Long Sword Techniques and History

(based on 16th century German Fencing Tradition)

Long Sword Techniques

Introduction to Joachim Meyer

A Master-at-Arms of a Marxbrüder fighting guild in Strasbourg, Alsace, Joachim Meyer is the author of one of the greatest *Fechtbücher*, or swordplay manuals, ever written. The work, entitled *A Thorough Description of the Free, Knightly and Noble Art of Fencing, Showing Various Customary Defenses, Adorned and Put Forth with Many Handsome and Useful Drawings by Joachim Meyer, Free Fencer of Strasbourg,* was written in German and was published in 1570, and then republished in 1600, 1660, and possibly 1610. Containing instructions on the use of many weapons of the period including the long sword, dusack, rapier, dagger, staff, halberd, and spear, the book covers the use of a very diverse set of weapons. The text used fanciful terminology to describe its wards, blows and maneuvers, as was the norm for the German school at the time (Anglo 120).

Meyer's techniques are founded in the techniques of the many German masters before him. The first of these masters, Johannes Liechtenauer, became well known toward the end of the fourteenth century (Anglo 12). Liechtenauer's text *The Art of the Long sword* describes a number of the same wards, blows, counters, and handwork that Meyer uses. Liechtenauer also divides the opponent into quarters, something that Meyer also uses in his teachings (Anglo 128-129). Even with the many similarities, there are differences; one of the most notable is that Liechtenauer's style used thrusts as well as cuts, whereas Meyer's style discarded thrusts entirely (Anglo 133 and Meyer 8r).

Another prominent German master was Hans Talhoffer. One of his most famous fighting manuals was written in 1467 (Talhoffer 9) and covers many styles of combat, including the long sword, armored combat, sword and shield, dagger, and fighting from horseback, amongst others. The manual consists of 270 drawings depicting various stages of combat along with a short caption regarding the image (Talhoffer 9). The long sword style shown in the images is similar to that used by Meyer. Like Meyer, Talhoffer emphasizes handwork, including wrestling, extensively throughout his long sword drawings. The wards used in Talhoffer are mostly identical to those described by Meyer. Since the drawings in Talhoffer's manual rarely related to one another and the captions are often cryptic, it is difficult to discern for certain whether or not the blows used by the two styles are the same. However, a few of the Talhoffer drawings, such as plates 5, 19 and 20, suggest that they are. One of the major differences between the Meyer and Talhoffer styles is that Talhoffer, like Liechtenauer, makes extensive use of thrusts with the long sword, where Meyer uses none. Another difference includes Talhoffer's use of the murder-stroke, where the sword is held by the blade and the crossguard is used to bludgeon or entangle the opponent. Another item of interest is the difference in the style of swords depicted in the two texts. While the swords in Meyer's text are obviously training swords, many of the ones in Talhoffer are those which were meant for mortal combat and are depicted as dealing bodily damage to the swordsman's opponent.
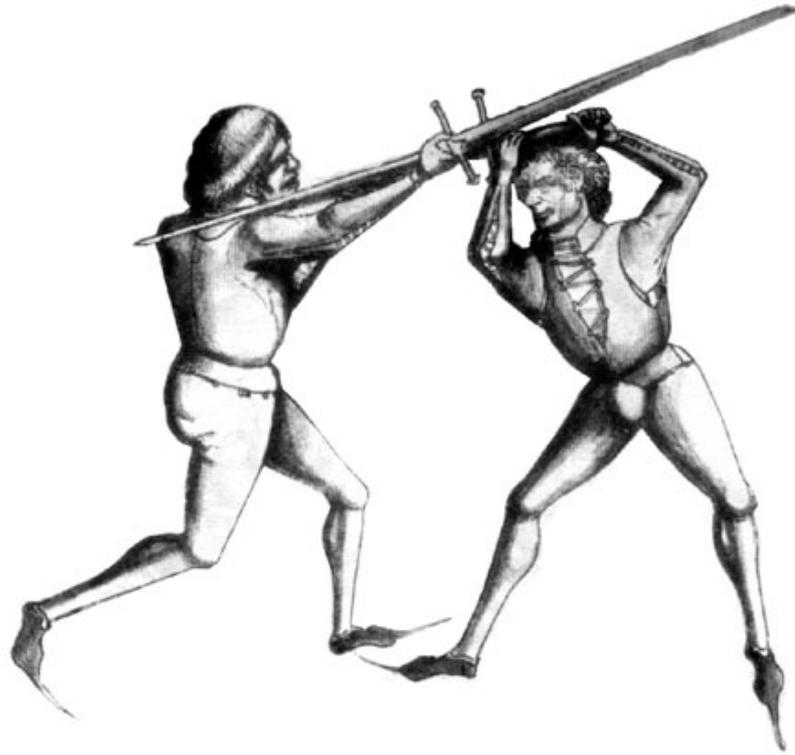
Figure 1: Plate 5 from Talhoffer, depicting a High blow by the swordsman on the left and a Squinting blow by the swordsman on the right

Emphases of the Style

According to Meyer, the techniques described within his work are to "overcome the other with foresight and all handiness, artfully, finely, and manfully in using [the long sword]" (Meyer 1v). This seems to imply that the main purpose of the text is to teach the long sword more as a sport than as a form of defense. However, Meyer does say that, if necessary, these techniques can be used to defend oneself in true combat if such a situation should arise (Meyer 1v). The purposes of learning the use of the long sword are many. First, and probably most important, the long sword combat is the basis for all other types of combat, so many of the tricks and skills learned while becoming proficient in the long sword are applicable to fighting with other weapons. Second, according to Meyer, a combatant takes great pleasure in overcoming an opponent using the "most artful and manliest of all other weapons" (Meyer 1r).

Meyer attempts to categorize combat by dividing it into three distinct segments. First is the "opening", when the two fighters are at a distance and, generally, in a ward. From this initial setup, one or both fighters execute an attack and the fight moves to the second stage, which Meyer calls the secondary work, or handwork. In this portion of the engagement, the two combatants' swords remain in contact with each other. In this portion, there are many tricks to try to gain an advantage over the opponent. Lastly, the fight moves to the withdrawal where, as the name implies, the two fighters break off contact and try put space between themselves, without being harmed. (Meyer 1v)

Similarly, Meyer divides the timing of each attack into three states, the "Before", the "Simultaneous", and the "After". These three are named for their relation to the timing of the opponent's actions. If you attack in the "Before", you are attacking before your opponent has had a chance to commit himself to an attack and you therefore prevent him from executing his plan and force him to work against your initiative. If you attack in the "After", your opponent has had time to launch his own attack, and forces you to first defend yourself and then to struggle to regain the initiative. Finally, there is attacking in the "Simultaneous", which means that both you and your opponent make your attacks at the same time. Attacking in the "Simultaneous" is a way of regaining the initiative if you have been forced on the defensive by attacking in the "After". (Meyer 24v)

Meyer also divides the defensive side of the fight into categories. However, there are only two categories of parries that he directly identifies, along with a third which he uses in his sequences. The first are parries in which the fighter does nothing more than stop his opponent from harming him. The second, and more desirable, method of parrying involves taking advantage of the opponent's attack to gain an advantage by simultaneously executing an attack and parrying the opponent's weapon. The reverse blows, which are discussed later, make use of this method of parrying. The third parry consists of striking at the opponent's blade in order to create an opening. This type of parry, while not identified directly, is mentioned in numerous places, including 16r, when Meyer talks about using a High blow to "suppress from above" all other blows.

The German art of the long sword, of which Meyer is a good example, is a very offensive one. Even when defending themselves, the Germans advocated the attack as the best form of defense, as is evident in the ubiquitous use of the simultaneous attack and parry. However, it is interesting to note that the German style as taught by Meyer limits the types of attacks used to just cutting blows. He mentions thrusts throughout the text, but the majority of them are meant simply as threats, and not as attacks. Although Meyer specifically states that "the thrust with the sword is abolished among us Germans" (Meyer 8r), he mentions its use in a few of places,

including on 39v when he describes how to fight from the Key ward and on 53r when he speaks of how to counter the Long point ward.

Divisions of the Target and the Weapon

Meyer divides the opponent's body into an upper and lower half, and a right and left half. The upper and lower division is made with a horizontal line just below the armpits and the right and left division is made with a vertical line right down the middle of the body. Together, these two divisions create the four openings which Meyer uses extensively throughout the book (Meyer 3v).

Since the head is a very common target especially during handwork, it too is divided into smaller sections, which are similar to the divisions made with the body. A horizontal line at the nose divides the head into an upper and lower half, and a vertical line down the middle of the face creates the left and right divisions. Together, these divisions divide the head into four quadrants which are used to describe the area of the head an attack is destined for (Meyer 3v, 4r).

The division of the long sword is slightly more involved than the division of the man. The blade of the long sword is divided into two segments, three faces, and the point (Meyer 4v). The two segments are the forte and the foible. The forte is the part of the blade that runs from the quillons to the middle of the blade. The foible is the rest of the blade from the midpoint to the point (Meyer 4v). The three faces of the blade are the true edge, false edge, and the flat. The true edge is the edge which would face the opponent if the sword was held vertically with the arms extended towards the opponent. The false edge is the edge that faces toward the fighter holding the sword when it is held in the same way (Meyer 4v, 5r). The flats of the blade are the flat parts between the false and true edges. The final element of the blade is the point, which is self explanatory.

The rest of the sword is divided into three sections as well. First is the quillons, which are located at the base of the blade and serve to protect the user's hands (Meyer 4v). Other names for the quillons include cross, shield, and hilt. They are also used to catch blows from the opponent, as mentioned on 14r when discussing the Crown Blow. Next is the grip, which is where the swordsman places his hands (Meyer 4v). The pommel, which is the knob below the lower grip, is the final portion of the sword (Meyer 4v).
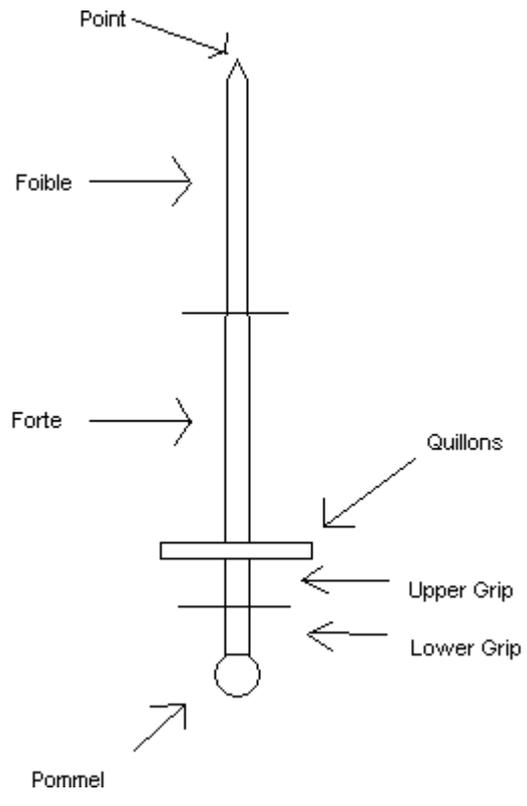
Figure 3: The divisions of the long sword

Stages of Combat

The Three Stages

The three stages, Opening, Clearing, and Closing, equate with Meyer and Sutor's Starting, Middle and End stages of long sword fencing. There is a rough equivalence between the three stages of combat and the three stages of instruction being proposed here.

- **Opening** - the opening stances, guards, measuring and distancing, basic probing and feinting. The primary goal of Opening is to clear the point.
- **Clearing** - the opening of attack opportunity. The act of clearing the point/blade and achieving a clear and open target. The form of clearing used is dependent on the opening methods.
- **Closing** - the various methods of attack. Varies from thrusts to slashes to throws. Closing method is dependent on clearing method.

Before and After

- Before - All moves initiated by you
- After - All moves initiated by your opponent.

