SCIENTIFIC
SADDLE FITTING

BY
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SUMMARY

For centuries, people have ridden horses with a multitude of different saddles, but with very little "scientific" understanding of the effect of the saddle on the horse. **Saddle fit is not only important in the context of the humane treatment of the animal, but has even greater importance to equestrians who participate in sports that demand great athletic performance from the horse.**

Signs of saddle related trauma include behavioral problems, tenderness, decreased performance, inhibited gait, loss of hair, white hairs, open sores, and certain forms of lameness. Obvious trauma to the animal promotes action, but there is often **little thought given to the effect of the saddle and rider on the performance of the horse when there is no visible problem such as swelling or abrasion.**

Much of the frustration with saddle fit occurs because it is unclear who are the authorities on the subject. ***Currently the saddle industry has no system to aid in fitting saddles or to help with manufacturing, design or quality control,***[1] so everyone ventures an opinion.

The saddler asserts the authority of experience, the trainer asserts the authority of experience, and the veterinarian asserts the authority of experience and so on. **But, no one has been able to actually "*PROVE*" that the saddle truly fits the horse, so who should we believe?**

Properly fitting a horse with the first saddle one buys is rare, because it takes time for the physical damage from a poorly fitting saddle to appear. **By the time the equestrian has ridden the saddle long enough to determine the saddle does not fit the horse, the saddle appears used and cannot be returned.** Consequently most equestrians have a collection of saddles, each with a story explaining why it "appeared" to fit the horse at the time of purchase. This "trial and error" approach costs a significant amount of money, often hampers the performance of the horse and is very frustrating for the rider.

What we really need to solve the majority of saddle fitting problems is some way to determine if the saddle panels actually contact the horse evenly. More importantly, if the panels do not fit we need to know what changes need to be made to achieve a proper fit. **By applying a modern perspective to saddle fitting we can develop a "scientific" understanding of the problem as well as develop a method to objectively fit a saddle to the horse**.

HISTORY

Horses have been under saddle for thousands of years and it is likely that saddle fit has always been an issue. However, there is a significant difference in the methods of saddle fitting before and after World War II.

If we look at the evolution of the horse, we see that breeds developed regionally to address the interests and needs of people in a particular area. Each breed had a variety of characteristics that were thought to be desirable in order to perform the tasks in vogue at the time. Thus, **horses of a particular breed were regionally grouped, so the shapes of the horses' backs were similar.** The saddles that evolved in those areas fit that particular regional breed.

The critical point is that, in the past, saddlers built saddles to address regional interests. In the 19th Century, **people did not go to a tack shop to buy a saddle; they took their horse to a saddler**. The saddler, a skilled craftsman, built the "tree" for the horse, built the saddle and then padded the panels to conform to the physical characteristics of that particular horse.

Historically, because horses were the only mode of transportation, they were ridden many hours a day. **If the saddler made an error in the saddle fit or the horse's conformation changed, a saddle-fitting problem would quickly become apparent.** The saddle and horse would be returned to the saddler for saddle adjustment until a proper fit was found. Most importantly, that particular saddle remained with that horse.

This is not the case today. First, horse breeds are no longer specific to an area. Second, there are many more cross breeds today, confusing the issue. **This fact makes it very difficult for mass production saddlers to know which shape of back to make the saddle.** In the current international market, for instance, a saddle could be built in England that will be used in California on a Friesian/Fox Trotter/Shire cross.

SO WHAT IS THE PROBLEM?

Equestrians have no reason to purchase saddles that do not fit their horses. The reason so many saddles are sold that do not fit is that the equestrian is given the impression that the saddle actually does fit their horse. **The problems arise because the equestrian has no way to determine for themselves that the saddle does or does not fit.** Since the horse cannot speak, not only is the customer buying a product that does not perform as claimed, but the horse can be injured.

Equestrians cannot protect themselves from purchasing poorly fitting saddles, because once you place the saddle on the horse you cannot see under the saddle to determine fit. Some saddlemakers suggest that the equestrian can check for saddle fit by placing the saddle on the horse and then lifting the saddle skirts and looking under the saddle to be sure that the saddle panels fit evenly.

This advice completely ignores the effect of the weight of the rider on the shape of the horse's back. Thus if the saddle did fit the horse without the rider, as soon as the rider steps into the saddle, the back of the horse will flex to some degree under the weight of the rider, therefore, **the heavier the rider the worse the saddle will fit.**

Some saddlers suggest that the equestrian can determine saddle fit by riding the horse and looking for any obvious trauma to the horse's back after the ride. Analogous to humans trying on shoes, if you scuff the soles you cannot return the shoes. Therefore, the rider can only use the saddle for a short ride or the saddle may appear used and cannot be returned.

Unfortunately an **equestrian cannot determine fit by obvious trauma to the horse on a short ride.** Physiologically, it takes a few hours for the animal's tissue to show any noticeable trauma from the pressure from a poorly fitting saddle. Thus an equestrian can only discover that the saddle does not fit after riding the saddle for a number of hours, and have seriously injured the horse, at which point the saddle is scuffed and cannot be returned. **Catch 22.**

HOW BIG IS THE PROBLEM ?

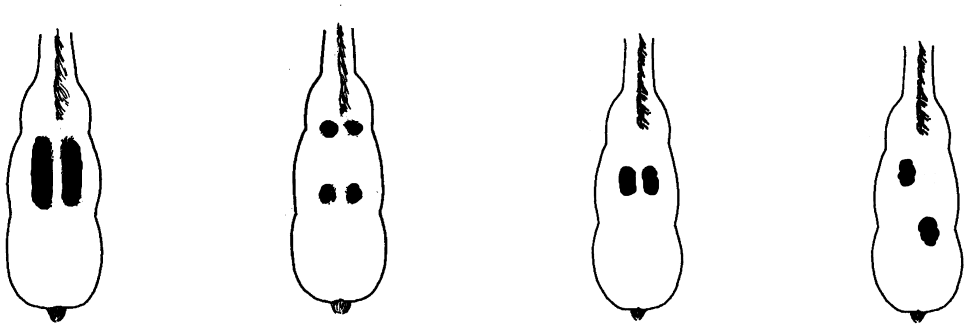
An audit by KPMG Peat Marwick, for the American Horse Council determined that in 1997 there were about 7,000,000 horses in the United States.[2] If you subtract the younger and older horses and breeding stock, there are at least 5,000,000 horses that require saddles. Since the vertebrae of horse's backs change as they age, it would be unusual for a saddle to fit for more that a few years. **So a very conservative estimate would place a ten-year life on a saddle which would mean that at least 500,000 saddles are sold each year in the U.S.**

Due to the error of fitting saddles without compensating for the weight of the rider, it is estimated that as high as ninety (90%) percent of the saddles do not fit. Even if one conservatively estimates that only fifty percent (50%) of the saddles do not fit - that accounts for **at least 250,000 saddles sold in the United States every year that do not fit the horses they are used upon**

WHAT IS SADDLE FIT?

"FIT" means that the shape of the saddle panel that is in contact with the horse's back is the same as the shape of the MOUNTED horse's back. If the shape of the panel is FLATTER than the shape of the horse's back, the saddle will "bridge", touching only in the front and the back on both sides of the spine. If the shape of the panel is MORE CURVED than the shape of the horse's back, the saddle will "rock", touching only in the middle, on either side of the spine. If the saddle only touches front and back on either side of the horse it is "twisted."

