# MILITARY TECHNOLOGY IN THE 12TH CENTURY

The following list is a compilation of various sources and is meant as a reference guide. It does not need to be read entirely before the conference.

The breakdown of centralized states after the fall of the Roman empire led a number of groups in Europe turning to large-scale pillaging as their primary source of income. Most notably the Vikings and Mongols. As these groups were usually small and needed to move fast, building fortifications was the most efficient way to provide refuge and protection. Leading to virtually all large cities having city walls. The fortifications evolved over the course of the middle ages and with it, the battle techniques and technology used to defend or siege heavy forts and castles. Designers of castles focused a lot on defending entrances and protecting gates with drawbridges, portcullises and barbicans as these were the usual week spots. A detailed reference guide of various technologies and strategies is compiled on the following pages. During the third crusade and before the invention of gunpowder the advantages and the balance of power and logistics usually favoured the defender.

Another major advancement and change since the Roman empire was the invention of the stirrup around 600 A.D. (although wide use is only mentioned around 900 A.D.). The stirrup enabled armoured knights to ride war horses, creating a nearly unstoppable heavy cavalry for peasant draftees and lightly armoured foot soldiers. With the increased usage of heavy cavalry, pike infantry became essential to the medieval army. The medieval, as well as the British medieval longbow, also became essential in taking down armoured knights. The British longbowman used a single-piece longbow to deliver arrow that could penetrate armour and mail at a distance of up to 200 meters. The longbow was a difficult weapon to master and required years of training and constant practice. A skilled longbowman could shoot up to 12 shots a minute. Usually, bodkin or the more expensive broadhead points were used on arrows and while they did not always penetrate armour, a volley of arrows could be used to break enemy formation. Eventually the pike and longbow put an end to the dominance of cavalry in European warfare, making the use of foot soldiers more important.

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## Swords

A sword is a long, edged piece of forged metal, used in many civilisations throughout the world, primarily as a cutting or thrusting weapon and occasionally for clubbing.

The word sword comes from the Old English sweord, from a Proto-Indo-European root *swer- "to wound, to cut".

A sword fundamentally consists of a blade and a hilt, typically with one or two edges for striking and cutting, and a point for thrusting. The basic intent and physics of swordsmanship have remained fairly constant through the centuries, but the actual techniques vary among cultures and periods as a result of the differences in blade design and purpose. Unlike the bow or spear, the sword is a purely military weapon, and this has made it symbolic of warfare or naked state power in many cultures. The names given to many swords in mythology, literature, and history reflect the high prestige of the weapon.

Swords can be single or double-bladed edges. The blade can be straight or curved.

Note that the Long Sword as well as  the broad sword are swords of the late middle ages and are therefore not discussed.

## Arming Swords

The arming sword (also sometimes called a knight's or knightly sword) is the single handed cruciform sword of the High Middle Ages, in common use between ca. 1000 and 1350, remaining in rare use into the 16th century.

Arming swords are generally considered to be descendant from the swords of the migration period and Vikings

Typically used with a shield or buckler, the arming sword was the standard military sword of the knight (merely called a "war sword", an ambiguous title given to many types of swords carried for battle) until technological changes led to the rise of the longsword in the late 13th century. There are many texts and pictures depicting effective arming sword combat without the benefit of a shield.

According to Medieval texts, in the absence of a shield the empty (normally left) hand could be used for grabbing or grappling opponents.

The arming sword was overall a light, versatile weapon capable of both cut and thrust combat; and normally boasts excellent balance. Although a variety of designs fall under the heading of 'arming sword', they are most commonly recognised as single-handed double-edged swords that were designed more for cutting than thrusting. Most 12th-14th century blades seem to vary between 30 and 32 inch blades. As a rule, arming swords began to polarise in design forms from the late 12th century, becoming either increasingly squat and heavily pointed, or longer and heavier in design. This would seem to reflect two separate methods of adapting the arming sword to combat increasingly tough armour; either to make the blade sufficiently heavy-duty to inflict blunt trauma through the armour, or narrow-pointed enough to pierce it with a thrust. Arguably these two forms of blade evolve into the longsword, and the cinquedea.

It is a common weapon in period artwork, and there are many surviving examples in museums. The arming sword was worn by a knight even when not in armour, and he would be considered 'undressed' for public if he were without it. The first longswords were actually little more than two-handed arming swords, but the difference in length grew substantially as time passed. Long after these larger weapons came into use, the arming sword was retained as a common sidearm, eventually evolving into the cut & thrust swords of the Renaissance.

Arming swords are sometimes incorrectly referred to as longswords or broadswords (the former actually refers to a long-bladed two-handed sword and the latter to a type of broad-bladed baskethilted sword popular in the 17th and 18th centuries).

## Falchions

A falchion ( from Old French fauchon, ultimately from Latin falx "sickle") is a one-handed, singleedged sword of European origin, whose design is reminiscent of the Persian scimitar. The weapon combined the weight and power of an axe with the versatility of a sword.

Falchions are found in different forms from around the 11th century up to and including the sixteenth century. In some versions the falchion looks rather like the scramasax and later the sabre, and in some versions the form is irregular or like a machete with a crossguard. While some propose that encounters with the Islamic shamshir inspired its creation, these "scimitars" of Persia were not developed until long after the falchion. More likely, it was developed from farmer's and butcher's knives of the seax type or in the manner of the larger Messer. The shape concentrates more weight near the end, thus making it more effective for chopping strikes like an axe or cleaver.

The blade designs of falchions varied widely across the continent and through the ages. They almost always included a single edge with a slight curve on the blade towards the point on the end and most were also affixed with a quilloned crossguard for the hilt in the manner of the contemporary longswords. Unlike the double-edged swords of Europe, few actual swords of this type have survived to the present day; fewer than a dozen specimens are currently known. Two basic types can be identified Cleaver falchions : shaped very much like a large meat cleaver, or large bladed machete.

It sometimes presumed that these swords had a lower-than-average quality and status than the longer, more expensive swords. It is also possible that some falchions were used as tools between wars and fights, since they were very practical pieces of equipment. It is commonly thought that falchions were primarily a peasant's weapon, but the weapon is commonly shown in illustrations of combat between mounted knights.

A number of weapons superficially similar to the falchion existed in Western Europe, including the Messer, hanger and the backsword.

## Dagger and knives

A dagger is a double-edged blade used for stabbing or thrusting. Daggers often fulfill the role of a secondary defence weapon in close combat. In most cases, a tang extends into the handle along the centreline of the blade.

Daggers may be differentiated from knives in that daggers are intended primarily for stabbing whereas knives are usually single-edged and intended mostly for cutting. This distinction is confused by the fact that many knives and daggers are capable of either stabbing or cutting.

Historically, knives and daggers were always considered secondary or even tertiary weapons. Most cultures mainly fought with pole weapons, swords, and axes at arm's length if not already utilizing bows, spears, slings, or other long-range weapons.

## Stilettos

A stiletto is a short knife or dagger with a long slender blade of various designs primarily used as a stabbing weapon. Its narrow shape, ending in a rigid pointed end, allows it to penetrate

deeply. Most stiletti are not suited for cutting, even with edged examples. A typical early stiletto had a one-piece cast-metal handle. The blade was hammer-forged in a triangular blade cross section without any sharpened edges. Other examples have round, square, and diamond cross sections.

The Italian word "stiletto" comes from the Latin stilus meaning: "a stake; a pointed instrument".

The stiletto, also called a misericorde ("mercy"), began to gain fame during the High Middle Ages, when it was the secondary weapon of knights. It was used to finish off a fallen or severely wounded heavily armoured opponent. The pointed, stout blade could easily pass through most mail or find its way through gaps in a knight's plate armour. A severely wounded opponent, who was not expected to survive, would be given a "mercy strike" (French coup de grace), hence the name misericorde.

This weapon could also be used as a means of killing an active adversary, as during a grappling struggle. The blade could be used against an opponent's face, or thrust through holes or weak points in armour, such as under the arm, with the aim of piercing the heart. The weapon was known from the 12th century and has appeared in the armaments of Germany and England.

## Clubs and Maces

A mace is a simple weapon that uses a heavy head on the end of a handle to deliver powerful blows.

A development of the club, a mace differs from a hammer in that the head of a mace is radially symmetric so that a blow can be delivered equally effectively with any side of the head. A mace consists of a strong, heavy, wooden, metal-reinforced (or metal) shaft with a head made of stone, copper, bronze, iron, or steel.

The head is normally about the same or slightly thicker than the diameter of the shaft and can be shaped with flanges or knobs to allow greater penetration of armour.

The length of maces can vary considerably. The maces of foot soldiers were usually quite short (two or three feet, or 70 to 90 cm). The maces of cavalrymen were longer and better designed for blows from horseback. Two-handed maces could be even larger.

During the Middle Ages metal Armour and chain mail protected against the blows of edged weapons and blocked arrows and other projectiles. Solid metal maces and war hammers proved able to inflict damage on well armoured knights, as the force of a blow from a mace is large enough to cause damage without penetrating the armour.

One example of a mace capable of penetrating armour is the flanged mace. What makes a flanged mace different from other maces is the flanges, protruding edges of metal that allow it to dent or penetrate even the thickest armour. This variation of the mace did not become popular until significantly after knobbed maces. Although there are some references to

flanged maces (bardoukion) as early as the Byzantine empire circa 900, it is commonly accepted that the flanged mace did not become popular in Europe until the 12th century.

Maces, being simple to make, cheap and straightforward in application, were common weapons. Peasant rebels and cheap conscript armies often had little more than maces, axes and pole arms. Few of these simple maces survive today. Most examples found in museums are of much better quality and often highly decorated.

A mace type commonly used by the lower classes, called the Holy Water Sprinkler, was basically a wooden handle with a wooden or metal head and radiating spikes; the name most likely originates from the similarity to the church object.

Maces were employed by the clergy in warfare to avoid shedding blood (sine effusione sanguinis).

Bishop Odo of Bayeux is shown wielding a club-like mace at the Battle of Hastings in the Bayeux

Tapestry. Other Bishops were depicted bearing the arms of a knight without comment, such as Archbishop Turpin who bears both a spear and a sword named "Almace" in the The Song of Roland. Bishop Adhemar of Le Puy, fought as a knight during the First Crusade.

## Morning star

The morningstar is a medieval weapon consisting of a spiked club resembling a mace, usually with a long spike extending straight from the top and many smaller spikes around the particle of the head.

The spikes distinguish it from a mace, which can have, at most, flanges or small knobs. It was used by both infantry and cavalry; the horseman's weapon had a shorter shaft. The mace, a traditional knightly weapon, developed independently, became all-metal with heads of various forms, while the morningstar retained its characteristic spikes, with a usually wooden shaft, often found in longer twohanded forms measuring up to six feet or more, was popular among troops.

