treatment. I suppose none of this contention would matter except for the single fact that horses inevitably fail to perform well when patterns of care leave the animal distressed.

At the hub of the domestic horse world, both farrier and veterinarian are compelled to sort through the maze of conflicting theories and practices of horse/hoof care in order to serve their clients--the horse owners. These differences often arise as sources of contention between service providers, and sometimes with their clients.

Although not all is well in our domestic horse world, people--clients and their service professionals--try hard to provide the best care possible under the circumstances for their horses. This has always been my attitude. Try to learn and do the best you can.

But, as every farrier and veterinarian knows who has spent time in the trenches of the every day horse world and cares as much about the animal as the money to be made, it can become a grating emotional roller coaster when one must constantly serve more than one master. What is right for the horse, according to our personal understanding of the animal, and what we must do to serve our clients and their often variant and conflicting demands, do not always align or resonate well within. Fierce competition in the ranks of the hoof care and veterinary providers may fuel the predilection to compromise.

It is the systemization of this inner conflict that drove me from the domestic horse world and into wild horse country years ago. Believe me, it was no casual sightseeing tour. Exhausted by the many conflicting theories--and practices--of hoof and veterinary care, I quietly took my leave of absence in hopes of supplanting the emotional war within with a new vision and harmonizing of horse care founded upon nature's "grand plan" (as I now refer to it) for this animal. In the soundness of the very dynamic natural world of wild horse society, I found this vision.

This journey has led me to a new awareness and appreciation for the personal struggles of both horse and the horse enthusiast. The old "conflict" has finally been put aside--out of the way, so to speak. In its place now is the recognition that there is much folly in human ignorance. I have learned to ignore the many outlandish assertions concerning the nature of the horse, to move beyond them. This confidence has come from learning "to learn" from the horse itself. Not surprisingly, the animal has much to convey to us.

Through further research and debate, we must educate our way out of the darkness of human ignorance. This will lead directly to better systems of horse stewardship. I don't think there is any other way.

Far, far away from the confines of the domestic horse world is the world of the wild--or feral--horse. There, the animal lives out its life according to the design within it forged by Nature's (or the Creator's, if you will) hand. When we ponder such matters as hoof care, diet, exercise, and balanced movement, nature--through the feral horse--stands ready to provide direct answers.

There, no well intentioned farrier's rasp insults and obscures the mark of hoof balance, no veterinarian offers the kind helping hand to reconfigure a painful misguided tooth or an intestinal tract overcome by parasites, and no equestrian adds or subtracts a single pound to the locomotive force that brings hoof size and proportion into equilibrium with the survival requirements of the animal. All of this, nature has pre-figured in perfection without the aid of human industry.

But I don't think its enough just to go and observe. For I have seen that a number of people have gone among these animals, only to return with questionable findings [see, e.g., "Trials of the Wild Horse," *Equus* 192; and Joel Berger's *Wild Horses Of The Great Basin* (University of Chicago Press, 1986);--are examples of misquided approaches to understanding wild horse society]. Instead, we must learn to frame responsible and worthwhile questions which have educational, and not wreckless or gratuitous, value. Otherwise, we will mislead ourselves and others, and waste everyone's time. And maybe even hurt horses in the process.

My work among wild horses was somewhat focused. Foremost, I surveyed their hooves, for hooves are something that I know about. As a hoof care provider, I wanted to know what nature's grand plan was for the hooves. We'll talk about what I found in the time I've been allotted here.

Equally, I wanted to know something about the array of balanced forces that serve to forge the naturally shaped hoof in the wild. This, I reasoned, would help me to understand better what imbalanced forces contribute to hoof problems among the

animal's domestic brethren. It is this area of investigation that helped me to realize that the responsibility for better horse and hoof care cannot be shouldered entirely by the farrier and veterinarian. Indeed, "force" implies motion, and, therefore, what the horse does with its owner, is of paramount importance to everything else we do.

If the force is not a balanced one--measured against the balanced locomotive force of wild horse society--than there will be trouble. From this discriminating probe, I have come to appreciate an equilibrium--a competition, if you will--between the forces of balance and imbalance. The outcome challenges us to circumscribe a holistic view around the horse's hoof and press out a viable definition of hoof balance.

One final note before we begin. The domestic horse world needs more accountability for how it cares for its animals. Sale barns and slaughterhouses swallow up much of this accountability. This I have seen first hand. When the animal can no longer take whatever it is we dish out, off to the auction block it goes to be sold for tallow, pet food, and who knows what else. As I speak, some tenacious animal protection groups are relentlessly trying to find ways to exploit these dark corners of the horse world to their own ends--either to shut down the horse industry altogether, or whatever part they believe to be particularly revolting.

Rather than having to respond from outside pressure to change our ways--due to political groups who know really very little about horses--I would prefer that we take the more wholesome and productive route as exemplified by the Bluegrass Laminitis Symposium. That is, to educate ourselves in the broadest sense to a much better place of understanding. Our horses deserve this.

PARADIGM FOR THE NATURALLY SHAPED HOOF: A PHILOSOPHY

If anything seminally useful is to be derived from the knowledge we might gain from wild horse society, such as hoof care strategies, then we must develop an understanding of the array of forces which converge to shape the animal's life. These forces will help us to understand how the hooves, for example, are shaped. Holistically, my understanding of these forces has been described diagrammatically upon the flip chart.

But this exercise is only half of our mission. The second half will be considerably more perplexing. Assuming that what we learn is valuable, how can we realistically transpose or translate this knowledge into our regimens of horse care--such as how we care for the horse's feet?

My way of answering the above is this. When one is exposed to the realities of wild horse society in a responsible

way (e.g., trying to understand the behavior of the animal, its locomotive habits, its natural gaits, and its hooves), the individual comes away with incontrovertible evidence concerning the natural state of the animal. This knowledge resonates in our minds, and restructuring our thinking habits concerning the horse, it promises to develop into a philosophy.

Part of this philosophy can be expressed in terms of what we know as fact. In the presentation that follows are the facts concerning naturally shaped hooves as I have come to understand them from spending much time among our wild horses in their natural state and in captivity (e.g., in BLM processing/holding centers, and in private ownership). I encourage the scientific community to conduct its own wild horse research to expand this data bank of facts.

This brings me to the door of the theoretical side of my "natural state" philosophy. The facts, when considered holistically, tend to converge in ways that enable me to predict hoof "behavior." For example, I have learned that the hooves, through calculated trimming strategies based on natural state theory, will respond in kind through changes in growth. I ask, and simply, they respond. I not only affect their size and proportion--I affect their growth behavior for the immediate future.

So, in these ways do natural state "fact" and "theory" work together for me. In the descriptions of naturally shaped hooves that follow, I have carefully attempted to distinguish fact from theory. Listeners can draw their own conclusions from my data, forming their own theories.

Summary

Before proceeding with the following description of wild horse hooves, I would like to offer these observations. When I say that something is *normal*, I would hope in each instance to clarify my frame of reference. What is normal and what is natural may not mean the same thing. Unless stated otherwise, assume that my expressions of normality apply only to what is relevant to wild horse society. What is normal there promises to collapse when framed by the exigencies of domestic horse life. Domestic horse hooves, for example, may assume considerably widespread proportions along their measurable axes, depending on the regimen of hoof care we are looking at. In contrast, in the wild nature tends to systemize hoof size and proportion within very specific limits. Thus, what is normal in one environment of domestic horse life, may differ from the next, and all may differ in part or wholly from the horse's natural state.

If there is an area of current misunderstanding concerning the natural state of the horse that promises to undermine all the other potential usefulness that could be derived from natural state theory in domestic horse care, I would have to identify this

as the locomotion of the horse. Systemized gait analysis, in my opinion, has not yet seen its day.

I have personally witnessed the awarding of the Gold Medal for dressage at one recent Olympiad to a distinguished equestrian whose riding method (e.g., the seat and legs) in my opinion wholly contradicts the natural locomotive action of the horse. A much lower contender rode, in my view, in perfect harmony with her mount--with no such recognition.

Part of the problem lie in the way the respective horses were shod. The loser's was very naturally trimmed, the winner's anything but. This judgement is based on the parameters of the horse's natural state, which we will discuss in a moment.

A bigger problem lay in the way the riders' bodies melded with the natural action of their respective horses. Both horses moved reasonably natural--notwithstanding the mechanically obstructive effects of the one trimmed unnaturally--but the riders apparent assumptions about what that meant very visibly differed. This was demonstrated in how they moved their bodies relative to the natural action of their respective mounts. I don't think there is any great mystery concerning which way was the more natural and efficient. And I think the difference could be demonstrated through systemized gait analysis, and--if I were the odd judge--a different winner would have been selected based on the results.

I believe that gait analysis will prove to be the key--the missing link--to improving not only better equestrian skills, but unraveling the mystery of hoof balance. As I now understand it, the natural gait complex (NGC) of the horse is extremely capable of absorbing fluctuations in hoof size and proportion in order to sustain the animal's balance. Just as it is capable of absorbing the unbalanced loading of the equestrians body weight. But there are limits.