Footwork

Footwork is based on movement around an imaginary triangle like the one in the picture below (Meyer 1r). When leading with the right foot, it is placed at position A, and the left foot is placed at position B. If you are leading with your left foot, it is placed at position A and the right foot is placed at position D. Meyer then identifies two different types of steps that are used with the long sword. The first step mentioned is a forward or backward step. To execute a forward step, the rear foot is moved straight up on the triangle a distance of twice the triangle's height (Meyer 1r).   To perform a backward step the lead foot is brought down the triangle a distance of twice the triangle's height (Meyer 1r). Next are the two varieties of sidesteps, the single and double. For a single sidestep, take the rear foot from either position B or D and place it at position C (Meyer 1r). A right-lead double sidestep is performed by first making a single sidestep, so that the right foot is in position A, and the left foot is in position C. Next, the right foot is moved right a distance of half the base of the triangle. Thirdly, another single sidestep to the right is performed. The last phase is to move the right foot again to the right a distance of half the base of the triangle. This will leave the right foot in the A position and the left foot in the B position. A left-lead double sidestep is carried out simply by reversing the lead foot and the direction of the steps (Meyer 1r). At the beginning of a left foot lead double step, the left foot is in position A, and the right foot is in position D. After the step is complete, the feet will be in the same position, translated the triangle's width to the left.
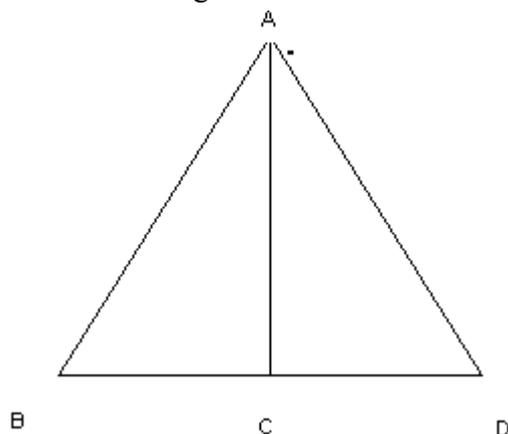
Figure 1: Footwork Triangle

Footwork 1: Gathering and Passing

Gather - to move the foot which is closest to the direction one is moving in: eg) if moving forward, move the forward foot first; if moving backward, move the back foot first.

Pass - to pass one foot past the other, thus changing which foot is forward.

   Footwork Exercises 1

- A box-step is good practice. Move front, then right, then back, then left while in the proper stance. Do it all with gather steps. Repeat with   other leg forward.
- A gather front-front-pass and thrust, gather back-back-pass and guard exercise helps footwork and exercises arms and shoulders. Also a   good CV workout. Try variations.

Footwork 2: Bursts and Lunges

The fechtbücher, all the way back to the Liechtenauer treatises, all say the same thing: when attacking left, step with your left; when attacking right, step with your right. This is almost too simple to understand at first look.

Common Rules for footwork:

This simple rule applies to all stances, no matter which foot is forward. There are two points to this lesson:
  (a) Avoid crossing your stance at all costs
  (b) Never turn your back on your opponent

Let's restate the rule with even greater simplicity: when stepping to the left, step with your left foot, whether it is forward or not; when stepping to the right, step with your right foot, whether it is forward or not.

If your back foot passes your front foot in a passing step, you have moved in a **burst**.

If you thrust forward with your forward foot, you have moved in a **lunge**.

Sword Exercises:

- 20 underhand thrusts with right hand followed by 20 more with the left.
- 20 overhand thrusts with right hand followed by 20 more with the left.
- 20 two handed thrusts delivered from the plough-right, followed with 20 more from the plough-left.

20 transitions from left to right Ox and back. Keep the point forward at all times in the transition - no flailing. (see Primary Guards for explanation of the Ox).

Grips

Both hands on the handle

There are many different techniques used for gripping the sword. One important grip that this particular sword was designed to accommodate is the grip in which both hands are placed on the handle of the sword. This grip appears to give the swordsman a lot of control over the sword, and allows them very powerful attacks. For this grip, the right hand was placed directly below the crossguard of the sword, and the left hand was placed a little above the pommel. This technique was mainly used for cutting maneuvers and defenses.
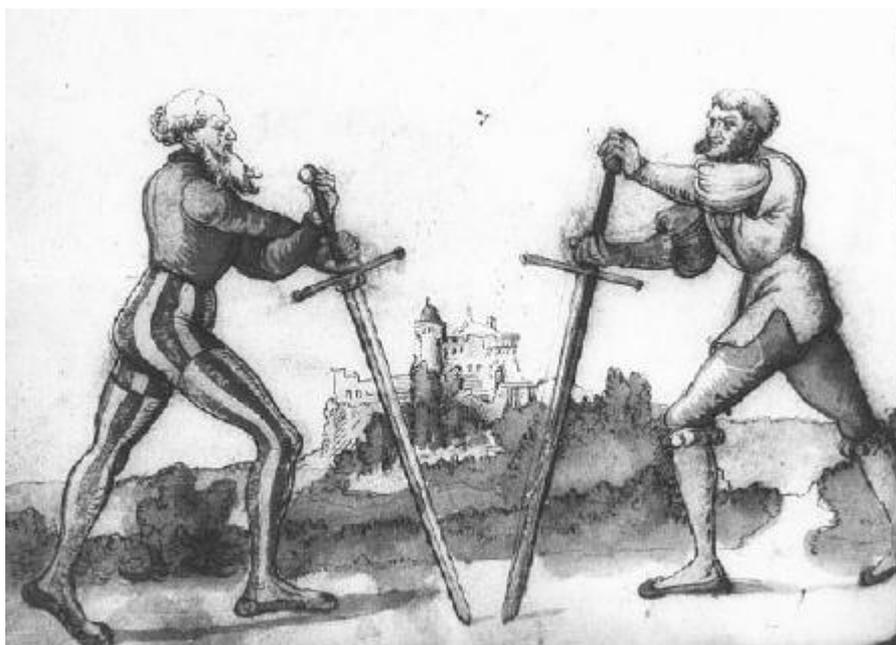
Crossed and Free

As seen in the image above, there are basically two grip orientations: crossed and free. A crossed grip is any grip where the wrists are crossed. A free grip is any grip where the wrists are uncrossed. The grip should be light and relaxed, more like holding a fishing rod than a baseball bat. Avoid clenching into a death grip as it reduces flexibility.

One hand on the handle other free

Another important grip was one in which there only is one hand on the handle of the sword, and the other hand is free. The right hand was generally the hand that remains on the handle of the sword. I would believe that this was always the case in the times when these swords were used because everyone was trained to be right handed. The right hand is placed close to the hilt at the top of the handle. I believe this placement provides the most control over the weapon. Since the swords only weighed around 5 lbs. they were still very maneuverable with just one hand. The free hand was very important. With this hand the swordsman could deflect an opponent's attack, or try to take control of their sword. This hand was quite often used to grab hold of the opponent's sword in some way that would not allow them to strike, or by grabbing their arm so that they couldn't proceed with a movement.

One hand on the handle other on the blade

A third commonly used grip was where one hand is placed on the handle of the sword, and the other hand is placed on the blade of the sword. The hand placed on the blade was usually placed approximately in the middle of the blade. The hand on the handle stays in the same place as in the other grips, that is, up near the crossguard. Gripping the sword in this way allowed the swordsman to barge or ram into their opponent. Also, it provided a great way in which to defend attacks. This grip could even be used in such a way that the hilt and the pommel of the sword could become very dangerous to the opponent.

	Right swordsman: Grip with one hand on the handle and other on the blade.

Defense based on this grip
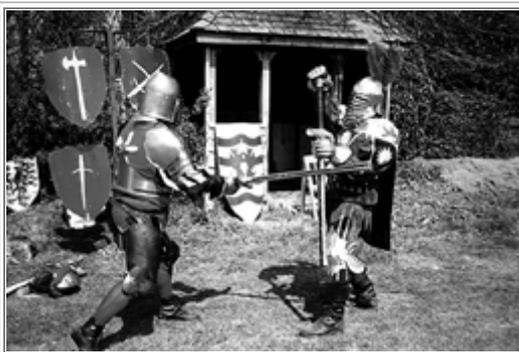
	Defense against incoming cut to the left...
	...and against a cut to the right. Note how the only difference is a slight pivot of the hips.
	Defense against a direct overhead cut. This is perhaps the most awkward and static position in the Thalhofer technique, offering fewest quick ripostes, but it is very strong.

Attack based on this grip

	The two-handed cut to the side of the head, used either immediately, or if a two-handed thrust misses. First, to the opponent's right, using a pushing motion after your left hip thrusts forward...
	...or to the opponent's left, using a pulling motion after thrusting the left hip forward, very much like a shot-putt motion. This move is commonly used after forcing the opponent's blade down and to the right, and comes up from waist height.

Both hands on the blade

The final common grip was when both of the swordsman's hands were placed on the blade of the sword. This grip doesn't seem to have much use, but it seems to be worth mentioning because it can provide some very useful attacks. Both hands were placed fairly close to the tip of the sword, for this grip. Holding the sword this way allows the swordsman to strike the opponent with the crossguard and/or pommel of the sword. With maneuvers such as these, it was very easy to strike the opponent in the head and knock them unconscious.

	Grip on the blade makes possible following move: the "hammer". Seen frequently in contemporary illustrations and engravings, this bizarre move remains puzzling other than as a surprise move. Further research has shown that this move was probably used to hook and pull the weapon of an opponent making an overhead defense.
	Another one move, the "hoist", which might, at least, render your opponent helpless as he sprawls in the mud! Both these moves would, in reality, require some adroitness to prevent the accidental severing of one's own fingers.

One hand on the pommel other free

Rarely seen but still useful grip was one in which there only is one hand on the handle of the sword, and the other hand is free. The right hand was generally the hand that remains on the handle of the sword. The right hand is placed around the pommel at the end of the handle thus forming construction similar to joint or hinge.

The deadly overhand thrust delivered one-handed. Once I have been physically knocked off my feet by this shot. The huge advantage you can gain is to suddenly outreach your opponent unexpectedly - but if you miss, you can watch your weapon sail off into the distance like a javelin!!!

All of these same grips were used in both armored and unarmored combat.

Wards

In the text, Meyer describes a number of wards, which he describes as "a graceful but also needful positioning and stance of the whole body with the sword" (Meyer 5v). These wards are used as the starting point for attacks and waypoints midway through an attack. For example, when executing a Scalp blow, the fighter begins in the Roof ward. Halfway through the blow, he finds himself in the Longpoint ward, and finally, he ends the blow in the ward of the Fool (Meyer 9v). By associating certain attacks with particular wards a fighter can quickly recall tricks which can be brought to bear against his opponent from his current position. The wards are divided into two categories, namely the chief wards and the wards which may be derived from them. Meyer doesn't name these derived wards as a group, so they will be referred to here as the derivative wards. Of chief wards, there are four. These are the Ox, the Plow, the Roof (also called the High ward), and the Fool. There are eight derivative wards: Wrath, Longpoint, Change, Near, Iron Gate, Hanging, Key and Unicorn. Below is a description of each of the wards.

Chief Wards

- The right-hand Ox ward is executed by standing in a left foot forward stance and the quillons near the face with the true edge facing upwards and the point directed at the opponent threatening his upper targets and drooping slightly towards the ground (Meyer 6v). In the Right Ox, the sword hand is raised to the level of the ear on the right side (assuming a right handed fencer) of the head, the pommel hand is back, the wrists are crossed. There also exists a left-hand variation which uses a right foot forward stance.
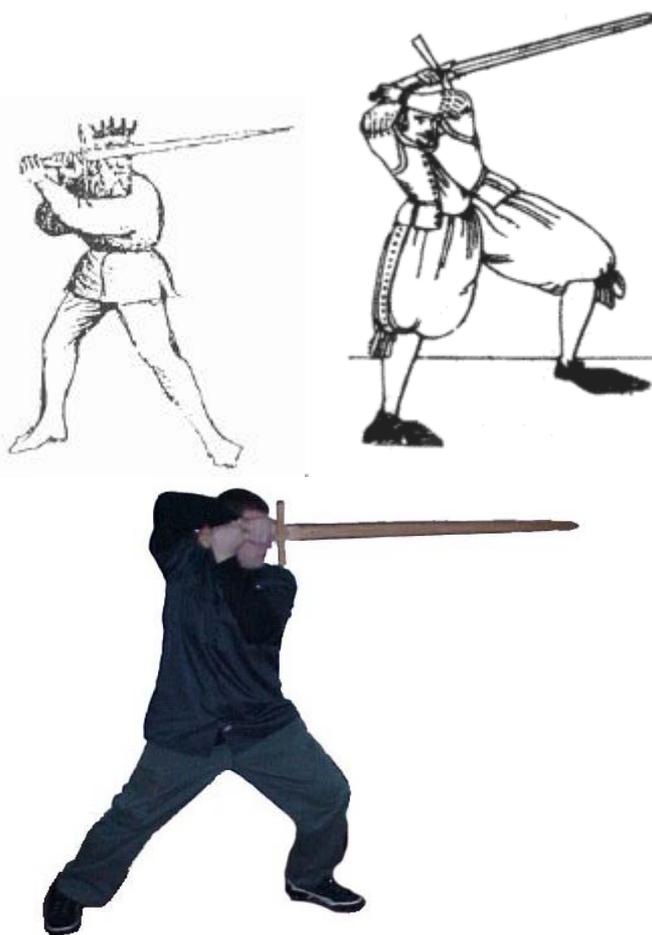

Figure 4: Right-Hand Ox Ward

- The right-hand Plow is performed by standing in a right foot forward stance and placing the hilt near the knees, with the point directed towards the opponent's chest and the true edge facing the ground (Meyer 6v). It is the basic en-garde position done with either foot forward. The sword hand is just inside of the leading knee, the blade is pointed forward with the point at the level of the opponent's chin. The pommel hand is just inside and forward of the leading hip. Like the Ox ward, the Plow also has a left-hand variety, which uses a left foot forward stance.