The morningstar first came into widespread use around the beginning of the fourteenth century, and the term is often applied to the military flail which consists of a wooden shaft joined by a length of chain to one or more iron balls or an iron shod wooden bar, in either case with or without spikes (heavy sword pommels have also been used as weights).

Although it is often assumed that the morningstar was a crude peasant weapon, this is not entirely correct. There were three types in existence, all differing in quality of workmanship. The first was the well crafted military type used by professional soldiers, made in series by expert weaponsmiths for stocking in town arsenals. The second and much simpler type would have been hand cut by peasant militiamen, rather than turned on a lathe, from wood they had gathered themselves and fitted with nails and spikes by the local blacksmith.

The shaft and head were usually of one piece but sometimes reinforced at the top with an iron band.

The third type was decorative in nature, usually short hafted and made of metal, one sixteenth century example being of steel and damascened with inlaid gold and silver, in the Wallace Collection of London.

## Holy Water Sprinklers

The holy water sprinkler (from its resemblance to the aspergillum used in the Catholic Mass) was a morning star used by the English army in the sixteenth century and made in series by professional smiths. One such weapon can be found in the Royal Armouries and has an all steel head with six flanges forming three spikes each, reminiscent of a mace but with a short thick spike of square cross section extending from the top. The wooden shaft is reinforced with four langets and the overall length of the weapon is 74.5 inches (189.2 cm).

The term can also be used to describe a type of military flail, this being the name for the weapon in French (goupillon).

## Flails

The military flail or simply flail is a weapon commonly attributed to the Middle-Ages but for which only a limited amount of historical evidence currently exists for most of this era.

In spite of the lack of frequent historial reference to use of flails, the weapon (sometimes called mace and chain or ball and chain) was a stock figure in Victorian Era Medievalist literature and thus has become entrenched in popular medieval fantasy and thus the neomedievalist imagination.

Typically, the weapon is depicted as one (or more) weights attached to a handle with a hinge or chain. Modern authors have used multiple conflicting names for this weapon: the "mace and chain" is the equivalent of the German "morningstar and chain" referred to above, but the latter term is rarely used in English. Additionally, the English terms "morning star" (a rigid haft topped with a spiked ball), and even "mace" (a bludgeoning weapon similar to a morning star), which properly refer to non-chained weapons, have also been used to refer to the military flail. [citation needed]

Throughout the Middle-Ages, agricultural flails were sometimes employed as an improvised weapon by peasant armies conscripted into military service or engaged in popular uprisings.

Another in the Royal Armouries collection has two spiked iron balls attached by separate chains.

## War Hammers

A war hammer is a late medieval weapon of war intended for close combat action, the design of which resembles the hammer.

The war hammer consists of a handle and a head. The handle may be of different lengths, the longest being roughly equivalent to the halberd, and the shortest about the same as a mace. Long war hammers were pole weapons (polearms) meant for use against riders, whereas short ones were used in closer quarters and from horseback. Later war hammers often had a spike on one side of the head, thus making it a more versatile weapon.

War hammers were developed as a consequence of the ever more prevalent surface-hardened steel surfacing of wrought iron armours of the late medieval battlefields during the fourteenth and fifteenth centuries. The surface of the armour was now as hard as the edge of a blade, so a blade tended to ricochet. Swords, or the blade of a battleaxe, were likely only to give a glancing blow, losing much of the impact, especially on the high curvature of the helmet. The war hammer could deliver the full force to the target.

War hammers, especially when mounted on a pole, could damage without penetrating the armour. In particular, they transmitted the impact through even the thickest helmet and caused concussions. A blade or spike tended to be used against other parts of the body where the armour was thinner, and penetration was easier, than through the helmet. The spike end could be used for grappling the target's armour, reins, or shield, or could be turned in the direction of the blow to pierce even heavy armour. Against mounted opponents, the weapon could also be directed at the legs of the horse, toppling the armoured foe to the ground where he could be more easily attacked.

## Horseman's Picks

The horseman's pick was a weapon of Islamic origin used by cavalry during the Middle Ages in Europe. This was a type of war hammer that had a very long spike on the reverse of the hammer head. Usually this spike was slightly curved downwards, much like a miner's pickaxe. The term is sometimes used interchangeably with war hammer.

The horseman's pick was often used as a means to penetrate thick armour or chain mail which the standard sword could not. However, a number of drawbacks limited the weapon's effectiveness. Its relative heaviness made it unwieldy and, thus, easily avoided.

The injury caused by the weapon was also small and rarely immediately fatal. Additionally, if swung too hard the weapon often became embedded in the victim or their armour making retrieval difficult. It also could be used as a throwing weapon.

## Pole Arms

A pole weapon or polearm is a close combat weapon in which the main fighting part of the weapon is placed on the end of a long shaft, typically of wood. The purpose of using pole weapons is either to extend reach or to increase angular momentum—and thus striking power—when the weapon is swung. The idea of attaching a weapon onto a long shaft is an old one, as the first spears date back to the Stone Age.

Spears, glaives, poleaxes, halberds, and bardiches are all varieties of polearm. Staff-weapons in Medieval or Renaissance England were lumped together under the generic term "staves"

Pole weapons are relatively simple to make, and easy for most people to use as they were often derived from hunting or agricultural tools.

Massed men carrying pole weapons with pointed tips (spears, pikes, etc.) were recognised early in the history of organised warfare as effective military units. On defence the men holding the polearms were hard to reach; on the attack they were devastating to any units that could not get out of the way.

With the advent of armoured fighters, especially cavalry, pole weapons frequently combined the spearpoint (for thrusting) with an axe or hammerhead for a swinging strike which could pierce or break armour.

## Quarterstaves

A quarterstaff is an English weapon that was used during the medieval period and up to the 18th Century. The term refers to a shaft of hardwood between five and seven feet in length, sometimes with metal tips, ferules or spikes.

The origin of the weapon's name is uncertain. The name may come from the way that the staff is held: one hand at the centre of the staff, and one hand halfway between the centre and one end. However, this grip is not prescribed in early sources. Another theory links the word to its length being equal to the wielder's height plus another quarter.

Swetnam writing in 1615 differentiates the quarterstaff of 6 or 7 feet in length from the long staff of

12 feet and the pike of 18 feet. Perhaps the most likely origin of the word is in its relationship to the "great" staff or pike, that was used to fight cavalry. Unlike its bigger cousin, a quarter-staff is literally one that is held and used in "close quarters" for personal combat, able to defend all four quarters of the body.

A simple weapon to manufacture, the quarter staff has a long history of use, and a wide cultural dispersion. The quarterstaff proper was a common weapon in England, where it is featured in the Robin Hood legend as the favourite weapon of Little John.

The quarterstaff is held with the back hand at the butt end of the staff and the other hand about a foot above it, as a two-handed sword would be held. The body is turned so the forward hand and forward foot are both facing the opponent, the feet taking the same stance as is used in sword or rapier fighting. This basic position is known as the low guard.

Assuming the butt is gripped with the left hand, moving the staff slightly to the right to defend blows is called the outside guard. Moving it slightly to the left is called the inside guard. Raising the butt end up and pointing the point of the staff at the opponent's face to parry a blow to the head is called the middle guard.

Raising the staff directly back over the head letting the tip point back at the ground behind oneself and looking under the butt end of the staff in front of oneself is called the open or hanging guard. The George guard or St. George guard is formed by grasping the staff at the thirds and raising it horizontally overhead to ward a direct overhead downward blow.

Of these the low guard is considered the central guard. Blows were primarily delivered downwards either directly or at angles. Parries of blows to the legs were done either by lifting the leg away from the line of attack or by thrusting one end of the staff into the ground and releasing the foremost hand which was in danger of being struck. Thrusts were often performed with the release of the forward hand and a step with the forward leg like a fencing lunge, stretching forward the back hand as far as possible. Longer thrusts were delivered with a full step forward with the back leg accompanying the back hand. It was recommended that when delivering a blow that at the end of it the back leg and foot should be compassed about so as to fall roughly into a line with the front foot and the point of the weapon. The same circling round of the back leg was applied to parries also. Singularly among the three authors, Swetnam recommends preference of thrusting over striking. Silver and Wylde describe striking and thrusting as equally valid attacks.

## Spears

A spear is a pole weapon consisting of a shaft, usually of wood, with a sharpened head. The head may be simply the sharpened end of the shaft, or it may be of another material fastened to the shaft, such as obsidian, iron, or bronze. The most common design is of a metal spearhead, shaped like a triangle or a leaf.

Spears were one of the most common personal weapons from the Stone Age until the advent of firearms. They may be seen as the ancestor of such weapons as the lance, the halberd, the bill and the pike. One of the earliest weapons fashioned by human beings and their ancestors, it is still used for hunting and fishing. Its influences can still be seen in contemporary military arsenals as the riflemounted bayonet.

Spears can be used as both ballistic and melee weapons. Spears used primarily for thrusting may be used with either one or two hands and tend to have heavier and sturdier designs than those intended exclusively for throwing. Those designed for throwing, often referred to as javelins, tend to be lighter and have a more streamlined head..

After the fall of the Roman Empire, the spear and shield continued to be used by almost all Western European cultures. Since a medieval spear required only a small amount of steel along the sharpened edges (most of the spear-tip was wrought iron), it was an economical weapon. Quick to manufacture, and needing less smithing skill than a sword, it remained the main weapon of the common soldier. The Vikings, for instance, though often portrayed with axe or sword in hand, were armed mostly with spears, as were their Anglo-Saxon, Irish, or continental contemporaries.

Spears were either designed to be kept in hand (thrusting spears), or to be thrown (throwing spears). Within this simple classification, there were a remarkable range of types.

Notable types of Early medieval spears include the Angon, a throwing spear with a long head like a Roman pilum used by the Franks and Anglo-Saxons and the winged (or lugged) spear, which had two prominent wings at the base of the spearhead, either to prevent the spear penetrating too far into an enemy or to aid in spear fencing . Originally a Frankish weapon, the winged spear was also popular with the Vikings. It would become the ancestor of later medieval polearms, such as the partisan and spetum.

The thrusting spear also has the advantage of reach — being considerably longer than other weapon types. Exact spear lengths are hard to deduce as few spear shafts survive archaeo-logically but 6 ft. - 8 ft. (1.8m - 2.5m) would seem to be the norm. Some nations were noted for their long spears, including the Scots and the Flemish. Spears were usually used in tightly ordered formations, like the shieldwall or the schiltron To resist cavalry, spear shafts could be planted against the ground. William Wallace drew up his schiltrons in a circle at the Battle of Falkirk in 1298 to deter charging cavalry, but it was a widespread tactic, sometimes known as the "crown" formation

Cavalry spears were originally the same as infantry spears and were often used with two hands or held with one hand overhead. In the 11th. Century, after the adoption of stirrups and a high-cantled saddle, the spear became a more powerful weapon. A mounted knight would secure the lance by holding with one hand and tucking it under the armpit (the couched lance technique). This allowed all the momentum of the horse and knight to be focused on the weapon's tip whilst still retaining accuracy and control. This use of the spear spurred the development of the lance as a distinct weapon which was perfected in the medieval sport of jousting.