I am convinced that there would be far more hoof and riding based lamenesses if more equestrians were capable of frivolously exploiting the full spectrum of locomotive possibilities made possible by NGC. But most don't know how, and probably would get bucked off if they tried to press their horses to such extremes. As a distinguish rider from the Spanish Riding School once told me, most equestrians are doomed to mediocre levels of relatively harmless free forward riding. Just as well, for artificially driven into the advanced movements of the High School, most horses--not properly prepared through progressive gymnastic development--would simply break down.

Thank you for your patience in this lengthy introduction, if I may now turn to the remarkable hooves of our feral horses.

ACTIVE/PASSIVE WEAR

Not all parts of the hoof wall bear and transmit body weight --interpreted as a compressional force moving downward through the digit and across the interdigitated laminae to the hoof capsule-- equally. Evidence that this is the case is demonstrated by *active* and *passive wear* in the hooves of feral horses.

The flip chart diagrams give several views of how active/ passive wear emerges in naturally shaped hooves. According to natural state theory, areas of passive wear are inversely proportional in magnitude to the incidence of compressional force directed there. Areas of the hoof that endure greater force, in other words, protrude more than those areas that receive less force.

In this interpretation, areas of recession (i.e., passive wear) are not interpreted as being composed of inferior horn. They simply recede rather than protrude so as to absorb less force-energy in the ongoing equilibrium between hoof and locomotive balance. Therefore, natural state theory suggests that there are "weak" and "strong" forces operative during hoof shaping (and balancing). These weak/strong forces coincide with areas of active/passive wear.

According to natural state theory, weight normally borne by one part of the hoof wall is free at all times to migrate or transfer to other parts of the wall in order to correct imbalance--that is, realign the equilibrium between force and form. This dynamic lays a significant pillar beneath our definition of hoof balance: Hoof size and proportion, sculpted by weak and strong forces, are not static. They modulate constantly, responding to the many influences affecting the horse's existence (e.g., socialization, diet, lameness, and age).

Going one step further, we may predict that in the equilibrium between locomotive force and hoof form there is a relatively unrestricted realm of horn growth dedicated to driving --subtly so in the normal hoof, drastically so in the laminitic hoof--the entire posture and shape of the hoof capsule in various directions. The direction taken and at what rate of change, and also the magnitude of horn involved, depend on the intensity and duration of the imbalancing insult.

At this time I am unable to say if the hoof is capable of altering its posture by building in, or removing, horn as needed; or that it simply changes its posture by regulating its angle of growth through the intensification or de-intensification of its areas of active and passive wear. Perhaps it does both.

So far as I can tell, this region of dedicated growth lies behind the quarters and--as stated, in ways that I do not fully understand--contributes to the balancing of the hoof. I will speculate more specifically about its locality and possible

mechanics shortly (see **ANGLE OF GROWTH**).

For now, what this means to me is that the hoof, by differentiating weak from strong forces through areas of active/passive wear, can "prop itself up" so as to sustain a fairly standard orientation relative to the ground--at impact and throughout support--until the hoof is unloaded at breakover. Although each hoof's angle-of-growth varies considerably from horse to horse (and normally from front to hind, for the same horse, but not normally left to right), all in my opinion are effectively "balanced" or propped up upon the ground through active/passive wear in the same way. Otherwise, naturally shaped hooves would become very distorted--lopsided, excessively long, and a host of other possible forms never seen in wild horse society. I will discuss the parameters for this balanced orientation in the discussion of hoof symmetry. (see **HOOF SYMMETRY AND ASYMMETRY**).

Active/passive wear may also be a mechanism for restoring (i.e., healing) the laminitic hoof. Accordingly, we can predict that the hoof, in order to sustain the horse's new requirements for locomotive balance, and to ease pain, will completely re-posture and remodel itself to provide more efficient support. It may even shed the entire hoof capsule, if the attack is severe enough, to pave the way quickly for a whole new hoof. The direction of new dedicated horn for re-posturing the hoof, according to natural state theory, is toward more active wear at the heels, and more passive wear forward of the heels.[1] I believe this hypothesis can be tested in feral horse populations with the cooperation of the BLM. Researchers could "tag" and chart the course of active/passive wear (and by measuring changes in angle of growth) in horses stricken with laminitis in carefully monitored control groups. Such studies could lead to more clearly defined trimming prescriptions for re-balancing laminitic hooves.

BEVEL OF WALL

The bevel of the hoof wall refers to the bend, or turn, along the bearing surface of the outer wall. The term *wall bevel* is probably misleading. When I think of bevel, what comes to mind is the bevelled edge of a chisel, and that imagery does not work for what I have seen among feral horses. Rounded is a more fitting description, not necessarily the bevel shape that is apparent in a beveled-edge chisel.

The flip chart diagrams illustrate the sort of wall bevel observed in naturally shaped hooves. Something never seen is abrupt, sharp edges, precisely the type of chisel-like bevel that would be worn away and honed smooth in wild horse country.

Also, as seen on the flip chart, rolled toes, squared toes, walls worn more heavily on one side of the hoof's median line than the other, contradict natural state. Such hooves presuppose that the equilibrium between locomotive force and hoof form favors an

omnidirectional breakover at support--for example, at the toe. But analysis of the horse's natural gait complex suggests otherwise. Lateral movements are probably more common than "straight line" movements and, thus, explain why wall bevel is so uniform around the hoof.

Walls that, for whatever reason, require "unloading" (i.e., need a weak force) at any particular point do so through active/passive wear. Bevel remains constant. This is also demonstrated in the biospecimens everyone is free to inspect.

Lastly, note also that the caudal hemispheres of the frog/heel-bulb complex are also worn with the same degree of bevel as the outer wall. We'll address this observation later.

ANGLE-OF-GROWTH

The angle at which the hoof grows down below the hairline toward the ground is visible in the organization of the wall's grain. Roughly, it does this at the angle of the toe wall, when the hoof is viewed from the side. The diagrams of the flip chart demonstrate the alignment of the wall's grain in three profiles: from the side, from above, and from behind.

While it appears that the alignment of the wall's grain is rather parallel, with closer inspection we find that this is not actually the case. As we move from the (dorsal) toe wall to the heels, the angle of growth decreases, particularly behind the widest bend of the hoof (i.e., the quarters).

Relative to the hoof capsule's overall conformation, this organization of growth has another interesting dimension. As the angle of growth decreases from the toe to the heels (as described above), the absolute angle of the outer wall--for example, when the hoof is viewed from the front--increases. This is particularly evident in the medial quarters of hind hooves (much less so in front hooves), where wall angles approach 80 to 90 degrees.

As the heel-buttresses are approached, the wall "rolls" over and the grain appears to lie very close to being parallel with the ground; I would place this angle at 15 to 20 degrees--30 to 40 or more degrees lower than at the toe! In fact, based on my hoof specimens, arguably the hoof is enduring passive pressure on the "back" of the heels. By hoof care standards in our industry, naturally shaped hooves would appear to be run under--in fact, that was my first impression of them years ago. Yet, in retrospect, I see now that this is not the case. The tubular grain constituting the heels, as with the supporting grain of all portions of the outer wall, endures active contact at its ends and not along its lengths.

Peculiarities of Hoof Angle

According to natural state theory, nature has configured the horse's hooves to exist day-to-day at minimum length and optimum angle. Later in this discussion, I will attach actual numbers (normality range, standard deviation, and mean) from my research data so that we might quantify statistically what lengths and angles are representative of the herds I sampled.

What is significant here is that nature seems to have found a way to affect change in hoof angle (i.e., angle of growth) while making little or no change in hoof length. For example, we can see in the flip chart diagrams that two hooves with identical heel and toe lengths can have different toe angles. Similarly, two hooves having identical heel lengths and toe angles can have different toe lengths. How is this possible?

Apparently, the angle of the hoof is not a function of its relative toe to heel length. That is, the length of the toe relative to the length of the heels has no apparent bearing on the actual axis or angle of the hoof (e.g., toe angle).

My understanding is that hoof angle must somehow be a function of its angle of growth. I think of this occurring in terms of a "bootstrap" theory, in which changes in hoof angle are induced by growth changes in the hoof wall roughly just behind the quarters. Behind this point the outer wall is no longer bound or interdigitated through its laminae with the coffin bone--which is supported at its "wings" by the lateral cartilages (the "bootstraps"). And so it is free to assume a different angle of growth than the grain riveted to--but moving downward upon--the coffin bone. Which, as we saw earlier, it readily does.

Strong forces passing through the heels, according to natural state theory, will tend to elevate hoof angle, while weak forces will lower it. Therefore, we may predict in laminitis, that weak forces at the toe caused by breakdown of the structural integrity of the laminae, will be offset by strong forces at the heels. In other words, we may speculate that a higher than normal hoof axis is indicated for the laminitic hoof's healing pathway. The heels will endure more active wear, they will probably grow faster (and possibly longer) than usual, and at a higher angle of growth. Such growth should be accompanied by more accentuated collection-based behavior (e.g., more active participation of the horse's hindquarters).

In conclusion, changes in hoof angle appear to be regulated through changes in growth patterns (i.e., the angle of growth). In treating laminitis, we can draw heavily upon this unique behavior of the hoof to help us get it on the healing pathway.

