The Basics of Optimal Design and Construction in Western Style Swords

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The goal of this text is to help explain the safety and performance issues inherent in European-style swords and how they can be solved through proper construction techniques and design. This text only applies to the design of straight, western-style swords and can not be applied to other styles of work such as sabers, rapiers, Eastern and Middle Eastern swords, etc.

The most common safety issues lie in the tang and pommel of the sword. To be strong the tang needs to be as wide as possible and run the full length of the hilt. A thick tang adds strength and stiffness to the hilt and the added mass of a thick tang helps to balance the sword. The stiffness of a thick tang can also improve the harmonics of the sword by toning down some of the vibrations in the hilt. There should be a radius of at least 1/8" at the junction of the tang to the blade. This radius avoids the creation of a "Stress Riser", in engineering terms, a point where stress is concentrated. A squared off corner or one with a radius of less than 1/8" is more likely to crack and fail as damage due to shock and vibration accumulate in a small area.

The next safety point is pommel attachment. There are three main attachment methods. The first and most traditional method is the piened pommel. On a sword with a piened pommel the tang passes all the way through the pommel and is either hammered down tight into the pommel or a piece called a "Pien Block" is placed over the end of the tang and the tang is hammered down over it. When executed correctly a piened tang is very strong, but one down side of this method of construction is that modern steel alloys often crack at or just below the piened head. Antique swords often had a wrought iron tang forge welded on, and the wrought iron tang did not have this issue with cracking. A second problem with this style of pommel attachment is that it prevents easy disassembly of the hilt; disassembling the hilt makes it much easier to replace broken handles, replace fittings, or clean and repair the blade.

The second, and most common method of pommel attachment, is the threaded pommel. In this construction, the end of the tang is threaded and the pommel is essentially a giant nut that screws down onto it. Since threaded sections must be round or nearly round and the tang must be able to pass through the guard, the size of the tang as it passes into the pommel must be essentially the same diameter as the thickness of the blade at the guard. This narrows the tang in one of the weakest areas of the sword, the junction of the grip and the pommel. A thicker blade allows larger sized threads, and a tightly fitted hilt can help reinforce the junction, but it is still a likely failure point. Most production swords are no more than ¼" thick at the base of the blade, so the threads going into the pommel are typically ¼" diameter or less. Also, remember that a threaded rod is effectively thinner due to the threads cut into it. This small, threaded tang is especially problematic in swords with overly large pommels as the added weight of a large pommel puts more stress on this joint. Another issue with this assembly method is that hilts often loosen over time from use and changes in temperature and humidity and the only way to adjust the fit is to tighten the pommel. In many designs this will rotate the pommel out of line with the blade, which detracts from the swords aesthetic and utilitarian aspects. Shims can also be added to the assembly, but this is often a tedious job of adding and subtracting until the fit is regained. Lastly, due to such a relatively large rotating mass pivoting on a small threaded joint, this style of pommel is prone to loosening up due to the vibration of the sword as it strikes. The major upside of threaded pommel construction is ease of disassembly and reassembly for cleaning and repairs.

The last style of common pommel attachment is the pommel nut. Done correctly, this method matches the strengths of the piened tang with versatility of the threaded pommel. Rather than the pommel itself being threaded, the threaded end of the tang passes through the pommel and the attachment is made with a threaded nut where it passes out of the other side. If the hole through the pommel is simply round and the tang is round and threaded for the full length of its passage through the pommel this construction is no better (and possibly worse) than the threaded-pommel construction. However, in a well-designed pommel nut construction the tang will pass full width into the pommel, with a thread beginning inside of the pommel rather than before it. The nut being set onto this thread pulls the pommel down tight onto the grip and tang. Using this method, both the issues of a pommel twisting out of line or having a weak spot at the joint of the grip and pommel, are neatly solved and the nut is much less likely to loosen due to its lower mass and the friction of being tightened onto the pommel. The sword can still be easily disassembled should it need to be inspected, repaired, or polished.

Any and all welds must be properly re-heat treated. If there are welds in the tang they must be well done and as close to a 100% weld as possible with no inclusion or voids. If the tang has cracks in it from poor forging technique or botched heat treating it will fail in use, it is only a matter of when. When welding in high carbon steels the HAZ (heat affected zone) develops large grains in the steel. These large grains are much weaker than a fine-grained steel structure and can lead to the tang failing. Many sword steels can also have issues with air hardening in the HAZ of the weld area. An un-heat treated weld will be in a very weak and brittle state, prone to cracking and breaking with out warning. Some alloys (L6, O1, etc) do not respond well to welding even if heat-treated afterwards. Welding in these alloys should be avoided and/or replaced with a one piece construction or a brazed joint.