## Winged Spears

The winged (also lugged or barred) spear was a common type of thrusting spear during the early Middle Ages. It consisted of a leaf or lozenge shaped head, beneath which on the socket there were prominent wings. The earliest use of barred spears for hunting is recorded by Xenophon in the 4th. Century BC and illustrations of Roman examples are known. Its use in war, however, seems to relate to German tribes in the Early Middle Ages, particularly the Franks, and it was used by the Vikings. The type is commonly illustrated in Early Medieval Art, including the Bayeux Tapestry and the Golden Psalter of St. Gallen..

The winged spear is shown used by both cavalry and infantry. Although some authors claim the intention of the wings was to prevent the weapon from penetrating too deeply into an enemy, others see them as an aid to spear-fencing.

## Lances

The word lance is a catchall term for a variety of different pole weapons based on the spear. The name is derived from lancea, Roman auxiliaries' javelin..

A lance in the original sense is a light throwing spear, or javelin. The English verb to launch "fling, hurl, throw" is derived from the term (via Old French lancier), as well as the rarer or poetic to lance. The term from the 17th century came to refer specifically to spears not thrown, used for thrusting by heavy cavalry, and especially in jousting.

A thrusting spear which is used by infantry is usually referred to as a pike.

The Roman cavalry long thrusting spear was not called lance, but contus (from Greek language kontos, barge-pole). It was usually 3 to 4 m long, and grasped with both hands. It was used by equites contariorum and equites catafractarii, fully armed and armoured cataphracts.

The use of the basic cavalry spear is so ancient, and warfare so ubiquitous by the beginning of recorded history, that it is difficult to determine which populations invented the lance and which learned it from their enemies or allies.

The best known usage of military lances was that of the full-gallop closed-ranks and usually wedgeshaped charge of a group of knights with underarm-couched lances, against lines of infantry, archery regiments, defensive embankments, and opposition cavalry.

It is commonly believed that this became the dominant European cavalry tactic in the 11th century after the development of the cantled saddle and stirrups and of rowel spurs which enabled better control of the mount. Cavalry thus outfitted and deployed had a tremendous collective force in their charge, and could shatter most contemporary infantry lines.

While it could still be generally classified as a spear, the lance tends to be larger - usually both longer and stouter and thus also considerably heavier, and unsuited for throwing, or for the rapid thrusting, as with an infantry spear. Lances did not have spear tips that (intentionally) broke off or bent, unlike many throwing weapons of the spear/javelin family, and were adapted for mounted combat. They were often equipped with a vamplate, a small circular plate to prevent the hand sliding up the shaft upon impact. Though perhaps most known as one of the foremost military and sporting weapons used by European knights, the use of lances was spread throughout the Old World wherever mounts were available. As a secondary weapon, lancers of the period also bore swords, maces or something else suited to close quarter battle, since the lance was often a one-use-per-engagement weapon; after the initial charge, the weapon was far too long, heavy and slow to be effectively used against opponents in a melee.

In Europe, a jousting lance was a variation of the knight's lance which was modified from its original war design. In jousting, the lance tips would usually be blunt, often spread out like a cup or furniture foot, to provide a wider impact surface designed to unseat the opposing rider without spearing him through. The centre of the shaft of such lances could be designed to be hollow, in order for it to break on impact, as a further safeguard against impalement. They were often 4 m long or longer, and had special hand guards built into the lance, often tapering

for a considerable portion of the weapon's length. These are the versions that can most often be seen at medieval re-enactment festivals. In war, lances were much more like stout spears, long and balanced for one handed use, and with sharp tips.

## Pikes

A pike is a pole weapon, a very long thrusting weapon used extensively by infantry both for attacks on enemy foot soldiers and as a counter-measure against cavalry assaults. Unlike many similar weapons, the pike is not intended to be thrown. Pikes were used by European troops from the early Middle Ages until around 1700, and wielded by foot soldiers deployed in close order. While the soldiers using such spears may not have called them "pikes", their tactical employment of these weapons ran along broadly similar lines.

The pike was an extremely long weapon, varying considerably in size, from 3 to 6 metres (10 to over 20 feet) long. It had a wooden shaft with an iron or steel spearhead affixed. The shaft near the head was often reinforced with metal strips called "cheeks" or langets. When the troops of opposing armies both carried the pike, it often grew in a sort of arms race, getting longer in both shaft and head length to give one side's pikemen an edge in the combat; the longest pikes could exceed 6 m (22 feet) in length. The extreme length of such weapons required a strong wood such as well-seasoned ash for the pole, which was tapered towards the point to prevent the pike sagging on the ends, although this was always a problem in pike handling.

The great length of the pikes allowed a great concentration of spearheads to be presented to the enemy, with their wielders at a greater distance, but also made pikes unwieldy in close combat. This meant that pikemen had to be equipped with a shorter weapon such as a sword, mace, or dagger in order to defend themselves should the fighting degenerate into a melee. In general, however, pikemen attempted to avoid such disorganised combat, at which they were at a disadvantage. To compound their difficulties in a melee, the pikeman often did not have a shield ..

On the battlefield pikes were often used in "hedgehog" formations, particularly by troops such as rebel peasants and militias who had not received a great deal of training in tactical manoeuvres with the weapon. In these, the troops simply stood and held their pikes out in the direction of the enemy, sometimes standing in great circles or squares with the men facing out in all directions so that the enemy was confronted by a forest of bristling pikeheads, and could not attack the formation from the sides or rear.

Better-trained troops were capable of using the pike in an aggressive attack, each rank of pikemen being trained to hold their pikes so that they presented enemy infantry with four or five layers of spearheads bristling from the front of the formation.

As long as it kept good order, such a formation could roll right over enemy infantry, but had its own weaknesses – as the men were all moving forward, they were all facing in a single direction and could not easily turn to protect the vulnerable flanks or rear of the formation,

and the huge block of men carrying such unwieldy spears could be difficult to manoeuvre, other than for straightforward movement.

As a result, such mobile pike formations sought to have supporting troops protect their flanks, or would manoeuvre to smash the enemy before they could themselves be outflanked. There was also the risk that the formation would become disordered, leading to a confused melee in which pikemen had the vulnerabilities mentioned above.

In the Middle Ages, the principal users of the pike were urban militia troops such as the Flemings or the peasant array of the lowland Scots. For example, the Scots used a spear formation known as the schiltron in several battles during the Wars of Scottish Independence including the Battle of Bannockburn in 1314, and the Flemings used their geldon long spear to absorb the attack of French knights at the Battle of the Golden Spurs in 1302, before other troops in the Flemish formation counterattacked the stalled knights with plancons. Both battles were seen by contemporaries as stunning victories of commoners over superbly equipped, mounted, military professionals, where victory was owed to the use of the pike and the brave resistance of the commoners who wielded them.

These formations were essentially immune to the attacks of mounted men-at-arms as long as the knights obligingly threw themselves on the spear wall, but the closely-packed nature of pike formations rendered them vulnerable to enemy archers and crossbowmen who could shoot them down with impunity, especially when the pikemen did not have adequate armour. Many defeats, such as at Roosebeke and Halidon Hill, were suffered by the militia pike armies when faced by enemies who employed their archers and crossbowmen to thin the ranks of the pike blocks before charging in with their (often dismounted) men-at-arms.

Medieval pike formations tended to have better success when they operated in an aggressive fashion. The Scots at the Battle of Stirling Bridge (1297), for example, used the momentum of their charge to overrun an English army while the Englishmen were halfway through the process of crossing a narrow bridge. And then, at the Battle of Laupen (1339), Bernese pikemen overwhelmed the infantry forces of the opposing Habsburg/Burgundian army with a massive charge before wheeling over to strike and rout the Austro-Burgundian horsemen as well. It was not uncommon for aggressive pike formations to be composed of dismounted men-at-arms, as at the Battle of Sempach (1389), where the dismounted Austrian vanguard, using their lances as pikes, had some initial success against their predominantly halberd-equipped Swiss adversaries. Dismounted Italian men-at-arms also used the same method to defeat the Swiss at the Battle of Arbedo (1422).

## Fauchards

A fauchard is a type of polearm used in medieval Europe from the 11th through the 14th centuries. The design consisted of a curved blade on top of a 6–7-foot long pole. The blade bore a moderate to strong curve along its length. Unlike a glaive the cutting edge was only on the conc side. This made the fauchard blade resemble that of a sickle or a scythe.

This was not a very efficient design for the purposes of war, and was eventually modified to have one or more lance points attached to the back or top of the blade. The modern name for this weapon is a fauchard-fork, but is very often erroneously referred to as a guisarme or bill-guisarme since it superficially appears to have a "hook".

## Glaives

A glaive is a polearm consisting of a single-edged tapering blade similar in shape to a modern kitchen knife on the end of a pole. The blade is fixed in a socket-shaft configuration similar to an axe head, both the blade and shaft varying in length.

Illustrations in the 13th century Maciejowski Bible show a short staffed weapon with a long blade used by both infantry and cavalry. Typically however, the blade was around 18 inches (55 cm) long, on the end of a pole 6 or 7 feet (180–210 cm) long. Occasionally glaive blades were created with a small hook or spike on the reverse side. The modern term for these is glaive-guisarmes.

## Guisarmes

A guisarme (gisarme, giserne or bisarme) was a pole weapon used in Europe between 1000–1400. It was used primarily to dismount knights and horsemen. Like most polearms it was developed by peasants by combining hand tools with long poles, in this case by putting a pruning hook onto a spear shaft.

While hooks are effective for dismounting horsemen from mounts, they lack the stopping power of a spear especially when dealing with static opponents. Early designs were simply a hook on the end of a long pole. Later designs implemented a small reverse spike on the back of the blade.

Eventually weapon makers incorporated the usefulness of the hook in a variety of different polearms and guisarme became a catch-all for any weapon that included a hook on the blade.

## Danish Axes

The Danish Axe (also Broad Axe, Dane-axe) is a weapon with a heavy crescent-shaped head mounted on a haft 4ft. to 6ft. (1.2-1.8 m.) in length.

Originally a Viking weapon, it was adopted by the Anglo-Saxons and Normans in the 11th century, spreading through Europe in the 12th and 13th centuries.

## Sparths

In the 13th century, variants on the Danish axe are seen. Described in English as a sparth (from the Old Norse sparðr) or pale-axe], the weapon featured a larger head with broader blade, the rearward part of the crescent sweeping up to contact (or even be attached to) the haft. Another development extended the forward part of the crescent.