ROCK, FIT, BRIDGE & TWIST



Fit Bridge Rock Twist

Some saddles fit and some do not. The question is, **how do you know which saddle fits which horse?** Many people view saddle fit as a black and white issue: either the saddle fits or it does not. If the horse doesn't get white hairs on its back the saddle appears to fit, but is that truly the case?

WHAT IS THE PROBLEM?

Saddle fit is a multifaceted biomechanical problem in which many different factors converge, including:

1. The weight of the rider, affecting the
2. Tree of the saddle, affecting the
3. Panels of the saddle, affecting the
4. Saddle pad or (pads), affecting the
5. Capillaries in the skin of the horse, affecting the
6. Capillaries in the longissimus dorsi muscle, affecting the
7. Curvature of the spine of the horse, affecting the
8. Horse's range of motion, affecting the
9. Performance of the horse, affecting the
10. Behavior of the horse, affecting
11. Attitude and performance of the rider

MANAGEMENT OF PRESSURE

SADDLE FIT IS THE MANAGEMENT OF PRESSURE. There is no way to eliminate the pressure under the saddle, nor is there any need to. **There is only a need to understand what the horse's tissues need to remain healthy**. With that knowledge we can learn how to intelligently administer pressure to the horse's back.

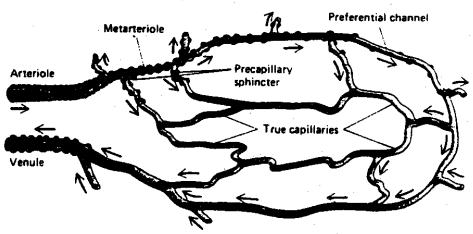
As a practical matter, if we do not see any damage to the horse we assume that the saddle fits, but is that an accurate assumption? A rider and tack usually represent 15% to 20% of the weight of the horse when standing, in motion the rider's downward force (moment) can represent 25% to 50% of the weight of the horse - which is a significant force applied perpendicularly to the spine of the animal. ***The question remains: what is the physiological effect of the saddle and rider on the horse?***

PHYSIOLOGY

To understand what might be a good saddle fit, we need to understand the "**Issue"** with saddle fit in the first place. While there is little scientific research applied directly to the problem of saddle fitting, there has been extensive research on the effect of external pressure on blood flow in mammalian tissue. This research was undertaken because of the devastating problem of bedsores, which traumatize over 2,000,000 Americans every year. **Bedsores are caused by the pressure from the weight of the patient cutting off the blood flow to the skin**.[3] **Bed sores and saddle sores have many similar physiological factors.** Most of this tissue research has been applied to a variety of mammals, providing a scientific perspective of saddle fitting.

CAPILLARY CLOSING PRESSURE

Skin and muscle tissue require a <u>constant intermittent flow</u> of blood to remain healthy.[4] In strenuous exercise the muscles require significantly more blood flow to maintain a healthy metabolism. This exchange of oxygen and waste products occurs in the capillary bed. [5]



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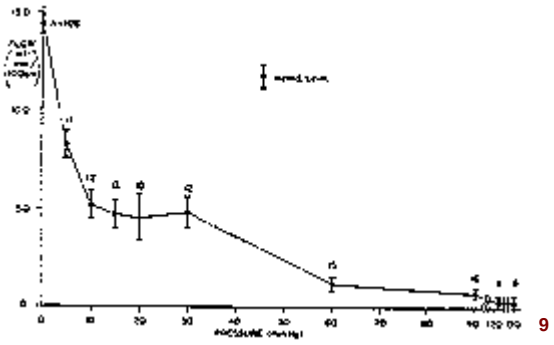
The saddle fitting problems occur when the saddle causes continuous excessive pressure on the capillaries that exceeds the blood pressure and structural strength of those vessels and the capillary vessels collapse. This collapse leads to the deprivation of oxygen and nutrients brought by fresh blood and the removal of waste products.[7] **CAPILLARY CLOSING PRESSURE IS THE CRITICAL ISSUE IN PREVENTING SADDLE-RELATED TRAUMA AND IMPROVING THE PERFORMANCE OF THE HORSE'S MUSCLES UNDER SADDLE.**

IT DOES NOT TAKE MUCH TO STOP THE SHOW

The following experiment was made to determine the relationship of external pressure on blood flow by using a radioactive isotope ^{133}Xe. The amount of radioactivity was measured as external pressure was applied. One can observe that as external pressure increases the blood flow reduces. What is most notable is that pressures as low as .25 P.S.I. or 4 ounces can reduce flow by as much as 60%.[8] This is a significant point when related to saddle fit, especially with a bridging saddle that does significantly increase pressures.



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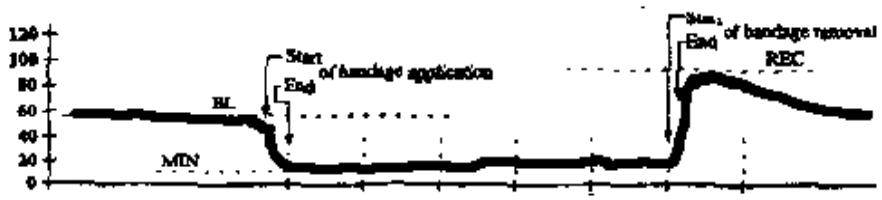
Serious saddle fitting problems develop particularly on "bridging" saddles in a relatively short amount of time because pressures can easily reach 4 P.S.I or 64 ounces. This excessive pressure not only cuts off the blood supply but can additionally traumatize the muscle tissue itself.

IN GOES THE GOOD BLOOD OUT GOES THE BAD BLOOD

In all cases pressure release is followed by reactive hyperemia and the parts originally starved of arterial blood are instantly flooded with oxygen. The extent and duration of the blood in flow is proportional to the needs of the tissues.[10]

Below is a study performed at University of Georgia on a horse using a compression bandage. One can observe that the blood flow decreases significantly with the application of pressure, however, when released the blood flow increases beyond the original base flow.[11] This is a clinical verification of reactive hyperemia and reveals what happens to the tissue when the saddle is removed i.e. heat bump.



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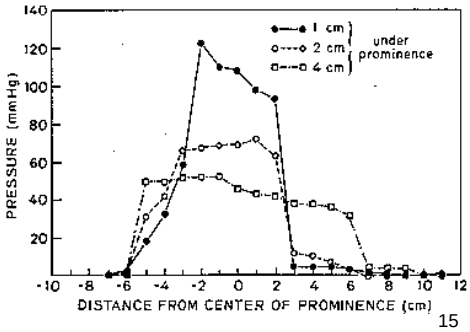
INTERNAL EFFECT OF SADDLE PRESSURE

For a given pressure applied to the surface of the skin (interface pressure) capillary closure pressure will vary from horse to horse, as well as location to location on the horse, depending on the amount of fat, location of adjacent bone, status of the vascular system, systemic blood pressure and general health of the animal.[13] As the animal ages its physiology also changes, compounding this significant Issue.