Figure 5: Left-Hand Plow Ward

- The Roof ward is done by standing in a left foot forward stance with the sword held high over the head, pointing slighting backwards (Meyer 6v). The Roof is a high guard, point overhead. It is the only primary guard which takes the point off the opponent and is thus the only guard not used in wall mode. It can involve either foot forward and leads well into all slashes and forceful counters.
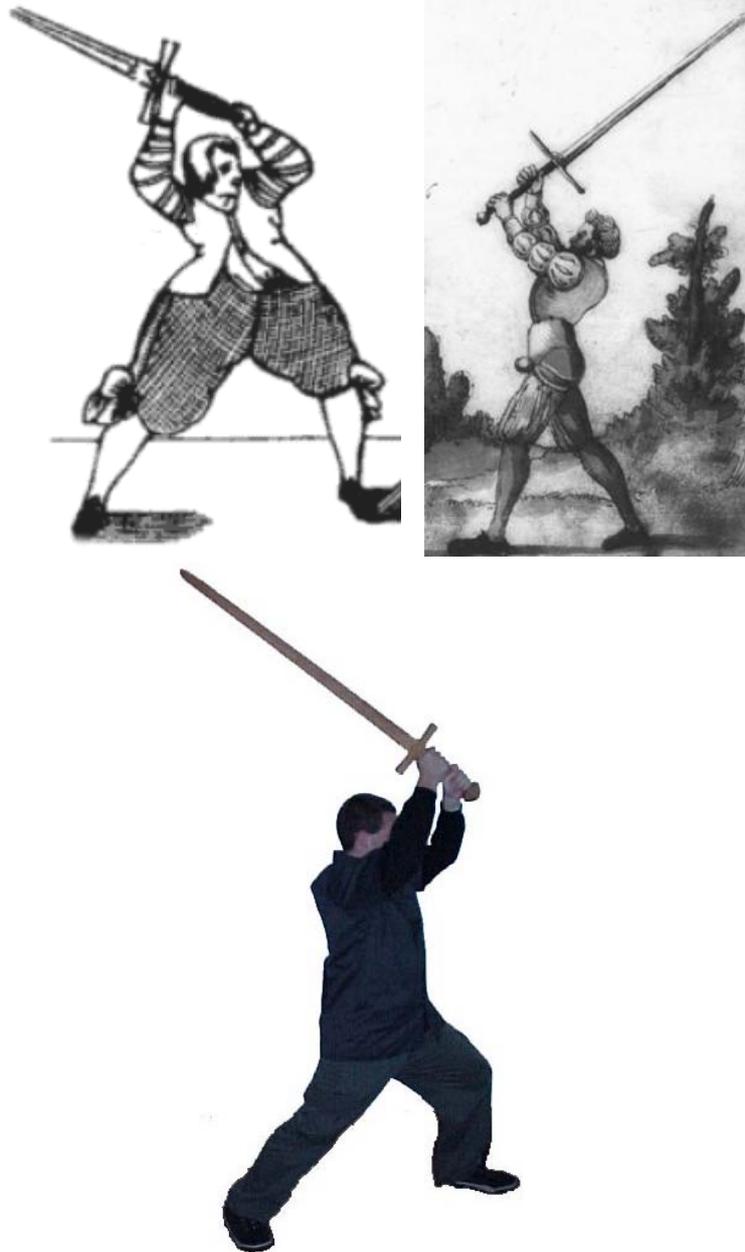
Figure 6: Roof /High Ward

- Finally, the Fool ward is accomplished by standing in a left foot forward stance with the sword, true edge down, stretched outward toward the ground in front of your front foot. (Meyer 7v) The Fool is a forward free guard. In the fool, the sword hand is held out in front of you in a free grip. The blade is held forward and slightly downward, the point is aimed at the ground. Either leg is forward.

Figure 7: Fool Ward

Derivative Wards

- The Wrath ward is done by standing in a left foot forward stance with the sword over the right shoulder, with the point hanging towards the ground. Meyer makes a point of mentioning that all devices which are performed from the Ox ward may also be performed in the Wrath ward (Meyer 7v). The Wrath Guard (Zornhut) is both threatening (wrathful) and enticing (woman's guard). It is enticing in that it looks vulnerable and can encourage a rash response. It is wrathful in that the stance is "fully cocked" to lead into a Wrathful Strike. It is a left foot forward stance where the sword is held over the right shoulder with the blade hanging across the back with the point somewhat forward. One's weight is shifted about 2/3 over the right or rear foot.
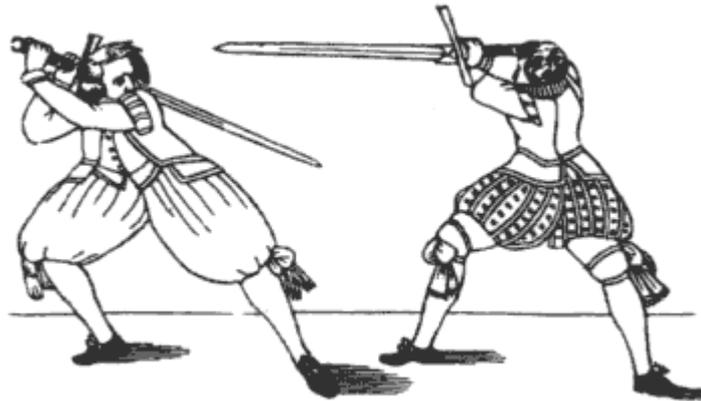
Wrath Guard   **Unicorn**

Figure 8: Wrath Ward

- The Unicorn ward is performed in a left foot forward stance with the sword, again held by crossed hands, in front of the face with the point directed upwards at an angle (Meyer 9r). The Unicorn is a high guard with the point aimed forward at one's opponent's face or high targets. Stand with your left foot forward and hold your sword high to your right with crossed hands. It is basically a high forward variation of the right Ox.

Figure 16: Unicorn Ward

- The Longpoint ward is performed by placing the left foot forward and extending the arms and holding the sword towards the opponent's face, true edge facing the ground (Meyer 7v).

Figure 9: Longpoint Ward

- The Near ward is performed by placing the left foot forward and holding the hilt next to your waist with the point pointing back and toward the ground with the false edge facing you (Meyer 8r).

Figure 11: Near Ward

- The Iron Gate ward isn't widely used in the German style since it facilitates thrusting, which had been abandoned by the time of Meyer, however he includes it since it is often confused with the Cross ward. To perform the ward, stand with the right foot forward, and hold the hilt in front of the forward knee with the point towards the opponent's face, true edge down (Meyer 8r).

Figure 12: Iron Gate Ward

- Next is the Cross (Crossed) ward, which is performed with the left foot forward and the sword held in front of the body, point down, with crossed arms so that the true edge faces the opponent (Meyer 8r). The Crossed Guard (Schranckhut) is a blocking stance with crossed hands held out in front and to the side. The point is aimed at the ground.

Crossed Guard   **Hanging Point**

Figure 13: Cross Ward

- The Hanging ward is done by placing the right foot forward and extending the arms in front of the face holding the sword with uncrossed arms, and the point directed towards the opponent's feet (Meyer 9r). The Hanging Point (Hangetort) is a free handed stance where the sword is held out in front and somewhat to the side. The point is aimed slightly downward and the right foot is forward. It is similar to a free Ox but more "up front."

Figure 14: Hanging Ward

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• The Key ward is executed by standing in a left foot forward stance with the sword, held by crossed arms, in front of the chest pointing towards the opponent's face with the false edge lying on the left arm (Meyer 9r). The Key (Schlüssel) is both a good transitional stance and a good enticing stance. It provides a "wound spring" point-on stance that is difficult to rush, and yet it still looks vulnerable and may encourage a rash response. The stance puts the left foot forward with the sword held in front of one's chest in a crossed grip, the blade rests on the left arm above the elbow.

Key   **Changer**

Figure 15: Key Ward

• The Change (Changer) ward is executed by standing in a right foot forward stance with the sword stretched toward the ground on the left side, so that the false edge faces the opponent (Meyer 8r). The Changer (Wechsel) is a transitional stance that allows for upward cuts. It can involve either foot forward.
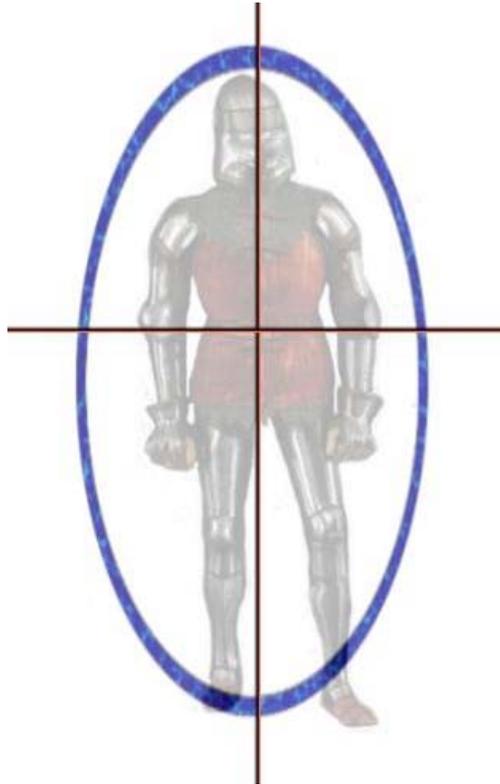
Figure 10: Change Ward

Blows

The Four Targets

Divide the body into quadrants with divisions crossing at the belt. There are thus four main targets, upper, lower, left and right. The four way principle applies in all areas. There are four primary guards, four primary strikes, and four primary counterstrikes, all because there are four targets.

In the image above, we see the full body view of the targets. Each division is a quadrant: High, Low, Right, and Left. The circle around the body is the circle of defense that must not be penetrated.