In Ireland, this axe was known as a Sparr. Originating in either Western Scotland or Ireland, the sparr was widely used by the galloglass. Although sometimes said to derive from the Irish for a joist or beam, a more likely definition is as a variant of sparth. Although attempts have been made to suggest that the sparr had a distinctive shaped head, illustrations and surviving weapons show there was considerable variation and the distinctive feature of the weapon was its long haft.

## Bardiches

A bardiche (berdiche, or long poleaxe), is a type of polearm known in medieval and renaissance Europe, especially in Eastern Europe and Russia where it was used instead of halberd.

Occasionally the weapons of such form were made in Antiquity and Early Middle Ages, but the regular and massive usage of bardiches started in the late 14th century.

## Becs de Corbin

A bec de corbin is a type of pole weapon that was popular in medieval Europe. The name is Old French for "crow's beak".

Similar to the Lucerne hammer, it consists of a modified hammer's head and spike mounted atop a long pole. Unlike the Lucerne hammer, the bec de corbin was used primarily with the 'beak' or fluke to attack instead of the hammer head. The hammer face balancing the beak was often blunt instead of the multi-pronged Lucerne, and the beak tended to be stouter; better designed for tearing armour. Also, the spike mounted on the top of head was not nearly as long and thin as in the Lucerne. Bec de corbin occasionally becomes a catchall for any type of warhammer, such as a maul or a horseman's pick.

A similar name bec de faucon (meaning 'falcon's beak') refers to a related weapon called a poleaxe or, more specifically, to the hook on its reverse side.

## Ranged Weapons

A ranged weapon is any a projectile or weapon that launches a projectile. In contrast, a weapon intended to be used in man-to-man combat is called a melee weapon.

Early ranged weapons include weapons such as javelins, throwing axes the bow and arrow, and medieval siege engines like catapults, ballistas and trebuchets.

Ranged weapons were effective in combat in comparison to melee weapons, as they gave the wielder opportunity to launch multiple projectiles before an enemy armed with melee weapons or shorter ranged missile weapon posed a threat to him.

Siege engines were also used for passing or hitting obstacles like fortifications.

After the invention of gunpowder and the development of firearms, ranged weapons became the weapon of choice. Maximum effective range of a weapon is the greatest distance fired and able to produce casualties or damage consistently.

## Throwing axes - Franciscas

The francisca (or francesca) is a throwing axe used as a weapon during the Early Middle Ages by the Franks. It was a characteristic Frankish national weapon at the time of the Merovingians from about 500 to 750 AD and is known to have been used during the reign of Charlemagne (768 - 814). Although associated with the Franks, it was also used by other Germanic peoples of the period including the Anglo-Saxons. Examples have been found in England.

The term francisca first appeared in the book *Ethymologiarum sive originum*, libri XVIII by Isidore of Seville (c. 560 - 636) as a name used among the Spanish to refer to these weapons "because of their use by the Franks".

The francisca is characterised by its distinctly arch-shaped head, widening toward the cutting edge and terminating in a prominent point at both the upper and lower corners. The top of the head is usually either S-shaped or convex with the lower portion curving inward and forming an elbow with the short wooden haft. The upswept point and downturned edge were both capable of penetrating chain mail.

Sometimes the head is more upswept forming a wider angle with the haft. Most franciscas have a round or teardrop-shaped eye designed to fit the tapered haft, similar to Viking axes. Based on surviving heads of franciscas recovered at Burgh Castle and Morning Thorpe in county Norfolk, England the length of the head itself measured 14-15 cm (5-6 in) from the edge to the back of the socket.

The Roman historian Procopius (c. 500 - 565) described the Franks and their use of throwing axes:

"...each man carried a sword and shield and an axe. Now the iron head of this weapon was thick and exceedingly sharp on both sides while the wooden handle was very short. And they are accustomed always to throw these axes at one signal in the first charge and thus shatter the shields of the enemy and kill the men."

The weight of the head and length of the haft would allow the axe to be thrown with considerable momentum to an effective range of about 12 m (40 ft). Even if the edge of the blade were not to strike the target the weight of the iron head could cause injury.

Another feature of the francisca was its tendency to bounce unpredictably upon hitting the ground due to its weight, shape, lack of balance and curvature of the haft, making it difficult for defenders to block. It could rebound up at the legs of opponents or against shields and through the ranks. The Franks capitalised on this by throwing the franciscas in a volley in order to confuse, intimidate and disorganise enemy lines either before or during a charge to initiate close combat.

The régime of Vichy France used the image of a stylised double-headed francisque as part of its iconography (compare fasces). Today, the francisca remains in popular use as a throwing axe in competitions and as a weapon for re-enactors of medieval warfare.

## Javelins

The javelin is a light spear designed primarily for casting as a ranged weapon. The javelin is almost always thrown by hand (unlike the arrow and slingshot which are projectiles shot from a mechanism). it was used throughout medieval Europe.

There is some literary and archaeological evidence that the Norse were familiar with and used the javelin for hunting and warfare, but they commonly used a spear designed for both throwing and thrusting.

Viking grave excavations have revealed spears and spearheads among the funerary offerings. They were one of the most common weapons found.. These spears included throwing javelins, as well as pikes for thrusting. The employment of javelins in battle by the Vikings was documented in the Anglo-Saxon poem about the 991 AD Battle of Maldon.

The Anglo-Saxon term for javelin was *france*. In Anglo-Saxon warfare soldiers usually formed a shield wall and used heavy weapons like Danish axes, swords and spears. Javelins, including barbed angons, were used as an offensive weapon from behind the shield wall or by warriors who left the protective formation and attacked the enemy as skirmishers.

The Almogavars were a class of Aragonese infantrymen armed with a short sword, a shield and two heavy javelins, known as assegai. The equipment resembled that of a Roman legionary and the use of the heavy javelins was much the same.

Jinetes were Spanish light horsemen armed with a javelin, sword and a shield. This troop type developed in the Middle Ages in response to the massed light cavalry of the Moors. Often fielded in significant numbers by the Spanish, and at times the most numerous of the Spanish mounted troops, they were proficient at skirmishing and rapid manoeuvre, and played an important role in Spanish mounted warfare throughout the Reconquista and up until the sixteenth century.

The Welsh, particularly the North Welsh, used the javelin as one of their main weapons. During Norman and later English invasions, the primary Welsh tactic was to rain javelins on the enemy troops and then retreat into the mountains or woods before they could pursue and attack them.

## Bows, Longbows

A bow is a weapon that projects arrows powered by its elasticity .It is a form of spring. As the bow is drawn, energy is stored as potential energy in the limbs of the bow and transformed into kinetic energy as the string is released, the string transferring this energy to the arrow

A longbow is a type of bow that is tall (roughly equal to the height of the person who uses it). This allows its user a fairly long draw, at least to the jaw. The average length of arrowshafts recovered from the 1545 sinking of the Mary Rose is 75 cm or 30 in). A longbow is not significantly recurved. Its limbs are relatively narrow so that they are circular or D-shaped in cross section.

Flatbows can be just as long; the difference is that, in cross-section, a flatbow has limbs that are approximately rectangular.

Traditional longbows are made from a single natural piece of wood. They have been used for thousands of years, for hunting and warfare. . Worldwide the average power for bows of all designs is about 220 newtons (50 pounds) at 70 cm (28 inches) of draw which is suitable for most hunting applications. Bows for warfare tend to be more powerful, with the most powerful bows being the English longbow which topped the 900 N (200-pound) at 80 cm (32 inches) mark.

Many men in later medieval England were capable of shooting bows from 670–900 N (150–200 pounds) — skeletons of archers reveal spur like projections on the bones where their over-developed muscles pulled. These men trained daily from an early age and they had the incentive of knowing that their lives would depend on being able to use such powerful bows. There are modern day examples of men who train similarly and are able to draw such powerful bows.

In the Middle Ages the Welsh and the English were famous for their very powerful English longbows, used to great effect in the civil wars of the period and against the French in the Hundred Years' War, with notable success at the battles of Crécy (1346), Poitiers (1356) and Agincourt (1415).

A typical military longbow archer would be provided with between 60 and 72 arrows at the time of battle. Most archers would not loose arrows at maximum rate, as it would exhaust even the most experienced man. A modern warbow archer does not like to try for more than six a minute. Not only are the arms and shoulder muscles tired from the exertion, but the fingers holding the bowstring become strained;

Ranged volleys at the beginning of the battle would differ markedly from the closer, aimed shots as the battle progressed and the enemy neared. Arrows were not unlimited, so archers and their commanders took every effort to ration their use.

Resupply during battle was necessary. Boys were often employed to run additional arrows to longbow archers while in their positions on the battlefield. As one commentator has put it "The longbow was the machine gun of the Middle Ages: accurate, deadly, possessed of a long range and rapid rate of fire, the flight of its missiles was likened to a storm."

This rate of fire was much higher than that of its nearest rival on the battlefield, the crossbow. It was also much higher than the standard early firearms right up the nineteenth century although the lower training requirements and greater penetration of firearms eventually led to the longbow falling into disuse.

Because the longbow can be made from a single piece of wood, it can be crafted relatively easily and quickly. Amateur bowyers today can craft a longbow in about ten to twenty hours, while highly skilled bowyers can craft wooden longbows in a few hours.

One of the simpler longbow designs is known as the self bow. By definition, a self bow is made from a single piece of wood. Truly traditional English longbows are self bows, made from yew wood. The bowstave is cut from the radius of the tree so that the sapwood (on the outside of the tree) becomes the back two thirds and the belly, the remaining one third, is heartwood. Yew sapwood is good only in tension, while the heartwood is good in compression. However, one must make compromises when making a yew longbow, as it is difficult to find perfect unblemished yew. The demand for yew bowstaves was such that by the late 1500s, mature yew trees were almost extinct in northern Europe. In other desirable woods such as Osage orange and mulberry the sapwood is almost useless and is normally removed entirely.

Longbows, because of their narrow limbs and rounded cross-section (which does not spread out stress within the wood as evenly as a flatbow's rectangular cross section), need to be either less powerful, longer or of more elastic wood than an equivalent flatbow. In Europe the last approach was used, with yew being the wood of choice, because of its high compressive strength, light weight and elasticity.

## Crossbows

A crossbow is a range weapon that shoots projectiles (called bolts or quarrels) consisting of a bow mounted on a stock. The medieval crossbow was called by many names, most of which derived from the word ballista, a Roman torsion engine resembling a crossbow in appearance.

Historically, crossbows played a significant role in the warfare of Europe, and the Mediterranean.

A crossbow is a bow mounted on a stock (or tiller) with a mechanism that holds the drawn bow string. Early designs featured a slot in the stock, into which the cocked string was placed. To fire this design, a vertical rod is thrust up through a hole in the bottom of the notch, forcing the string out. This rod is usually attached perpendicular to a rear-facing firing lever called a trigger or 'tickler'.

