Effective Game Killing

To become a successful hunter, one must understand the principles of effective game killing. Those of an anti-hunting nature may like to portray hunting as being a brutal and negative expression of mankind, however, hunting is a part of who we are. It is all very well to push vegan ideals in societies where food can be imported as quickly as an international courier consignment can be created. But we must never lose sight of the fact that many humans living in both primitive (to us) and modern society are reliant on meat as are the millions of carnivores which live on this planet. Perish the thought of a protestor heading to Papa New Guinea or the Amazon to 'convert the natives' to tofu and facebook.

We are what we are. Yet it seems that accepting who we are with the greatest sense of compassion is a most difficult challenge for the human race, difficult enough to bring about great wars.

We hunt, just like cats (of all sizes) and wolves, we are just like any other predator and most definitely share the same characteristics as some omnivores including other primates along with the humble pig. Yet there is one major difference between ourselves and other omnivores and predators - we have great intellect. This has also created what might best be described as unnatural guilt in that we experience this emotion in a way that other animals do not in their Zen like state. The bible attempts to portray the same in its own manner of speaking with the story of Eve and the apple. You do not need to be of a religious mind to see how intellect and guilt are tied together. If a deer was to step on its fawn, the fawn would cry and the mother would feel immediate empathy along with what we might call a natural guilt which acts as a preventative. Animals do feel guilt - just ask your dog who dug that hole in the yard to see for yourself. Humans on the other hand have the capacity to carry guilt beyond that of animals due to intellect. This can be useful but also at times damaging. We can harbor guilt that becomes self -destructive or in our anti-hunting example, we can simply harbor guilt to the point that we reject our very being and harbor hatred for our own species.

On the flip side, as humans we also have the ability to experience great love and compassion. We can utilize intellect, empathy, love and compassion to navigate our way through this world. And it is because of these traits that we can become more effective at hunting. Have you ever seen a domestic cat hunt birds or mice? Small cats can be very cruel at times and many of you will have witnessed this. As humans, even though some folk may think we are un-evolved by continuing to hunt in this modern age, the opposite can be true in that we can use our intellect and compassion to make us far better hunters than our fellow predators.

Effective game killing is based on empathy. We wish to hunt and utilize the flesh of another animal. Empathy drives us to find better or what we call more humane ways to achieve this. We do not want to live on whey, soy or tofu protein because we as hunters accept who we are and we learn to accept that we too will pass from our flesh one day. We want to hunt because it feels right. The feeling can at times physically burn in our heart and the area of our solar plexus. It is natural and healthy. In fact as hunters, we can become more infinitely aware of our natural place within the universe. This connection can at times be far deeper than simply listening to native American music on youtube while burning sage. It can take us deeper than the ramblings of a church minister or monk - regardless of the fact that any of these practices can be of great benefit to us for our own personal reasons.

When we hunt, we face and accept who we are while at the same time feeling a deep connection to the land and animals of our world. It is a direct experience; we are engaged in such a way that cannot be put into words. For those who do not understand this, you may be able to perceive a glimmer of the intensity of this sensation when watching a documentary showing the intense concentration of a lioness as she prepares to attack. However, even this is a very poor example as again, the viewers perspective is indirect.

Hunting is not for everybody - we are all unique. This is especially important now that the population of our planet is so high. But for those who do feel the calling, it is one that cannot easily be resisted. The man who lives in an apartment, wants to hunt but never hunts due to fears of rejection from his wife is no better off than a caged animal. There is no nobility in denying this aspect of ones self. Such a man should at the very least seek to engage himself in a combat sport so that he can in one way hone his predatory skills and fulfill his nature in a healthy manner. Better still, he might stand up to his wife, buy himself a rifle and be the man she always wanted but was too afraid to date out of her own fears of rejection. Compassion must start with the self.

Those of us who do hunt, find we are at our best when we are constantly honing and refining our skills. This very process defines both the hunter and warrior protector.

The information ahead will help you to become a better hunter. We will start with a brief history of game killing and then move on to the subjects of how bullets kill, what fast killing actually means and then look at shot placement. The discussion will then lead into more technical detail with regards to how the shape of a bullet tip (meplat) affects terminal performance.

History

All though ballistics studies may appear to be a relatively new field of research; it is as old as man himself. One of the first technological breakthroughs in arms was the invention of the bow and arrow. Early bow hunters took effective game killing very seriously. The method in which the arrow killed was through its blades, which were as broad as practical, severing as many arteries in the animal’s chest as possible to cause death through blood loss.

An ancient cave painting from Tassili n'Ajjer, a mountain range in the Algerian region of the Sahara.

On average, the primitive bows of the world had a draw weight of 40lb which as power goes is very light. The bow was of course also highly valued in warfare. Warfare drove bowyers of the day to develop ever more powerful bows to meet battlefield needs. As soldiers adopted heavier armor and greater formations, the power of the bow increased from 40 to 80lb, from 80lb to between 120 and 150lb and in extreme cases, up to 200lb. By the middle ages, two distinct types of arrow were in use, a very heavy armor piecing arrow and a much lighter flight arrow for long range volley fire.

As the bow became a more effective battle weapon, it also became a much more effective game killing weapon. European hunters discovered that rather than try to fire and lodge an arrow into the chest of an animal, an 80lb hunting bow firing an arrow of sufficient weight to create a complete pass through, effected a much quicker death. The combination of both an open entry and exit helped initiate fast bleeding. The faster bleeding caused a much faster kill and this in turn enabled the hunter to locate downed game from within a short distance of the initial shot rather than the common risk of being unable to locate the dead animal. The complete pass through of the arrow also created a swarthy blood trail to follow. It is from this historical experience that modern European hunters prefer rifle ammunition that completely penetrates and exits game.

Two holes as a means to drain a vessel is a most basic principle of physics. Today, this principle is employed in the design of all fuel systems and can be duplicated by trying to empty the liquid contents of a tin or drum, first with only one hole, then with an opposing breather hole. However, it is important to understand that we can deviate from these principles to some degree. There is a vast difference between a lodged arrow and an extremely wide internal wound caused by a high velocity bullet that creates extremely fast internal bleeding without need of external bleeding. Just because we can't see it, this does not mean that the animal has not bled out its circulatory system. Nevertheless, bush / woods hunters do at times need a wide swarthy blood trail to follow.

The black powder musket eventually superseded the longbow; however it differed very little in its method of killing. The musket produced the most effective kills when loaded with the widest possible ball. A later invention was rifling to impart a spin on the projectile for greater flight stability. Rifling not only added accuracy to the ball but allowed for the development of cylindrical shaped round nosed bullets. Eventually cartridge design reached a stage where compromises had to be made. For instance, as much as .52 to .58" caliber bores were effective killers, they did not have the flat trajectories of the aerodynamic .38" bores. To duplicate the trajectory of a .38 bore using a .52 or .58 bore the rifleman would have to adopt an extremely long, heavy projectile in his .52 or .58 caliber rifle and suffer the recoil. The black powder rifle reached the epitome of design with the breech loading .44 and .45 caliber rifles of the early to mid 1800's. These bore sizes achieved the ultimate balance of killing power versus trajectory versus obtainable velocity.
Lesson one: At low velocities and when using non expanding bullets or bullets that do not shed weight, the wider the bullet, the faster the kill.

After the advent of smokeless powder in 1886 much higher velocities were achievable causing bullet diameter and weight to be reduced in order to minimize recoil. The first smokeless cartridge projectiles featured round nosed bullets with a gilding metal jacket to minimize the fouling that would otherwise occur if traditional lead projectiles were fired at high velocity.

Regardless of the stability imparted to projectiles from rifling, round nosed bullets still showed slight irregularities in flight, the technical term called yaw. On impact the yaw of the bullet increased, sometimes creating wound channels out of proportion to the caliber used. This phenomenon, described at the time as ‘explosive’, was first recorded by French researchers in 1848.

The next major step forwards was the introduction of pointed bullets to increase aerodynamics. These first appeared towards the turn of the 19th century. Prior to the development of rifling it would have been impossible to propel the pointed bullet point first as physics dictate that the center of gravity (at the base) would force the bullet to turn in flight and continue to fly base first. Rifling however imparted stability to the projectile allowing only the slightest amount of yaw. Nevertheless, on impact the pointed FMJ projectiles had a tendency to tumble violently and create a devastating wound.

By taking these discoveries to the extremes, it was discovered that a projectile with an exceptionally light but long point would maximize instability on impact. The English were perhaps the first to adopt a design based on this premise, filling the nose section of the military .303 projectile with cardboard or aluminum. The British military utilized this projectile design for many years.