To a large extent the shape and form of a cross guard is irrelevant to the safety and performance of the sword. So long as the guard is thick enough to support the grip, is well fit to the tang, and is free of cracks it will work fine and is a matter of style and preference. Regardless of style, sharp edges should be eased to avoid cutting the hand and chrome plating should be avoided as over time it can chip and flake off. This is not just an aesthetic issue; these chips and flakes that come off will be as sharp as a razor and can easily give a painful and deep cut.

The grip should be made of a strong wood, antler or bone, and should be well fit to the tang. Grips can be made in one piece or be formed from two separate pieces; if formed of two pieces, the glue joint should be solid with no voids. It must be free of cracks and splitting and should be well sealed from moisture. Leather or cord wraps should be tight and glued in place.

Another very common way in which a sword may have a problem is in the temper. A poorly tempered blade will not only perform badly, but will also be a safety issue. Tempering is the step that follows hardening, and the goal is to achieve the proper balance of properties in the steel. Too hard and the blade will be brittle, prone to chipping, cracking, or snapping. Too soft and the blade will tend to dull quickly, roll edges, and be prone to taking permanent bends. With the proper balance in the temper the blade will be hard enough to hold a good edge, yet soft enough to flex with out cracking, but not so soft as to stay bent when flexed.

The actual hardness of this balance is dependant on the alloy used. The hardness of steels is often measured using the Rockwell C scale (RC). With simple alloy steels (1050, 1060, etc…) the blade's hardness should fall around 52-55RC. Some of the high alloy and spring steels (L6, 5160, 9260) can be used at a much higher hardness levels in the 55-60RC range. Regardless of the alloy used the temper needs to be even along the blade. Overly hard spots in the blade cans cause cracking and overly soft spots can lead to bending in that spot and building up stress there leading the blade to fail. The edge will be more likely to chip out in harder areas and dull or roll over in the softer areas. In essence, a blade with an uneven temper does not perform evenly or absorb stresses evenly along its length, and this can be problematic in both the short and long term.

The grind on a blade plays an important roll in both the performance and safety of a sword. Although it is good for the thickness and width to taper slowly over the length of the sword, if the blade's thickness changes drastically along the edge or spine the cutting ability of the sword will be greatly affected. Thick spots can bind in the cut while thin spots can set up poor harmonics in the blade, narrowing the sweet spot and making the sword feel erratic in the hand. In extreme cases the vibration can concentrate the stresses in one area of the blade leading to the stresses building up over time, which will cause cracking and failure of the blade.

For the performance of the blade the over all shape and geometry play an important roll. Both are dictated by the style of the sword, which is to say the intended use of the design. For example a type XVIIIb long sword is a sword that is designed for both the cut and thrust against opponents wearing light armor. To this end the blade has a lot of taper both in profile and thickness (distal taper). The blade is rather thin behind the edge on this style allowing for a keen cutting edge. With its thin, light blade and long handle the XVIIIb needs a rather small pommel to balance fairly close to the hilt making for a very fast, light and well-balanced sword well capable of cutting and thrusting.

On the other hand a sword like the falchion or the gross messer is optimized for the cut and only the cut. It is designed more for opponents wearing heavier armor. These blades are thicker at the edge, heavier for their size and have little or no distal taper. The balance point will be further from the guard giving swords of this type more power in the cut. The width of the tip and the over all shape of the blade are also aimed at cutting rather than thrusting. As such, they cut and chop very well but are awkward and all but useless when thrusting.

To a large degree the weight and balance of a given sword are largely a matter of personal preference within a given style of sword. The use of fullers, hollow grinding, and distal taper can adjust a sword's weight and balance to meet a wide spectrum of preferences within any given sword type.

Across all styles there are constants in the blade shape and grind that should be followed in a good sword. The evenness of the flats or hollows, the proper edge geometry affect the cutting performance of the blade while the evenness of the distal and profile tapers affect not only the balance and weight, but also the harmonics of the sword. If the harmonics of a sword are off the sword can behave wildly in the cut and the sweet spot will be narrow and ill placed. With a badly balanced sword striking off of the sweet spot will cause the sword to jump wildly and uncontrollable in the hands. In extreme cases this can make for a sword that is not only difficult to cut with but also dangerous.

In conclusion, it should be noted that swords are about personal preference. All of this information should only be applied to a blade intended for use. There is, however, nothing wrong with owning a blade that is beautiful, but useless and unsafe to cut with. After all, some of the ceremonial and bearing swords of the medieval era and renaissance were useless as fighting swords; they were only made to look impressive. A sword failing in use can easily wound or kill both the swordsman and any bystanders. In short, it is important to make sure that the sword being purchased is appropriate to the intended use.