A later design implemented a rolling cylindrical pawl called a 'nut' to retain the cocked string. This nut has a perpendicular centre slot for the bolt, and an intersecting axial slot for the string, along with a lower face or slot against which the internal trigger sits. They often also have some form of strengthening internal 'sear' or trigger face, usually of metal. These 'roller nuts' were either freefloating in their close-fitting hole across the stock, tied in with a binding of sinew or other strong cording, or mounted on a metal axle or pins.

Removable or integral plates of wood, ivory or metal on the sides of the stock kept the nut in place laterally. Nuts were made of antler, bone, ivory or metal, usually brass.

A trigger system, (usually made of iron or steel from medieval times onwards), was used to retain the force of the cocked string in the nut and then release the nut to spin and the string to shoot the bolt. Complicated iron triggers that could be released with little strength are known in Europe from the early 1400s. As a result crossbows could be kept cocked and ready to shoot for some time with little effort, allowing crossbowmen to aim better.

The bow (called the "prod" or "lath") of early crossbows was made of a single piece of wood, usually ash or yew. Composite bows are made from layers of different material—often wood, horn and sinew—glued together and bound with animal tendon.

These composite bows, made of several layers, are much stronger and more efficient in releasing energy than simple wooden bows. As steel became more widely available in Europe around the 14th century, steel prods came into use

The crossbow prod is very short compared to ordinary bows, resulting in a short draw length. This leads to a higher draw weight in order to store the same amount of energy. \Thick prods are less efficient at releasing energy, but more energy can be stored.

Traditionally the prod was often lashed to the stock with rope, whipcord, or other strong cording. This cording is called the bridle.

The strings for a crossbow are typically made of strong fibres that would not fray. Whipcord was very common. Linen, hemp, and sinew were used as well. In wet conditions, twisted mulberry root was occasionally used.

Very light crossbows can be drawn by hand, but heavier types need the help of mechanical devices. The simplest version of mechanical cocking device is a hook attached to a belt, drawing the bow by straightening the legs. Other devices are hinged levers which either pulled or pushed the string into place, cranked rack-and-pinion devices called 'cranequins' and multiple cord-and-pulley cranked devices called windlasses.

The Saracens called the crossbow *qaws Ferengi,* or "Frankish bow," as the Crusaders used the crossbow against the Arab and Turkoman horsemen with remarkable success. The adapted crossbow was used by the Islamic armies in defence of their castles. Later foot-strapped version become very popular among the Muslim armies in Iberia. During the Crusades, Europeans were exposed to Saracen composite bows, made from layers of different material—often wood, horn and sinew—glued together and bound with animal tendon. These composite bows could be much more powerful than wooden bows, and were adopted for crossbow prods across Europe.

The repeating crossbow automated the separate actions of stringing the bow, placing the projectile and shooting. This way the task can be accomplished with a simple one-handed movement, while keeping the weapon stationary. As a result, it is possible to shoot at a faster rate compared to unmodified version

The arrow-like projectiles of a crossbow are called bolts. These are much shorter than arrows, but can be several times heavier. There is an optimum weight for bolts to achieve maximum

kinetic energy, which varies depending on the strength and characteristics of the crossbow, but most could pass through common chain mail.

Bolts typically have three fletches, commonly seen on arrows. Crossbow bolts can be fitted with a variety of heads, some with sickle-shaped heads to cut rope or rigging; but the most common today is a four-sided point called a quarrel. A highly specialise type of bolt may be employed today to collect blubber biopsy samples from marine mammals to be used in biology research.

Crossbows can also be adapted to shoot lead bullets or stones, in which case they are called stonebows. Primarily used for hunting wildfowl, these usually have a double string with a pouch between the strings to hold the projectile.

A bullet crossbow is a type of handheld crossbow which rather than arrows or bolts shoots spherical projectiles made of stone, clay or lead. There are two variants, one has a double string with a pocket for the projectile; the other has a barrel with a slot for the string.

The use of crossbows in European warfare dates back to Roman times and is evident from the Battle of Hastings until about 1500 AD. They almost completely superseded hand bows in many European armies in the twelfth century for a number of reasons. Although a longbow achieves comparable accuracy and faster shooting rate than an average crossbow, crossbows release more kinetic energy and can be used effectively after a week of training, while a comparable single-shot skill with a longbow takes years of practice.

In the armies of Europe, mounted and unmounted crossbowmen, often mixed with javeliners and archers, occupied a central position in battle formations. Usually they engaged the enemy in offensive skirmishes before an assault of mounted knights. Crossbowmen were also valuable in counterattacks to protect their infantry.

The rank of commanding officer of the crossbowmen corps was one of the highest positions in any army of this time. Along with polearm weapons made from farming equipment, the crossbow was also a weapon of choice for insurgent peasants .

Mounted knights armed with lances proved ineffective against formations of pikemen combined with crossbowmen whose weapons could penetrate most knights' armour. The invention of pushlever and ratchet drawing mechanisms enabled the use of crossbows on horseback, leading to the development of new cavalry tactics. Knights and mercenaries deployed in triangular formations, with the most heavily armoured knights at the front. Some of these riders would carry small, powerful all-metal crossbows of their own.

The smallest crossbows are pistol crossbows. Others are simple long stocks with the crossbow mounted on them. These could be shot from under the arm. The next step in development was rifle shaped stocks that allowed better aiming.

Crossbows were eventually replaced in warfare by more powerful gunpowder weapons, although early guns had slower rates of fire and much worse accuracy than contemporary

crossbows. Later, similar competing tactics would feature harquebusiers or musketeers in formation with pikemen, pitted against cavalry firing pistols or carbines.

With a crossbow, archers could release a draw force far in excess of what they could have handled with a bow. Moreover, crossbows could be kept cocked and ready to shoot for some time with little effort, allowing crossbowmen to aim better. The disadvantage is the greater weight and clumsiness compared to a bow, as well as the slower rate of fire and the lower efficiency of the acceleration system, but there would be reduced elastic hysteresis, making the crossbow a more accurate weapon.

Crossbows have a much smaller draw length than bows. This means that for the same energy to be imparted to the arrow (or bolt) the crossbow has to have a much higher draw weight.

Cannon. 29 of the Second Lateran Council called by Pope Innocent II in 1139 banned the use of crossbows against Christians.

## Arbalests

The arbalest (also arblast) was a late variation of the medieval European crossbow. A larger weapon, the arbalest had a steel prod ("bow"). Since an arbalest was much larger than earlier crossbows, and because of the greater tensile strength of steel, it had a greater force. The strongest windlass-pulled arbalests could have up to 22 kN (5000 lbf) strength and be accurate up to 900 m. A skilled arbalestier (arblaster) could shoot two bolts per minute. Arbalests were sometimes considered inhumane or unfair weapons, since an inexperienced arbalestier could use one to kill a knight who had a lifetime of training.

The arbalest required special systems for pulling the sinew via windlasses. For siege warfare the size of crossbows was increased to hurl large projectiles such as rocks at fortifications.

Such crossbows needed a massive base frame and powerful windlass devices. Such devices include the oxybeles. The ballista has torsion springs replacing the elastic prod of the oxybeles, but later also developed into smaller versions. "Ballista" is still the root word for crossbow in Romance languages such as Italian (balestra).

The term arbalest is sometimes used interchangeably with crossbow. 'Arbalest' is Medieval French corruption from the Roman name arcuballista for crossbow; Modern French uses the word arbalète.. The word applies for both crossbow and arbalest.

## Artillery - Stone Throwing Engines

The Word Pierrier denotes a stone throwing device and is used as a general term to cover a number of different types of war engine.

Pierriers were employed either to smash masonry walls or to throw projectiles over them.

All pierriers were made from wood. With the introduction of gunpowder, the pierrier ceded its place as the siege engine of choice to the cannon.

## Traction Trebuchets

The trebuchet derives from the ancient sling. A variation of the sling contained a short piece of wood to extend the arm and provide greater leverage. This was evolved into the traction trebuchet by the Chinese, in which a number of people pull on ropes attached to the short arm of a lever that has a sling on the long arm. This type of trebuchet is smaller and has a shorter range but is a more portable machine and has a faster rate of fire than a larger counterweight powered one. The smallest traction trebuchets could be powered by the weight and pulling strength of one person using a single rope; but most were designed and sized to need from 15 to 45 men, generally two per rope. These teams would sometimes be local citizens assisting in the siege or in the defence of their town. Traction trebuchets had a range of from 2000 to well over 3000 feet when casting weights up to 750 pounds (60 kg). A traction trebuchet functions in the same way as a counterweight trebuchet, except that instead of a hoisted weight, the hurling arm is powered by a crew of men, pulling on ropes attached to the short lever arm. A counterweight trebuchet is powered by a very heavy counterweight, acting on a lever arm. The fulcrum of the lever (usually an axle) is supported by a high frame, and the counterweight is suspended from the short arm of the lever. The sling is attached to the end of the long arm of the lever.

One end of the sling is captive, while the other end is hooked to the long arm in such a way as to release when the arm and sling reach the optimal hurling angles. The trebuchet is energised by lowering the long arm and raising the weighted short arm, usually with a winch, and is locked into the charged state by a trigger mechanism (cocked). With the long arm lowered near ground level, the sling is loaded with the projectile, and laid out on the ground, with the captive and hooked ends away from the target, and the load and pouch laid on the ground toward the target, under the trebuchet. When the trigger is released, the weighted short arm is driven by gravity into an accelerating pendulum motion, causing the lighter, long arm of the lever to revolve around the fulcrum at the opposite arc, which in turn, pulls the sling and its contents into a whipping motion at the end of the long arm. As the arm continues to swing past the vertical position, the counterweight rises, causing the lever motion to begin to slow down, while the sling continues to whip forward around the end of the long arm. When the sling reaches its launch angle, one end slips from its hook, releasing the projectile toward the target.

It is believed that the first traction trebuchets were used in China as early as in the 5th century BC, descriptions of which can be found in the 5th century BC. The traction trebuchet next appears in Byzantium. The Strategikon of Emperor Maurice, composed in 539, calls for "ballistae revolving in both directions," , probably traction trebuchets. The Miracles of St. Demetrius, composed by John I, archbishop of Thessalonike, describe traction trebuchets in the Avaro-Slav artillery: "Hanging from the back sides of these pieces of timber were slings and from the front strong ropes, by which, pulling down and releasing the sling, they propel the stones up high and with a loud noise."

## Counterweight Trebuchets

The counterweight trebuchet appeared in Christian and Muslim lands around the Mediterranean Sea in the twelfth century. It could fling three hundred pound (140 kg) projectiles at high speeds, at times including corpses infected with various diseases including the black plague, in an attempt to infect the people under siege, as a medieval variant of biological warfare. Trebuchets were far more accurate than other forms of medieval catapults.

