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COMPARATIVE CHARACTERISTICS OF JAPANESE AND EUROPEAN SWORDS

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European technology of swords forging

Throughout history, different sword smiths of different cultures devised different ways of reliably achieving the result of a strong sword that was also sharp. The craft required the highest technology of the day but in the end it was an art. Whatever the method and technology and whatever the design, there were always certain aspects of sword smithing indispensable to creating tough and resilient blades. Yet even for the very same type of swords there was no uniform standardization among different smiths for the way in which it could be produced.

Historically, it was better for a sword to be too soft than too hard. A softer blade may certainly become bent, but it will still cut and it won't snap. They did not have to be nearly as "springy" as many modern "replica" swords now give the impression. Steel springs certainly bend before breaking, but are not the best for the tough and resilient needs of long fighting blades. Medieval metal smiths were certainly capable of making chisels and other tools with very hard edges from very hard steels. But again, as with springs, these properties alone were not those ideal for fighting blades. A blade of softer steel is harder to break because it will deform and bend instead, but this is not an indicator of its overall strength. Impact strength is a fine balance between hardness and plasticity. Flexibility alone is a poor gauge of these properties as it does not guarantee impact strength in a blade and is less a factor of tempering than cross-sectional geometry.

We might imagine for a moment that if a sword could somehow be made of rubber it would have the ideal resilience to withstand impacts and bend as needed without ever breaking or deforming. Of course it wouldn't cut or stab well at all. Similarly, if a sword could be made of glass it could have the sharpest of razor thin edges, but it would also shatter on impact and be useless. If the two qualities of rubber and glass could somehow be combined though, they would produce an ideal bladed weapon. In a sense then this is what real swords of fine steel have always tried to accomplish.

We can note that during the Medieval and Renaissance periods an enormous variety of techniques for producing iron and steel as well as for methods of blade forging and heat-treatment were all in use. In Europe metal was produced using bloomery furnaces, blast furnaces, and crucible melting. Differences were understood between various steels even if the science behind them was not. There was not a direct linear development of technologies or methods whereby earlier ones were quickly discarded as obsolete. Several might be in use at any one time in the same region or even by the same maker. There is also evidence that many varied methods of differential tempering (i.e., softening one portion of the blade slightly more than another) were practiced and though each could generate different effects on the structure of a metal blade, they all aimed at similar results.

Sword smiths in northern Europe discovered a method of sword making (now called pattern-welding) whereby various pieces of iron and or steel rods of different hardness were combined by twisting and folding them together. This was used in Europe until the early Middle Ages. The ability to work metal in this way to create unique visible patterns on a blade's surface may have been considered a sign of the metal's quality and the smith's skill. By the later Middle Ages sword smiths were already constructing blades of more homogeneous steels by forge-welding together different bars of iron and steel (without the requirement for twisting rods). Others were of more homogeneous but differentially heat-treated steel.

Some blades were made of a laminate construction, produced by “folding” the steel over and over then forge welding at each fold (resulting in “layers”). In this lamination the methods to refine and make the steel more homogenous it was folded and forge welded. The sword smith had to “fold” the bar of metal, resulting in a doubling of the “layers” and in the process blending the qualities of the various pieces of steel in the billet. The more the steel was folded, the more homogeneous the metal in the blade became. The amount of folds would be determined by both the material and the final qualities the smith was looking for. One other way to combine smaller amounts of better steel into a larger useable billet was to create a piled structure where a few bars of refined steel were stacked together then welded as one and forged out into a blade shape without any further folding. But swords made by whatever means consisted essentially of careful combinations of softer iron with harder steel.

A good sword smith would also have surely understood that just as different portions of a blade had different roles in guarding, binding, and striking they were not each uniform in their cross-section. To withstand the unique stress placed upon the shoulder of the blade (just below the cross) the tang especially had to have a different consistency than other portions. Whatever fighting techniques a particular blade might be designed for the sword smith would be familiar with the specific qualities required.