After the pointed bullet, the next advance in projectile design came from the development of the tapered tail bullet now known as the boat tail. Designed to increase accuracy at extended ranges for military use, the boat tail moved the center of gravity towards the center of the projectile. This design, while causing less yaw inside the target, successfully stabilized the projectile in flight at ranges of between 1000 and 2000 yards as the projectile passed from super to subsonic velocities, a transition that causes excessive yaw in flat based pointed bullets. Due to this increased stability these designs had (and have) a tendency to produce straight penetration and narrow wounding. There have however been exceptions to this such as Eugene Stoners initial 5.56 bullet design along with some recent FMJ military bullets designed in such a way as to deliberately lose stability on impact (though results are sometimes less than optimal). However and generally speaking, FMJ military bullets are not suitable for hunting medium game with regards to fast and humane killing.

The sporting cartridge benefited greatly from military developments; however a departure in design occurred due to the fact that military convention (once) dictated that full metal jacket bullets must be used in war to minimize excessive cruelty to soldiers, as well as easing the work of the surgeon. Sporting projectile design differed after the discovery that an exposed soft lead nose or hollow nose caused expansion of the projectile on game and maximized wound channels. A major benefit of the expanding bullet was that after developing its frontal area, the weight and center of gravity of the projectile were well forwards. The forwards weight created stability that lead to straight, deep penetration. This forwards transition of weight after expansion of an ‘ideal’ projectile is referred to as shoulder stabilization. It is worth noting that although expanding point projectiles have less penetrative abilities than FMJ round nosed dangerous game hunting bullets, expanded shoulder stabilized projectiles are far less prone to tumbling during penetration.

How bullets kill

A projectile kills by causing either one or a combination of the following:

1. Blood loss.
2. Damage to the nervous system.
3. Destruction of vital tissue and organs.
4. Septicemia or asphyxiation.

Each causing the effect that life can no longer be sustained.

For hunting purposes the primary task of the projectile is to provide a fast humane kill. This minimizes suffering to the animal and simplifies location of the carcass. Destruction of the major nervous centers such as the brain or forwards portion of the spine cause the fastest killing but such targets are often difficult to hit.

The most reliable method of killing is through causing blood loss. Blood loss is categorized as either fast bleeding or slow bleeding. Fast bleeding refers to the destruction of the major arteries of the chest and neck creating a fast kill while slow bleeding refers to the muscles and arteries that feed them, such as the femoral artery. When slow bleeding areas are destroyed, the result is a slow kill.

When a projectile destroys vital organs such as the lungs, liver or heart, death occurs in the first instance through blood loss, not through the destruction of the organ itself. This is simply because these organs are major carriers of blood therefore kills are relatively fast.

Slow kills can also be caused by asphyxiation as a result of minor wounding to the lungs or neck. Gut shots cause a slow death through infection (septicemia) along with the introduction of digestive acids into the bloodstream and any surrounding damaged organs. A commonly used term for death from gut shots is 'blood poisoning' which although gives little away in its description, does at least partially indicate that gut shots do not produce an immediate kills. Put simply, a gut shot can cause immense suffering.

Mechanisms

The modern high power sporting cartridge relies on high velocity loaded with soft expanding type projectiles. As the projectile strikes flesh, it mushrooms (or tumbles) causing displacement of tissue through both physical contact as well as pressure. The projectile transfers its kinetic energy to the surrounding tissue causing acceleration of fluid particles in and around its path. This creates an explosive temporary wound channel that subsides to a wound channel far greater than the diameter of the projectile. The temporary wound channel reaches its maximum size within one millisecond, collapsing to its final size within several milliseconds. The size of the temporary wound channel is proportional to how much energy is delivered and can be given numerical values. In both military and sporting applications these two types of wound damage are referred to as the temporary wound channel and permanent wound channel, both having the effect of causing blood loss, organ and nerve damage relative to shot placement.

At this point I would urge readers to ditch the temporary versus permanent wound channel terminology. Such terms may make us sound like experts in the know of such things but help us little in the field. A hunter does not walk up to a kill and state, “boy, you should have seen that temporary wound channel, lucky I didn’t blink”. I do not believe any human has the ability to see such things frame by frame and therefore, a wise man should drop such intellectual pontification. There are far more important factors to focus on…

Fast Killing

To begin with, please understand that much of the information presented from here is unique to my own research. You will not read the same in other places unless the information has been derived from my research. Although there are many people who work as experts in the field of terminal ballistics, I firmly believe that there is still a great level of misunderstanding within this subject.

Fast killing is an important factor for two reasons. The first is with regards to humane killing. Compassion must always be at the fore front of the hunters mind, at least in my opinion. The second factor of importance is the ability to secure game quickly, without losing the animal. In bush hunting situations it is not uncommon for a dead run animal to be lost after traveling between 100 and 300 yards before expiring, falling into a gut or hole, never to be seen again. Frustrating, isn’t it? For the tops hunter, it means securing an animal on the ledge it was perched on. Dead running game on the tops can very easily expire when traversing a ravine, the animal falling, becoming stuck in a position that is neither recoverable from the top or bottom of the bluff system. Been there, done that, don’t want to go through it again.

In order to get the best results it is important to understand the mechanisms of killing and how a fast kill occurs.

A common misconception when witnessing game collapses at the moment the bullet impacts is that the force of the projectile has physically knocked the animal to the ground. We tend to call this an instant kill. Newton’s law suggests that for every force there is an equal and opposite force. To this end the force of the bullet impacting game is no greater than the recoil of the rifle. So what causes the instant collapse or poleaxe as it is often caused?

Instant collapse occurs when the central nervous system (CNS) is damaged or electrically disrupted as a result of one of two mechanisms, either direct or indirect contact.

Direct contact refers to a bullet directly striking and destroying one of the major nerve centers, including the thoracic and cervical vertebrae, the brain or the autonomic plexus, regardless of velocity, this will result in instant death.

Indirect contact refers to the effects of a high velocity bullet imparting its energy, creating a hydrostatic shock wave. In terminal ballistics, the terms hydraulic shock and hydrostatic shock both refer to kinetic energy transferred as shock waves through flesh, however, each term describes different results.

Hydraulic shock is the civil engineers term also known as water hammer but in terminal ballistics context refers to the pressure of accelerated fluid particles that create the temporary wound channel.

Hydrostatic shock transfer refers to the effect when shock waves travel through flesh to distant nerve centers, disrupting their ability to emit electrical impulses.

Be very much aware that the terms hydraulic and hydrostatic shock are quite often misused by both hunters and professionals - including ballisticians working for bullet making companies.

Wide, disproportionate to caliber wounding (hydraulic shock) thanks to the 162gr Hornady SST combined with high velocity which also caused hydrostatic shock (instant collapse).

The reason why game animals drop instantly with chest shots that do <u>not</u> directly strike the CNS, is due to hydrostatic shock transfer to the spine which passes through to the brain. A high velocity cartridge well matched to game body weights imparts over half its energy within the first 2cm of penetration, creating a shock wave. This electrical shock wave travels outwards via the rib cage until it reaches the spine and then continues through to the brain (CNS). The result is an immediate loss of consciousness as the body shuts down for diagnostics.

Along with the loss of consciousness, the projectile has also created a large wound channel, draining all of the body's blood within several seconds. The loss of blood and damage to vital organs cause death to the animal before it has the chance to regain consciousness. This action creates the illusion that the projectile has knocked its victim to the ground, killing it instantly. More careful examination shows that the shot caused coma, followed by blood loss, followed by death. The hydrostatic shock created by a hunting bullet is identical in action to when a boxer is struck on the jaw by his opponent, disrupting the functions of the brain with a resulting loss of consciousness.

The Stasborg tests also revealed that a large wound cavity can cause a blood pressure spike to the brain, inducing immediate coma, though this is relative to hydraulic shock, not hydrostatic shock as described here. This phenomenon also helps produce ethical killing.

Four major factors affect whether hydrostatic shock transfer occur and all are relative to each other.

Velocity

This has the greatest effect on hydrostatic shock. Put simply, the higher the impact velocity, the greater the shock. Velocity is also the most influencing factor in hydraulic shock, having a huge bearing on the size of the internal wound channel.

Hydrostatic shock, in bore sizes from .243” up to .338”, begins to lesson at impact velocities below 2600fps and most modern high velocity sporting cartridges including the magnums gradually lose shocking power beyond 300 to 350 yards. Of the thousands of animals harvested during TBR tests, 2600fps has been the most common cut off point with repeatable results (reactions) occurring when deliberately testing the impact velocity of 2650fps versus the impact velocity of 2550fps.
High velocity is not however a sole factor to be worshipped and held above other factors. For example, if velocity is increased too far without increasing bullet weight, the surface tension of water within the animal can cause so much resistance as to overcome the energy of the bullet. Ultra-high velocities can then also lead to shallow penetration. Generally speaking, the high velocity cut off point for small bore bullets used on medium game is around 3150fps. If for example we are using a 140 grain 7mm bullet at an impact velocity of 3250fps, chances are that even if the bullet penetrates vitals, the animal may still run some distance.