A critical discovery in tissue research was that in a given location, pressure is not even throughout the tissue. Clinical studies have established that the internal pressure close to bones is three to five times higher than on the surface.[14]



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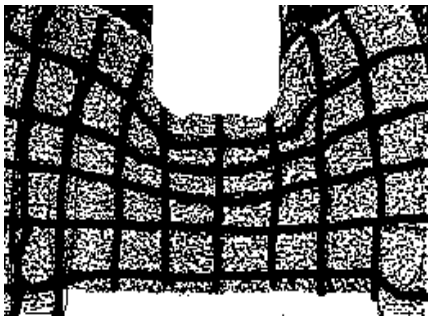

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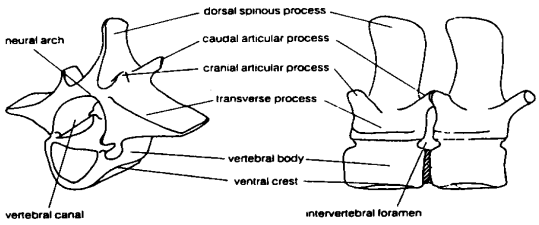
This principle is easily demonstrated with a simple sponge as illustrated above. One can observe that when two different size areas are pressed towards each other, the smaller area will create higher pressures. **Weight divided by surface area equals interface pressure.** This is shown by the lines moving closer together nearest the smaller surface.

This is an important issue for horses because the longissimus dorsi muscle, one of the major muscles used in locomotion, lies adjacent to the spinal column and is directly affected by saddle pressure. Each vertebrae of the spinal column has bony prominances with small surfaces that concentrate points of pressure down the length of the longissimus dorsi muscle.

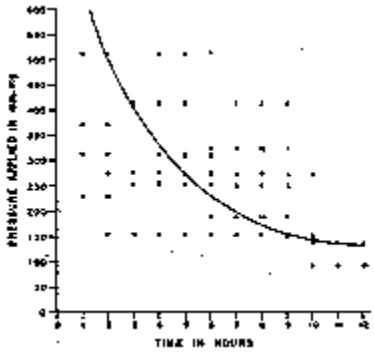


It is critically important to understand that muscles are far more susceptible to the effects of pressure than skin.[17] The internal damage to the tissue caused by the surface pressure only becomes obvious at the surface over an extended time. **Many serious pressure sores first occur internally adjacent to the bone and then radiate to the surface**. [18]

This fact makes it very difficult to use apparent trauma to the horse's back as an indicator of saddle fit, because during the time interval that the horse is not being ridden, the horse begins to heal the internal trauma. **This makes it virtually impossible to develop a cause and effect relationship between saddle fit using observable external trauma to the horse as the standard.** Therefore, just because we do not see obvious damage to the skin of the horse does not mean that damage has not occurred internally.

PRESSURE OVER TIME

The most important issue to remember with tissue trauma is that higher pressures do damage in shorter periods of time, however, even low pressure for long periods of time can do damage.[19] the following graphs illustrates the point



[20]

This is significant to saddle fit because the fit of the saddle relates to how much time one can ride before causing trauma to the horse. Obviously if the saddle fits one can ride the horse longer without sustaining damage than a saddle the bridges and causes high pressures.

THE CRITICAL ISSUES

Tissues do not need a constant flow of blood, but tissues do need a CONSTANT INTERMITTENT FLOW OF BLOOD.[21] This is the reason a healthy individual does not get bedsores. By tossing and turning in our sleep we provide our tissues a constant intermittent flow of blood.

It is also important to understand that tissue damage is variable from very slight damage to extremely debilitating damage. As an example, human bedsores are graded in Stages I, II, III, IV, from a slightly red skin to an open sore. The following is a simple scale of increasing severity of trauma caused by an ill-fitting saddle:

- **Decline in performance**
- **Discomfort - indicated by attitude change in the horse**
- **Inhibited Gait - noted by the horse being a little "off"**
- **Lameness - secondary lameness due to pain or excessive pressure**
- **Swelling - slight swelling under the saddle panels**
- **Bruising - significant inflammation indicating capillary damage**
- **White hair - due to damaged follicles**
- **Hair loss - obvious trauma to the skin and internal muscles**
- **Ulcerous condition - an open, oozing wound with swelling**

WHAT DO WE "REALLY" KNOW ABOUT PHYSIOLOGY?

The clinical research on a variety of mammals has established the following factors to give us a better understanding of the issues relating to saddle fit.

- **Tissue damage is a function of pressure over time.**[22]
- **Pressure is not distributed evenly throughout tissue.**[23]
- **Pressure on the surface of the skin increases 3 - 5 X close to bones.**[24]
- **Muscle is more susceptible to pressure damage than skin.**[25]
- **Low pressure for long periods of time is more damaging than high pressure for short periods of time.**[26]

SO WHAT IS GOAL HERE?

IN PRACTICE THE GOAL IS TO ACHIEVE THE MOST EVEN PRESSURE THROUGHOUT THE SADDLE CONTACT AREA WITH A RIDER MOUNTED AND TO REMOVE THE SADDLE EVERY FEW HOURS FOR A SHORT PERIOD OF TIME TO PERMIT BLOOD TO FLOW TO THE TISSUES.

OH, MY ACHING BACK

"***Quantifying the degree and precise site of pain in animals always has been difficult.*** *This is complicated further because the major clinical sign in many horses with a back problem is impair performance rather than pain. On the other hand, many horses appear to perform satisfactorily despite some low-grade back pain. To add to the confusion, some horses are naturally sensitive and resent being palpated along the back, which might be wrongly interpreted as a sign of pain."*[27]

After decades of equine back research, Dr. Leo Jeffcott, BvetMEd, MA, PhD, DVSc, FRCVS, Dean of Cambridge University Veterinary Clinic, notes that

1. **Some horses can perform badly without suffering from a back problem**
2. **Some horses can perform adequately despite having a back problem**
3. **Spontaneous recovery for many types of back problem is quite common**[28]

It is interesting to note that parallel research studying the human animal, drew similar conclusions. The August 1998 issue of Scientific American notes that **"Part of the mystery of back pain comes from the diagnostic challenge of determining its cause in a mechanical and biochemical system of multiple parts, all of which are subject to insult."** [29]

The results of a national survey of physicians "*can be summed up by the subtitle **"What you see is what you get".** For example rheumatologists were twice as likely as physicians of other specialties to order laboratory tests in search of arthritic condition. Neurosurgeons were twice as likely to ask for imaging tests that would uncover herniated disks. And neurologists were three times more inclined to see the results of electromyograms that were implicate nerves. If patients are confused they were not alone*." [30]

The challenge is to understand this research in the context of a meaningful strategy to fit a saddle and rider to the horse. To put this research in context, let us retrace the steps of fitting a saddle starting with the rider.

The Rider

The rider has a significant influence on the amount of pressure exerted by the saddle on the horse's tissues and the amount of curvature to the horse's spine. **A saddle with a light rider could fit the horse, but when a heavier rider mounts, the saddle may not fit because the curvature of the spine of the horse was significantly changed by the additional weight.**

The effect of the weight of the rider on the horse is compounded by how the rider sits in the saddle and the rider's equitation. English riders competing in jumping, hunting, and eventing have a tendency to ride out of the saddle which is different from western and dressage riders who tend to sit deeper in the saddle. Some riders lean to one side, some lean back. The better the rider's equitation the less weight they put in the saddle when the horse is in motion. Therefore, a heavy rider who rides well affects the horse less than a lightweight rider who rides poorly.

IN SEARCH OF THE "ULTIMATE" SADDLE

Saddle design has evolved over the past centuries into three basic designs: English, Western and Australian, as well as a significant number of experimental designs. These designs have developed into a number of variations on a theme. Some have rigid trees, some have flexible trees and others have rigid trees with flexible panels. Some of the panels are covered with a thick flocking, some are not. Some panels have adjustable flocking, some do not.