The quadrants can be reached by two main methods: pointing and slashing.
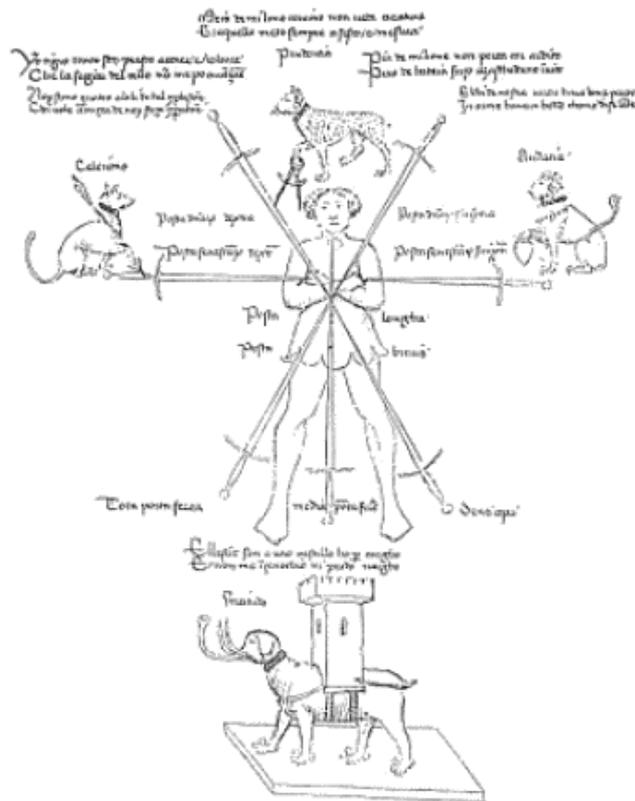
We see above the representation of the targets from De Liberi's Flos Duellatorum . Note that the sword pointing straight upward from below is aimed at the chin. This denotes the primary thrust from the Plough. The diagonal swords meet at the belt and point into the four targets explained in the Overview. The two traverse swords point to the high targets.
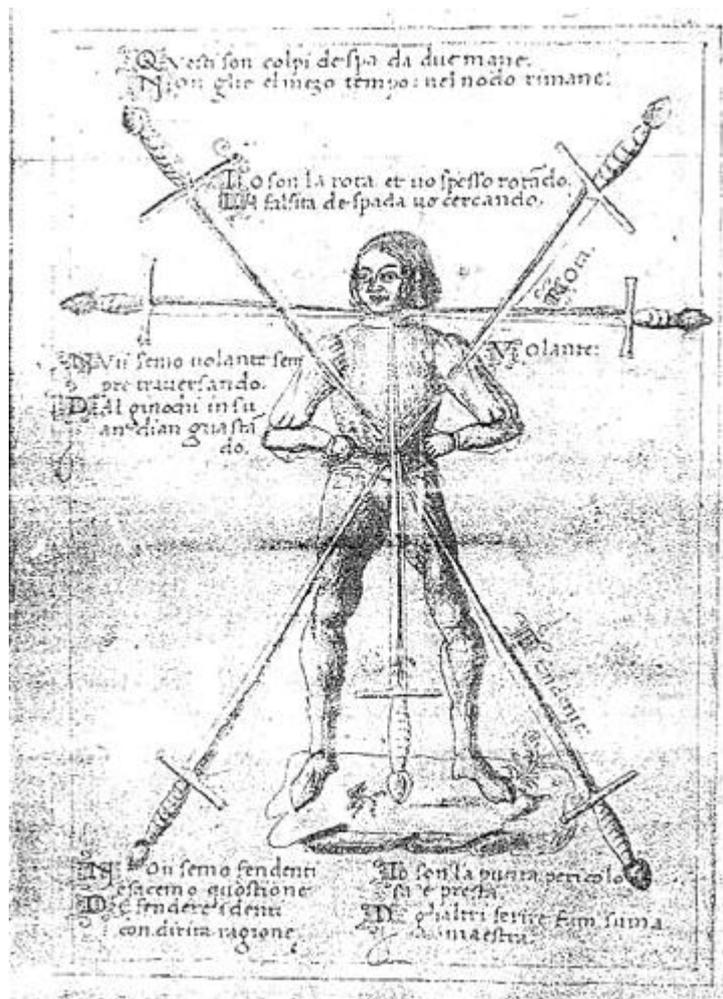
Above is another view, this time from Fillipo Vadi's 1485 manuscript , where we see a similar representation of the four targets. Note that the traverse blades now point to the throat, which is described as the optimum target.

Students should try to aim for the four targets while practicing thrusts.

Students should be aware of their opponent's and their own four targets in both strikes and displacements. With this awareness we can move onto the finer points of pointwork and bladeplay.

Blows in Meyer's text are divided into two categories. These two categories are straight and reverse blows. The straight blows are any blow that is delivered with the true edge. According to Meyer, every possible blow can be categorized under one of the four different straight blows, those being the High, Wrath, Middle, and Low blows. For this reason, the straight blows are also called the chief four principle blows (Meyer 10v). The second category of blows is the reverse blows, which are the Clash, Short, Crown, Squinting, Crooked, Cross, Rebound, Blind, Wind, Knuckle, Plunging and Change blows. They are also called derivative blows since they are each, in one form or another, a variation on a Straight blow. What demarcates them from the straight blows from which they are derived is that they are delivered with either the false or flat of the blade, as opposed to the true edge (Meyer 10v). Additionally, there exists a subset of attacks called Master blows. These blows are the Wrath, Crooked, Cross, Squinting, and High blows. They are called Master blows due to their wide usage in the style,

and not because knowing them makes one a master of the art (Meyer 11r). Below is a short description of some of the blows.

* - indicates a Master blow

Straight Blows

- The High blow*, which is also known as a Scalp blow, is a vertical blow from above against the opponent's head (Meyer 11r)
- The Wrath blow*, which is considered the strongest of the blows, is executed by swinging the sword from above and to the side, diagonally downward towards the opponent's ear. (Meyer 11r).
- The Middle blow is executed by swinging the sword horizontally, either from left to right, or from right to left (Meyer 11v).
- To execute a Low blow, begin in the right-handed Ox, and swing the sword from below upwards toward the opponent's left arm (Meyer 11v).

Reverse Blows

- A Squinting blow* is performed by starting in either of the High or Wrath wards, with the left foot forward. When the opponent strikes, step toward his left with your right foot and strike downward with the false edge of the blade, hitting both the opponent and his sword.
- A Crooked blow* begins in the Wrath ward, with the left foot forward. When the opponent strikes, strike his blow with the true edge with crossed hands while stepping with the right foot towards the opponents left.
- To deliver a Cross blow*, start with the left foot forward in the Wrath ward. When the opponent strikes from above, strike his blow with the false edge from below while stepping to his left.
- A Blind blow is performed from the bind, which is discussed in the next section. When the opponent attempts to escape from the bind, snap the end of the sword at his left side.
- To perform a Winding blow, strike at a blow, which is coming in from above, from below on the left side with crossed hands. Once the blows meet, pull the pommel in a circle towards your left side. This causes the blade to wrap around the opponent's blade, and to strike him over his right arm, then finish the blow by performing a Cross blow.
- A Crown blow is performed by striking with crossed hands upward against an attack from above, and catching the opponent's blade on the quillons. Once the swords meet, raise the quillons high upwards and strike from above with the false edge against the opponent's head.

Strikes: The Thrust / Point

The Thrust is the principle behind the **Wrathful Point,** or **Zornort.** The thrust is the first principle of striking: The Direct Strike.

There are four Strike Principles: Vertical, Diagonal, Horizontal, and Direct which underlie the Principal Strikes. The Wrathful Point is the first Principal Strike. The other Principal Strikes are Slashes, (Over, Under, Wrathful and Traverse) which are examined in later in this book.

Basic thrusts should be practiced from all the 3 point-on primary guards.

- Thrusts can be a simple step thrust - kicking forward with the leading leg - the lunge.
- Thrusts can also be passing step thrusts - passing forward with the trailing leg - the burst.

Student Exercises

From the primary guards, perform:

- Arm Extension (long point)
- Short Step Thrust (lunge)
- Passing Step Thrust (burst)

Repeat the above while aiming for a target such as a buckler or a padded hand.
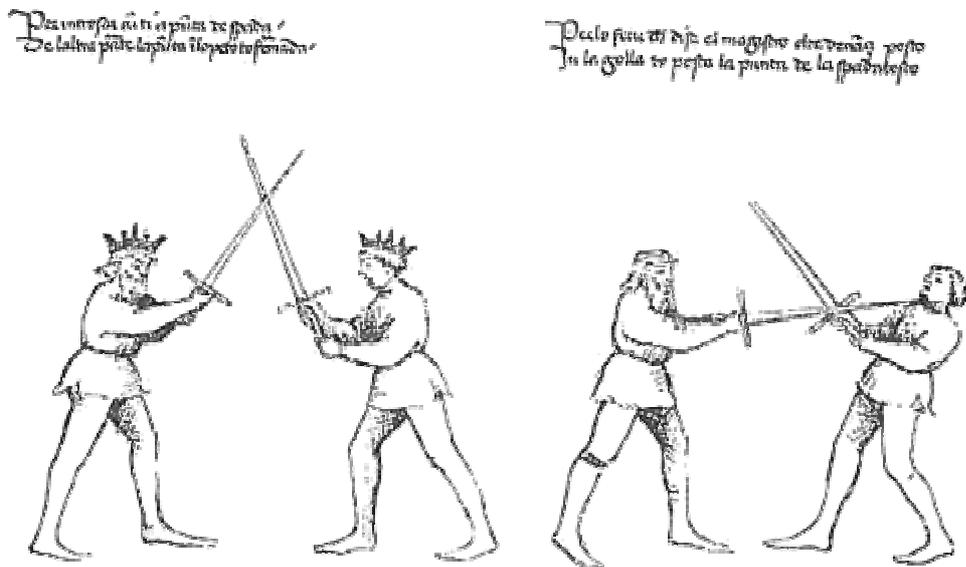
Long point: From the plough or close guard, extend your arms and point.

Langer Ort - The long point. The beginning of any thrust from the Plough is the raising of the arms into a long point, where "point" is understood to mean the act of pointing. One must point at one's target in order to hit it with a thrust.
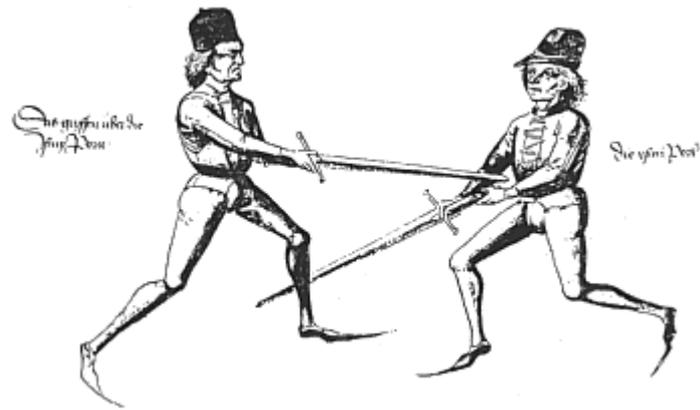
Bursting out of the Plough: Long point and step forward.

Sturzhau - The Plunging Strike

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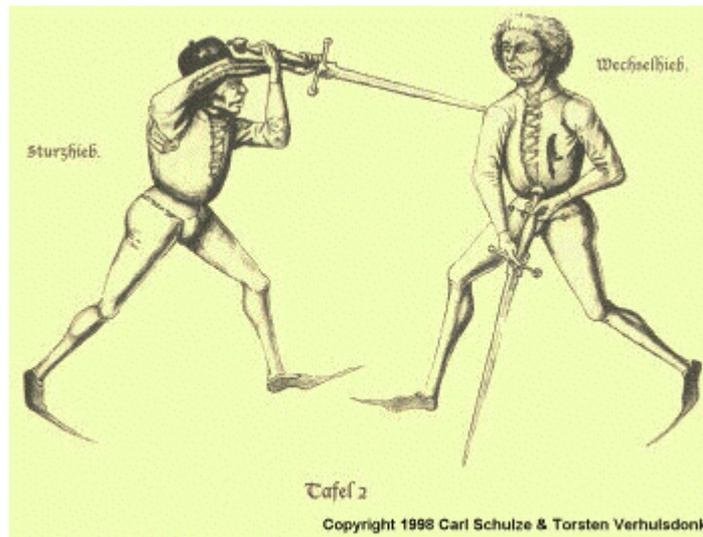
     A thrust from a Right Ox or Crossed Point down and forward is a plunging strike. The arms will unwind with the extension. This is most effective in a passing thrust or burst.

Zornort - The Wrathful Point (The Wrath blow)
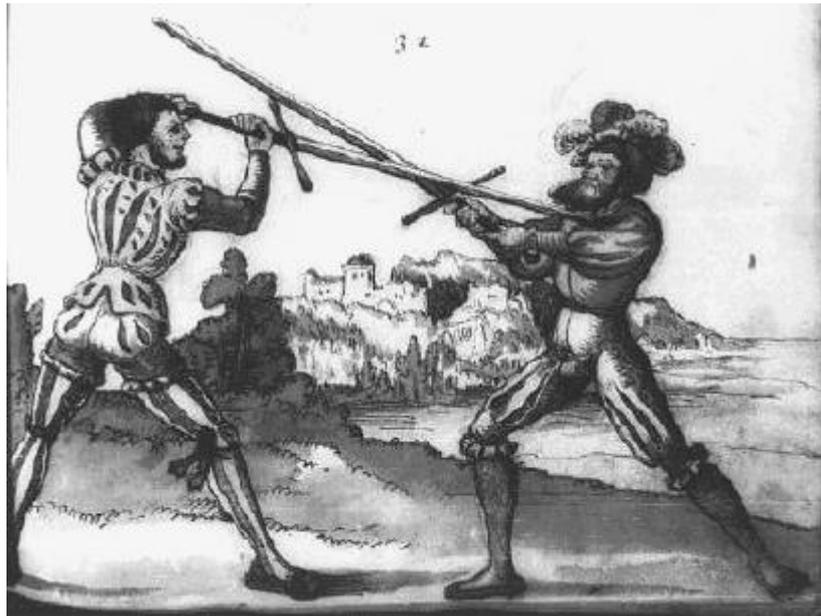
A Wrathful Point is a thrust to a high target delivered with a free grip.

Slices

A slicing thrust is any thrust against your opponent, which is not designed to hit with the point, but designed to slice with either edge of the blade.