CONTOUR OF THE CORONET

The junction of the hairline with the hoof wall defines the

contour of the coronet. The highest point of the coronet lies over the toe wall, from which it more or less descends in a downward path to the heel buttresses. Does this descent occur in a single plane? My studies cannot rule out this possibility in some hooves, but they do show definitively that it does not occur in the hoof specimens in my possession.

Some farriers are reporting to me that their trimming methods can affect the relative height of the coronary band. Their intent, ostensively, is to induce it to align in a single plane--thereby "balancing the hoof." The truncated cone in the flip chart diagram illustrates this alignment.

If anything, the biospecimen presented here suggests that "rises" in the contour of the coronet coincide with areas of passive wear at the wall's distal end or bearing surface, particularly behind the toe wall. As such, they are associated with weak forces, according to natural state theory. What the consequences would be for arbitrarily altering (e.g., lowering) the contour of this naturally shaped hoof's coronet is not clear to me. If the hoof may be defined as being balanced as it is, then insulting its conformation (i.e., size and proportion) in any way that changes it from what it is, could serve to imbalance it. At least this is worth considering.

RELATIVE CONCAVITY

The bottom of the naturally shaped hoof is arched, forming a concaved volar "dome." Every structure within the dome contributes in some way to the arch. For example, the contour of the wedge-shaped frog mass is arched from its apex to the heel-bulbs, with which it intermeshes. Similarly, the arched sole forms a vaulted ceiling within the volar dome that complements the arched frog. Even the bearing surface of the outer wall, notwithstanding variations in wall length due to active/passive wear conforms to the arch; this occurs through the bevel as well as the arched bars which divide the collateral sulci of the frog from the sole.

How the volar dome breaks down in terms of gradations of concavity from one structure, and layer, to the next is well defined in naturally shaped hooves. The gradations are illustrated in the flip chart diagrams.

Following the diagrams, the arching begins subtly at the junction of the outer wall with the white line, where the hoof makes active (or passive) contact with the ground. It reaches its highest degree of arch at, or just behind, the frog apex. Between these two extremes, there are a total of at least four distinct transitions, or gradations, in the hoof's arch:

1. Water line of the outer wall to white line
2. White line to sole (white line forms junction of stratum internum with solar dome)

3. Sole to bar
4. Bar to frog/frog apex/frog cleft

Although the bars and sole may at some points lay higher than the frog within the volar dome, the theory of relative concavity holds that these structures nevertheless have ordered positions relative to one another. The normal functioning of the hoof, according to natural state theory, depends on this arrangement. Therefore, in our trimming and shoeing methods and strategies, we should respect this natural ordering of concavity to assure that hooves in our care are properly arched. This way too we are assured that we are serving both the physiology of the hoof as well as the hoof's structural requirements upon which the horse's natural gait complex depends.

CONFORMATION OF FROG

Much discussion is possible concerning the structure and purported function of the frog. Here, we will be concerned with its natural shape. As stated above, the naturally worn frog is roughly a triangular, or wedge-like, shaped mass. Its contour, again, is concaved, since it occupies and contributes to the hoof's volar dome.

As can be seen in the flip chart diagrams, the frog stretches about 2/3 of the way across the hoof's volar profile. Its apex, as seen in the sagittal section, lies somewhat behind an axis following the dorsal surface of the coffin bone. Both my statistical evaluations of hoof measurement data, and hoof dissections, suggest that these observations hold true across all my feral horse samples.

Logically, given the hoof's arched volar dome, we can appreciate that the arched frog endures passive contact with the ground. This, to my way of thinking, can be likened to the arch of the human foot, which, if not fallen, also endures passive contact with the ground.

According to the parameters of relative concavity, the frog also forms part of the base of the volar dome--that is, the stretch between the heel buttresses. Nevertheless, close observation reveals that this stretch of the frog mass remains passive relative to the heel buttresses. It is recalled from the earlier discussion that the angle-of-growth of the buttresses, although very low (approaching 15 to 20 degrees), provides for some measure of heel length (less than 1 centimeter albeit). Apparently, this small amount of horn is sufficient to assure the frog passive contact with the ground--protection, in my interpretation, from having to provide support during the limb's weight bearing phase.

In view of the above, we may conclude that trimming and shoeing methods/strategies which encourage or force the frog to experience active contact with the ground (i.e., endure strong

forces most of the time) are contraindicated by natural state theory.

The texture of the frog is another area of observation worth discussing. Normally, frogs are rather dry, tough, and leathery. Most hooves I examined revealed frogs that were worn rather smooth; yet, in some, the surfaces were extremely scraggly and uneven, with dense, tough almost gnarled folds of dry leathery tissue. I would liken them to the badlands of the Dakotas. In either extreme, the cragged convolutions of the frog--like the well-defined convolutions of the central and collateral sulci were not so pronounced as to harbor large particulates of debris from the environment. Smaller particles of debris, however, were commonly ensconced in the frog's areas of recession--apparently worn and exfoliated along with old/dead horn. It was never clear to me if the frog was expressed at all through molting.

I invite the audience to my display table to study the close up photos of frogs, along with the hoof specimens derived from feral horses. These evidence the ranges of frog textures I observed.

HOOF PIGMENTATION

Hooves I surveyed were either black, white (yellow?), or some combination of the two. The flip chart pie graph quantifies my findings. Most hooves, approximately 70 per cent, were all or predominantly black. Another 20 per cent were of some combination of black and white. Less than 10 per cent had hooves that were all white or nearly so.

These results could be tempered further by identifying those horses which had hooves of different combinations of the above. In which case, far fewer horses would be designated as having black hooves--driving upward my counts in the other two categories. Also, the uninformed should be aware that the BLM systematically culls horses of "color"--with colored hooves--from the rangelands. These "sell" quickly in the government's adoption program ("Adopt-A-Horse"), and thereby have the effect of potentially skewing color in the favor of bays, chestnuts, etc.

HOOF SYMMETRY AND ASYMMETRY

As shown in the previous discussions, and as is evident in the biospecimens and photographic evidence, the supporting structures of the hoof wall vary considerably in size, proportion, and even texture from one locality to another. For example, the medial stretch of the outer wall may be worn considerably different than the bearing surface of its opposing lateral wall. But what of a given structure's size and proportion relative to the hoof's median line--that is, the axis which bisects the hoof through the frog's central sulcus? Will the divided halves be symmetrical or asymmetrical?

The flip chart diagrams illustrate my findings. In terms of linear dimensions, my data shows that the median axis divides the hoof into fairly equal halves in its volar profile. This is true for both front and hind hooves. The sides may be worn very differently (e.g., one side has a pattern of active/passive wear different from the other side), but their measurable dimensions are very close.

When the same front and hind hooves are viewed from the front, the median line (drawn as a vertical extension of the axis dividing the volar profile) also roughly bisects the hoof. In the front hoof, the halves are virtually identical in size and proportion. However, this is not the case with the hind; here, the lateral side differs in size and proportion from the medial side. My observations are that the medial wall rises at a higher angle of growth--relative to the median axis. It also lies at a somewhat shorter distance from the median axis than its opposing lateral wall. The hind hoof, therefore, is asymmetrically divided by its median axis when viewed from the front. It is also asymmetrically divided when viewed from above.

Apparently, the median axis of the volar profile does not align in the same plane as the median axis of the hoof when viewed from the front. Rather, the two axes form an angle of intersection. Exactly how these axes intersect each other relative to the coffin bone within is something I have not looked at.

My explanation for this orientation--if the hooves have not deceived me!--is that nature has intentionally configured a higher angle of growth in the medial wall of hind hooves in order to sustain more active wear there. But without compromising a symmetrical base of support. This makes sense if we consider that the lateral propulsory actions of the hindquarters--particularly during collection based behavior--will require that strong forces be directed there (i.e., over the medial toe wall) during turns and other similar lateral directed movements. Such is not the case with the more support oriented front hooves, which may explain why they are more symmetrically configured than corresponding hinds.

FRONT AND HIND SHAPES: SIZE AND PROPORTION

This part of the discussion attempts to quantify front and hind hoof size and proportion, and further describe basic differences in their respective shapes. On the average, how large or small are the hooves of feral horses? At what angles, relative to the ground, are their angles of growth? How do hind hooves contrast with their corresponding fronts? And what factors--such as hoof pigmentation, the horse's age, and body weight--tend to influence or not influence hoof size and proportion.

The flip chart diagrams attempt to answer these questions. The illustrations for front and hind hooves are "average" shapes;

that is, they are a harmony of the various measurement categories for the four hundred or so hooves I sampled from feral horses just removed from rangelands by the Bureau of Land Management.

The actual measurement categories are identified along the axes of the diagrammed hooves. The data presented is for adult male and female horses over age five years. Each category is expressed statistically as a mean, and includes the range and standard deviation (SD) for that particular hoof axis.

For example, average adult front and hind toe lengths both measured approximately 3 inches. Approximately 70 per cent of all hooves measured between 2-3/4 and 3-1/4 inches. And no hooves measured over 3-1/2 inches according to my data range.

Note that, on the average, front and hind hooves also measured approximately the same in terms of heel width. Yet front hooves measured wider across the quarters, across the point-of-frog, and across the hoof's median line passing through the central sulcus of the frog. Comparative analysis of front to corresponding hind hooves reveal that growth patterns for size/proportion are basically the same for the entire sample.