The search for the "ultimate" saddle design is a centuries old endeavor. In fact over 130 years the U.S. States government has searched for such a saddle for use by the U.S. Cavalry beginning in 1812. Early saddles were copies of European military saddles. The first American saddle came with the issuance of the Hope, or Texas saddle in 1857.[31] The second was the McClellan saddle. The McClellan saddle itself evolved with over eight different designs. From 1812 to1942 the U.S. Cavalry issued over 29 different designs.[32] No one design stood the test of time to remain as "the" saddle to fit all horses.

The fact that the U.S. Cavalry never found "**THE**" saddle is notable because the cavalry tended to only purchase horses that had a similar conformation. The reason they tried to maintain a similar conformation is to permit a universal saddle to be issued. The problem is that even if the horse begins with a similar back over the years as the horses were conditioned and as they aged, the back change significantly. **AFTER A CENTURY OF GOVERNMENT FUNDED RESEARCH WE HAVE TO UNDERSTAND THAT IT IS IMPOSSIBLE TO EVER BUILD THE "UNIVERSAL" SADDLE THAT WILL FIT ALL HORSES, HELLO.**

Today, there are a infinite variety of saddles sold which claim every possible combination of features, again this is noteable because even with so many different variations, **NO ONE SADDLE DESIGN HAS BEEN PROVEN TO BE SUPERIOR. There are many testimonials, but there is no "scientific" evidence supporting any particular design as having a superior fit to any other type of saddle.** In fact, history has shown that Saddles must be fit to individual horses and be double checked over the years to be sure that the conformation for the horse does not change significantly.

BIGGER IS BETTER

The following basic principle applies to all saddles. **The larger the saddle panels, the lower the interface pressure between the loaded saddle and the horse's back. This is a simple calculation: weight divided by surface area equals interface pressure.** Thus a larger surface will spread the same load over a larger area and thereby lower the interface pressure.

Therefore, **the size of the panel is a critical factor in saddle pressure.** The challenge is to fit the saddle so that the twist and the arc of the saddle panels are the same as the twist and arc of the mounted horse's back so that there is an even distribution of pressure over the entire surface of the panel.

SADDLE PADS

Saddle pads can provide subtle improvements to a saddle that fits properly. However, **a poorly fitting saddle cannot be properly fitted by just adding a saddle pad.** Saddle pads are often thought to be the saddle equivalent of penicillin and will solve a saddle fitting problem. So we put the pad on and never give saddle fit another thought until a new problem arises. Unfortunately, there is no penicillin for saddle fit.

We usually judge a saddle pad by the touch; if it feels soft and pliable it must be good. However, we often overlook what happens to the saddle pad when we mount. **Basically, whatever material makes up the pad is now compressed and made denser because of the weight of the rider.** With a gel pad, the gel is forced away from the saddle's high spots that cause excessive pressure and in time the gel often bottoms out. With felt, foam and sheepskin the high spots are pressed denser than low spots, **so rather than being softer in the high spots the pads are actually denser or harder.**

Many people are concerned with shock absorption in saddle pads. However, it should be noted that once the rider is mounted, the shock absorption capabilities change.[33] If you fill your car with a number of people you see the shock absorbers lose some of their qualities. **In a similar fashion, as the pad is compressed between the saddle and the horse the density of the material and the thickness of the pad change significantly and in turn lose some elastic or shock absorption properties.**

This is why pads are generally not as effective as we would expect. Although pads do tend to even out some of the irregularities of the saddle panel, **saddle pads generally do not permit an ill-fitting saddle to fit properly.** In certain situations a saddle pad can actually make the fit even worse. This situation often occurs with horses that have higher withers. In this situation the gullet becomes significantly narrower with the thicker pad and can make a saddle no longer fit. Therefore, saddle pads need to be used with caution. **Saddle pads should only be used to complement a good fitting saddle in order to compensate for the seasonal fitness changes in the conformation of the horse. Saddle pads can not adjust for a poorly fitting saddle**.

WHERE DO YOU PLACE THE SADDLE ?

Saddle placement is a critical factor in saddle fitting. Because the back of the horse has a significant arc, small movements positioning the saddle forward or backward have significant effects on the fit of the saddle to the horses back.

The "Monty Foreman" school of thought believes that the saddle should be "all on the shoulder". The claim is that "*there is one place on the horse where he is able to carry his weight fastest at any distance, jump higher and wider, yet be in control at all speeds……Now if a feller wants more speed, endurance, control and better performance, shouldn't he start figuring out how to ride that "carrying spot".*[34]

On the other hand, **there is another school of thought that believes that the balanced ride places the center of the saddle over the horse's 14th vertebrae.**[35] This places the saddle further back than the "all of the shoulder" theory and on many saddles frees the scapulae of the horse from touching the saddle. [19]

Saddle placement stirs many zealots who argue their position with fervor, However, regardless of which saddle position is adopted, **THE CRITICAL ISSUE IS THAT ONE MUST FIT THE SADDLE TO THE POSITION THAT IT WILL BE RIDDEN IN AND BE SURE THAT THE SADDLE CAN REMAIN IN THAT POSITION.** If the saddle is fit in a forward position and then because of the conformation of the horse slides back, one cannot expect the saddle to fit.

SADDLE BALANCE

There may be situations where the saddle could actually fit the horse very well; however, because of the conformation of the horse the saddle would be completely out of balance for the rider. Some horses have loins that are lower than their withers, some horses are just the opposite with loins higher than the withers, and some are even. These conformations are often referred to as **uphill** and **downhill** horses.

An **UPHILL** Horse

An **EVEN** Horse

A **DOWNHILL** Horse

The challenge in saddle fitting is to find a saddle that fits the horse as well as the rider or to be able to adjust the saddle accordingly. **The positioning of the saddle "all on the shoulder" or back to free the scapulae will have a significant effect on this balance point.**

A saddle that is fit forward on a downhill horse could fit both horse and rider, however, when placed on an uphill horse the rider is thrown backward and would find riding very difficult. The reverse is also true; thus the goal is to fit all the parameters.

PSYCHIC SADDLE FITTING

"I think it fits, therefore it fits." The most common test for saddle fit is "Experience." Experience is based on the subjective observation of how the horse "feels" when ridden or how the horse "goes". While **subjective judgements can often be correct, they can also be the source of misinterpretation.**

The problem with using subjective "experience" is there is **no way to verify that what someone thinks is happening is actually happening for the reasons they believe that it is happening.**[36] That is why the "Scientific method" was developed.

By using independently measured observation, if the observation is correct the same results should be repeatable. **When we use "subjective" observations we often slant our view, so that we do not need to change our understanding of what we know through "experience" to be true.**

For centuries it was obvious to everyone that the earth was flat and that the planets revolve around the earth. However, once instruments were invented that permitted **OBJECTIVE** observation a new understanding of planetary order evolved. That continues even today with the Hubbell telescope. **New instruments provide new insight. MEASUREMENT IS THE KEY TO UNDERSTANDING.** While psychic saddle fitting is the most common method of saddle fitting used today, its reliability should be questioned.