One factor to be very careful of with ultra-high velocity conditions is to not blame a delayed kill exclusively on ‘bullet blow up’. For example, if we were using the same 140gr 7mm bullet and the entry wound did indeed show signs of wide entry wounding and surface bullet blow up (or possibly blow back), even though this is undesirable performance, we still need to investigate further if we are to truly understand factors at play. In this instance, once the animal is recovered, it is important to study the vital organs and determine whether they were actually destroyed. If the vitals were destroyed, we can then conclude that the bullet did its job (even if in a less than desirable manner) but without hydrostatic shock.

A noticeable change in hydrostatic shock occurs as bullet diameter is increased to .358” (such as the .35 Whelen) and larger bores (see bullet diameter). With the medium and large bores, hydrostatic shock can occur on our medium game species at velocities as low as 2200fps. Fast incapacitation can remain evident at velocities as low as 1800fps depending on bullet designs. Below 1800fps, the wider the bore the better. Further to this, there are also highly traumatic pistol bullet designs such as the Hornady XTP.

Frangible bullets tend to produce coma at much lower velocities than traditional hunting bullets (see bullet construction). With frangible bullets at low velocities, instant coma may be due to hydraulic shock causing blood pressure spikes in the brain as suggested by Hornady ballisticians. In other instances, coma can follow very shortly after impact due to multiple pain centers being disrupted to such an extent that the animal must go into coma. That said, frangible bullets may also send out particles which strike the CNS directly.

When testing hydrostatic shock on Bovines, I have discovered that impact velocities of 2600fps with suitable bullet weights (and construction) produced instant poleaxe in a repeatable manner. However, in many instances Bovines would attempt to rise, the action of attempting to rise resulting in increased blood loss with death following within seconds.

Bullet weight versus game weights

If the bullet is too light for the intended game it may simply lack enough kinetic energy to cause hydrostatic shock, meeting far too much resistance on impact. This a common occurrence with the .22 centrefires but can also occur in any small bore cartridge especially the large magnums when using soft, light for caliber projectiles. If the bullet is driven too fast and lacks sufficient weight, it can also fail to initiate hydrostatic shock (see Velocity).

Less obvious, is the result of using a bullet weight that is too heavy for the intended game. If the projectile contains too much momentum, the bullet may fail to meet enough resistance to impart energy where it is required i.e. the ribs through to the spine. Wound channels may be as wide as a lighter bullet however; the hunter may find that game run a long way before succumbing to the shot. These factors can create many difficulties for the hunter when selecting an appropriate cartridge and bullet as a certain level of momentum is required if the bullet is expected to penetrate into vitals from any angle or give satisfactory performance on a variety of game body weights.

Quite often a .30 caliber 180 grain hunting style bullet is simply too stout and carries too much momentum to initiate hydrostatic shock / rapid coma on lean bodied deer - even at magnum velocities. The bullet may produce a nice mushroom and seemingly adequate internal wounding; however game may run a long way before expiring. A simple change to a 150 or 165 grain bullet can make all the difference in these instances. That or a change in bullet construction such as changing from a core bonded bullet to a fast expanding design like the Hornady SST. Energy retention as a result of heavy bullet construction and the retention of momentum can be even more of a problem in the .338 bore which has many projectiles designed specifically for Elk hunting. Furthermore, many hunters use match bullets in the .338 for long range hunting, some of which are simply hopeless on game.

Projectile construction

The third factor that effects hydrostatic shock transfer and counteracts bullet weight while also having the capacity to counteract impact velocity is bullet construction. For example, the stout Sierra .30 caliber 180 grain Pro-Hunter, whether driven from the .308 Winchester or .300 Win Mag creates a large internal wound on light or lean bodied deer, yet it can retain too much momentum to initiate hydrostatic shock on these animals and kills can be very slow. The same can be said of some of the stout core bonded designs such as the 180 grain Interbond along with the Barnes TXS bullets.

By simply changing to the 180 grain Speer BTSP, the 180 grain SST or 178 grain A-Max, a faster kill can be obtained. These projectiles are soft and frangible. The Hornady A-Max in particular can produce fast coma at impact velocities of 2000fps or lower where the ProHunter shows a clear cut off point at an impact velocity of 2550fps.

In contrast, as game body weights reach 90kg (200lb) and above, stout bullets begin to come into their own, meeting a great deal of resistance on impact. Hydrostatic shock is still absent at impact velocities below 2600fps, however the heavy resistance of larger bodied medium game helps initiate immense trauma and broader internal wounding than on lighter game body weights, resulting in a kill that is delayed by only a few seconds, as opposed to up to 45 seconds.

The further you shoot, the softer your bullet needs to be in order to affect a wide wound and fast killing at low velocities. This is discussed at length within my long range hunting book series. At closer ranges, a tougher bullet may be needed in order to ensure adequate penetration. There may also be times when you need to dual load which is again discussed within the book series but also within the knowledge base. An example of dual loading might be as an example, having a 140 grain Nosler Partition in the top of the magazine of your 6.5x55 rifle while under this, you have three or four 143 grain ELD-X bullets ready for long range work.

Perhaps the greatest challenge hunters now face when choosing bullets, are the challenges presented by homogenous copper bullet designs. These are the toughest bullets on the market and due to their design, are unable to shed weight and lose momentum for maximum energy transfer. Some designs boast petal loss as a means to aid energy transfer but such features can make the bullet even worse, causing the shank of the remaining bullet to pencil through game creating narrow wounding, especially at lower impact velocities.

Homogenous bullets work best at high impact velocities. The bullet makers know well that momentum is a problem and in more recent years have generally worked towards offering lighter and then lighter still bullet designs. This reduction in weight and bullet length greatly aids wounding so long as velocity can be kept high. Homogenous copper bullets tend to initiate hydrostatic shock like other bullet designs at impact velocities above 2600fps providing the bullet weight is properly matched to game weights. In the .30 caliber, this can mean dropping right back to a 130 or even a 110 grain bullet design. Wounding generally remains adequate to 2400fps. Below 2200fps, all bets are off, especially if shot placement is less than ideal. Game may run long distances and may not allow the hunter the opportunity for a follow up shot.

The greatest benefit of homogenous copper bullets is that they penetrate well. The Barnes TSX for example, creates both excellent wounding and penetration when properly matched to game weights and used in high velocity cartridges out to moderate ranges. This is a homogenous copper bullet at its best, tackling tough animals from varying angles. But to say that one can eat up to the bullet hole (in the absence of lead toxicity) can be rather misleading. The current Tipped TSX design (used in high powered cartridges) can cause gut ruptures as a result of hydraulic forces, spreading gut material into meat. Those concerned about meat damage or meat fouling need to understand this - bullets kill via destruction of tissue. We can’t always have it both ways.

Unfortunately in the rush to market their bullets as environmentally friendly, governments have lapped up these bullet designs and there are now states and countries which have banned the use of lead bullets for hunting. The downside of this is that many animals have and will die slowly as a result of a combination of the design of these bullets and their misuse.
Homogenous copper bullets need to be driven fast, bullet weights needs to be selected with care while shot placement needs to be taken into due consideration. Please do not buy into these bullets as being 'the only choice for the future' as greedy corporates and their green government friends might have you believe. There are other ways we can move ahead. We can have our cake and eat it too with the likes of the DRT bullet design. This bullet has a copper jacket and compressed powdered metal core and works much like many of the traditional bullets currently available. Having said this, DRT are but one company carrying the spark of a possible future and at this time of writing have limited options. Nevertheless, I urge readers to investigate what DRT have to offer.

Bullet diameter

The fourth factor is bullet diameter and put simply, the wider the caliber, the less need there is for high velocity to initiate shock. Bullet weight can be high (200-300 grains) yet kills may be faster than our stout .30 caliber 180 grain bullet example from earlier. This can be due to the wider frontal area meeting more resistance on impact, or a reduction in momentum (the bullet may be short even though it is heavy due to its width) or a combination of both. The net result is that a medium or large bore can break all the rules we are familiar with when using small bores and with or without high velocity, produce very fast killing.

As previously mentioned, small bores generally behave in a similar manner with regards to hydrostatic shock cut off point. But a major change is seen once we step up to the .358 bore which can produce hydrostatic shock on medium game at velocities of 2200fps and lower.

On heavy game and using a medium or large bore with heavy (e.g. 300 grains plus) and sturdy projectiles, it is possible to initiate hydrostatic shock at impact velocities above 2600fps. However, this is more of a factor of bullet weight and velocity as opposed to being strictly related to bullet diameter.

Unfortunately, having a wide bullet cannot in itself fully compensate for or overcome any issues as a result of bullet construction. If the jacket of the medium or large bore bullet has been designed for heavy game, chances are that kills on light or lean game may be delayed, though internal wounding may be wide directly as a result of hydraulic forces. But if on the other hand the bullet has been designed for general hunting such as is found throughout the .358 bore, one can expect generally fast 'knockdown' (often exceptional performance) on a wide range of game. A key factor here is to understand that even if you opt for a medium or big bore as 'the fix' to quickly anchor game in difficult to track bush / woods / swamp, you will still have to match bullet construction to the job at hand. If you choose a very stout and heavy bullet and use this on a lean bodied deer, the animal may still run.