Our first clear written record of a counterweight trebuchet comes from an Islamic scholar, Mardi alTarsusi, who wrote in 1187, "Trebuchets are machines invented by unbelieving devils." (Al-Tarsusi, Bodleian MS 264).

At the Siege of Acre in 1191, Richard the Lionheart assembled two trebuchets which he named "God's Own Catapult" and "Bad Neighbour". During a siege of Stirling Castle in 1304, Edward Longshanks ordered his engineers to make a giant trebuchet for the English army, named "Warwolf". Range and size of the weapons varied. In 1421 the future Charles VII of France commissioned a trebuchet (coyllar) that could shoot a stone of 800 kg, while in 1188 at Ashyun balls up to 1,500 kg were used.

Average weight of the projectiles was probably around 50-100 kg, with a range of ca. 300 meters. Rate of fire could be noteworthy: at the siege of Lisbon (1147), two engines were capable of launching a stone every 15 seconds.

The largest trebuchets needed exceptional quantities of timber: at the siege of Damietta, in 1249, Louis IX of France was able to build a stockade for the whole Crusade camp with the wood from 24 captured Egyptian trebuchets.

The lever must be as light as possible for maximum acceleration, yet strong enough not to break under the stress. The ratio of the length of the long to the short arms of the lever, and to the sling length, are important factors in determining the range of the projectile. The object of a good design is to transfer as much energy as possible from the falling counterweight into the projectile. The maximum range for a hypothetical 100% energy transfer, R, of the projectile can be shown to be R = 2hM /m, where h is the distance the counterweight falls, and M and m are the mass of the counterweight and projectile, respectively. The efficiency of a real trebuchet is the ratio of the actual range achieved to the calculated maximum range.

There are no really detailed descriptions of medieval or earlier trebuchets that give the dimensions or shape of the beam, the ratio of its long arm to its short arm, and so on. No specimens or models from medieval times survive. The few extant contemporary drawings of them are highly schematic and sometimes show physically impossible proportions. Methods used for optimising their performance and design were apparently closely held military secrets.

Placing and aiming the trebuchet was also, no doubt, done by empirical trials. Small adjustments could be made by changing the angle of the hook holding the free end of the sling, a process which requires a heated forge on a full-scale engine. For larger, quicker adjustments, the length of the sling can be altered. Small adjustments from side-to-side can also be made

by moving the channel in which the missile and sling slide in the base of the frame. The trebuchet itself could be moved as well, but with larger trebuchets, this would have been difficult; the largest trebuchets could weigh many tons.

Because of the time required to load the sling and to raise the counterweight, a large trebuchet's rate of fire was slow, perhaps not more than a couple of shots an hour. This was due both to their size and the mass of their counterweights. Smaller trebuchets can fire a couple of times a minute. The payload of a trebuchet was usually a large rounded stone, although other projectiles were occasionally used including dead animals, beehives, the severed heads of captured enemies, small stones burned into clay balls which would explode on impact like grapeshot, barrels of burning tar or oil, Greek fire, pots of burning lime, unsuccessful ambassadors, prisoners of war, hostages, and captured spies.

Trebuchets were powerful weapons, with a range of up to about 300 yards/ 270 m. Castle designers often built their fortifications with trebuchets in mind; The range of many trebuchets was in fact shorter than that of a longbow in skilled hands, making it dangerous to be a trebuchet operator during a siege

A trebuchet can increase its efficiency by allowing the counterweight to take the straightest possible downward path. This maximises the transfer of the counterweight's potential energy to the projectile rather than to stressing the frame. Mounting the counterweight on a pivot (below top) straightens the path of its fall, increasing its effectiveness. A fixed counterweight trebuchet in particular can therefore be made more efficient by the addition of wheels to allow the frame to move freely back and forth (below bottom). This also allowed the trebuchet to fire farther.

The addition of wheels also makes the trebuchet more stable as part of the forward momentum of the falling counterweight is transferred to the forward motion of the trebuchet instead of a tilting action of the vertical frame, possibly tipping over of the machine or severely damaging the structure. The velocity of the trebuchet frame is added to that of the item being thrown, increasing its velocity and range by up to 33 percent. The wheeled trebuchet can effectively employ a fixed counterweight, mounted to the short end of the throwing arm, rather than the pendulum weight described above. The weights were usually stones and rubble, since lead was far too expensive and could be used for better purposes in a siege.

That of dead, and often partially decomposed, carcasses of animals or people. These were used to intimidate the defending force, lower their morale, and often to spread disease amongst the besieged. This tactic often proved effective as the short supply of food, which was often of low quality or rotting, combined with the cramped living space of the defenders, poor hygiene, and infestations of vermin (which made convenient vectors for disease) made the ideal scenario for the spread of disease. Burning sand also could have been thrown at enemies. This has the effect of sand sticking in armour holes, which leads to a most painful burning or death.

Despite its low accuracy, the versatility and manoeuvrability of the mangonel ensured that it was the most popular siege catapult used during the medieval period.

## Onagers and Mangonels

The onager was a post-classical Roman siege engine. Its name comes from that of an onager (a wild jack ass), the similarity being its violent kicking action. The onager was a type of catapult that used torsional pressure, from twisted rope, to store energy for the shot. It consisted of a frame placed on the ground to whose front end a vertical frame of solid timber was rigidly fixed. Through the vertical frame ran an axle, which had a single stout spoke, on the extremity of which was a sling used to launch a projectile.

In action the spoke was forced down, against the tension of twisted ropes or other springs, by a windlass. It was then suddenly released. The spoke kicked the crosspiece of the vertical frame, and the projectile at its extreme end was shot forward. Onagers of the Roman Empire were mainly used for besieging forts or settlements. They would often be armed with huge stones or rocks that could be covered with a flammable substance and set alight. The Romans greatly improved the onager's manoeuvrability by adding wheels to its base. The wheels and the onager's light weight made it easy to move.

In the Middle Ages (recorded from around 1200) a less powerful version of the onager was used that held the projectile in a fixed bowl instead of a sling. This was so that many small projectiles could be thrown rather than one large one. This engine was sometimes called the mangonel, although the same name may have been used for a variety of siege engines.

A mangonel was a type of catapult or siege machine used in the medieval period to throw projectiles at a castle's walls. The mangonel did not have the accuracy or range of a trebuchet and threw projectiles on a lower trajectory than the trebuchet.

The mangonel was a single-arm torsion catapult that held the projectile in a sling. A similar and perhaps older device was nicknamed the scorpion because of its resemblance to a scorpion's tail and sting.

The word mangonel is derived from the Greek word 'magganon' which means "an engine of war", but was first used in medieval accounts of sieges.

Mangonels shot heavy projectiles from a bowl-shaped bucket at the end of the arm. The bucket was used to launch more rocks than a sling could; this made it different from an onager. In combat, mangonels hurled rocks, burning objects (or vessels filled with flammable materials which created a fireball on impact; fire pots), or anything else readily available to the attacking and defending forces.

## Ballistas and Springalds

The balista seems to have died out with much other technical know-how when the Roman Empire became Christian and learning was heavily discouraged (Everything a good Christian needed to know was in the Bible).

The technology was rediscovered in the late middle ages when an exception was made for military engineering.

## Siege Weapons

Besiegers had a number of techniques for gaining control of their objective - either by forcing a way in, or by forcing the besieged garrison out. Specific techniques - established since prehistoric times - include:

**breaching the walls or doorways**. Attackers would use weapons to get through walls. Examples are stone throwing machines petriers such as trebuchets and mangonels); machines to knock holes in walls such as battering rams; and engines to extract individual dressed stones one by one (cats, weasels and simple picks).

**tunelling under the walls.** Attackers would build mines, either to gain access to the interior or to undermine and collapse the defensive walls.

**getting over the walls.** Attackers would use scaling ladders and siege engines such as large mobile wooden towers known as belfries.

**sitting and waiting.** If communications between the besieged and the outside world could be cut then the defenders could be denied food supplies and sometimes water (as at

Beaucaire, Carcassonne, Minerve, and Termes). This was not always possible (as for Raymondet at Beaucaire and at Montsegur). The word siege means "to sit", an indication that this was a standard technique.

**A Fifth Column**. Inducing someone on the inside to assist the attackers, either by bribery or exploiting divided loyalties. They could for example open a postern gate at night. Occasionally attackers could be smuggled in to the besieged fortification to fulfil this role, as for example in ancient times in the famous Trojan horse.

**Diplomacy, threats, terror and psychological techniques.** To help weaken the will of the defenders, attackers could make threats or promises, or terrorise the defenders - for example by mutilating or executing hostages, or by using throwing machines to lob fire, or human heads or other body parts, into the the fortification.

**Biological Warfare.** Medieval besiegers were known to project diseased animals into fortifications with the deliberate intention of spreading disease and so weakening the garisson. I some cases it was possible to poison water supplies, though most fortifications had their own wells or water cisterns.

**Siege Towers (Belfries, Belfrois)**

The medieval belfry was not a church tower, but a siege engine - the modern meaning seem-sto have come about by the erroneous association of towers and bells (etymologically, the bel in belfry is not connected with the word "bell").

A belfry was used for gaining access to a castle, generally at the level of the battlements. It was typically constructed in wood, on several stories - as many as necessary to reach the battlements. Each story offered a location for attack - bows and crossbows in the lower levels, and armed men in the upper level, ready to drop a sort of drawbridge and gain access to the castle ramparts. The belfry was normally wheeled, so that it could be moved up against the castle walls, and like all exposed wooden engines of war it would be covered in the hides of freshly slaughtered animals and regularly dowsed in water to keep it fireproof.

One way to foil the approach of a belfry was to have sloping castle walls. This forced the attackers to cover a greater distance from the top of the belfry to the top of the castle wall. This was one of the benefits of a talus.

Another way to foil the approach was to build ditches and moats to prevent the approach of belfries.

As on the right, attackers often needed to fill up the ditch or moat to provide a level surface that extended all the way to the foot of the castle wall.

In practice, all sorts of material was used for this: earth, rocks, straw, dead bodies, wood, whatever came to hand. If too much wood was used in the infill then the infill itself became a target for fire setters.

## Battering Rams

A battering ram is a siege engine originating in ancient times to breach fortification walls or doors. In its simplest form, a battering ram is just a large, heavy log carried by several people and propelled with force against the target, the momentum of the ram damaging the target.

Some battering rams were supported by rollers. This gave the ram much greater travel so that it could achieve a greater speed before striking its target and was therefore more destructive. Such a ram was used by Alexander the Great

In a more sophisticated design, the ram was slung from a wheeled support frame so that it could be much more massive and also more easily swung against its target. Sometimes the ram's attacking point would be reinforced with a metal head. A capped ram is a battering ram that has an accessory at the head (usually made of iron or steel, traditionally shaped into the head and horns of a ram to do more damage to a building.