What this means is that the active/passive bearing surface area of the front hoof is greater than for corresponding hind hooves. Yet both have approximately the same toe lengths.

Further analysis reveals that hind toe angles are approximately three to four degrees higher than for corresponding front hooves. My statistical range for this measurement category reveals that front hooves never exceeded their corresponding hind hooves in toe angle, that they were the same in less than 2 per cent of my sample, and that in approximately 15 per cent of all horses hind toe angles exceeded fronts by a margin of 5 to 8 degrees. No hoof sampled exceeded a hind>front angle differential of 8 degrees.

The flip chart reveals other trends calculated from my data base. Several of these are particularly worth amplifying:

When data for each measurement category was sifted on the basis of hoof pigmentation, the generated statistical means and ranges were the same as those calculated for the entire sample.

When data was sifted according to age, hoof size appeared to change on the average until age five, at which point statistical averages leveled off. My data is not clear concerning changes in angle-of-growth (e.g., toe angle).

More research among feral horses is needed, for example, concerning the influences of body weight, conformation, the effects of moisture, predation (e.g., does band behavior influenced by mountain lion predation generate stronger forces and more active wear through the heels, yielding higher angles of

growth?[2]), terrain, socialization patterns, and diet.

CONCLUSION

The paradigm for the naturally shaped hoof presented here, based largely on my observations of the hooves of wild, free-roaming horses, is offered as another way to gauge our hoof care regimen for its domestic brethren. How useful is it to us here in the world of the domestic horse? That will depend on how creative we are. For it to be very useful, more research and debate must take place. Attached to my lecture notes are some of my ideas for research projects.

Going out to learn from these free spirits of the horse world is actually fun, and relaxing. The landscape is hauntingly beautiful, the air crisp and clean, everything is very quiet. And the horses are very inspiring to watch. Once they accept you into their lives, through a unique acceptance ritual, they are not difficult to travel along with.

On my first night among them, I lay upon the ground looking up into the stars. Suddenly, I was startled by what seemed like a loud, giant "tuba"--bellowing across the blackened alluvial valley. Rising in a panic to my feet, I listened again, through my own pounding heart beat, hearing another bellow off somewhere in the distance. Then another in yet another direction as though in response. Soon, I came to recognize these distinct trumpetings as communications between the monarch stallions--calling attention to each other in the night.

At times, it became a strain to focus on my mission (e.g., to study their hooves, gaits, and postures), so easily is one over taken by the entirety and movement of their lives and the land they roam in. In the mid-1980's several family bands I had become very close to were shot to death by unidentified, deranged nature haters. The white hooves among my specimens are the remnants of the carcasses devoured by coyotes and other scavengers. So far as horses go, their loss was a personal one to me, for they had truly been my teachers for several years.

Since then, I haven't been back to wild horse country. I know that BLM removal campaigns continue on as before to control their numbers. Save population control, there seems to be little scientific interest in them, although my understanding is that may change in the near future. Whatever, by and large, I am confident that our wild horses are out there doing things their way when possible. Such is the nature of the natural horse.

End.

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NOTES

1. See "Laminitis--Is There A Natural Healing Pathway," by Jaime Jackson. *American Farriers Journal*, December/1994 (20) (7) 11-17.

2. See "Seasonal mountain lion predation of a feral horse population," by John W. Turner, Michael L. Wolfe, and Jay F. Kirkpatrick. *Canadian Journal of Zoology*, 1992 (70) 929-934. Turner's research group concluded "the growth of this wild horse population is limited by predation." The horses he studied were along the border of California/Nevada. According to natural state theory, growth angles of horses in this population may be higher than in populations without lion predators.

Reflections on Hoof Balance

The expression "hoof balance" is a term much bandied about by many of us these days. As I reflect on the natural state of the horse's hoof, which, as we have discussed, exists constantly in a very special equilibrium with the locomotive force that gives the hoof its form, I am dubious if we can actually define hoof balance simply and solely along the measureable axes of hoof shape.

The shape of the hoof is not static. It is forever changing according to the forces that enter into and against it. Balance suggests that there is an equilibrium between these forces entering into and against the hoof, and the resulting form of the hoof produced by them.

But even this is not enough, in my opinion. I cannot accept that the hoof is without living design, and, therefore, is a helpless and voiceless by-product of the shaping forces.

In this view, my understanding of hoof balance is driven deeply into the complexities of *behavior*. The hoof is alive and behaves in various way, not unlike the animal which treads upon it. Why, for example, does the hoof grow at the rate it does? The answer lies in the behavior of the living hoof. Of course, it has everything to do with how much force nature has intended the hoof to endure within a framework of natural selection.

Hoof behavior, thus, is the living undercurrent or physiology which attempts to fit form with locomotive force. When the hoof behaves normally and naturally, its life is a balanced one. The horse can then behave normally and naturally upon it.

Hoof balance, then, is an outward expression of hoof behavior. It tells us how the hoof is feeling, by reflecting the success of the fit between force and form. How then do we know when the behavior of the hoof is normal and healthy, and, therefore, has entered into a balanced orientation?

When, collectively, the aggregate of characteristics of the hoof (e.g., relative concavity, angle-of-growth, and size/proportion), which we have discussed, align according to the paradigm of the naturally shaped hoof. *And*, when the locomotive expression of that balanced form can be expressed wholesomely through the natural gait complex. Force *and* form, both forever together, unsplitable pieces of nature's grand design for the horse.

1993 - Montgomery Pass Wild Horse Territory
Wild Horse General Reference List - J.W. Turner, Jr.

The Feral Horse (1986) A special issue of *Journal of Equine Veterinary Science* (W. Jones, Ed.), Vol. 6, Number 5, 65 pages. (Obtainable from *Journal of Equine Veterinary Science*), P.O. Box 197, Wildomar, California 92395-0197).

An excellent brief survey of many aspects of the biology, politics and economics of wild horses and their management.

Wild Horses and Sacred Cows (1985) Richard Symanski. Northland Publishing, Flagstaff, Arizona, 200+ pages.

An entertaining and personal view of the wild horse controversy, with numerous anecdotes and interviews.

Horse Behavior (1983) George H. Waring. Noyes Publications, Park Ridge, New Jersey, 292 pages.

An extensive and detailed treatise on the behaviors and adaptations of domestic and wild horses and ponies.

The Mustangs (1952) J. Frank Dobie. Little, Brown. Boston, Massachusetts, 376 pages.

An old but interesting book about the horses of American West: Highly anecdoted, but well documented.

Wild Horses of the Great Basin (1986) Joel Berger. University of Chicago Press, Chicago, Illinois, 326 pages.

A research-oriented examination of social behavior and population characteristics of wild horses, especially in Nevada's Granite Range. Unfortunately, it is overly speculative.

Given a Free Rein, Prolific Mustangs Gallop into Trouble (1984) John W. Turner, Jr. In: *Smithsonian Magazine*, February, pp. 88-96.

A short story and review up to 1984 of the research of Turner and Kirkpatrick toward the development of fertility control as a management tool for wild horses.

New Developments in Feral Horse Contraception and Their Potential Application to Wildlife (1991) John W. Turner, Jr. and Jay F. Kirkpatrick In: *Wildlife Society Bulletin* 19:350-359.

A summary of contraceptive research of Turner and Kirkpatrick up to 1991, with its potentially broader applications.

Horsewatching (1989) Desmond Morris. Crown Publisher Inc., 225 Park Avenue South, New York, New York. 10003 (1989, $12.95)

Body language, subtle expressions, social behaviors, equine psyche, motivations, historical bond of man and horse and amusing anecdotes.

The Natural Horse (1992) Jaime Jackson. Northland Publishing, Flagstaff, Arizona, 171 pages.

Lessions from the wild for the care of domestic horses.

Cougar, The American Lion (1992) Kevin Hansen. Northland Publishing, Flagstaff, Arizona, 129 pages.

Natural history and biology of the cougar (mountain lion).

PARADIGM FOR THE NATURALLY SHAPED HOOF

by Jaime Jackson

"Thus it appears advisable to me to look back from the perfect animal and to inquire by what process it has arisen and grown to maturity, to retrace our steps as it were, from the goal to the starting place, so at last when we can retreat no further, we shall feel assured that we have attained to the principles." (William Harvey, 1651)

"PARADIGM FOR THE NATURALLY SHAPED HOOF--A HOLISTIC VIEW"

by Jaime Jackson

Forward

I have travelled daily at my own expenses and time for weeks on end among hundreds of this country's feral horses. I have held in hand a thousand of their immaculate hooves. Looking back across to our domestic horse world, I can only conclude that we have much to learn still about what is right and wrong for our equine friends. Unfettered by the human hand, Nature's grand *design* for horse and hoof beckons us all.