The shape of the bullet tip also effects performance. Match bullets (without a plastic tip) tend to have very small hollow points which can at times lead to a failure to expand and therefore narrow wounding. Plastic tip bullets often disguise a very wide hollow point behind their tip. Hollow point hunting bullets can also offer a wide frontal area, simply lacking the plastic disguise. This subject also crosses over to bullet construction. For example, a wide hollow point will generally be weaker at the tip so it has both width and weakness to aid in energy transfer.

Lead soft point bullets can differ vastly in performance from one design to the next. Some are pointed, others round nose while some are flat tipped. Interestingly, the differences in terminal performance between round or flat nosed bullets and pointed bullets tend to become more pronounced as we increase bore and bullet diameter. For example, the .358 Hornady 250 grain spire point can produce delayed kills on medium game while its 250 grain round nosed counterpart can produce very fast coma. The same can be said of the medium bore Woodleigh Weldcore bullets. Obviously, the faster a bullet dumps its energy, the sooner it will run out of energy for penetration which may or may not be a good thing depending on the size animals we are hunting. For more info on bullet frontal area, please see the meplat section further ahead.

Putting the information together

The speed of incapacitation or what we call fast killing is one method for which the hunter is able to measure a cartridges effectiveness on game in comparison to other cartridges. It must be remembered however that the word effective by definition in this instance describes the ability of the cartridge to achieve fast incapacitation and has no maximum limit to power. An efficient cartridge on the other hand describes the ability of the cartridge to kill using the minimum necessary power. I do not believe that efficiency should ever be put exclusively ahead of effectiveness (fast killing).

With regards to shot placement versus mechanical wounding, a good example of this can be found in the .243 Winchester. At ranges beyond 200 yards and especially at ranges of around 300 yards the .243 can produce slow kills with rear lung shots due to narrow wounding. By bringing shot placement forwards to the line of the foreleg or 1 to 2” further forwards of the line of the foreleg, a fast kill can be obtained via direct destruction of the autonomic plexus (nerve ganglia between the heart and lungs). If however, such shot placement cannot be guaranteed, a change to (for example) the .270 Winchester, will ensure greater internal wounding with rear lung shots, effecting a faster kill.

Shot placement, as just described with the .243, can of course negate the need for hydrostatic shock or immensely wide wounding as a result of hydraulic shock. An accurate but low velocity rifle/ cartridge combination capable of striking the autonomic plexus of game in a reliable manner will anchor game just as quickly as a cartridge capable of producing hydrostatic shock with rear lung shots. On the other hand, the hunter is not always presented with the perfect shot. Therefore, the more effective a cartridge is regarding wounding, the more forgiving it can be with less than ideal shot placement.

So far we have discussed Hydrostatic shock in great detail while only touching on hydraulic shock. Like Hydrostatic shock, hydraulic shock is increased at high velocities and has similar cut of points at different velocity parameters. Looking at one projectile as an example, the 130 grain .270 Winchester Interbond expands to a diameter of between 13 and 17mm at high impact velocities. The wound channel this creates through vitals is around 50 to 75mm (2-3”) in diameter. This is what I call disproportionate to caliber wounding and it is very effective. As velocity falls to 2600fps, wounding tapers off slightly, the internal wounds being around 25-40mm (1-1.5”) in diameter.

As velocity falls below 2400fps, wounding gradually becomes proportionate to caliber, noticeably so at 2200fps. Between 2200fps and 2000fps (450 to 575 yards), the Interbond projectile expands to a diameter of around 8 to 9mm, creating a wound channel of around 8 to 9mm, resulting in slow bleeding and therefore, if the CNS is not destroyed, a very slow kill.

To regain disproportionate to caliber wounding at low velocities, the projectile must be capable of shedding a large amount of its bullet weight, up to 90%, allowing a cluster of fragments to create wide internal wounding to increase the speed of blood loss for fast killing. The term I use for this is “mechanical wounding” Here again my research deviates from the usual literature. And with the arms industry currently rushing to produce small low powered assault rifle cartridges that boast magical killing power, industry players are themselves having to more fully explore these subjects while terms like temporary wound channel lose even more of their sparkle.

Although bullet weight loss is critical for fast killing at low velocities, this does not mean to say that a .22-250 loaded with a varmint bullet will produce clean kills with chest shots on medium game. The cluster must also be matched to game body weights, having optimal density and momentum.

Although a frangible bullet is able to produce wide wounding due to mechanical destruction alone, hydraulic shock also occurs at much lower impact velocities than a controlled expanding bullet. As suggested earlier, Hornady research suggests that blood pressure spikes in the brain cause coma, resulting in (as much as possible) a painless death. Whether from a hydraulic or mechanical perspective, wounding of fragmentary bullets is much higher than that of controlled expanding bullets at low impact velocities, providing the cluster has sufficient density and momentum relative to game body weights.

During TBR testing, a packet of vintage Winchester Western .30-30 160 grain hollow point ammunition was tested on medium game animals. This is perhaps the earliest example of a frangible bullet. As best as could be determined after extensive research, it could be concluded that historically, the .30-30 was possibly not standing up to its design premise and that a frangible bullet was adopted to increase wounding capacity.

The .30-30 160 grain soft point load was intended to produce wide wounding and fast kills as a result of the newly discovered powders which generated exceptionally high velocities (for 1894). This was a complete turnaround from past terminal ballistics research which had proven that the bigger the bore, the wider the wound. The .30-30 (.30 WCF) loaded with a controlled expanding bullet is not a great deal more emphatic than the .45/70, the .45/70 having already proven to be an emphatic killer. Western’s hollow point load was introduced a little while after the soft point. While the frangible .30-30 bullet would have been acceptable for use on the smaller deer species of the U.S, one has to wonder how this load fared on the Grizzly bear featured on the ammunition box of the .30-30 hollow point ammunition. The results would most likely have been disastrous. About 200 grains is a safe minimum frangible bullet weight for these body weights.

Frangible bullets are important at low velocities, especially at long ranges. A frangible bullet

capable of rendering a wide wound in the absence of disproportionate to caliber wounding (high velocity) helps ensure fast bleeding for fast killing.
As a short recap, with ideal shot placement and utilizing a cartridge with sufficient power to penetrate the vitals of intended game, we can destroy the CNS and cause an instant kill - however this is often idealistic and unrealistic. With less than ideal shot placement, high velocity can initiate hydrostatic shock and hydraulic wounding to help ensure fast kills out to ordinary hunting ranges (300 yards). In the absence of high velocity, a fragmentary projectile can ensure fast killing via hydraulic shock and wide (mechanical) wounding, producing fast bleeding. In all instances, bullet weight and bullet construction need to be matched to the job at hand.

Please try to remember the following for medium game hunting:

Choose light and stout or heavy and soft.

A light but stout projectile can deliver hydrostatic shock while having the tough bullet construction needed to deliver sufficient penetration. However this has a range limitation, usually of around 300 yards, after which, careful shot placement is required. This can be counterproductive in cross winds. Nevertheless, this method is often the most effective for minimizing meat damage on lighter medium game at ordinary hunting ranges (out to 300 yards).

When chest shooting heavy game, a heavy but stout controlled expanding projectile driven as fast as the shooter can manage produces the fastest possible killing. As O'Rourke said, use enough gun.

Use enough gun. The .338 Win Mag and controlled expanding 225gr Nosler Partition can be put to great work on bear. That said, shot placement is a key factor to effect extremely fast killing.

A heavy yet soft and frangible or partially frangible projectile (loses some weight) may not deliver hydrostatic shock very far depending on game body weights, but providing the cluster is dense enough, it will be capable of rendering deep, broad and highly traumatic wounding across a wide range of body weights. Good frangible bullet designs can continue to produce mechanical wounding and a measure of hydraulic shock down to impact velocities of 1600fps with some exceptional projectiles continuing to produce excellent performance down to velocities as low as 1400fps.

For those wondering about the middle ground between light and stout and heavy and soft, there are certainly some good bullet designs on the market. One of the best middle ground bullets is the Hornady SST, a semi frangible bullet design that tries to retain some weight for penetration. A specific example is the 7mm 162 grain SST which is effective on Red/Mule deer at close ranges (adequate penetration) yet is capable of producing wide wounding at extended ranges (around 1000 yards in the 7mm Remington Magnum). On the other hand, we do have to be a bit careful with the middle ground. For example, the Nosler Accubond has core bonding in an attempt to toughen the bullet but is also designed to be fast expanding and is generally available in mid weights such as the 140 grain .270 Winchester bullet. This particular load works extremely well on mid-sized deer at ordinary hunting ranges however, the Accubond can suffer when pushed to the extremes. It can be too stout for low velocity work yet too soft for tough game. In this regard, we have to be careful as to how we use a ‘general purpose’ bullet design. You may wish to take a note from the Taoists and choose the middle ground so as to be prepared for any contingency, however if you fail to fully understand the limits of your cartridge versus your intended game, you may choose something which is neither fish nor fowl and does a generally bad job within the role you have chosen for it. For example, you may load the .375 caliber 260 grain Accubond for an African trip. And while this works exceptionally well on some larger bodied game, you might be in for a world of hurt if you try to tackle a cape buffalo with this bullet and find that it completely runs out of steam before reaching vitals. Please use my cartridge knowledge base and books to obtain a deeper understanding of how each of the manufacturers bullets work, their strengths and limitations.