Many battering rams had protective roofs and side-screens covered in materials, often fresh wet hides to prevent the ram being set on fire, as well as to protect the ram's operators of the ram from enemies firing arrows down on them.

An image of an Assyrian battering ram shows how sophisticated attack and defence had come by the 9th century BC. In the image defenders are trying to set the ram alight with

torches and have also put a chain under the ram. The attackers are trying to pull on the chain to free the ram - the same scene could have been depicted in Roman, Visigothic or Medieval times.

When a castle was being attacked, defenders attempted to foil battering rams by dropping obstacles in front of the ram just before it hit a wall, using grappling hooks to immobilize the log, setting the ram on fire, or sallying out to attack the ram. Battering rams had an important effect on the evolution of defensive walls - the talus for example was one way of reinforcing walls. In practice, wooden gates would generally offer the easiest targets.

## The Cat

A Cat was a wooden structure built (or moved) up to a defensive wall. From surviving documents it seems that an arm could manipulated to claw away at the castle wall - hence the name.

Cats could be large multi-purpose structures, perhaps with a trebuchet on top and sappers operating from the protected interior.

Cats were much feared and if they possibly could, castle defenders would try to destroy them by mounting sorties, by using stone throwing engines, or by setting fire to them.

Like all wooden siege engines they would be routinely covered in the skins of freshly slaughtered animals and regularly dowsed with water to keep them fireproof.

## The Weasel

A weasel was a similar sort of structure to a cat, but smaller and lighter. It seems to have been more manoeuvrable and used a spike rather than a paw to attack castle walls.

It may have taken its name from its business end looking like a weasel's nose, or perhaps its long thin body, or both.

## Chemical Weapons - Greek Fire

Incendiary devices were standard weapons of war. Wooden defences always needed protection from burning. Wet animal hides were highly effective against burning arrows so military engineers dedicated themselves to finding ways of ensuring that fires burned as long and as strongly as necessary to catch. All sorts of chemicals could be used for this purpose - petroleum, sulphur, quicklime and tar barrels for example.

Liquid fire is represented on Assyrian bas-reliefs. At the siege of Plataea in 429 BC the Spartans attempted to burn the town by piling up against the walls wood saturated with pitch and sulphur and setting it on fire, and at the siege of Delium in 424 BC a cauldron containing pitch, sulphur and burning charcoal was placed against the walls. A century later Aeneas Tacticus

mentions a mixture of sulphur, pitch, charcoal, incense and tow packed in wooden vessels, ignited and thrown onto the decks of enemy ships. Formulae given by Vegetius around AD 350 add naphtha or petroleum. Some nine centuries later the same substances are found and later recipes include saltpetre and turpentine make their appearance. The ultimate in this form of chemical warfare was called Greek-Fire.

Greek fire was a burning-liquid used as a weapon of war by the Byzantines, and also by Arabs, Chinese, and Mongols. Incendiary weapons had been in use for centuries: petroleum and sulphur had both been in use since the early days of the Christianity. Greek fire was vastly more potent. Similar to modern napalm, it would adhere to surfaces, ignite upon contact, and could not be extinguished by water alone.

Byzantines used it in naval battles to great effect because it burned on water. It was responsible for numerous Byzantine military victories on land as well as at sea - and also for enemies preferring discretion to valour so that many battles never took place at all. It was the ultimate deterrent of the time, and helps explain the Byzantine Empire's survival until 1453. There was no defence. As the Lord of Joinville noted in the thirteenth century "Every time they hurl the fire at us, we go down on our elbows and knees, and beseech Our Lord to save us from this danger." Men were known to simply flee their posts rather than face Greek Fire. On the other hand Greek fire was very hard to control, and it would often accidentally set Byzantine ships ablaze.

Greek Fire is said to have been invented by a Syrian Engineer, one Callinicus or Kallinikos, a refugee from Maalbek, or an architect from Heliopolis in the Byzantine Province of Judaea, in the seventh century (673 AD). The formula for Greek fire was a closely guarded secret and it remains a mystery to this day.

The term Greek Fire was not attributed to it until the time of the European Crusades. Some of the original names include *Liquid Fire*, *Marine Fire*, *Artificial Fire* and *Roman Fire*. (Muslims against whom the weapon was used called the Byzantines Romans).

The weapon was first used by the Byzantine navy, and the most common method of deployment was to squirt it through a large bronze tube onto enemy ships. Usually the mixture would be stored in heated, pressurised barrels and projected through the tube by some sort of pump, operators being protected behind large iron shields. Byzantines used Greek Fire only rarely, apparently out of fear that the secret mixture might fall into enemy hands. The loss of the secret would be a greater loss to Byzantium then the loss of any single battle.

In 678 the Byzantines utterly destroyed a Muslim fleet - over 30,000 men were lost. In 717-718 Caliph Suleiman attacked Constantinople (Byzantium). Most of the Muslim fleet was once again destroyed by Greek Fire, and the Caliph was forced to flee. There is virtually no documentation of its usage after this time by the Byzantines and it is generally believed that it was during this era that the secret of creating Greek Fire was lost. Formulae used after this date never seems to have had the same devastating effect.

Some form of Greek Fire continued to be used for centuries. Byzantines used it against the Venetians during the Fourth Crusade. A so-called "carcass composition" containing sulphur, tallow, rosin, turpentine, saltpetre and antimony, became known to the Crusaders as Greek fire but is more correctly called wildfire.

So far, no-one has been able to recreate Greek Fire. Arabian armies, who eventually created their own version sometime between the mid-seventh century and the early tenth. It was relatively weak copy of the original Byzantine substance, though still one of the most devastating weapons of the period. Arabs used the Greek Fire much like Byzantines, using brass tubes mounted aboard ships or on castle walls. They also filled jars with it, to be hurled by hand at their opponents. Arrows and javelins would be used to carry the mixture further and engines of war could be used to throw larger amounts over castle walls.

As a defence, water alone was ineffective. On land sand could be used to stop the burning .

Intriguingly it is also known that vinegar and urine were effective - suggesting an alkaline composition that could be neutralised by acid. According to some accounts pure or salt water served to intensify the burning, suggesting that Greek Fire may have been a 'thermite-like' reaction, perhaps involving quicklime. According to some sources, Greek Fire burst into flames on contact with water. Some have suggested phosphorus, Others have suggested a form of naphtha or another low-density liquid hydrocarbon (petroleum was already known in the East). There are numerous candidates including liquid petroleum, naphtha, burning pitch, sulphur, resin, quicklime and bitumen, along with a hypothetical unknown "secret ingredient". The exact composition is unlikely ever to be deduced from the inadequate surviving records.

It is not clear from contemporary reports if the operator ignited the mixture with a flame as it emerged from the syringe, or if it ignited spontaneously on contact with water or air. If the latter is the case, it is possible that the active ingredient was calcium phosphide, made by heating lime, bones, and charcoal. On contact with water, calcium phosphide releases phosphine, which ignites spontaneously. The reaction of quicklime with water also creates enough heat to ignite hydrocarbons, especially if an oxidiser such as saltpetre is present.

Ingredients were apparently preheated in a cauldron, and then pumped through a pump or used in hand grenades. If a pyrophoric reaction was involved, perhaps these grenades contained chambers for the fluids, which mixed and ignited when the vessel broke on impact with the target.

### *More information*

Professor J.R. Partington, *A History of the Greek Fire and Gunpowder*, Heffer, 1960.

Greek fire was not the only Chemical Weapon. Poisoned arrows could be employed and in the late medieval period gunpowder became common.

## Biological Weapons

Medieval warriors also used basic biological weapons, for example catapulting dead and diseased animals into a defended fortress to help spread disease.

## Psychological Weapons

Ancient armies had used sophisticated psychological weapons. For example would have mad armour suitable for a man of several times normal size. He would then leave a few samples laying around the scene of his victories against the Persians. After he had gone Persians would find this armour and were were soon spreading stories of Alexander's superhuman giant soldiers.

Christendom did not stretch to this level of sophistication, but it did engage in some psychological warfare, spreading rumours for example, sometimes with success effectively turning a military defeat into a political victory. Other examples of psychological warfare include making loud noises (an old Celtic practice) and catapulting the severed heads of captured enemies back into the enemy camp.

Defenders in castles under siege might prop up dummies beside the walls to make it look like there were more defenders than there really were. They might throw food from the walls to show besiegers that provisions were plentiful (Dame Carcas, who saw off the Franks, supposedly gave her name to Carcassonne after feeding the last few scraps of food in the besieged city to the last pig and then tossing over the walls as a present to the Franks. As intended, they deduced that their siege was useless and raised it the next day).

Firearms provided a strong psychological benefit when they were introduced, even though their rate of fire rendered them almost useless - and their users often blew themselves up rather than the enemy - literally hoist by their own petard.

## Mining, Undermining Defensive Walls

A "mine" was a tunnel dug to destabilise and bring down castles and other fortifications. The technique could be used only when the fortification was not built on solid rock. It was developed as a response to stone built castles that could not be burned like earlier-style wooden forts.

A tunnel would be excavated under the outer defences either to provide access into the fortification or more often to collapse the walls. These tunnels were supported by temporary wooden props as the digging progressed, just as in any mine. Once the excavation was complete, the mine was filled with combustible material. When lit it would burn away the props leaving the structure above unsupported and liable to collapse.

To save effort attackers would start the digging as near as possible to the wall or tower to be undermined. This exposed the sappers to enemy fire so it was necessary to provide some sort of defence.

Successful sapping usually ended the battle since either the defenders would no longer be able to defend and surrender, or the attackers would simply charge in and engage the defenders in close combat.

There were several methods to resist under mining. Often the siting of a castle would be such as to make mining difficult. The walls of a castle could be constructed either on solid rock or water-logged land making it difficult to dig mines. A very deep ditch or moat could be constructed in front of the walls, or even an artificial. This makes it more difficult to dig a mine and even if a breach is made the ditch or moat makes exploiting the breach difficult.

The defenders could also dig counter mines. From these they could then either dig into the attackers tunnels and sortie into them to either kill the sappers or to set fire to the pit-props to collapse the attackers' tunnel. Alternatively they could undermine the attackers' tunnel to collapse it.

If the walls were breached they could either place obstacles in the breach for example a chevaux de frise to hinder an attack, or construct a coupure.

The practice has left us reminders in English. "undermining" has acquired figurative as well as literal meanings. And military engineers are still known as Sappers.