A slicing withdrawal is the drawing of edge across your opponent while quickly withdrawing the blade.

Slices can begin with both thrusts and slashes and can be used when extracting from any overextension where your blade is close enough to make contact.

Slices are a way to strike while either thrusting or withdrawing your blade.

Slashes

Slashes form the basic principle behind three of the four Strike Principles: Vertical, Horizontal, and Traverse. The first Strike Principle is the thrusting strike, or Wrathful Point, which was examined in earlier in this book.

There are four Principal Slashes: the **Oberhau, Unterhau, Zornhau, and Mittelhau.**

The Wrathful Point should not be confused with the Wrathful Strike, although the latter can lead into the former and they both address the same targets.

Slashes are cuts with the blade delivered in an arc. They are usually second level attacks launched after the point has been cleared.

Oberhau / Over Strike - Vertical Upper body strikes, launched from above.

Zornhau / Wrathful Strike - Diagonal Upper body strikes, launched from above.

Mittelhau / Middle Strike - Traverse strikes, launched from either side.

Unterhau / Under Strike - Lower Body strikes, launched from below.
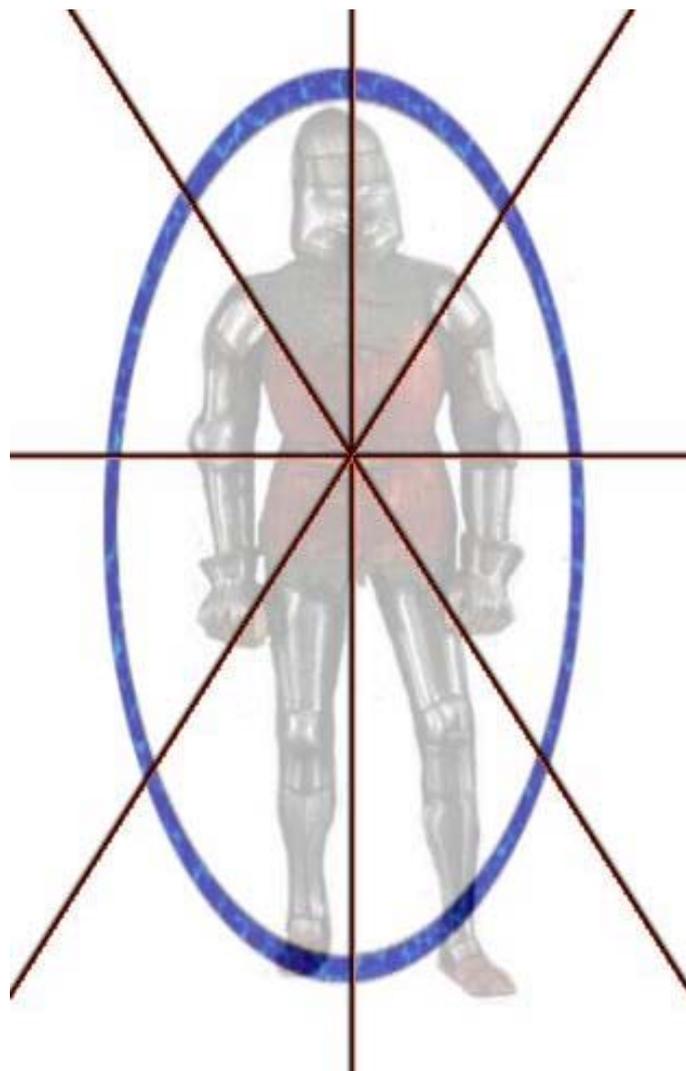
We see above a different view of The Targets. Here we see not just the four main target quadrants, but also the lines of attack. The lines slashing through the image invoke thoughts of slashing, but it should be remembered that each quadrant and each line of attack can also be addressed with the point, not just the edge.

The lines do, however, represent the pure lines of attack which can be delivered as slashes. When countering a slash, remember the targets and all lines of attack, both with the point and with the edge.
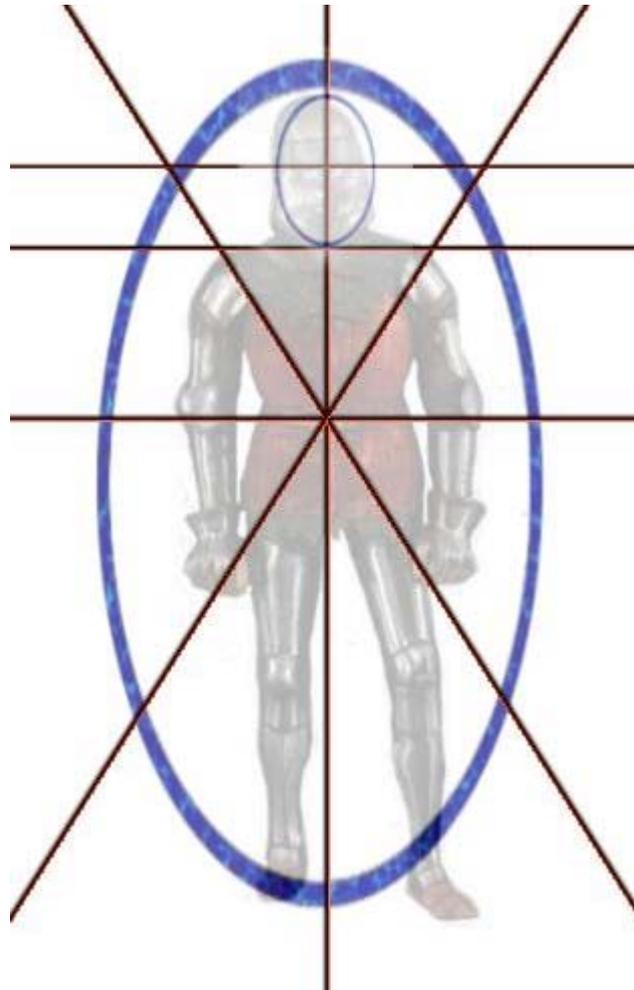
We see above the full view. The knight's head is now framed by a smaller target division. This is because the head is also targetable as Over, Under, Right and Left in its own right. Note that there are two traverse lines through the head, one at the throat, one at the eyes. These, like the lines through the body, are the optimum strike paths.

Other views of the targets can be found in Meyer's fechtbuch, and in Sutor's fechtbuch.

Student Exercises

Practice striking all of the above in "shadow boxing" mode.

Parries: Displacing

Tafel 3
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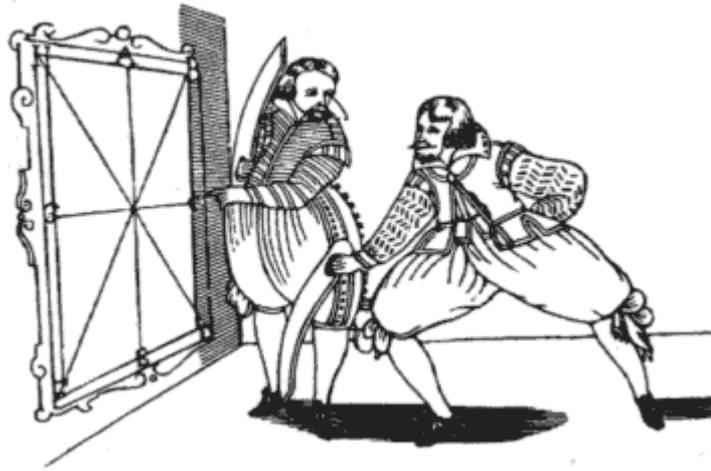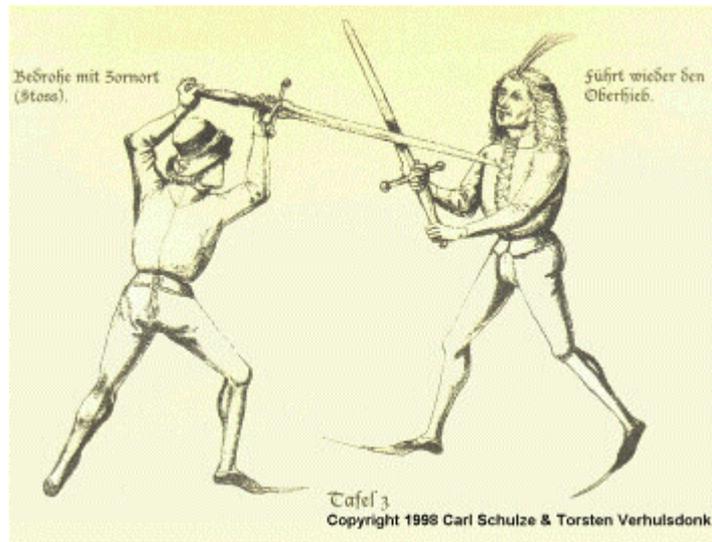
Displacing a Wrathful Point. Put aside the point/blade by displacing.

The simplest parries are blocks to put a threatening point off line, this is also known as displacement. Properly executed, a displacing parry will open an opportunity to riposte.

Basic parries from the Plough are simply blocking barriers where the point is either raised or dropped, and the opposing strike is struck aside.

Basic Parries from the Fool and are displacements that can curve either up or down while displacing aside.

Basic Parries from the High Guards, Hanging Point, and the Ox are simply blocks to either side, point down, which displace a blow.

Basic parries should be practiced from all primary guards. The exercise is to displace a simple thrust by parrying from all guards. Try different footwork variations, first by stepping back while parrying, then to the side, then forward. Look at position vis-a-vis your opponent after all footwork variables.

This leads us to the first student face-offs. Students should practice thrusts and displacements by working in twos. Thrusters will try to hit their opponent on the chest/torso while displacers try to prevent them from doing so. With this exercise, pay attention to footwork and introduce the concept of distancing.

Student Exercises

From each of the primary guards, displace a:

- Short Step Thrust
- Passing Step Thrust

Where the blows are delivered from all point-on primary stances.

Disengaging

Graphical material on the subject using long swords is basically nonexistent, being implied but not actually shown.

Disengaging your opponent's blade is one of the core principles of fencing and is referred to as such in the fechtbücher. The principle of disengaging is not to allow your opponent to find your blade while enticing her/him to try. The trick with the long sword is to remember its mass. Even a sharpened long sword at approximately 3 pounds (1.4 Kg) has more mass, and thus more inertia, than an epee or a rapier. On the one hand this means the speed of the disengage will be limited by mass and wrist strength. On the other hand, not only does an object in motion tend to stay in motion, the addition of extra inertia will make it harder to arrest that motion. This is the swat principle where one helps one's opponent's already-moving blade offline by swatting it along at the conclusion of the disengage. Of course if your opponent anticipates this, it might get applied in reverse against you, your swat can also have its interia augmented. This is explained further in Double and Multiple Disengages Below.

Basic Disengages

Present your point and aim at your target, when your opponent's blade follows to displace yours, disengage your opponent's blade, by flitting your Far Weak under and around his blade, maybe help his blade along by circling up to swat it, and either ride his blade to strike and/or repoint and threaten another target.

Applies to all point-forward guards and stances.

The student exercise is to practice thrusts and disengages along with basic displacement. Students should attempt to strike each other with thrusts, continue to practice displacement, and introduce the new action as an extension of the face-off. Now when the student presents a long point, and the other student moves to displace, we should encourage disengaging and repointing at the long point before thrusting at a second target.

Double and Multiple Disengages

This involves repeatedly eluding the opposing blade while rapidly retargetting, twitching from one side of the opposing point to the other.

Rapidly point, disengage, retarget and re-disengage (and perhaps again) prior to striking. Leads to variations involving changes of stance, target reselection and blade reorientation.

When you have disengaged your opponent's blade and circle to swat it along, your opponent may move back to displace, or even disengage in turn. Multiple disengaging involves the repeated actions of probe, feint, disengage, and repoint.

The student exercise follows from disengaging. We now introduce multiple disengages as part of the sparring session.

Circular movements are frequently mentioned. Think of a cone extending from your pommel forward. This is the circle of attack which can be broken out of at any point.

A circular disengage is a circular motion of the point over and/or under your opponent's point. It generally moves to either a strike out of the circle, or a strike from a matched plane (See below for explanation of both circular attacks and plane matching).