THE WORLD STILL IS FLAT: BALING WIRE, PLASTER CASTS, PEGBOARDS, AND BABY POWDER

Some people use baling wire or flexible curves that are contoured to fit the shape of the horse withers to determine saddle fit. It is thought that by transferring this shape to cardboard that a "measurement" of the horse's back is possible. **Many saddle fitting errors occur because using the withers is only one measurement of the three dimensional shape of the horse's back.**

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Even if a number of contours are taken along the back of the horse, the problem is determining the relationship of the contours to each other. Even if the contour of the spine is taken and a three dimensional form is constructed, **that form is only the shape of the horse's back without the weight of the rider.**

There are others who believe that taking a plaster cast of the horse's back is a solution to saddle fitting. The problem with plaster or fiberglass casting materials is that it takes some time to apply the material. During the curing process there is a significant amount of heat generated by the casting material. **Even the most docile horse will move during the application of the material and thereby distort the shape.**

To complicate matters the casting material itself does not apply evenly, so the bottom surface and the top surface are even further distorted. The other problem with this technique is that again it is the shape of the horse's back without the weight of the rider. **So the information is incorrect and useless to determine the shape in the mounted back.**

An ancient idea that has a few modern adaptations is the pegboard. This is a simple device consisting of about one hundred round pegs pushed into a flat board. This device permits a three dimensional contour of the horse's back to be made. If the pegs are all the same length, the top and bottom contour formed by the pegs will be the same. This appears to be an accurate method to determine the shape of the saddle**. Unfortunately, it is the wrong shape, because it ignores the effect of the weight of the rider.**

There are saddlers who recommend that saddle fit can be determined by applying baby powder lightly to the panels of the saddle and then carefully placing the saddle on the horse. While this technique is effective for fitting two **rigid** structures to each other, it is a useless technique when attempting to fit two **compliant** structures to each other. The baby powder technique only reveals the high points of the saddle without the effect of the weight of the rider. As soon as the rider mounts the baby powder is pressed into the horse's hair and the information becomes misleading.

There is a more significant problem with all of these traditional saddle-fitting techniques; they all lack a "**UNIT**" of measure. **While saddlers refer to baling wire, flexible rules, plaster casts and pegboards as measurement, they are not a method of measurement.**

Measurement by definition requires a "unit" of measure. Once a unit of measure is established then relationships between different measurements can be made as well as formulas developed to correct for variables.

The reason that saddle fitting causes so much confusion is that no unit of measurement has been established. **So subtle variations cannot even be detected.** This is why the difference between the shape of the ***unmounted*** horse's back and the shape of the ***mounted*** horse's back has not been determined.

OTHER TESTS FOR SADDLE FIT

Historically, there have only been a few ways to "Test" that a saddle fits: palpation, white hairs and dry spots. **The challenge is that these methods do not provide any "scientific" data that permits different saddling strategies to be OBJECTIVELY verified and repeated over time.**

A common method to test for saddle fit is "palpation." This technique is used by veterinarians and many saddlers to determine muscle soreness. While under certain circumstances saddle fit can well be the cause of muscle soreness, so can exercise and a variety of other causes. **Thus palpation can only determine that there is muscle soreness, but provides no information to determine the exact cause**

White hairs are an obvious sign of tissue damage. The problem is that there are months that pass between the initial trauma and the appearance of the white hairs. To risk the health of the animal by using this method to determine saddle fit is inhumane and should not be used. **White hairs also do not provide any unit of measurement to compare one saddle to another.**

Another test of saddle fit is "Dry Spots." There are some who theorize that moisture from the blood is brought to the sweat glands and secreted as perspiration. The theory maintains that when the saddle exerts excessive pressure on the skin the blood cannot flow so the fluid is stopped which causes dry spots to appear.

TEST THE TEST

Despite this popular concept, there is no scientific research establishing a correlation between dry spots, tissue trauma and saddle fit. Physiologically the mean arterial pressure in the horse is between 30 mmHg (.5 PSI) - 40mmHg (.75 PSI) and venous return pressure is between 10mmHg (.25 PSI) - 20mmHg (.33 PSI). The venous capillaries are several times as permeable as the arterial capillaries. **For determining fluid movement through the capillary membrane the venous capillary pressures** 10mmHg (.25 PSI) **are much more important than the arterial capillary pressures.** [38]

Extensive interface pressure measurements of good fitting saddles have established consistent saddle pressures in excess of 50mmHg (1 PSI). Therefore, the theory that blood flow is reduced to areas of high pressure is valid to a point, however, when applied to the problem of saddle fit we find that **the saddle pressure is consistently higher than even arterial capillary closure pressure which would, cause consistent large uniform "dry spots" on good fitting saddles, if the "dry spots" theory were correct.**

NO SWEAT

To make the issue of "dry spots" even more confusing physiologically "dry spots" or the "absence of sweating" is also called "Anhidrosis." **Anhidrosis is the loss of the ability to sweat in response to exercise or increased temperature. Sweating is prompted under the influence of the hormone epinephrine (adrenaline).**[39] When released into the blood stream; epinephrine acts directly on the sweat glands, causing them to secrete fluid.

Anhidrosis may be partial or complete and the onset gradual or abrupt. Thus, it is critical to understand Anhidrosis as a factor in "dry spots." The exact cause of the disorder is unknown. ***The most likely explanation is that prolonged or repeated exercise produces high blood levels of epinephrine. The sweat glands of some horses ultimately become desensitized to epinephrine and stop responding.***[40] Plugging of hair follicles by dried sebum may be a contributing factor. Regardless, we know that sweating is controlled by the hormone epinephrine and not pressure.

Sweating or the lack of sweating is not a reliable indicator of saddle fit because so many additional factors affect sweating. Therefore, a direct correlation can not be drawn between saddle pressure and sweat distribution.

FLAT, SWAY, HIGH

One of the more challenging aspects to saddling horses is determining the size of the horse's back. What size is the horse? "He is a flat backed wide horse." "She is a high withered Arab." "He is sway backed."

Relative terms like flat, sway, and high do not provide any information to describe the twist and arc of the horse's back which is necessary to make an accurate comparison of the shape of the saddle to the shape of the horse's back. Using relative terms significantly hampers communication between rider, saddler and veterinarians, because each interprets the same terms in entirely different ways.

NARROW, REGULAR, WIDE & "*ARC*"?

Traditionally saddles come in three widths - narrow, regular and wide**. The difficulty in fitting saddles arises because again these three widths are relative terms that have no established standards.** Is "wide" 110 degrees or 142 degrees?

Some saddle tree makers categorize their saddles or bars as "full quarter horse", "three quarter Arab" or "Arizona bars". While this appears to be a size the fact is there are no standards so each saddletree maker interprets these terms "creatively".

Some saddletree makers measure the gullet opening at the pommel and cantle as well as the flair by measuring the distance at the between the edges of the bars. While this appears to be a measurement method, it is completely dependent on how the bars are cut and how rounded they are sanded. More importantly, this strategy does not consider the "ARC" of the bar relative to the flair. So it is virtually impossible to establish consistency or quality control.

The only saddle measurement that is consistent and can be verified are the seat sizes of 14", 15", 16", or 17" which have nothing to do with the compound twist and arc that form the shape of the saddle panel. **Thus each saddler interprets the terms differently, so there is no continuity of shape or size from saddle to saddle or brand to brand.**

Any claims relating to saddle size are total speculation because there are no industry standards to determine what regular, narrow and wide mean. Thus a wide saddle from one manufacturer may or may not be similar to another saddle of the same "size" made by a different manufacturer or made by the same manufacturer.

To make matters worse, the supposed measurements of regular, narrow, and wide only focus on the angle at the shoulder of the horse. While the shoulder angle is important, it is more important that the "ARC" of the back of the "mounted" horse be the same as the "ARC" of the saddle, for optimum saddle to fit and distribution of pressure". **The saddle industry does not even have a measurement for the ARC of the horse's back**.