## Armour

Mail, or chainmail, made of interlocking iron rings, which may be riveted or welded shut is believed to have been invented in Eastern Europe about 500 BC. Gradually, small additional plates or discs of iron were added to the mail to protect vulnerable areas. Hardened leather and splinted construction were used for arm and leg pieces. A coat of plates was developed, an armour made of large plates sewn inside a textile or leather coat.

Early plate in Italy, and elsewhere in the 13th–15th century were made of iron. Iron armour could be carburised or case hardened to give a surface of harder steel. Plate armour became cheaper than mail by the 15th century as it required less labour and labour had become much more expensive after the Black Death, though it did require larger furnaces to produce larger blooms. Mail continued to be used to protect those joints which could not be adequately protected by plate, such as the armpit, crook of the elbow and groin. Another advantage of plate was that a lance rest could be fitted to the breast plate.

The small skull cap evolved into a bigger true helmet, the bascinet, as it was lengthened downward to protect the back of the neck and the sides of the head.

Probably the most recognised style of armour in the World became the plate armour associated with the knights of the European Late Middle Ages. Plate armour was not used during the third crusade.

## Chain Mail

Mail or chain mail is a type of armour consisting of small metal rings linked together in a pattern to form a mesh.

The word chainmail is of relatively recent coinage, having been in use only since the 1700s; prior to this it was referred to simply as mail.

The word itself refers to the armour material, not the garment made from it. A shirt made from mail is a hauberk if knee-length, haubergeon if mid-thigh length, and byrnie if waist-length. Mail leggings are called chausses, mail hoods coif and mail mittens mitons. A mail collar hanging from a helmet is camail or aventail. A mail collar worn strapped around the neck was called a pixane or standard.

In the Dark Ages chain mail was often referred to as "ring maille" to distinguish it from other types of mail, such as lamellar and splinted mail. In the Middle Ages scale mail died out, but chain mail remained, and people called it "maille" or "mayle." As with heraldry, the language of armour is French, and chain mail is no exception. The word maille comes from the French, meaning mesh or net.

The use of mail was prominent throughout the Dark Ages, High Middle Ages and Renaissance, and reached its apex in Europe, in terms of coverage, during the 13th century, when mail covered the whole body.

By the 14th century, plate armour was commonly used to supplement mail. Eventually mail was supplanted by plate for the most part. However, mail was still widely used by many soldiers as well as brigandines and padded jacks. These three types of armour made up the bulk of the equipment used by soldiers with mail being the most expensive. It was quite often more expensive than plate armour. A mail shirt interwoven between two layers of fabric is called jazzeraint, and can be worn as protective clothing.

Mail construction is mentioned in the Quran as knowledge that God gave to David.

It was We Who taught him the making of coats of mail for your benefit, to guard you from each other's violence: will ye then be grateful?  (21:80 Yusuf Ali's translation).

Mail armour provided an effective defence against slashing blows by an edged weapon and penetration by thrusting and piercing weapons; in fact The Royal Armoury at Leeds concluded that "... it is almost impossible to penetrate using any conventional medieval weapon..." Generally speaking, mail's resistance to weapons is determined by four factors: linkage type (riveted, butted, or welded), material used (iron versus bronze or steel), Weave density (a tighter weave needs a thinner weapon to surpass), and ring thickness (generally ranging from 16 to 12 gauge in most examples).

Mail, if a warrior could afford it, could provide a significant advantage to him when combined with competent fighting techniques. However, a good sword blow arriving in exactly perpendicular angle to surface could cut through the links; when the mail was not riveted, a well

placed thrust from a spear or thin sword could penetrate, and a poleaxe or halberd blow could break through the armour.

Special arrows, known as bodkins, were later made that were able to penetrate light mail through the loops of the chain. Some evidence indicates that during armoured combat the intention was to actually get around the armour rather than through it—according to a study of skeletons found in Visby, Sweden, a majority of the skeletons showed wounds on less well protected legs.

The flexibility of mail meant that a blow would often injure the wearer, potentially causing serious bruising or fractures, and it was a poor defence against head trauma. Mail-clad warriors typically wore separate rigid, helms over their mail coifs for head protection. Likewise, blunt weapons such as maces and warhammers could harm the wearer by their impact without penetrating the armour; usually a soft armour, such as gambeson, was worn under the hauberk. Mail, however, had importance in that it reduced the risk of cuts and infection that could often be life threatening to a soldier.

Several patterns of linking the rings together have been known since ancient times, with the most common being the 4-to-1 pattern (where each ring is linked with four others). In Europe, the 4-to-1 pattern was completely dominant. Historically, in Europe, from the pre-Roman period on, the rings composing a piece of mail would be riveted closed to reduce the chance of the rings splitting open when subjected to a thrusting attack or a hit by an arrow.

Up until the 14th century European mail was made of alternating rows of both riveted rings and solid rings. After that it was almost all made from riveted rings only. Both would have been made using wrought iron. Some later pieces were made of wrought steel with an appreciable carbon content that allowed the piece to be heat treated. Wire for the riveted rings was formed by either of two methods. One was to hammer out wrought iron into plates and cut or slit the plates. These thin pieces were then pulled through a draw-plate repeatedly until the desired diameter was achieved. Waterwheel powered drawing mills are pictured in several period manuscripts. Another method was to simply forge down an iron billet into a rod and then proceed to draw it out into wire. The solid links would have been made by punching from a sheet.

## Hauberk or Haubergeon

The hauberk is typically a type of mail armour constructed of loops of metal woven into a tunic or shirt. The sleeves sometimes only went to the elbow, but often were full arm length, with some covering the hands with a supple glove leather face on the palm of the hand, or even full mail gloves.

It was usually thigh or knee length, with a split in the front and back to the crotch so the wearer could ride a horse. It sometimes incorporated a hood, or coif.

The term Haubergeon ("little hauberk") refers to a shorter variant with partial sleeves, but the terms are often used interchangeably.

Slits to accommodate horseback-riding are often incorporated below the waist. Most are put on over the head. Hauberk can also refer to a similar garment of scale armour.

The earliest extant example was found in Ciumeşti in modern Romania and is dated to the 4th-5th centuries BC. Roman armies adopted similar technology after encountering it. Mail armour spread throughout the Mediterranean Basin with the expansion of the Romans. It was quickly adopted by virtually every iron-using culture in the world, with the exception of the Chinese. The Chinese used it rarely, despite being heavily exposed to it from other cultures.

The short-hemmed, short-sleeved hauberk may have originated from the medieval Islamic world.

The Bayeux Tapestry illustrates Norman soldiers wearing a knee-length version of the hauberk, with three-quarter length sleeves and a split from hem to crotch.

Such armour was expensive — both in materials (iron wire) and time/skill required to manufacture it — so common foot soldiers rarely were so equipped.

In Europe, use of mail hauberks continued up through the 14th century, when plate armour began to supplant it.

## Pixane

A mail collar. It is a circle with a hole for the neck to fit through. It covers the shoulders, breast and upper back.

## Chausses

Mail hose, either knee-high or cover the whole leg.

## Helmets

Helmets, or helms, are one of the best known artefacts from the middle ages.

They have never fallen out of use but have evolved not only for military use, but for many other spheres of live where there is a danger of head injury - mines, horse and motor cycle riding, building sites and so on.

The medieval version - or rather upwards of a dozen medieval versions - are also preserved in coats of arms where they form an essential part of the crest. Indeed crests were originally bird-like crests on the helmet.

### Spangenhelm & Nasal Helmet

The nasal helmet is a type of combat helmet used from the Early Middle Ages until the High Middle Ages.

The nasal helmet was a form of helmet with a domed or raised centre, usually formed around a basic skull-cap design, with a single protruding strip that extended down over the nose to

provide additional facial protection. The helmet appeared throughout Europe late in the 9th century, and became the predominant form of head protection, replacing the previous pudding-bowl design, and the Vendelstyle spectical helm. One of the earliest versions of the nasal helm is the Vasgaard Helmet. The Bayeux Tapestry features many such helmets, it being the most popular form of protection at the time. The helmet began to lose popularity at the end of the 12th century to helmets that provided more facial protection, and although the nasal helm lost popularity amongst the higher classes of knights and menat-arms, they were still seen amongst archers to whom a wide field of vision was crucial. The helmet can also be viewed throughout the Maciejowski Bible as a minority item for cavalrymen, giving the impression that it had become uncommon (though not unknown) by the mid-thirteenth century.

Nasal helmets have been found of both one-piece and Spangenhelm construction, with the later period helmets being made of a single, smooth raised dome to allow weapons to glance off with ease.

The Spangenhelm was a popular European war combat helmet design of the Early Middle Ages. The name is of German origin. Spangen refers to the metal strips that form the framework for the helmet and could be translated as clips. The strips connect three to six steel or bronze plates. The frame takes a conical design that curves with the shape of the head and culminates in a point. The front of the helmet may include a nose protector (a nasal). Older spangenhelms often include cheek flaps made from metal or leather. Spangenhelms may incorporate mail as neck protection, thus forming a partial aventail. Some spangenhelms include eye protection in a shape that resembles modern eyeglass frames. Other spangenhelms include a full face mask.

The spangenhelm originated in Central Asia and Ancient Persia, arriving in Europe by way of what is now southern Russia and Ukraine, spread by nomadic Iranian tribes such as the Scythians and Sarmatians who lived among the the Eursian steppes. By the 6th century it was the most common helmet design in Europe and in popular use throughout the Middle East. It remained in use at least as late as the 9th century.

The spangenhelm was an effective protection that was relatively easy to produce. Weakness of the design were its partial head protection and its jointed construction. It was replaced by similarly shaped helmets made with one-piece skulls (nasal helms), kettle hats and eventually the Great helm or casque.

## Torso

### Brigandine

A brigandine, a form of body armour, is a cloth garment, generally canvas or leather, lined with small oblong steel plates riveted to the fabric. The form of the brigandine is essentially the same as the civilian doublet, though it is commonly sleeveless. Depictions of brigandine armour with sleeves are known. Many brigandines appear to have had larger, 'L-shaped'

plates over the lungs.Rivets, or nails, attaching the plates to the fabric are often decorated, being gilt or of latten and often embossed with a design.

The brigandine was commonly worn over a gambeson and mail shirt and it was not long before this form of protection was commonly used by soldiers ranging in rank from archers to knights. It was most commonly used by Men-at-arms. Men-at-arms wore a brigandine, along with plate arm and leg protection, as well as a helmet.

Even with the gambeson and the mail shirt, a wearer was not as protected as when wearing plate, which was typically more expensive. The brigandine filled this gap well. The Brigandine was simple enough in design for a soldier to make and repair his own armour without needing the high skill of an armorer. Originally the term "brigand" referred to a foot soldier. A brigandine was simply a type of armour worn by a foot soldier. It had nothing to do with its alleged ability to be concealed by bandits. In fact, brigandines were highly fashionable and were ostentatiously displayed by wealthy aristocrats both in European and in Asian courts.