First Session

Model for Excellence: The Wild, Free-Roaming Horse

- Video & Slides--Glimpses of the inner life of wild horse society
- The Significance of Habitat
- Conundrum of the Locomotive Force
- Summary--Matrix of the Naturally Shaped Hoof
- Questions/Answers

Second Session

Architecture of the Naturally Shaped Hoof

- "Video Round-up"--Close-up journey inside and around the naturally shaped hoof
- Statistical Evaluation--Size/Proportion
- Value of the naturally shaped hoof in modern farriery and veterinary care
- Questions/Answers

Display Table

Biospecimens--invitation to see and touch the naturally shaped hooves of wild horse society

- Contacts to visit wild horse country

- Copies--*The Natural Horse* (Northland Publishing, 1992) by Jaime Jackson
- Related Articles published by the American Farriers Journal: please contact Frank Lessiter, Publisher, AFJ, P.O. Box 624, Brookfield, WI 53008-0624; telephone 414-782-4480; Fax 414-782-1252.

DISCUSSION

Introduction

At every inch of the way of the domestic horse's life it is at the total mercy and whim of its human master. In this life, the horse has little or no say about the conditions it must endure or the future that lies ahead of it. As a captive, its diet, socialization, health, and hooves, are entirely governed by the regimen of care humans deem appropriate.

As a farrier, I have participated at the center of this care regimen, noting that the horse's life is complicated further by the fact that few humans agree on what is best or appropriate for the horse. This division is demonstrated in many ways--how the horse's hooves are managed, how the animal is trained and ridden, and even what is considered abusive or humane treatment. I suppose none of this contention would matter except for the single fact that horses inevitably fail to perform well when patterns of care leave the animal distressed.

At the hub of the domestic horse world, both farrier and veterinarian are compelled to sort through the maze of conflicting theories and practices of horse/hoof care in order to serve their clients--the horse owners. These differences often arise as sources of contention between service providers, and sometimes with their clients.

Although not all is well in our domestic horse world, people--clients and their service professionals--try hard to provide the best care possible under the circumstances for their horses. This has always been my attitude. Try to learn and do the best you can.

But, as every farrier and veterinarian knows who has spent time in the trenches of the every day horse world and cares as much about the animal as the money to be made, it can become a grating emotional roller coaster when one must constantly serve more than one master. What is right for the horse, according to our personal understanding of the animal, and what we must do to serve our clients and their often variant and conflicting demands, do not always align or resonate well within. Fierce competition in the ranks of the hoof care and veterinary providers may fuel the predilection to compromise.

It is the systemization of this inner conflict that drove me from the domestic horse world and into wild horse country years ago. Believe me, it was no casual sightseeing tour. Exhausted by the many conflicting theories--and practices--of hoof and veterinary care, I quietly took my leave of absence in hopes of supplanting the emotional war within with a new vision and harmonizing of horse care founded upon nature's "grand plan" (as I now refer to it) for this animal. In the soundness of the very dynamic natural world of wild horse society, I found this vision.

This journey has led me to a new awareness and appreciation for the personal struggles of both horse and the horse enthusiast. The old "conflict" has finally been put aside--out of the way, so to speak. In its place now is the recognition that there is much folly in human ignorance. I have learned to ignore the many outlandish assertions concerning the nature of the horse, to move beyond them. This confidence has come from learning "to learn" from the horse itself. Not surprisingly, the animal has much to convey to us.

Through further research and debate, we must educate our way out of the darkness of human ignorance. This will lead directly to better systems of horse stewardship. I don't think there is any other way.

Far, far away from the confines of the domestic horse world is the world of the wild--or feral--horse. There, the animal lives out its life according to the design within it forged by Nature's (or the Creator's, if you will) hand. When we ponder such matters as hoof care, diet, exercise, and balanced movement, nature--through the feral horse--stands ready to provide direct answers.

There, no well intentioned farrier's rasp insults and obscures the mark of hoof balance, no veterinarian offers the kind helping hand to reconfigure a painful misguided tooth or an intestinal tract overcome by parasites, and no equestrian adds or subtracts a single pound to the locomotive force that brings hoof size and proportion into equilibrium with the survival requirements of the animal. All of this, nature has pre-figured in perfection without the aid of human industry.

But I don't think its enough just to go and observe. For I have seen that a number of people have gone among these animals, only to return with questionable findings [see, e.g., "Trials of the Wild Horse," *Equus* 192; and Joel Berger's *Wild Horses Of The Great Basin* (University of Chicago Press, 1986);--are examples of misquided approaches to understanding wild horse society]. Instead, we must learn to frame responsible and worthwhile questions which have educational, and not wreckless or gratuitous, value. Otherwise, we will mislead ourselves and others, and waste everyone's time. And maybe even hurt horses in the process.

My work among wild horses was somewhat focused. Foremost, I surveyed their hooves, for hooves are something that I know about. As a hoof care provider, I wanted to know what nature's grand plan was for the hooves. We'll talk about what I found in the time I've been allotted here.

Equally, I wanted to know something about the array of balanced forces that serve to forge the naturally shaped hoof in the wild. This, I reasoned, would help me to understand better what imbalanced forces contribute to hoof problems among the

animal's domestic brethren. It is this area of investigation that helped me to realize that the responsibility for better horse and hoof care cannot be shouldered entirely by the farrier and veterinarian. Indeed, "force" implies motion, and, therefore, what the horse does with its owner, is of paramount importance to everything else we do.

If the force is not a balanced one--measured against the balanced locomotive force of wild horse society--than there will be trouble. From this discriminating probe, I have come to appreciate an equilibrium--a competition, if you will--between the forces of balance and imbalance. The outcome challenges us to circumscribe a holistic view around the horse's hoof and press out a viable definition of hoof balance.

One final note before we begin. The domestic horse world needs more accountability for how it cares for its animals. Sale barns and slaughterhouses swallow up much of this accountability. This I have seen first hand. When the animal can no longer take whatever it is we dish out, off to the auction block it goes to be sold for tallow, pet food, and who knows what else. As I speak, some tenacious animal protection groups are relentlessly trying to find ways to exploit these dark corners of the horse world to their own ends--either to shut down the horse industry altogether, or whatever part they believe to be particularly revolting.

Rather than having to respond from outside pressure to change our ways--due to political groups who know really very little about horses--I would prefer that we take the more wholesome and productive route as exemplified by the Bluegrass Laminitis Symposium. That is, to educate ourselves in the broadest sense to a much better place of understanding. Our horses deserve this.

PARADIGM FOR THE NATURALLY SHAPED HOOF: A PHILOSOPHY

If anything seminally useful is to be derived from the knowledge we might gain from wild horse society, such as hoof care strategies, then we must develop an understanding of the array of forces which converge to shape the animal's life. These forces will help us to understand how the hooves, for example, are shaped. Holistically, my understanding of these forces has been described diagrammatically upon the flip chart.

But this exercise is only half of our mission. The second half will be considerably more perplexing. Assuming that what we learn is valuable, how can we realistically transpose or translate this knowledge into our regimens of horse care--such as how we care for the horse's feet?

My way of answering the above is this. When one is exposed to the realities of wild horse society in a responsible

way (e.g., trying to understand the behavior of the animal, its locomotive habits, its natural gaits, and its hooves), the individual comes away with incontrovertible evidence concerning the natural state of the animal. This knowledge resonates in our minds, and restructuring our thinking habits concerning the horse, it promises to develop into a philosophy.

Part of this philosophy can be expressed in terms of what we know as fact. In the presentation that follows are the facts concerning naturally shaped hooves as I have come to understand them from spending much time among our wild horses in their natural state and in captivity (e.g., in BLM processing/holding centers, and in private ownership). I encourage the scientific community to conduct its own wild horse research to expand this data bank of facts.

This brings me to the door of the theoretical side of my "natural state" philosophy. The facts, when considered holistically, tend to converge in ways that enable me to predict hoof "behavior." For example, I have learned that the hooves, through calculated trimming strategies based on natural state theory, will respond in kind through changes in growth. I ask, and simply, they respond. I not only affect their size and proportion--I affect their growth behavior for the immediate future.

So, in these ways do natural state "fact" and "theory" work together for me. In the descriptions of naturally shaped hooves that follow, I have carefully attempted to distinguish fact from theory. Listeners can draw their own conclusions from my data, forming their own theories.

Summary

Before proceeding with the following description of wild horse hooves, I would like to offer these observations. When I say that something is *normal*, I would hope in each instance to clarify my frame of reference. What is normal and what is natural may not mean the same thing. Unless stated otherwise, assume that my expressions of normality apply only to what is relevant to wild horse society. What is normal there promises to collapse when framed by the exigencies of domestic horse life. Domestic horse hooves, for example, may assume considerably widespread proportions along their measurable axes, depending on the regimen of hoof care we are looking at. In contrast, in the wild nature tends to systemize hoof size and proportion within very specific limits. Thus, what is normal in one environment of domestic horse life, may differ from the next, and all may differ in part or wholly from the horse's natural state.

If there is an area of current misunderstanding concerning the natural state of the horse that promises to undermine all the other potential usefulness that could be derived from natural state theory in domestic horse care, I would have to identify this

as the locomotion of the horse. Systemized gait analysis, in my opinion, has not yet seen its day.

I have personally witnessed the awarding of the Gold Medal for dressage at one recent Olympiad to a distinguished equestrian whose riding method (e.g., the seat and legs) in my opinion wholly contradicts the natural locomotive action of the horse. A much lower contender rode, in my view, in perfect harmony with her mount--with no such recognition.