Since horses come in all sorts of shapes and sizes, logic dictates that if the saddles only come in three sizes they would only fit three sizes of horses. So the question is: which horses are those sizes? **If the saddles come in a variety of sizes, but they are only categorized in three sizes, the question is which size is which, OR EVEN MORE IMPORTANTLY DO THE SIZES MEAN ANYTHING AT ALL?**

THE MEASUREMENT CHALLENGE

CURRENT CLAIMS ABOUT SADDLE FIT ARE NOT BASED ON ANY FORM OF MEASUREMENT THAT CAN BE OBJECTIVELY VERIFIED. More importantly, without measurement there is no way to really determine the effect of subtle changes or compare different saddles or pads to a particular horse. Because, traditionally, there has never been a way to really "measure" saddle fit, the subject causes much confusion.

Current methods of saddle fitting, including using baling wire, flexible curves and cardboard templates, do not provide any calibrated measurement. **Without a unit of measurement there is no way to determine interrelationships of these shapes.**

Traditionally, saddle fit has been based on subjective observation which is impossible to verify. Even today, an "experienced" method to fit a saddle is to place the saddle in the position on the horse's back thought to be appropriate. The gullet of the saddle is checked, making sure it does not touch the spine. The pommel and front of the panels are examined to determine whether they conform to the withers and scapula of the horse. One then checks to see that light can be seen down the gullet. Then by lifting the flaps or skirts one checks that the saddle panels or bars fit evenly on the horse's back.

But how do we know that the panel conforms to the curvature of the horse's back when the rider mounts? How do we know how much and where pressure is being exerted on the horse? How do we know that the panels of the saddle actually contact the horse evenly, or press on one, two, three or four spots under the saddle where we cannot see?

The conforming quality of the panel also becomes another factor. If the panel is stuffed very tightly with flocking it will have a tendency to bulge and not conform as much as a soft panel. Some foam panels cover a larger area but are not adjustable. Some flexible panels appear to conform, but that conformation is dependent on the material strength of the panel, the position of the structural mounts and the weight of the rider relative to the weight of the horse.

Therefore, any measurement of the UNLOADED saddle will be significantly altered by the weight of the rider. The critical question is how much will the horse's back bend under the weight of the rider

THE SOLUTION IS MEASUREMENT

A practical method for sizing saddles would be similar to sizing shoes for humans. When you go into a shoe store the salesman can measure the size of your foot with, a Branick Device, a calibrated device that measures the length and width of your foot. Based on this "calibrated size", shoes can be chosen. A smaller or larger size can then be determined by "trying it on for size."

Saddles are far more challenging to fit because of the complexity of the angles and arc that constitute the shape of the horse's back. Traditionally, the focus of saddle fit has been on the withers. However, the fit of the withers is only part of the story. **The other critical factor is the "ARC" of the spine of the horse relative to the angle of the withers.** This measurement determines if a saddle will "fit", "bridge" or "rock" on the back of the horse.

What is needed to measure horse's backs is some way to see under the saddle. If we could measure the contact area of the saddle with some sort of accuracy the interrelationships between the saddle and the horse could be determined.

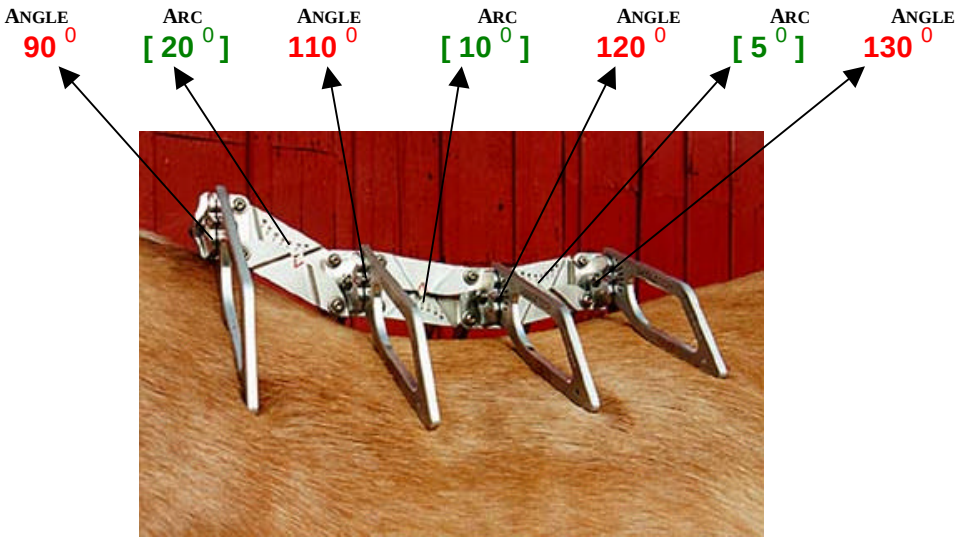
In the picture below are a number of short pencils that have been placed on the horse's back in the same position as the contact area of the saddle. Each of the pencils describes a series of points of contact between the horse and saddle. Each of these short lines also has an interrelationship to each of the other lines. If we had some way to numerically describe the interrelationship of the series of lines to each other as well as to perpendicular we would have a new standard of measurement.

It is interesting to note that although the horse's body is generally round, at the contact point between the saddle and the horse, the back on either side of the spine is generally flat for about five to six inches. This phenomenon permits a new method to measure the back of a horse and relate this shape to the mounted saddle.

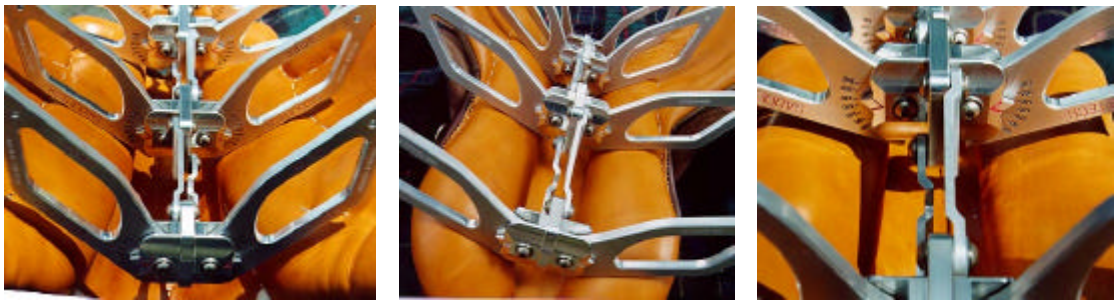
THE LOW TECH SOLUTION

Until recently there has not been any calibrated method to accurately size saddles. **However, a new method of measurement integrates some of the factors involved in saddle fit into an objective testing method that permits a "calibrated" solution to saddle fitting.** A series of numbers define the degree of the angle and arc of the horse's back and the saddle - making saddle selection accurate, quick and easy.

The **"SADDLETECH® GAUGE"** (patent pending) is a simple device that permits a Three-Dimensional measurement of the horse and the saddle.



MEASURE THE HORSE



MEASURE THE SADDLE

WHAT YOU SEE IS NOT WHAT YOU GET

The reason that so many saddles do not fit is that the saddles are fit to the horse without considering the effect of the weight of the rider. The pegboard device made with about a hundred pegs that are pushed through a piece of wood can duplicate the contour of the horse's back. The pegboard can then be turned over to adjust the saddle to that shape.

Wrong. That is exactly the mistake that we do not want to make. If we fit the saddle to the shape of the unmounted horse and we do not consider the effect of the weight of the rider relative to the weight of the horse, the saddle will bridge more and more as heavier and heavier riders step into the saddle.