I have been continuously researching wounding for most of my life and the results and variables are far greater than can be covered in one short document on effective game killing. Nevertheless a rudimentary understanding of the fundamentals of game killing, wounding and speed of killing can serve as a useful platform before continuing on and exploring my in-depth research as well as your own field observations.

Looking forwards, we seem to be heading towards some very strange extremes. In one camp, we have hunters looking for any excuse to use low powered cartridges in short barreled suppressed rifles and or AR-15 platform rifles while in the other extreme, a few gun companies continue to work towards barrel destroying ultra-velocity magnums. Either approach can cause a great deal of problems for hunters. Ultra-fast cartridges can cause shallow penetration at close ranges and ironically still lead to disappointment when bullets still display vast drop and wind drift at truly long ranges. The fastest cartridges may have a barrel life of less than 600 rounds, 200 of which may be used up during load development.

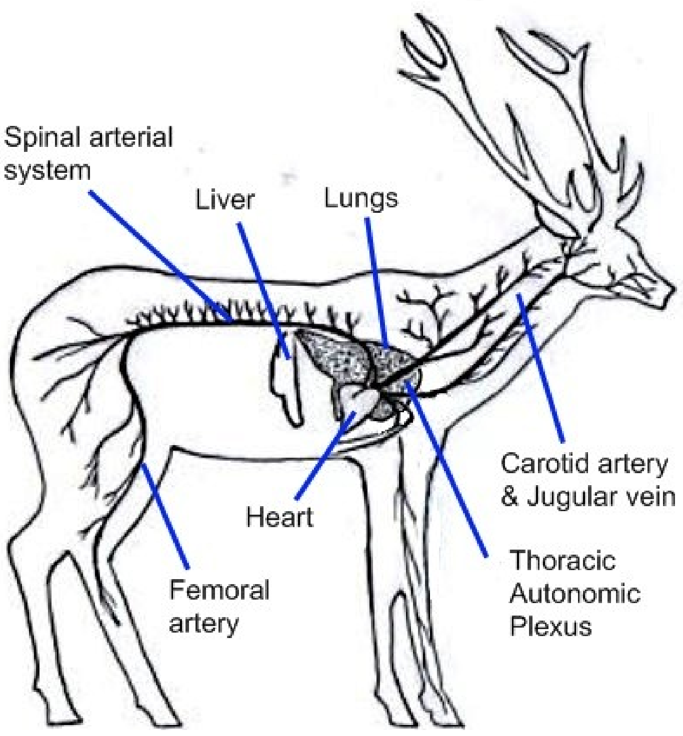
Modern low powered cartridges are simply that - low in power. You do not have to be rocket scientist to figure this out. If the bullet is the same weight as a 7.62x39 or .30-30 bullet and going at the same speed, it will produce the same results regardless of how it is labelled. To recap from earlier, the slower you go - the wider you need to go (think .45 etc) or the more the bullet needs to shed weight if we are seeking optimum killing performance. This also ties back into the problem of forcing people to use homogenous copper bullets for environmental reasons. Low power and stout bullets simply don't work that well together unless the projectile has specialized design characteristics.

If the bullet is to shed weight it may need significant weight to begin with (depending on the size animals you are hunting) in order to achieve reliable penetration. Also remember this; there is little that can be done now that has not been done before. There is no new magical cartridge that offers twice the killing power with half the energy. Projectile designs are certainly advancing in some areas however there are limitations as to how far this can be taken.

As a hunter, the primary factor that must be foremost in your mind is animal welfare, not how short or light your rifle is or whether it can handle a thirty round magazine (even if you are a culler). Factors such as recoil or cost should also be treated as secondary to the primary goal of a fast effective kill.

As far as new cartridge designs go, please try to refrain from becoming caught up in hype. The physics of wounding are really rather straight forwards once you have a full understanding of the basics. The trick is just that - to understand the basics. Once you have understood the fundamentals of game killing and how cartridges behave in general, then you can move forwards and not be misled by marketing fabrications.

Shot placement and vital zones



Deer vitals courtesy of my wife and life long research partner Steph.

The Lungs - aim here!

All of a mammal's blood must pass through the lungs where it can be released of carbon dioxide and enriched with oxygen to fuel the body. Blood leaves the heart situated below the lungs through the pulmonary artery which becomes a network of arteries feeding into the blood capillaries of the lungs. Once enriched with oxygen, the blood then travels back to the heart, then out through the aorta artery to be pumped throughout the body. Although associated with the respiratory system, destruction of the lungs is one of the fastest ways to bleed out the circulatory system ensuring a quick clean kill. On top of this the lungs present the largest, safest target for the hunter.

As viewed broadside, a deer's lungs begin at the intersection of the scapular and humerus bones of the foreleg. In height, the heaviest portions of the lungs are situated at the center of the chest, in line with the lower foreleg. The lungs reach to within an inch of the spine, which is not to be confused with the top of the fur line because above the spine, the dorsal vertebrae may extend upwards by three or more inches. At their lowest point, the lungs are again around three inches above the line of the brisket and are thinner at their extremities to accommodate the heart. Behind the foreleg the bottom of the lungs extend little more than 2 inches before tapering upwards sharply, running out to thin edges just short of the last few ribs.

Based on a White Tail deer sized animal viewed broadside, head to the right and using the straight lower leg as a center line, a shot to the center of the chest will destroy the heaviest portion of the lungs ensuring a fast bleed and therefore fast kill. A shot 3 inches above center at 12 o'clock will destroy the upper lungs, an equally fast kill. However, it is possible to strike too high between the lungs and spine or the dorsal vertebrae above causing instant collapse followed by recovery after a few seconds leading to escape and a slow kill.

Approximately two to three inches forwards of dead center (foreleg) at 3 o'clock is the ball joint intersection of the scapular and humerus bones. And from the front line of the front leg through to the ball joint intersection lies the autonomic plexus. This is a major network of nerves which when hit soundly, causes instant collapse and death. A shot in this area has the potential to destroy the autonomic plexus along with the forward portions of the lungs and locomotive muscles and bones. **The autonomic plexus (sometimes called hilar zone) is the most useful aiming point for fast killing.** This shot placement is also particularly useful when using cartridges that have enough bullet weight to penetrate bone but not enough velocity to initiate hydrostatic shock or extremely wide wounding.

It is important to understand that shot placement involves cultural traditions. For example, some cultures (particularly USA hunters) prefer a meat saver shot, striking the lungs behind the foreleg in an attempt to save meat. In Europe, the traditional method has been to aim forwards and although this does cause more meat destruction, this shot placement helps ensure rapid killing. Also, if you look more closely at this subject, you can see how small changes in POI may affect the hunter's perception of a cartridge. One hunter may state that X cartridge is a very fast and emphatic killer while another may call the same cartridge abysmal - each assessment based on differing traditions or habits relative to the hunter's point of aim. It is up to you to decide which method you wish to employ. Much will depend on the power and penetrative abilities of your cartridge. Ideally, you should be aware of both points of aim and should be able to switch from one to the other depending on the individual situation. If for example you are hunting with a high velocity cartridge using soft bullets that have the potential to suffer shallow penetration, then a meat saver shot will enable adequate penetration and hydrostatic shock can be counted on for a fast kill. On the other hand, it is very unwise to apply the meat saver shot when hunting large heavy bovines because even if you are using the likes of a .375 caliber rifle, this really is still quite a small bore diameter relative to the size of the animal you are hunting. Instead, a long heavy for caliber bullet of sound construction should be driven through the forwards portion of the chest where it can do the most damage.

As yet a further example, let’s say that we are using a .308 Winchester for a wide variety of game. On very large animals it can again be good to aim to strike the forwards chest with a long and heavy bullet of sound construction in order to affect a very fast kill. I can promise you that on large African plains game, your guide will be very happy if you hunt in this manner and achieve a fast kill without any need to track your animal for minutes or hours. Having said this, there comes a point where the size of the animal will overcome the wounding potential of our cartridge. If for example we are suddenly confronted with an angry bovine, our .308 bullet may not be enough to penetrate ball joints. By the same token, it will lack the wounding potential for a meat saver style shot. So in this example, we must look to the neck and head as our point of aim. All I wish to convey here is that while the forwards chest is an optimal point of aim, we do need to exercise some common sense.