Part of the problem lie in the way the respective horses were shod. The loser's was very naturally trimmed, the winner's anything but. This judgement is based on the parameters of the horse's natural state, which we will discuss in a moment.

A bigger problem lay in the way the riders' bodies melded with the natural action of their respective horses. Both horses moved reasonably natural--notwithstanding the mechanically obstructive effects of the one trimmed unnaturally--but the riders apparent assumptions about what that meant very visibly differed. This was demonstrated in how they moved their bodies relative to the natural action of their respective mounts. I don't think there is any great mystery concerning which way was the more natural and efficient. And I think the difference could be demonstrated through systemized gait analysis, and--if I were the odd judge--a different winner would have been selected based on the results.

I believe that gait analysis will prove to be the key--the missing link--to improving not only better equestrian skills, but unraveling the mystery of hoof balance. As I now understand it, the natural gait complex (NGC) of the horse is extremely capable of absorbing fluctuations in hoof size and proportion in order to sustain the animal's balance. Just as it is capable of absorbing the unbalanced loading of the equestrians body weight. But there are limits.

I am convinced that there would be far more hoof and riding based lamenesses if more equestrians were capable of frivolously exploiting the full spectrum of locomotive possibilities made possible by NGC. But most don't know how, and probably would get bucked off if they tried to press their horses to such extremes. As a distinguish rider from the Spanish Riding School once told me, most equestrians are doomed to mediocre levels of relatively harmless free forward riding. Just as well, for artificially driven into the advanced movements of the High School, most horses--not properly prepared through progressive gymnastic development--would simply break down.

Thank you for your patience in this lengthy introduction, if I may now turn to the remarkable hooves of our feral horses.

ACTIVE/PASSIVE WEAR

Not all parts of the hoof wall bear and transmit body weight --interpreted as a compressional force moving downward through the digit and across the interdigitated laminae to the hoof capsule-- equally. Evidence that this is the case is demonstrated by *active* and *passive wear* in the hooves of feral horses.

The flip chart diagrams give several views of how active/ passive wear emerges in naturally shaped hooves. According to natural state theory, areas of passive wear are inversely proportional in magnitude to the incidence of compressional force directed there. Areas of the hoof that endure greater force, in other words, protrude more than those areas that receive less force.

In this interpretation, areas of recession (i.e., passive wear) are not interpreted as being composed of inferior horn. They simply recede rather than protrude so as to absorb less force-energy in the ongoing equilibrium between hoof and locomotive balance. Therefore, natural state theory suggests that there are "weak" and "strong" forces operative during hoof shaping (and balancing). These weak/strong forces coincide with areas of active/passive wear.

According to natural state theory, weight normally borne by one part of the hoof wall is free at all times to migrate or transfer to other parts of the wall in order to correct imbalance--that is, realign the equilibrium between force and form. This dynamic lays a significant pillar beneath our definition of hoof balance: Hoof size and proportion, sculpted by weak and strong forces, are not static. They modulate constantly, responding to the many influences affecting the horse's existence (e.g., socialization, diet, lameness, and age).

Going one step further, we may predict that in the equilibrium between locomotive force and hoof form there is a relatively unrestricted realm of horn growth dedicated to driving --subtly so in the normal hoof, drastically so in the laminitic hoof--the entire posture and shape of the hoof capsule in various directions. The direction taken and at what rate of change, and also the magnitude of horn involved, depend on the intensity and duration of the imbalancing insult.

At this time I am unable to say if the hoof is capable of altering its posture by building in, or removing, horn as needed; or that it simply changes its posture by regulating its angle of growth through the intensification or de-intensification of its areas of active and passive wear. Perhaps it does both.

So far as I can tell, this region of dedicated growth lies behind the quarters and--as stated, in ways that I do not fully understand--contributes to the balancing of the hoof. I will speculate more specifically about its locality and possible

mechanics shortly (see **ANGLE OF GROWTH**).

For now, what this means to me is that the hoof, by differentiating weak from strong forces through areas of active/passive wear, can "prop itself up" so as to sustain a fairly standard orientation relative to the ground--at impact and throughout support--until the hoof is unloaded at breakover. Although each hoof's angle-of-growth varies considerably from horse to horse (and normally from front to hind, for the same horse, but not normally left to right), all in my opinion are effectively "balanced" or propped up upon the ground through active/passive wear in the same way. Otherwise, naturally shaped hooves would become very distorted--lopsided, excessively long, and a host of other possible forms never seen in wild horse society. I will discuss the parameters for this balanced orientation in the discussion of hoof symmetry. (see **HOOF SYMMETRY AND ASYMMETRY**).

Active/passive wear may also be a mechanism for restoring (i.e., healing) the laminitic hoof. Accordingly, we can predict that the hoof, in order to sustain the horse's new requirements for locomotive balance, and to ease pain, will completely re-posture and remodel itself to provide more efficient support. It may even shed the entire hoof capsule, if the attack is severe enough, to pave the way quickly for a whole new hoof. The direction of new dedicated horn for re-posturing the hoof, according to natural state theory, is toward more active wear at the heels, and more passive wear forward of the heels.[1] I believe this hypothesis can be tested in feral horse populations with the cooperation of the BLM. Researchers could "tag" and chart the course of active/passive wear (and by measuring changes in angle of growth) in horses stricken with laminitis in carefully monitored control groups. Such studies could lead to more clearly defined trimming prescriptions for re-balancing laminitic hooves.

BEVEL OF WALL

The bevel of the hoof wall refers to the bend, or turn, along the bearing surface of the outer wall. The term *wall bevel* is probably misleading. When I think of bevel, what comes to mind is the bevelled edge of a chisel, and that imagery does not work for what I have seen among feral horses. Rounded is a more fitting description, not necessarily the bevel shape that is apparent in a beveled-edge chisel.

The flip chart diagrams illustrate the sort of wall bevel observed in naturally shaped hooves. Something never seen is abrupt, sharp edges, precisely the type of chisel-like bevel that would be worn away and honed smooth in wild horse country.

Also, as seen on the flip chart, rolled toes, squared toes, walls worn more heavily on one side of the hoof's median line than the other, contradict natural state. Such hooves presuppose that the equilibrium between locomotive force and hoof form favors an

omnidirectional breakover at support--for example, at the toe. But analysis of the horse's natural gait complex suggests otherwise. Lateral movements are probably more common than "straight line" movements and, thus, explain why wall bevel is so uniform around the hoof.

Walls that, for whatever reason, require "unloading" (i.e., need a weak force) at any particular point do so through active/passive wear. Bevel remains constant. This is also demonstrated in the biospecimens everyone is free to inspect.

Lastly, note also that the caudal hemispheres of the frog/heel-bulb complex are also worn with the same degree of bevel as the outer wall. We'll address this observation later.

ANGLE-OF-GROWTH

The angle at which the hoof grows down below the hairline toward the ground is visible in the organization of the wall's grain. Roughly, it does this at the angle of the toe wall, when the hoof is viewed from the side. The diagrams of the flip chart demonstrate the alignment of the wall's grain in three profiles: from the side, from above, and from behind.

While it appears that the alignment of the wall's grain is rather parallel, with closer inspection we find that this is not actually the case. As we move from the (dorsal) toe wall to the heels, the angle of growth decreases, particularly behind the widest bend of the hoof (i.e., the quarters).

Relative to the hoof capsule's overall conformation, this organization of growth has another interesting dimension. As the angle of growth decreases from the toe to the heels (as described above), the absolute angle of the outer wall--for example, when the hoof is viewed from the front--increases. This is particularly evident in the medial quarters of hind hooves (much less so in front hooves), where wall angles approach 80 to 90 degrees.

As the heel-buttresses are approached, the wall "rolls" over and the grain appears to lie very close to being parallel with the ground; I would place this angle at 15 to 20 degrees--30 to 40 or more degrees lower than at the toe! In fact, based on my hoof specimens, arguably the hoof is enduring passive pressure on the "back" of the heels. By hoof care standards in our industry, naturally shaped hooves would appear to be run under--in fact, that was my first impression of them years ago. Yet, in retrospect, I see now that this is not the case. The tubular grain constituting the heels, as with the supporting grain of all portions of the outer wall, endures active contact at its ends and not along its lengths.

Peculiarities of Hoof Angle

According to natural state theory, nature has configured the horse's hooves to exist day-to-day at minimum length and optimum angle. Later in this discussion, I will attach actual numbers (normality range, standard deviation, and mean) from my research data so that we might quantify statistically what lengths and angles are representative of the herds I sampled.

What is significant here is that nature seems to have found a way to affect change in hoof angle (i.e., angle of growth) while making little or no change in hoof length. For example, we can see in the flip chart diagrams that two hooves with identical heel and toe lengths can have different toe angles. Similarly, two hooves having identical heel lengths and toe angles can have different toe lengths. How is this possible?

Apparently, the angle of the hoof is not a function of its relative toe to heel length. That is, the length of the toe relative to the length of the heels has no apparent bearing on the actual axis or angle of the hoof (e.g., toe angle).