For a thrusting sword no quality was more important than stiffness. To effectively stab through various materials a thrusting blade would not require any of the flexibility so associated now with modern sporting, theatrical, and recreational swords. A hard rigid point was what mattered. In the design of a cutting sword the primary concern was for the stress forces that would be applied against its edge. Structural strength perpendicular to the edge (that is, to the sides) though also important, was a secondary factor. Impact strength in a blade can be increased by plasticity (or ductility) but at the expense of hardness (stiffness and cutting ability).

Japanese technology of swords forging

Nihontō and wakizashi were often forged with different profiles, different blade thicknesses, and varying amounts of grind. Wakizashi were not simply scaled-down nihontō; they were often forged in hira-zukuri or other such forms which were very rare on nihontō.

The daishō was not always forged together. If a samurai was able to afford a daishō, it was often composed of whichever two swords could be conveniently acquired, sometimes by different smiths and in different styles. Even when a daishō contained a pair of blades by the same smith, they were not always forged as a pair or mounted as one. Daishō made as a pair, mounted as a pair, and owned/worn as a pair, are therefore uncommon and considered highly valuable, especially if they still retain their original mountings (as opposed to later mountings, even if the later mounts are made as a pair).

The forging of a Japanese blade typically took weeks or even months and was considered a sacred art. As with many complex endeavors, rather than a single craftsman, several artists were involved. There was a smith to forge the rough shape, often a second smith (apprentice) to fold the metal, a specialist polisher (called a togi) as well as the various artisans that made the koshirae (the various fittings used to decorate the finished blade and saya (sheath) including the tsuka (hilt), fuchi (collar), kashira (pommel), and tsuba (hand guard)). It is said that the sharpening and polishing process takes just as long as the forging of the blade itself.

The legitimate Japanese sword is made from Japanese steel "Tamahagane". The most common lamination method the Japanese sword blade is formed from is a combination of two different steels: a harder outer jacket of steel wrapped around a softer inner core of steel. This creates a blade which has a unique hard, highly razor sharp cutting edge with the ability to absorb shocks in a way which reduces the possibility of the blade breaking or bending when used in combat. The hadagane, for the outer skin of the blade, is produced by heating a block of high quality raw steel, which is then hammered out into a bar, and the flexible back portion. This is then cooled and broken up into smaller blocks which are checked for further impurities and then reassembled and reforged. During this process the billet of steel is heated and hammered, split and folded back upon itself many times and re-welded to create a complex structure of many thousands of layers. Each different kind of steel is folded differently to provide the necessary strength and flexibility to the different steels. The precise way in which the steel is folded, hammered and re-welded determines the distinctive grain pattern of the blade, the jihada, (also called jigane when referring to the actual surface of the steel blade) a feature which is indicative of the period, place of manufacture and actual maker of the blade. The practice of folding also ensures a somewhat more homogeneous product, with the carbon in the steel being evenly distributed and the steel having no voids that could lead to fractures and failure of the blade in combat.

The shingane (for the inner core of the blade) is of relatively softer steel with lower carbon content than the hadagane. For this, the block is again hammered, folded and welded in a similar fashion to the hadagane, but with fewer folds. At this point, the hadagane block is once again heated, hammered out and folded into a ‘U’ shape, into which the shingane is inserted to a point just short of the tip. The new composite steel billet is then heated and hammered out ensuring that no air or dirt is trapped between the two layers of steel. The bar increases in length during this process until it approximates the final size and shape of the finished sword blade. A triangular section is cut off from the tip of the bar and shaped to create what will be the kissaki. At this point in the process, the blank for the blade is of rectangular section. This rough shape is referred to as a sunobe.

The sunobe is again heated, section by section and hammered to create a shape which has many of the recognizable characteristics of the finished blade. These are a thick back (mune), a thinner edge (ha), a curved tip (kissaki), notches on the edge (hamachi) and back (munemachi) which separate the blade from the tang (nakago). Details such as the ridge line (shinogi) another distinctive characteristic of the Japanese sword are added at this stage of the process. The smith’s skill at this point comes into play as the hammering process causes the blade to naturally curve in an erratic way, the thicker back tending to curve towards the thinner edge, and he must skillfully control the shape to give it the required upward curvature. The sunobe is finished by a process of filing and scraping which leaves all the physical characteristics and shapes of the blade recognizable. The surface of the blade is left in a relatively rough state, ready for the hardening processes. The sunobe is then covered all over with a clay mixture which is applied more thickly along the back and sides of the blade than along the edge. The blade is left to dry while the smith prepares the forge for the final heat treatment of the blade, the yaki-ire, the hardening of the cutting edge.