Circular Actions and Plane Matching
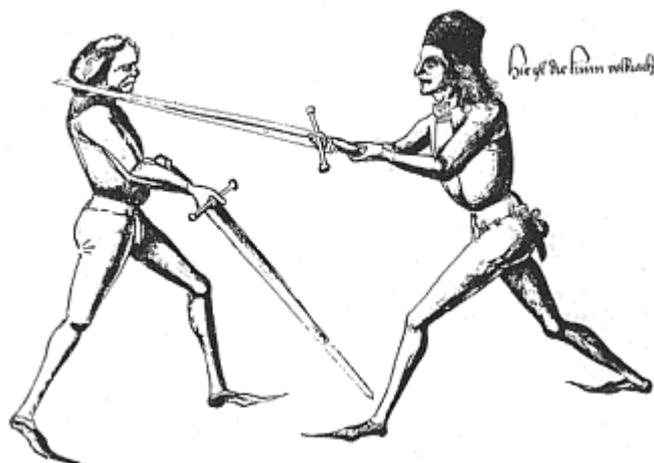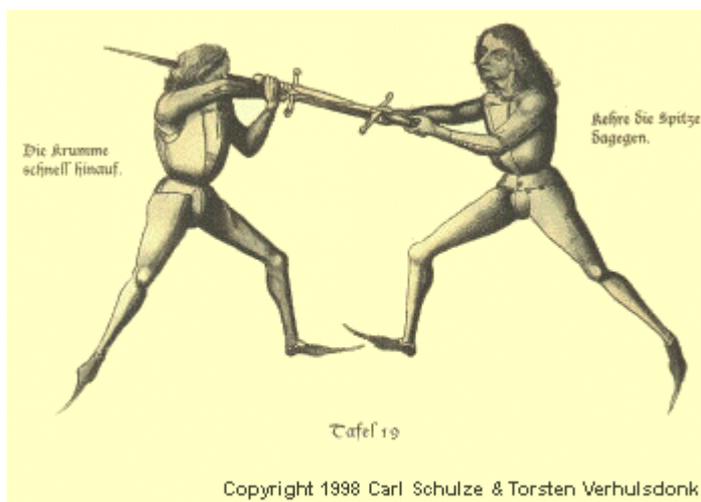
The above graphics are tafels 19 and 20 from Talhoffer's 1467 fechtbuch. Tafel 19 describes the "quick curving cut" and the defense of "turning the point against it." Tafel 20 shows a successful quick curved cut.

A rapid circular disengage launching into an attack past the point while delivering a forward tight circular cut is "the quick curved cut."

The rapid circular attack can be countered by raising one's point up and over the curve of attack. This is a forward moving defense that can enable a counterstrike opportunity.

This circular motion of the blade can be seen as a "cone." In a circular attack, the strike can come out of any point on the circle. The parries thus can be either "up and over" or "down and under."

Note: Meyer's fechtbuch at the bottom of page 14 has a brief look at the "Rusher or Point Mover" in which the circular point principle is examined as a strike opener.

Circular attacks and disengages lead us directly to plane matching.
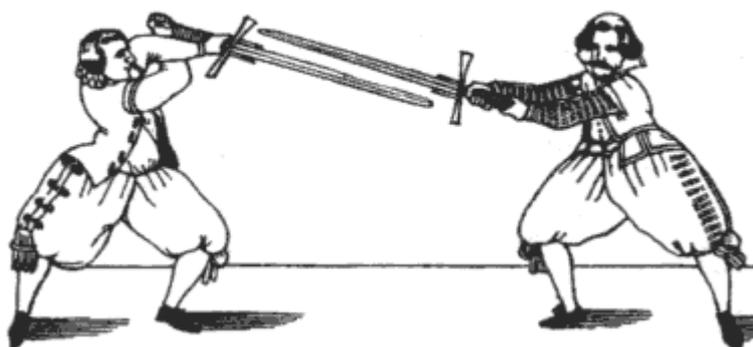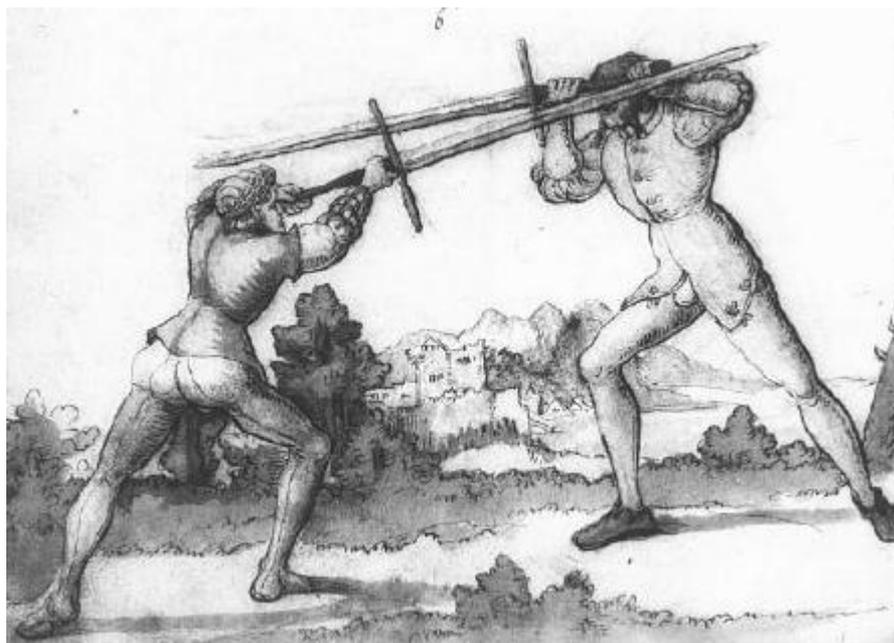
The above two images depict plane matching. This is where the angle of the blade in relation to the body is matched by the opposing blade, allowing a thrust or slash through in parallel. This is effective against hands and forearms, it is also effective against the point of the body in line with the plane behind the sword.

Plane matching often grows out of a circular motion either up and over or down and under your opponent's point. With the plane unmatched, disengage and continue the arc while moving to parallel the opposing blade. When the angle is matched, strike through.

Matching the plane often leads directly to re-crossing the plane while clearing the point, allowing for a change of strike angle while breaking through the point defense. This is called **Changing Through**, or Durchwechselen.

See Sutor page 15 for a description of a strike which matches then changes plane from the Fool or Hanging Point.

Student exercises by now should involve experimenting with new concepts in active sparring.

The Master Strikes

The Master Strikes are not strikes to be described, but are the master principles of both clearing and countering. They are: **Traversing, Glancing, Splitting, and Bending**, these are called **Zwerchhau, Schielhau, Scheitelhau, and Krumphau.**

Krumphau - The Bent Strike
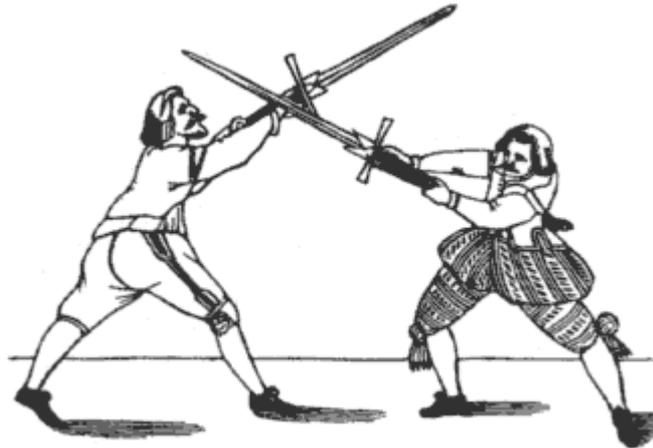
The krumphau is the act of step/bending out of the line of an attack and counterstriking. This is the principle of voiding.

If the attack is a slashed fendente, jump aside while peeling the blow off a crossed hanging guard and counterstrike to the head.

If the attack is to either side, step out (ausfallen,) away from the blow, and forward (vorfallen) thus turning your body perpendicular to your opponent while closing and facing the arc or line of attack. Now counterstrike in a slash to the arms or hands. This works for both traverse and unterhau strikes. This can also counter thrusts as well as slashes.

Snippet From Goliath: *Krumphau: Bend while throwing your point at the hands. Bend away from the stance which allows the cut. Strike defeats stabs and most moves to cut. When it falls from above, stand off and away from the strike. Bend to strike, do not plunge. Change through and strike behind the sword so he knows not where to defend.*

See also the 12th page of both Sutor and Meyer for more on the Krumphau.

Schielhau - The Glancing Strike
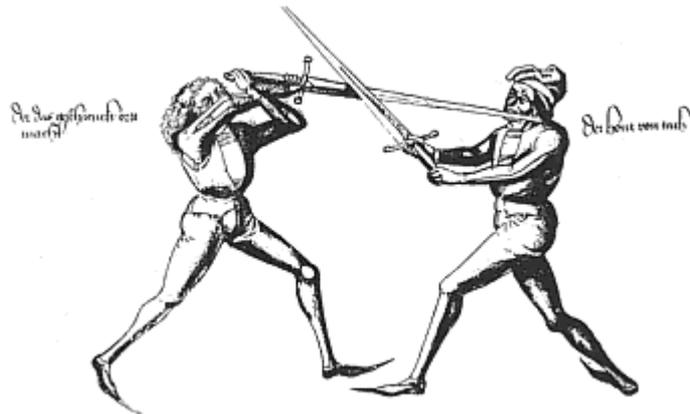
The Glancer is a move to intercept an outside strike from the inside, causing it to glance off the blade to the outside while one is counterstriking. The counter glances off the opposing blade to follow through on an inside line. The attack principle is to glance off the opposing blade. The defense principle is to let the attack glance off your blade to the outside while you move to counter. (See Talhoffer, tafel5 and tafel 18, Sutor page 8 and Meyer page 11).

Snippet from Goliath: *Schielhau: Glancing through breaks slashes or stabs by changing through. Strike aside on your strong and plunge through while shooting to thrust at his throat. Glance through while turning your sword hand over in the thrust until it is above.*

Scheitelhau - The Splitting Strike

The principle behind the **Splitter** is following through, where one pivots one's blade over, under, or around the opposing blade and strikes through - splitting the guard.

Meyer said that the scheitelhau was an oberhau strike to split the head and that to strike through was *duplieren.*

To compromise between masters, we can say the splitter is a high strike that starts with a slash and concludes with either a thrust or a cut, depending on the defense it meets.
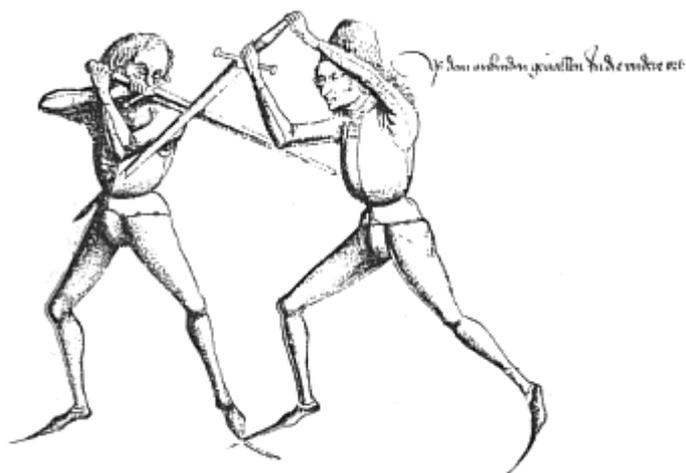
The splitter can be summed up as a slashing attack which follows though over a guard.