My understanding is that hoof angle must somehow be a function of its angle of growth. I think of this occurring in terms of a "bootstrap" theory, in which changes in hoof angle are induced by growth changes in the hoof wall roughly just behind the quarters. Behind this point the outer wall is no longer bound or interdigitated through its laminae with the coffin bone--which is supported at its "wings" by the lateral cartilages (the "bootstraps"). And so it is free to assume a different angle of growth than the grain riveted to--but moving downward upon--the coffin bone. Which, as we saw earlier, it readily does.

Strong forces passing through the heels, according to natural state theory, will tend to elevate hoof angle, while weak forces will lower it. Therefore, we may predict in laminitis, that weak forces at the toe caused by breakdown of the structural integrity of the laminae, will be offset by strong forces at the heels. In other words, we may speculate that a higher than normal hoof axis is indicated for the laminitic hoof's healing pathway. The heels will endure more active wear, they will probably grow faster (and possibly longer) than usual, and at a higher angle of growth. Such growth should be accompanied by more accentuated collection-based behavior (e.g., more active participation of the horse's hindquarters).

In conclusion, changes in hoof angle appear to be regulated through changes in growth patterns (i.e., the angle of growth). In treating laminitis, we can draw heavily upon this unique behavior of the hoof to help us get it on the healing pathway.

CONTOUR OF THE CORONET

The junction of the hairline with the hoof wall defines the

contour of the coronet. The highest point of the coronet lies over the toe wall, from which it more or less descends in a downward path to the heel buttresses. Does this descent occur in a single plane? My studies cannot rule out this possibility in some hooves, but they do show definitively that it does not occur in the hoof specimens in my possession.

Some farriers are reporting to me that their trimming methods can affect the relative height of the coronary band. Their intent, ostensively, is to induce it to align in a single plane--thereby "balancing the hoof." The truncated cone in the flip chart diagram illustrates this alignment.

If anything, the biospecimen presented here suggests that "rises" in the contour of the coronet coincide with areas of passive wear at the wall's distal end or bearing surface, particularly behind the toe wall. As such, they are associated with weak forces, according to natural state theory. What the consequences would be for arbitrarily altering (e.g., lowering) the contour of this naturally shaped hoof's coronet is not clear to me. If the hoof may be defined as being balanced as it is, then insulting its conformation (i.e., size and proportion) in any way that changes it from what it is, could serve to imbalance it. At least this is worth considering.

RELATIVE CONCAVITY

The bottom of the naturally shaped hoof is arched, forming a concaved volar "dome." Every structure within the dome contributes in some way to the arch. For example, the contour of the wedge-shaped frog mass is arched from its apex to the heel-bulbs, with which it intermeshes. Similarly, the arched sole forms a vaulted ceiling within the volar dome that complements the arched frog. Even the bearing surface of the outer wall, notwithstanding variations in wall length due to active/passive wear conforms to the arch; this occurs through the bevel as well as the arched bars which divide the collateral sulci of the frog from the sole.

How the volar dome breaks down in terms of gradations of concavity from one structure, and layer, to the next is well defined in naturally shaped hooves. The gradations are illustrated in the flip chart diagrams.

Following the diagrams, the arching begins subtly at the junction of the outer wall with the white line, where the hoof makes active (or passive) contact with the ground. It reaches its highest degree of arch at, or just behind, the frog apex. Between these two extremes, there are a total of at least four distinct transitions, or gradations, in the hoof's arch:

1. Water line of the outer wall to white line
2. White line to sole (white line forms junction of stratum internum with solar dome)

3. Sole to bar
4. Bar to frog/frog apex/frog cleft

Although the bars and sole may at some points lay higher than the frog within the volar dome, the theory of relative concavity holds that these structures nevertheless have ordered positions relative to one another. The normal functioning of the hoof, according to natural state theory, depends on this arrangement. Therefore, in our trimming and shoeing methods and strategies, we should respect this natural ordering of concavity to assure that hooves in our care are properly arched. This way too we are assured that we are serving both the physiology of the hoof as well as the hoof's structural requirements upon which the horse's natural gait complex depends.

CONFORMATION OF FROG

Much discussion is possible concerning the structure and purported function of the frog. Here, we will be concerned with its natural shape. As stated above, the naturally worn frog is roughly a triangular, or wedge-like, shaped mass. Its contour, again, is concaved, since it occupies and contributes to the hoof's volar dome.

As can be seen in the flip chart diagrams, the frog stretches about 2/3 of the way across the hoof's volar profile. Its apex, as seen in the sagittal section, lies somewhat behind an axis following the dorsal surface of the coffin bone. Both my statistical evaluations of hoof measurement data, and hoof dissections, suggest that these observations hold true across all my feral horse samples.

Logically, given the hoof's arched volar dome, we can appreciate that the arched frog endures passive contact with the ground. This, to my way of thinking, can be likened to the arch of the human foot, which, if not fallen, also endures passive contact with the ground.

According to the parameters of relative concavity, the frog also forms part of the base of the volar dome--that is, the stretch between the heel buttresses. Nevertheless, close observation reveals that this stretch of the frog mass remains passive relative to the heel buttresses. It is recalled from the earlier discussion that the angle-of-growth of the buttresses, although very low (approaching 15 to 20 degrees), provides for some measure of heel length (less than 1 centimeter albeit). Apparently, this small amount of horn is sufficient to assure the frog passive contact with the ground--protection, in my interpretation, from having to provide support during the limb's weight bearing phase.

In view of the above, we may conclude that trimming and shoeing methods/strategies which encourage or force the frog to experience active contact with the ground (i.e., endure strong

forces most of the time) are contraindicated by natural state theory.

The texture of the frog is another area of observation worth discussing. Normally, frogs are rather dry, tough, and leathery. Most hooves I examined revealed frogs that were worn rather smooth; yet, in some, the surfaces were extremely scraggly and uneven, with dense, tough almost gnarled folds of dry leathery tissue. I would liken them to the badlands of the Dakotas. In either extreme, the cragged convolutions of the frog--like the well-defined convolutions of the central and collateral sulci were not so pronounced as to harbor large particulates of debris from the environment. Smaller particles of debris, however, were commonly ensconced in the frog's areas of recession--apparently worn and exfoliated along with old/dead horn. It was never clear to me if the frog was expressed at all through molting.

I invite the audience to my display table to study the close up photos of frogs, along with the hoof specimens derived from feral horses. These evidence the ranges of frog textures I observed.

HOOF PIGMENTATION

Hooves I surveyed were either black, white (yellow?), or some combination of the two. The flip chart pie graph quantifies my findings. Most hooves, approximately 70 per cent, were all or predominantly black. Another 20 per cent were of some combination of black and white. Less than 10 per cent had hooves that were all white or nearly so.

These results could be tempered further by identifying those horses which had hooves of different combinations of the above. In which case, far fewer horses would be designated as having black hooves--driving upward my counts in the other two categories. Also, the uninformed should be aware that the BLM systematically culls horses of "color"--with colored hooves--from the rangelands. These "sell" quickly in the government's adoption program ("Adopt-A-Horse"), and thereby have the effect of potentially skewing color in the favor of bays, chestnuts, etc.

HOOF SYMMETRY AND ASYMMETRY

As shown in the previous discussions, and as is evident in the biospecimens and photographic evidence, the supporting structures of the hoof wall vary considerably in size, proportion, and even texture from one locality to another. For example, the medial stretch of the outer wall may be worn considerably different than the bearing surface of its opposing lateral wall. But what of a given structure's size and proportion relative to the hoof's median line--that is, the axis which bisects the hoof through the frog's central sulcus? Will the divided halves be symmetrical or asymmetrical?

The flip chart diagrams illustrate my findings. In terms of linear dimensions, my data shows that the median axis divides the hoof into fairly equal halves in its volar profile. This is true for both front and hind hooves. The sides may be worn very differently (e.g., one side has a pattern of active/passive wear different from the other side), but their measurable dimensions are very close.

When the same front and hind hooves are viewed from the front, the median line (drawn as a vertical extension of the axis dividing the volar profile) also roughly bisects the hoof. In the front hoof, the halves are virtually identical in size and proportion. However, this is not the case with the hind; here, the lateral side differs in size and proportion from the medial side. My observations are that the medial wall rises at a higher angle of growth--relative to the median axis. It also lies at a somewhat shorter distance from the median axis than its opposing lateral wall. The hind hoof, therefore, is asymmetrically divided by its median axis when viewed from the front. It is also asymmetrically divided when viewed from above.

Apparently, the median axis of the volar profile does not align in the same plane as the median axis of the hoof when viewed from the front. Rather, the two axes form an angle of intersection. Exactly how these axes intersect each other relative to the coffin bone within is something I have not looked at.

My explanation for this orientation--if the hooves have not deceived me!--is that nature has intentionally configured a higher angle of growth in the medial wall of hind hooves in order to sustain more active wear there. But without compromising a symmetrical base of support. This makes sense if we consider that the lateral propulsory actions of the hindquarters--particularly during collection based behavior--will require that strong forces be directed there (i.e., over the medial toe wall) during turns and other similar lateral directed movements. Such is not the case with the more support oriented front hooves, which may explain why they are more symmetrically configured than corresponding hinds.