This process takes place in a darkened smithy, traditionally at night, in order that the smith can judge by eye the color and therefore the temperature of the sword as it is repeatedly passed through the glowing charcoal. When the time is deemed right (traditionally the blade should be the color of the moon in February and August which are the two months that appear most commonly on dated inscriptions on the nakago of the Japanese sword), the blade is plunged edge down and point forward into a tank of water. The precise time taken to heat the sword, the temperature of the blade and of the water into which it is plunged is all individual to each smith and they have generally been closely guarded secrets. Legend tells of a particular smith who cut off his apprentice’s hand for testing the temperature of the water he used for the hardening process. In the different schools of sword makers there are many subtle variations in the materials used in the various processes and techniques outlined above, specifically in the form of clay applied to the blade prior to the yaki-ire, but all follow the same general procedures.

The application of the clay in different thicknesses to the blade allows the steel to cool more quickly along the thinner coated edge when plunged into the tank of water and thereby develop into the harder form of steel called martensite, which can be ground to razor-like sharpness. The thickly coated back cools more slowly retaining the pearlite steel characteristics of relative softness and flexibility. The precise way in which the clay is applied, and partially scraped off at the edge, is a determining factor in the formation of the shape and features of the crystalline structure known as the hamon. This distinctive tempering line found near the edge of the Japanese blade is one of the main characteristics to be assessed when examining a blade.

The martensitic steel which forms from the edge of the blade to the hamon is in effect the transition line between these two different forms of steel, and is where most of the shapes, colours and beauty in the steel of the Japanese sword are to be found. The variations in the form and structure of the hamon are all indicative of the period, smith, school or place of manufacture of the sword. As well as the aesthetic qualities of the hamon, there are, perhaps not unsurprisingly, real practical functions. The hardened edge is where most of any potential damage to the blade will occur in battle. This hardened edge is capable of being reground and sharpened many times, although the process will alter the shape of the blade. Altering the shape will allow more resistance when fighting in hand to hand combat.

Almost all blades are decorated, although not all blades are decorated on the visible part of the blade. Once the blade is cool, and the mud is scraped off, the blade may have designs or grooves (hi or bo-hi) cut into it. One of the most important markings on the sword is performed here: the file markings. These are cut into the nakago or the hilt-section of the blade, where they will be covered by the tsuka later. The nakago is never supposed to be cleaned: doing this can reduce the value of the sword by half or more. The purpose is to show how well the blade steel ages.

Some other marks on the blade are aesthetic: dedications written in kanji as well as engravings called horimono depicting gods, dragons, or other acceptable beings. Some are more practical. The presence of a groove (the most basic type is called a hi) reduces the weight of the sword yet keeps its structural integrity and strength.

Resume

Steel, which is used for forging swords in Japan and Europe, is not much different in quality. The main resource for the production of steel in Japan is the "iron sand", which gave fewer impurities, but did not give sufficient quality of iron.

The Japanese swords were applied for the cutting blows on targets, which were poorly protected or not protected by armor. Heavy armor wasn’t widely spread in Japan. The edge of the sword of hard or very hard steel was well sharpened and maintained sharpness for a long period of time. Historical references mentioned that the Japanese swords could cut iron.

On the other hand, the European swords were to punch the heavy armor of knights. Therefore, they had a large weight and narrow edges of the blade. The European swords could inflict effective thrusts unlike the Japanese swords. The Japanese swords were more brittle and less flexible than the European swords.

The technology of making swords appeared, developed and changed according to the volume of ore mining, the methods of machining, and the quality of produced steel. Each type of swords should meet the definite requirements to fulfill its task more efficiently. Despite the differences between these types of swords, some of their properties were similar. For example, the location of the balance point of the sword was similar to that of the Japanese and the European swords.

Forging of swords was not only the art of making weapons, but also one of the main technological processes. The development and improvement of weapon forging greatly influenced the production of other forged products.