Unfortunately, many people - including those with vast past experience, lack the confidence to aim forwards. Instead, in a halfhearted attempt to break bone, the point of aim is brought forwards to the center line of the leg but no further forwards for fear of a forwards miss. And while this point of aim can be quite sufficient, it does not produce the same instantaneous results on the likes of African game as the forwards shoulder shot, destroying tissue, bone and the autonomic plexus.

The key to the forwards shoulder shot is to use the front line of the front leg. This may sound like nit picking relative to the center line of the front leg but I can assure you that there are differences which you will discover. If the shot goes further forwards, you will still achieve a fast kill. If the shot goes to the rear, you will still achieve a clean kill via a center lung hit. If you strike true, well you will see the results for yourself.

Although slightly quartering, this photo shows the point of aim for an autonomic plexus (forwards shoulder) broad side (and slightly quartering) shot. Note that the crosshair is aligned with the front line of the leg- not the center line. Many hunters lack the confidence to aim in this manner.

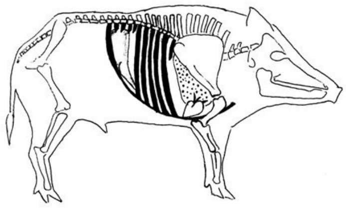
If you wish to study this for yourself, you can replicate my research if you hunt with a low velocity rifle such as a .30-30 or like velocity cartridge loaded with hunting projectiles (6.5x55 with factory ammunition is another good example). If you are used to utilizing the meat saver shot, try now to utilize the autonomic plexus shot and see what happens. Note how quickly the animal drops when using the front line of the front leg as your point of aim. Once you have an understanding of just how effective this shot placement is, you will never use your low velocity cartridge as you once did.

Getting back to other areas of the lungs, a shot striking a deer around three inches low at 6 o’clock strikes the bottom of the lungs and the arteries feeding into them from the heart, a reasonably fast killing shot but if it is slightly too low the shot may severe the heart (see heart) or simply the brisket, both slow killing shots. A shot striking three to five inches to the rear of the chest at 9 o’clock from dead center is a slow killing shot unless the cartridge used has immense wounding potential. High power cartridges may damage the rear portions of the lungs as well as rupturing the diaphragm however, animals usually run at least as far as when heart shot. The rear thin portions of the lungs, directly behind the foreleg tapering up and along the ribs, are considered a slow bleeding area and therefore a larger amount of tissue must be destroyed to effect a fast kill. High velocity cartridges such as the .270 .280 and .30-06 win out over smaller, milder calibers for fast killing in this area.

The greatest method of creating Spinal shock transfer is through shots that strike the upper half of the chest. Below center, the ribs are a long way from the spine therefore mid to low shots sometimes fail to produce shock, such as the heart shock and game may cover considerable ground after such a shot.

A true rear lung shot or ‘meat saver’ should be taken with the foresight or crosshair aimed **snugly behind the foreleg**. If the aim is taken any further back (as is common amongst inexperienced hunters these days), the shot will strike the tapered region of the lungs. The cross body meat saver shot is especially important to .22 center fire user as it allows the projectile to deliver more energy to the lungs, avoiding bullet failure on the shoulder. But again, keep shots tight! The other point of aim suited to .22 centerfire users is the soft junction between the shoulder and neck, giving access to the lungs when game are quartering on as well as the nerves and arterial system of the lower neck when broadside.

In pigs, the layout of the lungs can be very deceptive; the curvature of the spine at the shoulder is very low with the top third of the chest as viewed from the side consisting of dorsal vertebrae, cartilage and muscle to power the head. For this reason, it is important to consider the lower two thirds of the pigs shoulder as a vital zone. The lungs are completely protected by the shoulder, tapering up almost vertically at the rearmost line of the foreleg with the diaphragm positioned directly behind the foreleg. Therefore not only is the vital zone limited to the lower two thirds of the chest, but also from the foreleg forwards including the arteries and veins of the neck. That said, a shot high (below the spine) and flush behind the shoulder will strike the rear lungs and can be a good killer but slight error may result in either a liver or a gut shot. Bear also have a ‘low profile’ and again, it is important to avoid making the mistake of aiming too high, striking fat, dorsal vertebrae (or just fur) while missing vitals. A high hit boar (pig or bear) can be a nightmare in that the animal will be knocked unconscious via hydrostatic shock, but is for all intents and purposes only ‘sleeping’. The wound may even look thorough. Then suddenly our quarry awakens and all hell breaks loose and we seemingly become instant experts at highland dancing. This is also why I carry a good long knife!



Steph's pig anatomy 101.

Upon gutting any game animal, it is worth studying the causes of death and condition of each organ. A good lung shot will leave the chest cavity full of congealed blood; the meat will be well bled out for the table negating the necessity to bleed out the arteries of the neck.

Please note: if you are a long range shooter, more on the subject of shot placement can be found within my long range book series (Particularly Long Range Cartridges and Long Range Shooting). Techniques do vary when long range hunting and there is a great deal to consider.

The Heart
At the bottom of the chest, starting in line with the foreleg and ending three to four inches behind, lies the heart. The heart is responsible for pumping oxygen and nutrient rich blood to all parts of the body. Despite popular belief, the heart is not a good target for a fast killing shot. A heart shot without complete destruction can allow oxygen rich blood to be locked in the brain and locomotive muscles, allowing an animal to run long distances before collapsing. Shots falling low into the heart may allow some species of deer to run several hundred yards often making tracking difficult.

The Liver
Viewed broadside the liver appears roughly in the middle of an animal. The liver hangs from the spine descending roughly halfway down, between the paunch and the diaphragm. The liver is responsible for metabolizing fats, proteins and carbohydrates into the blood. It also detoxifies the blood as well as performing many other functions. The Hepatic artery and vein pass through the liver although most of the liver can be considered a fast bleeding area.

The liver is a very small target and difficult to hit deliberately and for this reason the liver should not be regarded as an aiming point. However, the liver is often hit when game step forwards as the hunter takes the shot, or are running when the shot is taken, or when angling shots are taken. If the liver is destroyed an animal may run someway (usually quite stiffly / bunched up) but will succumb quickly. Sometimes, less experienced hunters will simply divide the animal into four quarters with their scope crosshairs and pull the trigger, the result is either a fluke hit to the liver or else a wounding gut shot.

Long range hunters can make use of the liver as a secondary target however this is a subject I will not delve into here. These specialized topics are covered within my long range book series.

Directly behind the liver and attached to the spine are the kidneys, responsible for filtering waste from the blood. The kidneys are slow bleeding organs and if wounded result in a slow death.

The Abdominal Cavity
The gut is a slow killing zone. Gut shots may take hours or days to kill depending on the extent of wounding. Death may be caused by infection as well as general ‘blood poisoning’ as a result of digestive acids passing into the blood stream. Other factors may include severe pain trauma which then eventually leads to coma after several hours. Following this, the animal may remain in a coma until its eventual death.

Visible indicators of a gut shot include a deep audible ‘whock’ sound as the bullet strikes and game will often rear up on hind legs before running, although it is not uncommon to see no sign of a hit at all. Potent cartridges loaded with very soft fast expanding projectiles can sometimes anchor game through the destruction of such a large amount of the gut that the body is forced into coma quickly. Beyond these exceptions, many cartridges allow game to escape leaving no blood trail and often no gut fiber trail either, leaving the animal to endure a slow painful death.

The Neck
From the lungs forwards, arteries, veins and nerves of the chest cavity taper into the neck. The vital systems of the neck includes the spine and spinal nerves, the carotid artery transporting blood to the

head and the jugular vein transporting blood back to the heart. Destruction of any of these causes a fast kill and even if the spine is not hit, suitable projectiles will often transfer shock to the spine causing instant collapse. That said, during the roar or rut, the neck of a male deer can become very swollen and shots to the neck may result in flesh wounds only. This is largely due to the fact that the arteries and veins are incredibly elastic; sometimes remaining intact after the bullet has passed through the neck.

Typically, projectiles that create an explosive wound destroy both the spine and circulatory system however; it is often impractical to hunt with such loads. The neck shot should be limited to ranges for which a margin of accuracy can be guaranteed. Broadside shots are best placed to strike just below the spine which, for rifles sighted three inches high at 100 yards, means a hold on the bottom line of the neck on medium sized game at ranges of between 50 and 200 yards.

It is worth noting that in an accident where a human breaks their neck, the human may live on. In contrast to this, a rifle shot will generally completely destroy the spine, circulatory system, nerve ganglia and surrounding tissues. The damage is so severe that regardless of variations to this description and mechanisms, life simply cannot be sustained. A shot which destroys the spine (from the chest forwards) will generally cause instant coma followed by death. A shot which destroys the rear section of the spine may not cause coma / collapse (although the animal has no control over its rear extremities). If blood loss is slow, life may continue for some time, resulting in a slow kill.