Snippet from Goliath: *Scheitelhau: Splitting the defense is is accomplished by driving through and following the guard he takes - cut through and break the defense by thrusting over to slice.*

Zwerchhau - The Traversing Strike
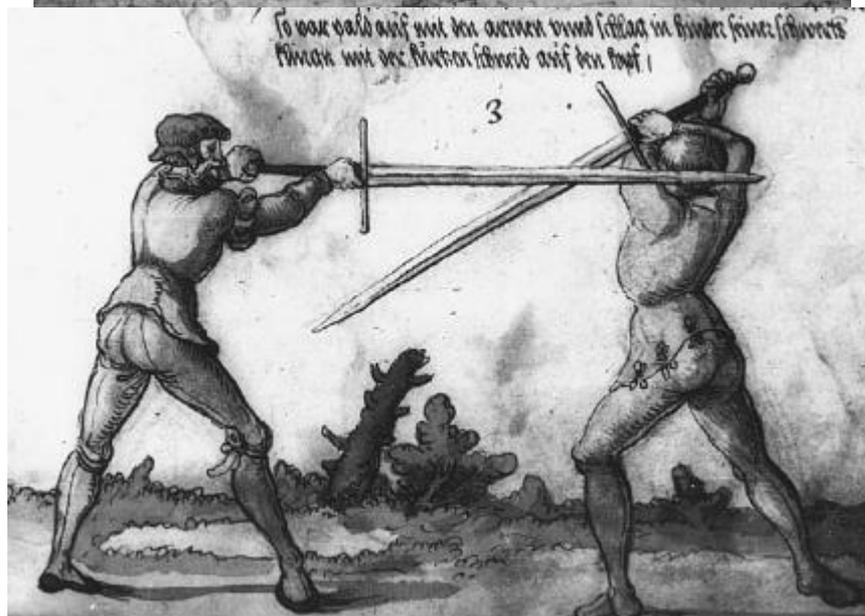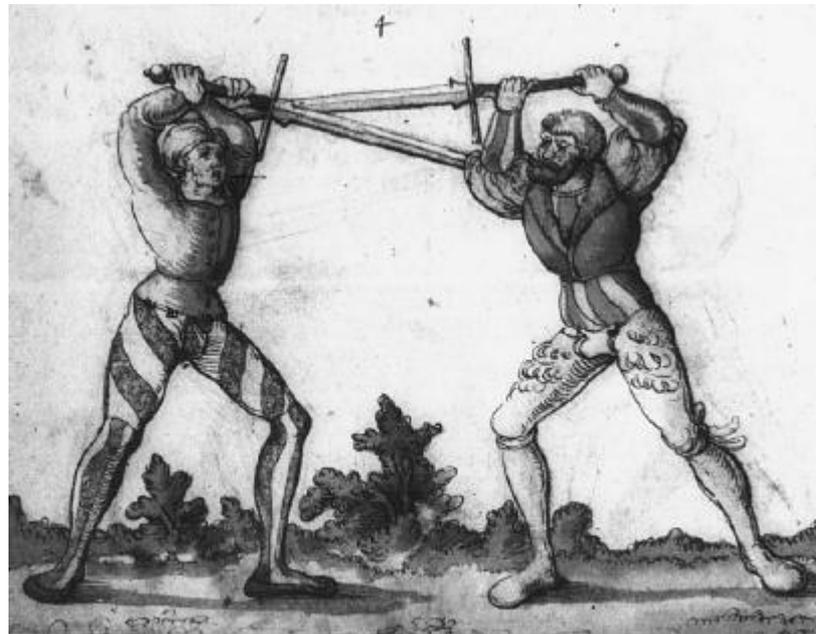
Crossed Traversal
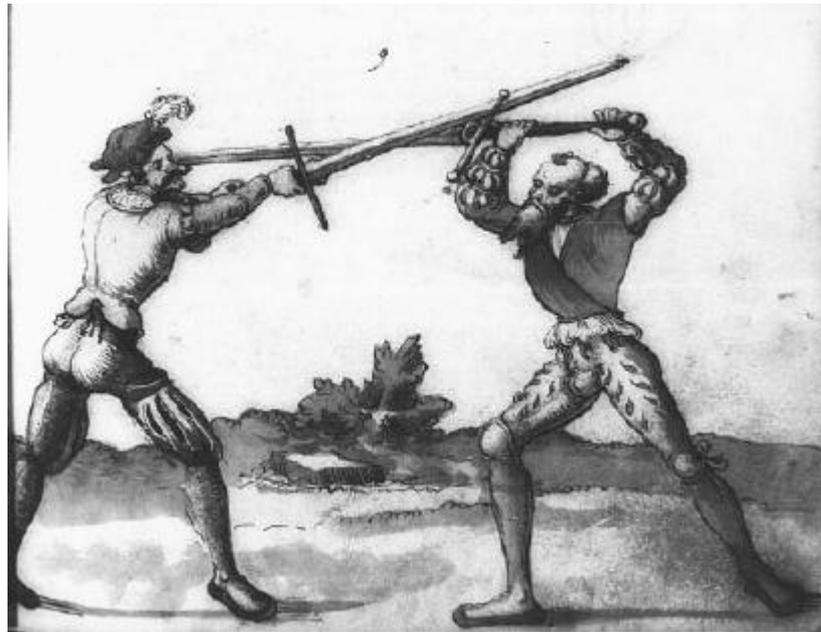
Free Traversal

The **Traversal** follows the principle of meeting force with force. The Traversal breaks an incoming attack by striking blade against blade and following through to counter.

If the strike is to your left (assuming a right handed defender), Jump to your right and break the blow with a crossed hanging guard held high with the point down and forward. Now counter with either a plunging strike (sturzhau) or a high pommel punch.

If the strike is to your right (same assumption), jump left and break the blow with a free guard held high and with the point half forward. Now counter with a plunging thrust or a high traverse slash.

A breaker from the Plough is as simple as raising the sword with force to meet the blow, causing it to be deflected in the same instant as your sword is aimed into a wrathful strike.

See Meyer page 12, Sutor page 16, and Talhoffer tafel 12 for more on the Breaker.

Snippet from Goliath: *Zwerchhau: A counter launched from the Roof. Engage with the sword and strive to counterstrike. If from the Plough, works well against attacks from the Ox. What you wish to accomplish is to counter a strike by standing more steady and striking under and against the force of the blow. Follow the blow and step through while striking from the elbows. Is best accomplished as a single move, not as a two stage move as the advantange is lost in a bind.*

Note: all of the above countering principles are effective against both slashes and thrusts. Any parry which takes the opposing blade out of play while resulting in a counterattack is an effective parry.

Student Exercises

Continue practicing both striking and parrying slashes. The students should not only demonstrate at least two defenses for each slash, they should now apply both a displacement and a counter for each strike.

Voiding

Voiding and Countering Thrusts

Be where the sword is not.

Voiding a thrust is simply the act of stepping out of the thrust's way. Countering any strike while voiding is the principle behind both **Krumphau** and **Wechselhau**, the Bent Strike and the Changing Strike.

Since thrusts are linear strikes, voiding the thrust is a matter of going offline, either left or right, forward or back. It comes down to footwork and the line of attack. How one's feet are placed, as in which foot is forward, will be the largest determinant of voiding direction.

With the right foot forward, and when the strike comes from your sword's right, it is best to burst left and forward in a passing step, away from the opposing blade and facing the line of attack. When the strike comes in on your blade's left, it is best to kick right and forward in an offline lunge while turning in to face the line of attack. These moves are called best as they allow one to close while clearing the point.

With the left foot forward, the same holds true, only the directions are switched. The principle in voiding is the same principle of motion explained in the Overview. When moving left, step with your left, whether it is forward or not. When stepping right, step with your right.

Stepping back and turning also allows one to void thrusts. Again direction of turn depends on which foot one has forward and which side of one's blade the strike is coming from. If one's right foot is forward and the strike is on the left side of the blade, one can turn back with one's left foot to face the line of attack. The voiding withdrawal works the same with the left leg forward, one turns back and away with the right leg. There is no practical voiding counter possible when stepping back with the leading leg. That is merely a withdrawal.

The selection of Bent or Changing counter comes down to how you position the blade while voiding. If one raises the blade while voiding, the counter will be a downward strike - a slashing Krumphau. If one keeps the point on one's opponent, the counter is a thrusting Krumphau. If one lowers one's blade, the counter will be an upward cut, or Wechselhau.

Voiding and Countering Slashes

Exiting and re-entering the circle

Voiding a slash is the same basic concept as voiding a thrust, but with the added element of arc of attack, as opposed to the line of attack.

Oberhau attacks are voided by kicking forward and outward with the leading leg and raising one's arms to counterstrike while facing inward to the line of attack. One then strikes the opponent's hands or forearms.

Zornhau attacks are voided by bursting to the opponent's side opposing the side of attack with the outside leg moving forward. If the outside foot is already forward, the burst is a kick step. If the outside foot is trailing, the burst will be a passing step. Raise one's arms while stepping out and facing inward. Counter by striking your opponent's arms.

Mittelhau attacks are voided by stepping back while raising the blade or dropping the blade. If the blade was raised, counter with an oberhau immediately after your opponent's point misses you. If you dropped the blade, raise the point and step to thrust immediately after your opponent's point misses you.

Unterhau attacks are voided in much the same way as Zornhau attacks, only one should always drop the blade in the face of a Unterhau so as to be able to follow under the arc of attack and strike one's opponent.

Uppercuts should be voided in much the same way as Oberhau attacks, only with the blade dropped.

Student Exercise

Students should work in pairs to experiment with voiding and countering thrusts from all four guards, delivered to all four targets against all four guards. Students should then continue to work in pairs to experiment with voiding and countering slashes delivered along all eight lines of attack.

Nachreissen: Following After

1. Following the Point back

Whenever one's opponent withdraws the point, from any probe or attack, one should take the opportunity to follow the point back with your own point and try to strike an opening while the point is in reverse and not threatening.

To avoid being followed, it is important to back away with the feet, not the sword. Always try to withdraw at the long point. Try not to pump your arms when presenting, disengaging, and retargetting.

2: Following under the Raised Blade

Whenever your opponent takes the point off you, and yours is still in play, you have an opportunity to strike.

When your opponent's arms are raised in preparation to strike, try to follow the motion to strike under and through.

To avoid being followed in this way, always make sure your opponent's point is cleared before taking yours off target, whether you are preparing to strike or not.

Try to avoid attempts to bash your opponent's blade away, as the most forceful blade-to-blade strikes are often the easiest to disengage and result in a point well out of play, and thus a wide open selection of targets for your opponent to strike at.
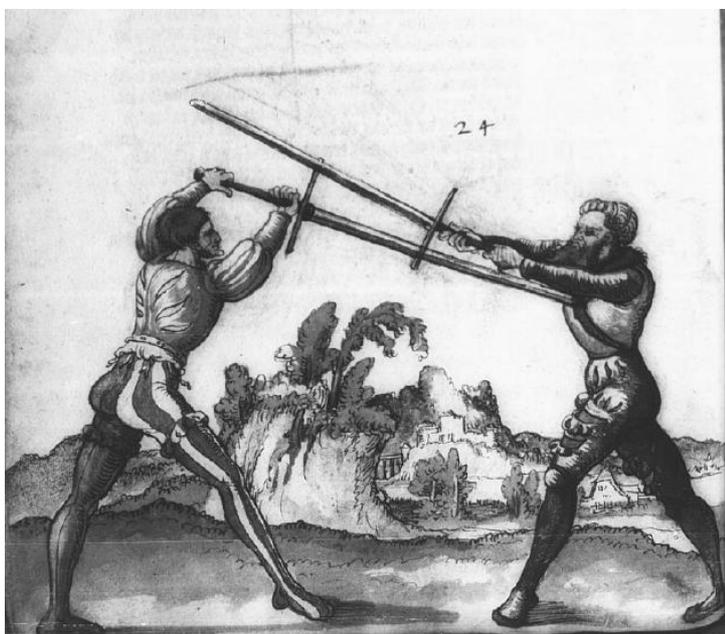
Goliath Page 83

The picture above illustrates a counter where the left fencer has evaded an unterhau and followed after the raised blade to deliver a wrathful thrust.

Handwork

Handwork, or secondary work, occurs during the middle of a fight after the two combatants have closed the distance between them and their blades are engaged with each other. It is not only an integral part of long sword combat, but also requires the greatest skill (Meyer 2r). Meyer identifies twenty-eight different handwork techniques, and most of these target the opponent's head. This is one of the main reasons why the head is divided into four sections as mentioned above (Meyer 3v). The techniques identified by Meyer are as follows: Binding, Stop-Attacking, Slicing, Striking Around, Running Off, Deceiving, Vanishing, Setting Off, Slinging, Doubling, Reversing, Whipping Around, Feinting, Circling, Moulinet, Winding, Winding through, Changing, Stop-Cutting, Pressing the Hands, Shifting, Hanging, Wrenching, Blocking, Barring, Gripping Over and Running In. Below is a description of a number of these handwork techniques.

Techniques

- Binding occurs when the two swords come, and stay, in contact with each other (Meyer 17v).
- Stop-Attacking is a method to prevent your opponent's blows from being completed by trying to land a blow before the opponent's finishes. This method works particularly well against opponents who use wide, sweeping strikes (Meyer 17v).
- Striking Around is performed from the bind. To perform a Strike Around, pull the sword back and strike quickly to the side opposite to the bind.
- Slicing is also performed from a bind. When bound, remain that way until the opponent tries to Strike Around. When he does, press forward, keeping the true edge on his arm. Then push him away using either the forte or quillons and then immediately strike at an opening (Meyer 18v).
- Vanishing is a useful technique against a defensive opponent. If the opponent attacks the sword as opposed to the body, pull the blow back before his sword strikes and strike again against a different opening (Meyer 19v).
- To perform the Pulling handwork, begin with a strike to any opening with the true edge. After the blow has landed, pull the sword back and then quickly strike again against the same opening using the false edge (Meyer 19r).
- Doubling is performed by first striking at the opponent's ear with the true edge. When the swords collide, cross your hands while raising the hilt, then strike at his head with the false edge (Meyer 19r).
- Reversing is another handwork which is performed from the bind. When bound with uncrossed hands cross your hands so that your sword is on top of his and press downward to prevent the opponent from attacking (Meyer 19v).
- Hanging is performed from the Plow. If the opponent strikes from above, raise the hilt high up with the point hanging towards the ground so that the opponent's blow is caught with the flat of the blade (Meyer 22r).
- Blocking is a mechanism to use against an opponent in the Fool or Change ward. Strike against his blade with the true edge and as soon as the blades collide, cross your arms and pin his sword down so he cannot attack.