FRONT AND HIND SHAPES: SIZE AND PROPORTION

This part of the discussion attempts to quantify front and hind hoof size and proportion, and further describe basic differences in their respective shapes. On the average, how large or small are the hooves of feral horses? At what angles, relative to the ground, are their angles of growth? How do hind hooves contrast with their corresponding fronts? And what factors--such as hoof pigmentation, the horse's age, and body weight--tend to influence or not influence hoof size and proportion.

The flip chart diagrams attempt to answer these questions. The illustrations for front and hind hooves are "average" shapes;

that is, they are a harmony of the various measurement categories for the four hundred or so hooves I sampled from feral horses just removed from rangelands by the Bureau of Land Management.

The actual measurement categories are identified along the axes of the diagrammed hooves. The data presented is for adult male and female horses over age five years. Each category is expressed statistically as a mean, and includes the range and standard deviation (SD) for that particular hoof axis.

For example, average adult front and hind toe lengths both measured approximately 3 inches. Approximately 70 per cent of all hooves measured between 2-3/4 and 3-1/4 inches. And no hooves measured over 3-1/2 inches according to my data range.

Note that, on the average, front and hind hooves also measured approximately the same in terms of heel width. Yet front hooves measured wider across the quarters, across the point-of-frog, and across the hoof's median line passing through the central sulcus of the frog. Comparative analysis of front to corresponding hind hooves reveal that growth patterns for size/proportion are basically the same for the entire sample.

What this means is that the active/passive bearing surface area of the front hoof is greater than for corresponding hind hooves. Yet both have approximately the same toe lengths.

Further analysis reveals that hind toe angles are approximately three to four degrees higher than for corresponding front hooves. My statistical range for this measurement category reveals that front hooves never exceeded their corresponding hind hooves in toe angle, that they were the same in less than 2 per cent of my sample, and that in approximately 15 per cent of all horses hind toe angles exceeded fronts by a margin of 5 to 8 degrees. No hoof sampled exceeded a hind>front angle differential of 8 degrees.

The flip chart reveals other trends calculated from my data base. Several of these are particularly worth amplifying:

When data for each measurement category was sifted on the basis of hoof pigmentation, the generated statistical means and ranges were the same as those calculated for the entire sample.

When data was sifted according to age, hoof size appeared to change on the average until age five, at which point statistical averages leveled off. My data is not clear concerning changes in angle-of-growth (e.g., toe angle).

More research among feral horses is needed, for example, concerning the influences of body weight, conformation, the effects of moisture, predation (e.g., does band behavior influenced by mountain lion predation generate stronger forces and more active wear through the heels, yielding higher angles of

growth?[2]), terrain, socialization patterns, and diet.

CONCLUSION

The paradigm for the naturally shaped hoof presented here, based largely on my observations of the hooves of wild, free-roaming horses, is offered as another way to gauge our hoof care regimen for its domestic brethren. How useful is it to us here in the world of the domestic horse? That will depend on how creative we are. For it to be very useful, more research and debate must take place. Attached to my lecture notes are some of my ideas for research projects.

Going out to learn from these free spirits of the horse world is actually fun, and relaxing. The landscape is hauntingly beautiful, the air crisp and clean, everything is very quiet. And the horses are very inspiring to watch. Once they accept you into their lives, through a unique acceptance ritual, they are not difficult to travel along with.

On my first night among them, I lay upon the ground looking up into the stars. Suddenly, I was startled by what seemed like a loud, giant "tuba"--bellowing across the blackened alluvial valley. Rising in a panic to my feet, I listened again, through my own pounding heart beat, hearing another bellow off somewhere in the distance. Then another in yet another direction as though in response. Soon, I came to recognize these distinct trumpetings as communications between the monarch stallions--calling attention to each other in the night.

At times, it became a strain to focus on my mission (e.g., to study their hooves, gaits, and postures), so easily is one over taken by the entirety and movement of their lives and the land they roam in. In the mid-1980's several family bands I had become very close to were shot to death by unidentified, deranged nature haters. The white hooves among my specimens are the remnants of the carcasses devoured by coyotes and other scavengers. So far as horses go, their loss was a personal one to me, for they had truly been my teachers for several years.

Since then, I haven't been back to wild horse country. I know that BLM removal campaigns continue on as before to control their numbers. Save population control, there seems to be little scientific interest in them, although my understanding is that may change in the near future. Whatever, by and large, I am confident that our wild horses are out there doing things their way when possible. Such is the nature of the natural horse.

End.

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NOTES

1. See "Laminitis--Is There A Natural Healing Pathway," by Jaime Jackson. *American Farriers Journal*, December/1994 (20) (7) 11-17.

2. See "Seasonal mountain lion predation of a feral horse population," by John W. Turner, Michael L. Wolfe, and Jay F. Kirkpatrick. *Canadian Journal of Zoology*, 1992 (70) 929-934. Turner's research group concluded "the growth of this wild horse population is limited by predation." The horses he studied were along the border of California/Nevada. According to natural state theory, growth angles of horses in this population may be higher than in populations without lion predators.

Reflections on Hoof Balance

The expression "hoof balance" is a term much bandied about by many of us these days. As I reflect on the natural state of the horse's hoof, which, as we have discussed, exists constantly in a very special equilibrium with the locomotive force that gives the hoof its form, I am dubious if we can actually define hoof balance simply and solely along the measureable axes of hoof shape.

The shape of the hoof is not static. It is forever changing according to the forces that enter into and against it. Balance suggests that there is an equilibrium between these forces entering into and against the hoof, and the resulting form of the hoof produced by them.

But even this is not enough, in my opinion. I cannot accept that the hoof is without living design, and, therefore, is a helpless and voiceless by-product of the shaping forces.

In this view, my understanding of hoof balance is driven deeply into the complexities of *behavior*. The hoof is alive and behaves in various way, not unlike the animal which treads upon it. Why, for example, does the hoof grow at the rate it does? The answer lies in the behavior of the living hoof. Of course, it has everything to do with how much force nature has intended the hoof to endure within a framework of natural selection.

Hoof behavior, thus, is the living undercurrent or physiology which attempts to fit form with locomotive force. When the hoof behaves normally and naturally, its life is a balanced one. The horse can then behave normally and naturally upon it.

Hoof balance, then, is an outward expression of hoof behavior. It tells us how the hoof is feeling, by reflecting the success of the fit between force and form. How then do we know when the behavior of the hoof is normal and healthy, and, therefore, has entered into a balanced orientation?

When, collectively, the aggregate of characteristics of the hoof (e.g., relative concavity, angle-of-growth, and size/proportion), which we have discussed, align according to the paradigm of the naturally shaped hoof. *And*, when the locomotive expression of that balanced form can be expressed wholesomely through the natural gait complex. Force *and* form, both forever together, unsplitable pieces of nature's grand design for the horse.

1993 - Montgomery Pass Wild Horse Territory
Wild Horse General Reference List - J.W. Turner, Jr.

The Feral Horse (1986) A special issue of *Journal of Equine Veterinary Science* (W. Jones, Ed.), Vol. 6, Number 5, 65 pages. (Obtainable from *Journal of Equine Veterinary Science*), P.O. Box 197, Wildomar, California 92395-0197).

An excellent brief survey of many aspects of the biology, politics and economics of wild horses and their management.

Wild Horses and Sacred Cows (1985) Richard Symanski. Northland Publishing, Flagstaff, Arizona, 200+ pages.

An entertaining and personal view of the wild horse controversy, with numerous anecdotes and interviews.

Horse Behavior (1983) George H. Waring. Noyes Publications, Park Ridge, New Jersey, 292 pages.

An extensive and detailed treatise on the behaviors and adaptations of domestic and wild horses and ponies.

The Mustangs (1952) J. Frank Dobie. Little, Brown. Boston, Massachusetts, 376 pages.

An old but interesting book about the horses of American West: Highly anecdoted, but well documented.

Wild Horses of the Great Basin (1986) Joel Berger. University of Chicago Press, Chicago, Illinois, 326 pages.

A research-oriented examination of social behavior and population characteristics of wild horses, especially in Nevada's Granite Range. Unfortunately, it is overly speculative.

Given a Free Rein, Prolific Mustangs Gallop into Trouble (1984) John W. Turner, Jr. In: *Smithsonian Magazine*, February, pp. 88-96.

A short story and review up to 1984 of the research of Turner and Kirkpatrick toward the development of fertility control as a management tool for wild horses.

New Developments in Feral Horse Contraception and Their Potential Application to Wildlife (1991) John W. Turner, Jr. and Jay F. Kirkpatrick In: *Wildlife Society Bulletin* 19:350-359.

A summary of contraceptive research of Turner and Kirkpatrick up to 1991, with its potentially broader applications.

Horsewatching (1989) Desmond Morris. Crown Publisher Inc., 225 Park Avenue South, New York, New York. 10003 (1989, $12.95)

Body language, subtle expressions, social behaviors, equine psyche, motivations, historical bond of man and horse and amusing anecdotes.

The Natural Horse (1992) Jaime Jackson. Northland Publishing, Flagstaff, Arizona, 171 pages.

Lessions from the wild for the care of domestic horses.

Cougar, The American Lion (1992) Kevin Hansen. Northland Publishing, Flagstaff, Arizona, 129 pages.

Natural history and biology of the cougar (mountain lion).