The SADDLETECH®GAUGE can measure the horse as well as the saddle. But…what is the relationship of those two shapes? **If the weight of the rider causes the back of the horse to deflect, then even the SADDLETECH®GAUGE measurements of the unloaded horse need to be "corrected" to determine the proper shape of the "loaded" saddle.** However, how much does the horses back actually bend under the weight of the rider?

AS ABOVE, SO BELOW….. AIN'T SO

We do not want the exact same shape of the horse's back for the shape of the saddle, consequently the **SADDLETECH®GAUGE does not provide the same arc on the saddle measurement side as it does on the horse measurement side.**

The "angles" of the SADDLETECH®GAUGE are the same for the horse as well as the saddle, however, because the parallelogram linkage that keeps the angles in relationship with each other is rotating around a short radius, this causes the top side of the gauge which rests against the saddle to be slightly smaller than the arc that rests against the horse. **This is exactly what we want to achieve the best fit for the horse.** However, how do you know what is the correct permutation for the "ARC"?

CALIBRATION

TO ACCURATELY DETERMINE HOW MUCH THE BACK OF THE HORSE IS ACTUALLY AFFECTED BY THE WEIGHT OF THE RIDER, which will then permit us to determine the proper shape of the saddle, and how that relates to the difference in shape or (hysterisis) in the Saddletech Gauge itself, we need some objective criteria.

The key to greater accuracy of any measurement is to build a "feed back loop". A feedback loop permits a cause and effect relationship to be established. If a factor is changed by one increment the feed back loop permits the documentation of the effect of that change. Repeating the process reveals a relationship than can be described in a formula.

Baling wire, plaster casts and even rows of pegboard pins do not provide any numerical values. **Without numerical values there is no way to "calibrate" or compare any two shapes.** ***Calibration by definition is the accurate comparison of any measuring instrument to a known standard, and more importantly the determination of the errors of its scale.***[41]

Because saddle fitting has so many variables, it is critical to have a measurement instrument and formula to compensate for as many variables as possible. To compensate for the difference in the measurement of the horse's back without the rider to a new shape with the weight of the rider, a "Formula" is needed.

The question then becomes how to create a formula if you do not even know if the saddle really fits. To calibrate any instrument requires a second instrument that is itself calibrated to a known standard. Fortunately, that technology is available.

THE HIGH TECH SOLUTION

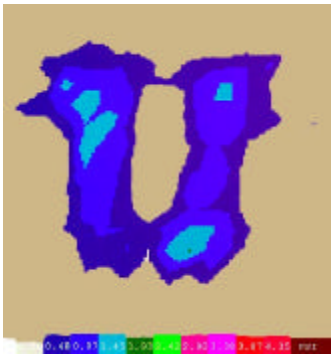
To scientifically develop a calibrated formula and verify that these calculations are in fact accurate we must use another technology.

In 1993, the U.S.Patent Office issued U.S. Patent #5,375,379 for ***A Curve Conforming Sensor Array and Method for Measuring Pressures between a Saddle and a Horse***.[42] This technology is sold under the trade name **Saddletech Computer Saddle Fitting System**, and can provide the information needed to measure the effect of the weight of the rider on the saddle panels, saddle pad and the spine of the horse.

The **Saddletech Computer Saddle Fitting System** consists of a pressure sensitive pad attached to a computer. The pad contains an array of 256 pressure sensors that measures 24 inches by 32 inches.

The Saddletech Computer Saddle Fitting System sensors are themselves "Calibrated" with a pressure gauge that has been "Calibrated" to a "Calibrated" manometer. To calibrate the sensors, they are placed on a vacuum table and the air is carefully removed from the envelope containing the sensor array in incremental amounts. The computer then compares the resistance in each of the sensors to the known standard from the calibrated manometer and builds a look up table to compensate for the variations in the system. Each time the pressure pad senses pressure between the saddle and the horse, it compares the electrical resistance of that particular sensor to the known standard, corrects for any differences (hysterisis), and then displays that data to the screen or file.[43] In this manner a very accurate measurement of interface pressure can be made.

To use this pressure sensitive pad, the pad is placed between the horse and the saddle/pad combination and is connected to the computer. When the rider mounts the horse, the system graphically displays a variable color map that shows the amount of pressure and the location of the pressure exerted by the saddle and rider on the horse.



A Saddle That Fits

A Saddle That Bridges

THE FORMULA

We need to establish criteria to determine a formula that can use the measurement from an unmounted horse's back and then apply a calculation to approximate the effect of the load of the saddle and rider. A new set of numbers can then be established to represent the shape of the mounted horse's back and saddle shape.

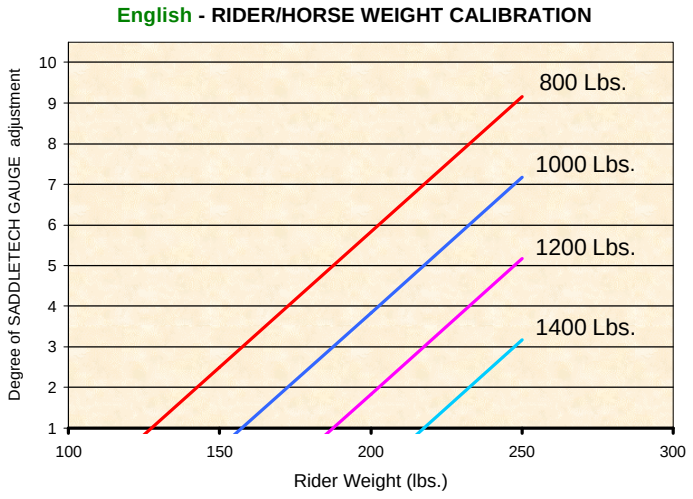
By adding a predetermined number of degrees (A) for each increment of rider weight (B) greater than an established standard (C), relative to the rider's weight (RW) the curvature of the gauge can be increased to approximate the curvature the spine of the horse would experience placed under that incrementally higher weight. Conversely, the formula can be reversed for a lighter rider with weight less than a known standard, which would have less effect on the horse; the arc is proportionately reduced.

The same principle also applies to the weight of the horse. By subtracting a predetermined number of degrees (X) for incremental horse weight (Y) greater than an established standard (Z), relative to the horse's weight (HW) the curvature of the gauge can be decreased. Conversely, the weight of the horse that is less than an established standard would be affected more by the weight of the rider and should therefore have an established number of degrees added to the arc of the gauge and the saddle measurements.

The basic formula for an eight wing Saddletech gauge to compensate for rider weight is A = (RW - C) / B. *(patent pending)* For an "average horse and rider" there is one degree increase for every 15 lbs. of rider weight over 150 lb. of rider weight. **The basic formula to compensate for horse weight is X = (Z - HW) / Y *(patent pending)*** or one degree for every 100 lbs. of horse weight over 1000 lbs. of horse weight. **By adding the two factors together a weight compensation factor, WCF = A + X, *(patent pending)* can be determined.**

It should be noted that extreme rider/horse weight ratios that requiring more than 5 degree of adjustment should be calibrated with the computer system to identify additional factors such as age or conditioning which could alter the shape of the saddle.