The Head

There are two aspects of the nervous system. The Peripheral system refers to all of the branches of nerves throughout the body acting as sensory organs monitoring internal and external environments, responding to stimuli and conducting impulses. The central nervous system (CNS) refers to the brain and the highway of all information, the spinal cord. The destruction of the brain or spinal cord as far back as the shoulder causes instant death by simply shutting down the vital systems of the body (apart from the self-regulating heart).

Far from the ideal shot due to the accuracy required, the head shot is best suited to close ranges and for finishing wounded animals. Suitable points of aim include the ear or between the ear and eye as viewed broadside. From the front aim between the eyes if the rifle is sighted to shoot high or slightly above the eyes if the rifle is sighted dead on. Pigs are one of the toughest animals to head shoot front on because of both the shape and density of the skull. As an example, a .308 bullet of any weight and style of construction may simply bounce of the skull. This may result in a cut and mild bruising or it can cause instant collapse with severe internal hemorrhage. It is always difficult to predict exact results. If you do shoot a pig in the head front on and the animal collapses, be sure to check the wound quickly to make sure the bullet has actually penetrated the skull. The pig may only be rendered unconscious and if this is the case, you need to bleed the animal quickly to ensure a fast and humane kill (and to bleed out the meat). This also helps prevent any impromptu incidents of highland dancing.

If head shooting game at very close ranges (inside 15 yards), you must understand that your bullet will be traveling at least 1.5 inches below the center of the crosshair on a scoped rifle due to the physical height difference between the scope and the bore below. If this is not taken into consideration, there is a severe risk of a low strike, resulting is an immensely cruel, slow killing wound. Although scopes have given us superior accuracy over open sights their added height can cause confusion for close range head shots. A simple method for close range or coup de grace shots out to 15 yards is to place the horizontal crosshair flat across the top of the head.

While certainly a fast killing shot, a lot can and does often go wrong with head shots. Jaw shots are the most common mistake and game do run long and hard with a jaw shot which can make tracking extremely difficult. A cattle beast can present us with a relatively large target area but a deer or antelope is an entirely different story. The head shot is certainly one of the least ethical points of aim.

Game at Varying Angles

The quartering away shot describes a shot taken at an animal facing partially away from the hunter. In order to destroy the lungs for a fast kill the shot may have to be placed to pass through the paunch or rear ribs. Solidly packed gut fiber or in-line ribs may be encountered as the bullet makes its journey to the lungs therefore bullet construction is a vital factor. Long for caliber bullets, offering high sectional densities and straight line penetration win out over light super explosive bullets on this shot and the more powerful of cartridges will often transfer shock to the spine, after passing through the lungs and impacting the frontal ribs of the offside.

A quartering on shot describes a shot taken at an animal partially facing the hunter. When angling shots through the front quarter into the lungs, the point of the shoulder (ball joint) is often the best place to aim. However if the animal is facing slightly more toward the hunter the point of aim can be placed on the crease between the brisket and the shoulder muscle. This shot if true will strike the main nerve centers as well as the lungs, pole axing the animal for sure.

From the front, even at close ranges, shots placed squarely in the middle of the chest can sometimes pass between and fail to destroy the lungs. A large wound channel can minimize such failure however, as a power level example, it is not uncommon for some brands of .270win factory ammunition to cause slow or unrecovered kills on animals as light as 40kg (80lb) when hit this way at close range. Where doubt exists, a more reliable result can be obtained by either aiming slightly off center or aiming higher towards the neck and spine.

Tail on Shots

Also known as the Texas heart shot, the tail on shot refers to the common occurrence when deerstalking of finding an animal facing directly away from the hunter but usually looking back towards the hunter, poised for flight. This shot is considered unethical in Europe but is from time to time regarded as acceptable in the USA Australia and NZ.

There are two distinct methods of applying the tail on shot relative to cartridge power. With lighter cartridges, one method is to angle the shot to destroy the spine and follow through quickly with a finishing shot. Another method is to use a cartridge of great power with wide wounding projectiles to completely destroy one ham, causing the femoral artery to bleed out while also employing a finishing shot to the neck or head.

With potent calibers and bullets of sound construction, it is possible to achieve full length penetration, destroying the lungs as well as the autonomic plexus causing instant poleaxe. Bullet construction is much more important than sectional density for this shot and many projectiles fail under these circumstances, even those seemingly purpose built for the job such as heavy round nosed bullets. Optimum projectiles for this task should be of a premium controlled expanding design and boast a high sectional density. The Barnes TXS and TTSX are ideal; the Nosler Partition can be useful in certain combinations (where weight and SD are very high) as well as some core bonded bullet designs.

A heavy and potent chambering can certainly achieve a fast kill with tail on shots however there is still a lot that can go wrong leading to slow and cruel kills. Furthermore, tail on shots can render a carcass un-edible after it has been fouled from end to end with gut contents. Nevertheless, there are times when you may have to take a tail on shot in order to finish a wounded animal. It therefore pays to have a firm understanding of this subject and not simply skip over these paragraphs.

Meplat shape and surface area versus killing performance

The word meplat is a term used in ballistics terminology that has survived from a bygone era. The word itself is a French noun which means 'the flat of' and in ballistics it refers to the tip of a projectile. Meplat is not an adjective; it does not describe the shape of the tip or diameter in any way. Our current term could easily have been 'tip' or 'point' or even 'Fred' but instead, ballistic engineers of the world use the word meplat. The French were very much at the cutting edge of ballistics during the 19th century and the word meplat has survived out of an unconscious respect for these early pioneers. The term most likely stems from the days when all conical projectiles had flat points. The front was therefore called the flat and the rear dubbed the heel. Nevertheless, do not be confused, the word meplat simply means 'tip' in today's terms.

As most will guess, the shape of the meplat (tip) has a great effect on external ballistics (how the projectile flies through the air). The shape can also have an effect on terminal ballistics and performance with regard to projectile energy transfer on game, projectile expansion and stress to the projectile during this rapid change in medium. Put simply, a wide flat meplat projectile has far greater potential to transfer its energy immediately upon impact than a sleek pointed projectile when bullet construction of both designs is equal.

The differences become even more pronounced when using solid, non-expanding bullets, whether they be constructed of hard cast lead or full metal (copper) jackets. Unfortunately, a wide flat pointed meplat can also handicap a projectiles potential trajectory as well as a huge loss in velocity and energy at moderate to longer ranges which can in turn result in low energy transfer.

Ideally, to fully utilize a wide, flat meplat projectile, it needs to be used in firearms that are designed for close range work or - in cartridges which already have such low velocity, that trajectory is not greatly affected by bullet meplat design.

Historically, U.S Gun writer Elmer Keith was the first hunter to both study and publish the effects of a wide, flat meplat, non-expanding projectile used on game. There were definitely other hunters and ballisticians experimenting before him but it was Keith and his tenacious nature that made the wide, flat meplat into a 20th century issue. Keith pioneered the design of a flat point 250 grain .44

caliber hard cast lead projectile for his .44 special revolver in 1926 with results that would forever shape his opinions on hunting bullet design and forever influence his staunchest fans. Yet today, more than 80 years later, the subject of meplat shape and surface area is largely untapped

Mechanisms

In plain terms, a wide flat pointed solid non expanding bullet, even if driven at handgun velocities, creates disproportionate to caliber wounding where a pointed, non-expanding bullet would create a caliber sized wound. It is this dis-proportionate to caliber wounding that is of most interest to the hunter as it is this mechanism that promotes fast clean killing.

The physics involved in wide/ flat meplat wounding are very simple, the flat point meets huge resistance on impact causing the water in flesh to be forced violently away from the path of the bullet; this in turn results in broad wounding. At velocities above 1700fps and using a wide caliber, the .45-70 (.458") which this article is focused around, entry wounds using the widest possible meplat may be up to an inch in diameter with the wound channel slightly larger and remaining the same diameter for several feet. This opens up both the possibility of both broad wounding with solid projectiles combined with penetration not normally available with expanding type projectiles.

At this point it must be noted that the higher the impact velocity, the greater the resistance. This occurs simply because the water molecules of the animal cannot move away from the flat point bullet at relative speeds. So as velocity is increased, wound channels increase in diameter however penetration may not necessarily be deeper due to increased resistance at the target. Pointed FMJ projectiles do not seem to show much difference in wounding or penetration at varied velocities. As an example, a 147 grain 7.62 FMJ projectile fired from a .300 Win mag creates the same size permanent wound cavity as it does when fired from a .308 Win rifle. Some extra bruising does occur throughout the lungs however the actual speed of killing remains unchanged and kills with this projectile on medium game are generally slow.

Oddly, although entry wounds with wide flat meplat bullets are almost always large, non-expanding bullets of this style do not seem to produce hydrostatic shock at the typically low muzzle velocities produced by big bore rifle and handgun cartridges. By hydrostatic shock, I mean the ability of the projectile to send a shock wave through the ribs and into the spine with such speed that the central nervous system shuts down the brain (temporary coma) during which time the vitals bleed out before the animal regains consciousness, giving the illusion that it has died 'instantly'.

Due to the fact that slow, non-expanding wide, flat meplat projectiles do not produce any shock effect whatsoever, when using such bullets on dangerous game, hunters are advised to expect clean but delayed kills, a potentially deadly situation. Flat meplat non expanding bullets definitely give optimum results when striking major bones. When bones are hit, wound channels change from being consistent 1 to 2" wide wound channels to much more dramatic wounding. When this type of bullet strikes bone, the fragments that separate tend to be very large and incapacitating.

On average, again using the .45-70, wound channels created by flat meplat non expanding projectiles are about four times the size of the original .458" caliber hard cast bullet, however expanding projectiles in .45-70 will normally produce internal wounds twelve times their original bullet diameter at close ranges and in high velocity loadings. Needless to say, expanding bullets are capable of producing faster kills. The use of a flat meplat non expanding bullet therefore requires careful consideration.

As stated, wide, flat meplat non expanding projectiles are typically slow or 'delayed' killers, even with good shot placement. This can pose serious problems when hunting large dangerous game. Worse still, in a moment of intense stress such as during a charge, poor shot placement by the hunter may lead to minimal wounding where a premium controlled expanding bullet may have been capable of more devastating wounds. It is a tough call, on frontal shots, the flat meplat non expanding projectile driven at moderate velocities, even if missing the vitals or forwards locomotive muscles and bones, still has the potential to smash pelvis and rear leg bones. Several reports indicate that hunters have indeed anchored large heavy animals in this way.

There is not only great room for experimentation with wide meplat bullets, but also expanding wide meplat bullets, an area which most manufacturers have yet to tap into. Authorities on the subject of wide meplats generally view .300" as being the minimum and .360" being the maximum practical width for meplats of .458" caliber. These measurements prove true when tested on game and the difference that a .060" (1.5mm) increase in meplat width makes to wounding and fast killing is often dramatic.

Below are a series of photos taken from a simple day’s experimentation with the .45-70. The game hunted on this occasion were simply feral billy goats due to the fact that it allowed me to repeat tests over and over in a semi controlled environment - close range bush hunting where the abundance of game allowed me to take identical shots throughout a series of gullies. The average body weights for these animals was 50kg (110lb) and all animals were shot when relaxed, none were adrenalized before the shot.

The projectile used in the experiment was the Speer 400 grain flat soft point, a very good all-rounder for a huge variety of game including light/ lean game up to bodyweights of around 320kg (700lb). What made this experiment interesting is that animals were taken with the Speer bullet fired backwards as well as forwards. Kids, don't try this at home. While the Speer is one of the few projectiles which already offers a generously wide/ flat meplat, firing it backwards offered the maximum width meplat possible for the .45-70. The rifle (a custom bolt action) was also tested for accuracy and surprisingly, the backwards Speer grouped well and showed no signs of instability when observing the uniformity of bullet holes through paper.

.45-70, 400gr Speer FP, MV1900fps, range 50-60 yards. Picture shows entry wound, rear lung, snug behind shoulder.

.45-70, 400 grain Speer FP wound channel through rear lungs. Wound is large and widely diffused. Animal only made one step forwards before expiring, results repeatable.

.45-70 400gr Speer
MV1900fps, range 50-60yd.
Bullet fired backwards
Note large disprortionate to calibre entry wound (not due to poor flight!). The wide metplat forces flesh out of its way. The wound channel is similar all the way through the animal. Shot placement was the same as regular Speer bullet tests (behind Shoulder, rear lung) but animals always ran minimum 50 yards. Fast anchoring only acheiviable with BOTH shoulder/ leg bones broken. Would be better on medium game to have max metplat expanding type bullet. Note: Normal Speer shown in pic.

.45-70, 400gr speer
MV1900fps, range 50-60yd.
Bullet fired backwards.
Wound is smaller than softpoint Speer but is still consistant. Similar to .308Win with Softpoint beyond 200 yards (also .30-30).

The purpose of these experiments was really to determine speed of killing. In recent years there has been a lot of argument throughout various public hunting forums as to the effectiveness of a wide flat meplat bullet traveling at low velocity for use on dangerous game in comparison to both a low velocity expanding projectile and at the other extreme, high velocity big bores such as the .460 Weatherby. Each of these has its strengths and weaknesses. The most important factor is that the hunter be provided with correct information as to what to expect when each load is used on game and how to utilize projectiles, exploiting the strengths of the projectile designs.

For my own part, I much prefer the extremes, using a high velocity big bore. I am not so much a fan of clean but slow kills, regardless of deep penetration. I have used the .45-70 and the 400 grain Speer to take wild cattle but much prefer something a whole bunch faster. High velocity and careful shot placement gives me great satisfaction but I am also aware that penetration may be sacrificed on angling shots. For others, a classic big bore cartridge from yester year is far more thrilling to use than my latest ten million magnum. Variety is certainly the spice of life.

As for wide, flat meplats in small bores, the greatest problem with wide meplats in the small bores is that ballistic coefficients are greatly reduced, especially with regard to wind drift. Such changes tend to handicap otherwise flat shooting cartridges with the negatives outweighing any other benefits. Secondly, most small bores have high velocity in their favor, a major proponent in wide wound channel creation negating any need for increased performance. Perhaps the only advantage of using wide meplat non expanding projectiles in high velocity small bores would be in the design of full metal jacket projectiles in 7mm and .30 caliber for follow up shots on large game. In military ammunition, a small flat point rather than a fully pointed FMJ jacket does make a notable difference in stopping power, the ramifications are obvious.

Some examples of flat meplats discussed throughout the small bore texts of my research include - the Norma Vulcan in 6.5mm, 7mm and .30 caliber along with several brands of flat point .30-30 bullets. Of these, the Vulcan in all calibers and the .30-30 Sierra projectiles showed very good results.

Wide meplats really start to become more and more useful in the .358" caliber and upwards. Many medium bores are utilized at limited ranges of up to 200 to 250 yards and in such cases, the poor BC's created by wide meplats is of little handicap. By simply changing from a pointed soft point to a round nose soft point, many cartridges become fast killers on light or lean game where before the bullet may have carried too much momentum, failing to impart its energy. Results of the change in bullet style in the medium bores are often dramatic on all manner of game. That said, only a very few, mostly custom bullet makers, offer true flat point medium bore projectiles. Most manufacturers offer round nose bullets, nevertheless, the Woodleigh Weldcore, mentioned throughout the medium bore texts, is a good example of a fast killing round nose bullet in comparison to its pointed counterpart. Both of the Woodleigh designs have their strengths which are explained in the medium and big bore texts.

As discussed, Elmer Keith was one of the very few hunter/ researchers that experimented with wide meplats in large calibers. Keith's work revolved around experiments in the calibers .38 (.357"), .44 (.430") and .45 (.451") with non-expanding bullets. Very few others have experimented with big bore wide meplats, most notably Garret Cartridges, experimenting with both .430" and .458" caliber bullets while Lyman, Lee and RCBS offer Keith style bullet molds. Speer is the only manufacturer to offer a wide meplat jacketed soft point bullet which comes in the form of the .45-70 400 grain jacketed flat point. Apart from this, the market remains open to the development of wide, flat meplat expanding soft nose bullets.

In recent years, Woodleigh bullets of Australia have developed a line of “hydrostatically stabilized” projectiles for game hunting, particularly heavy game. These are designed to produce the same disproportionate to caliber wounding as described and photographed here (the backwards Speer) while remaining stable (not tumble) throughout penetration. Readers will also note that there are new buzz words used these days in an attempt to define disproportionate to caliber wounding. Cavitation is one such word (as in the principles of a boat motor propeller). I urge readers not to become too hung up on which mechanism is which and simply understand in plain terms that accelerated water displacement is the key factor in disproportionate to caliber wounding.

For those who wish to use a hard cast, non-expanding, wide meplat big bore bullet for hunting large, heavy bodied dangerous game, shot placement is the key to optimum results. The hunter must attempt to destroy the Autonomic Plexus on game if possible, with the first shot. For many hunters this is not a natural point of aim. The Autonomic Plexus is located at the junction of the heart and lungs in all mammals and viewed broad side; it is located towards the ball joint intersection of the scapula and humerus bones. This joint is slightly forwards of the line of the front leg. That said, this point of aim is only applicable for broadside shots. Front on, the Autonomic Plexus is located at the center of the chest but slightly high, from quartering angles the hunter must be able to visualize the Autonomic Plexus and aim shots accordingly. For newer hunters, performing these mental checks in the field can end up overwhelming, resulting in a generalized chest shot. The only way to avoid this prior to a big game hunt is to practice over and over, either mentally (visualization) or when hunting lesser game or even on small game, using a .22lr.