NO BRAINER MEASUREMENT



Saddletech research has found that using a 150 lb. rider on a 1000 lb. horse happens to be the balance point for the Saddletech Gauge itself. **This balance point permits the majority of riders to use the Saddletech Gauge without the need of adjustment.**

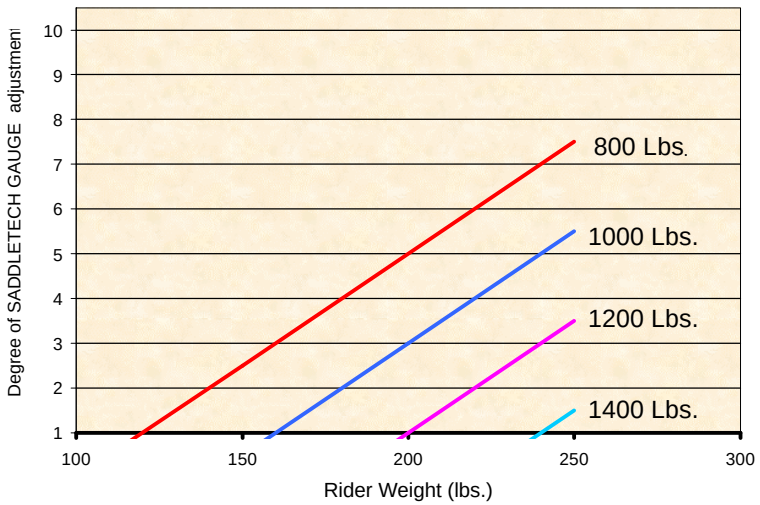
However, it is important to note that this calculation is for an average weight rider on average weight horse, without consideration for other factors, such as age, breed, conditioning or discipline. The chart above only illustrates the basic relationship between horse and rider and may be different for a particular horse, rider and saddle combination.

CALIBRATING THE FORMULA FOR ADDITIONAL FACTORS

It is important to note that the formula that is appropriate for the 8-wing gauge used on English saddles is different than the formula for the longer 10-wing gauge used on larger Western saddles. This is due to a number of factors. First the 10-wing gauge is longer and therefore is measuring over a greater area and the incremental hysterisis between the top and the bottom of the gauge is not the same. Second the surface area that the 10- wing gauge measures is actually 25% more than the 8 wing gauge **This means that the same load is spread over a larger area and will not have the same effect as is measured by the smaller gauge.**

The basic formula for a ten wing (western) gauge to compensate for rider weight is A = (RW - C) / B. Thus for an average horse there is one degree increase for every 25 lbs. of rider weight over 100 lbs. of rider lbs. The basic formula to compensate for horse weight is x = (Z -HW) / Y, or one degree for every 100 lbs. of horse weight over 1000 lbs. of horse weight By adding the two factors together a weight compensation factor, WCF = A + X can be determined.

Western - RIDER/HORSE WEIGHT CALIBRATION



Again, it is important to note that this calculation is for an average weight rider on average weight horse, without consideration for other factors, such as age, breed, conditioning or discipline.

By adjusting the predetermined number of degrees (X) or (A) and the incremental horse weight (Y) or (B) or the established standard (Z) or (C) the curvature of the arc of the gauge can be adjusted for a variety of factors.

If the Saddletech Gauge or the Saddletech computer scan reveals that the saddle is "bridging," causing high pressure on the withers and the loin, then the saddle can be readjusted to fit for each increment of rider weight (B) by incrementally increasing the arc of the saddle to permit the saddle to contact the back of the horse and evenly distribute the weight over the entire saddle panel.

Additional data acquired from the Saddletech Computer Saddle Fitting System can be used to refine the formulas to compensate for additional factors and increase the accuracy of the formulas. By testing a variety of horses under various loaded conditions, a relationship between the Saddletech Gauge measurements and actual real time interface pressure measurements can be made using the Saddletech Computer Saddle Fitting System. A database and offset table can be built and thereby compensate for any hysterisis in the gauge as well as the variety of factors affecting the horse.

THE CALIBRATING FOR THE BREED AND DISCIPLINE

The age of the horse, style of riding, type of saddle and the condition of the horse will also affect this calculation. By using the Saddletech Gauge and the Saddletech Computer Saddle Fitting System calibrated measurements can be correlated to compensate for a variety of interrelationships.

As an example, there are some equestrians who observe that some horses lift their backs when trotting. **It is then theorized that the horse must round its back into the saddle and therefore one needs the saddle to bridge to allow the horse to "round" into the saddle.** While it is possible that a few very highly trained dressage horses may have the strength to lift their back with the rider mounted, it is unlikely that the majority of horses can achieve this rounding of their backs.

Saddletech Computer scans have been made of Olympic Grand Prix level dressage horses with equally skilled riders and the dynamic computer data has NOT confirmed that these particular horses did lift their backs. However, using the Saddletech Gauge and the Saddletech Computer Saddle Fitting System high level riders may find that their particular horse does lift its back and the saddle shape can be precisely adjusted based on the horse's performance and objective measurements.

In contrast, riders of Peruvian Paso horses believe the opposite is happening with their horses, because the Paso horse lifts its head when it is in gait. It is believed that an even greater arc, or hollow, is shown on the back of the horse. Western pleasure riders believe that good conformation includes having the horse's head held very low. Each discipline has its reasons to train the horse to a particular conformation. Using the Saddletech Method of measurement each theory can be proven or disproven and the appropriate saddle fit to the horse.

LOOKING INTO THE TELESCOPE

Since accurate saddle measurement instruments have only recently become available, the actual amount of back movement has not been documented with a large enough sample to observe significant patterns.

Further research with the **Saddletech Gauge** and **Saddletech Computer Saddle Fitting System** will provide the opportunity to refine our understanding of movement of the back of the horse relative to the saddle which will improve saddle fit and the horse's performance.

A FORMULA FOR EVERY BARN

It is anticipated that different schools of thought will develop each with different formulas. Dressage riders will use entirely different formulas than endurance riders. Ropers will build different saddles than barrel racers. **Significantly, however, for the first time in history the performance of the horse can be "SCIENTIFICALLY" measured and correlated to the subjective observations of the riders.**

THEORY INTO PRACTICE

Theory is great, but how can someone actually translate all this information into a saddle that really does fit the horse. If it is the first time you are buying a saddle for over $1,000 or you have spent more money on saddles than you did for the horse, you may be interested in a new content rich internet site with over 100 pages about saddle fitting. **SADDLETECH.COM** provides the basic information needed to find a saddle that really does fit your horse by using measurement.

The Saddletech Gauge permits an equestrian to measure existing saddles to find the appropriate saddle for the horse. Or, if an equestrian already has a saddle that they wish to keep, they can send the saddle to a saddle repair shop that uses the Saddletech Gauge to readjust the saddle to precise measurements.

Since horses' backs change shape as they age, this technique permits one saddle to be used with one horse over the years. If the equestrian uses one saddle on a number of horses, by measuring all the horses, the best average saddle shape for those horses can be determined and the saddler can adjust the saddle accordingly.

Additionally, the Saddletech Adjustable Jig uses the Saddletech Gauge for the frame and adds a stand and clamps. This system permits the saddler to adjust the Saddletech Adjustable Jig to the Saddletech Gauge measurements and in effect have a form of the horse's back, compensated for the weight of the rider, in the saddle shop.

The Saddletech Adjustable Jig also permits the saddler to make the saddle bars or panels out of thin pieces of veneer that are glued up and clamped into the "molded plywood" shape of the horse's back. Once the saddletree is built, the Saddletech Gauge can used to doubled check to be sure that the saddle fits the horse before the leather is attached.

SADDLETECH.COM provides research, education, a network of veterinarians and Saddlemakers, tack shops, measurement services, Saddletech Gauge rentals, and a data base of new and used saddles measured with the Saddletech Gauge that permits an equestrian to find a saddle that will fit their horse.

F T A EN T EA RE ENT

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