Sample Sequences

A significant portion of the long sword section is devoted to sequences where Meyer threads together a combination of wards, blows, and handwork. These sequences are used to describe how to either attack from a specific ward or to defend against a particular set of blows. Most sequences presented are completely linear and do not describe alternate possibilities. Also the sequences generally do not cover an entire encounter. In addition to showing proper procedure for dealing with a particular situation, these sequences give the reader a general understanding of how the individual pieces of the style interact. Below are four of the sequences used by Meyer to describe how to fight from the wards.

- When starting in the Roof ward, if the opponent strikes from your left against your head, step diagonally forward and to your right. Simultaneously strike at his foible with the flat of the blade and try to strike him in the head with your own foible. Once this blow lands, pull the sword back and strike against his right from below while stepping with your left foot toward his right. Then again pull back and strike at his ear with uncrossed hands using the false edge. Then, cross your hands and strike again at his right ear with the false edge. After this blow, strike a Cross blow and withdraw. If he counters your blow from below against his right, perform the Slice handwork on him when he pulls his sword back (Meyer 31v).

- If the opponent strikes from below at your left, step towards your right. Simultaneously, strike with the true edge against his forte. Once the blades strike, pull the sword back upward and strike downward with the false edge against his left ear from above. Quickly bring the sword around and strike with the true edge against his right ear while stepping towards his right. If possible, use the Slice handwork against him here, otherwise stay bound with him, and when able, strike quickly at an opening and withdraw. (Meyer 31v-32r)

- If the opponent strikes against your right, step to your left with your left foot. Simultaneously, strike with your true edge against his forte. Once the swords collide, cross your arms to hit his head with the false of your blade. If he parries this, let the false edge run off his blade while stepping to his left. Then strike with the true edge from above but, before the blow lands, pull back and strike with a Cross blow towards his left ear and then withdraw (Meyer 32r).

- When starting the fight in the Roof ward and you are able to strike first, cross your hands, right over the left, so that the sword points downward towards the opponent. Then swing the sword around and perform a Cross blow against his left ear. Then begin a Cross blow against his lower right, but Pull the blow and strike with the false edge against his left ear, then again with the false edge against his right ear. One this blow makes contact, step back with the left foot and strike with the true edge from below against his left ear. If the opponent attempts a Low blow while you step back, step forward and strike his blow with the false edge. When he brings his sword back up, move your sword to your left, keeping your hands crossed. When he next strikes, hit his blow hard with the flat of the blade, keeping the sword horizontal. Then, step toward his right and strike with a Cross blow at his left ear. Then strike at him again as you step away (Meyer 33r).

Biomechanics

Introduction

Biomechanical modeling can be applied to studying the practice of any martial art. These methods can be used to help elucidate the operation of any technique. This project is really a pioneering study since this type of analysis doesn't seem to have been applied to a martial art in the past. These biomechanical models are just the basis of what could be turned into years of work to fully explain and examine these situations. Due to the complexity of producing quantitative models, and the scope of this project, we have only generated qualitative models that give a good start for any further study.

The purpose of these biomechanical models is to assist in understanding the way in which one swordsman would gain an advantage over another. Also, we wanted to better understand why a particular maneuver becomes more effective in certain situations. If you have worked with the weapon, some of the information in this section may seem intuitive. Using the models that we derived we are able to give concrete reasons why something is true, so we were able to validate these intuitions. This section covers key components of Meyer's style of combat (binding, true and false edge maneuvers, foot and body placement, and stepping with the blow). We also include some situations where these components are used in combination to execute a complex maneuver.

Binding

Meyer characterizes binding as the time at which the swords make contact (17v). Using force diagrams as in mechanical physics, one can model binding and understand, for example, why meeting an opponent's blade with the foible offers less control than with the forte. First, basic assumptions must be made such as identical blades and identical right-handed swordsmen. Of course, these assumptions are not actually realistic, but they still allow us to model the principles that occur in real situations.

Next, the blade is modeled using a force diagram, assuming that there is an axis of rotation where the right hand would be placed, near the hilt. This axis of rotation is the point by which we define two distances, x and h. The distance x is from the axis of rotation to the point at which the blades make contact and the distance h is from the axis of rotation to the left hand placed on the lower grip.
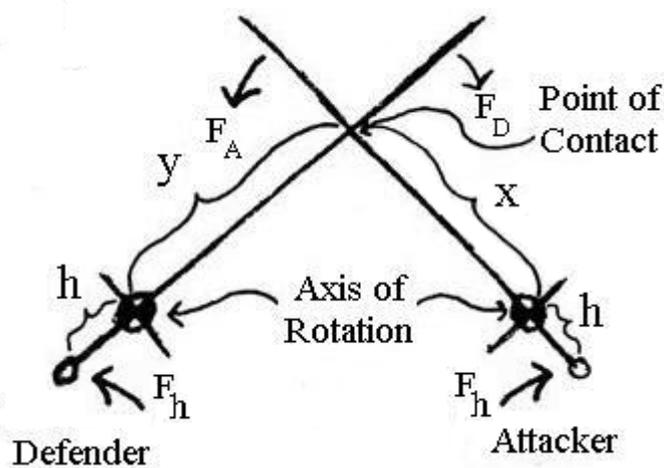
Figure 17: Binding

In binding, two forces are important, the force that the attacker puts into his blade and the force that the defender exerts against that attacker's blade. As shown in figure B1, the attacker and defender each exert a force on the pommel with their left hands, F_h, which is the force applied distance h from the axis of rotation. At the point of contact, the force originating from the defender's blade, F_d, competes with the force exerted by the attacker, F_a, defined as F_h multiplied by the ratio between h and x:

$$F_a = F_h * h / x$$

Also, the defender experiences the equivalent relation:

$$F_d = F_h * h / y$$

where y is the distance between the point of contact and the axis of rotation on the defender's blade. If F_a is greater than F_d, then the attacker overcomes the defender and takes control of the bind. Through closer examination of the figure, assumptions and relating equations, one notices that the attacker can increase his force F_a by decreasing the point of contact x. Assuming equal strengths and identical blades, F_h and h are the same for both the attacker and defender. The ratio between F_a and F_d is then:

$$F_a/F_d = y/x$$

By decreasing the distance between point of contact and axis of rotation on the attacker's blade and increasing the distance between the point of contact and the axis of rotation on the defender's blade, the attacker gains the advantage. In the case that the distances x and y are the same, that is the ratio equals 1, the two swordsmen are at an impasse, with neither having an advantage over the other.

True edge vs. false edge

Using the true edge of the sword versus the false edge of the sword is a topic that comes up often in Meyer (10v). As mentioned earlier concerning the division of the weapon, the true edge of the sword is the side toward which the knuckles point; the false edge is the opposite side. In Meyer, the first attack is typically made with the true edge, delivering a strong initial blow. Subsequent blows are usually made with the false edge, being faster and more efficient, but not as forceful. The following models show this claim to be valid.

The true edge and false edge blows can be modeled in terms of pushing and pulling, respectively. When swinging with a true edge blow, the swordsman is pushing the sword and the main muscle group being used is the triceps. The false edge blow is delivered by pulling the sword, involving mainly the biceps. To understand why the true edge delivers a more powerful attack than the false edge, one simply needs to understand the qualitative difference between pushing and pulling. A person can push more weight than he can pull. Figure 18 illustrates the muscle groups used in the delivery of true and false edge blows.
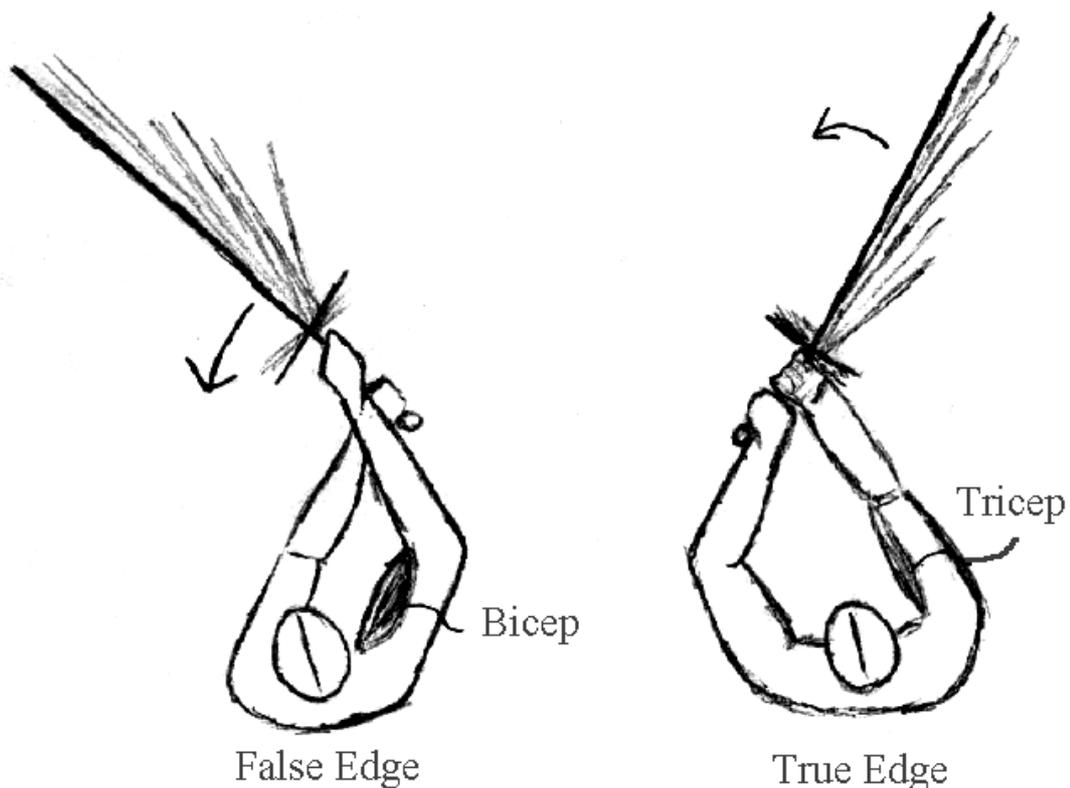
Figure 18: Used Muscle Groups

Since the triceps are the main muscle group used for pushing, the equation used to describe a true edge blow would be:

$$F_{true} = F_{triceps}$$

and since the biceps are the main muscle groups used for pulling, the equation for a false edge blow would be:

$$F_{false} = F_{biceps}$$

The ratio between the force delivered by the false edge to the force delivered by the true edge for a given swordsman would be:

$$F_{false}/F_{true} = F_{biceps}/F_{triceps}$$

From our own experiments, an average male can exert approximately 40lbs (18kg) of force with his biceps and approximately 60lbs (27kg) of force with his triceps. Therefore, for an average male, the force ratio between a false edge blow and a true edge blow would be 0.67.

Although using the false edge offers a weaker blow in terms of raw force, there are advantages to using a false edge blow. To aid in this explanation, I am going to use an example of the way that a combat might occur. The first blow is generally delivered with the true edge. This attack is used first because of its power that can throw the opposing swordsman off guard, making him more vulnerable. If we now assume that the defender successfully blocked the initial blow, then the two swordsmen will be positioned as in Figure 19 (Attacker, True edge). From this picture it is apparent that the swordsman can't easily deliver another true edge attack if he wants to attack the same side of the defender's body. The attacker would have to take about 2 steps diagonally to his right and draw his sword back again to be able to deliver another blow. This task would be very complex, take some time, and probably leave the swordsman vulnerable to an opposing attack. A much better option would be to take a single step to the right and switch to a false edge blow. This act would position the two swordsmen in a situation similar to that in the false edge part of Figure 19. It is apparent that from this position the swordsman does not have to move as far to make another attack on his opponent.
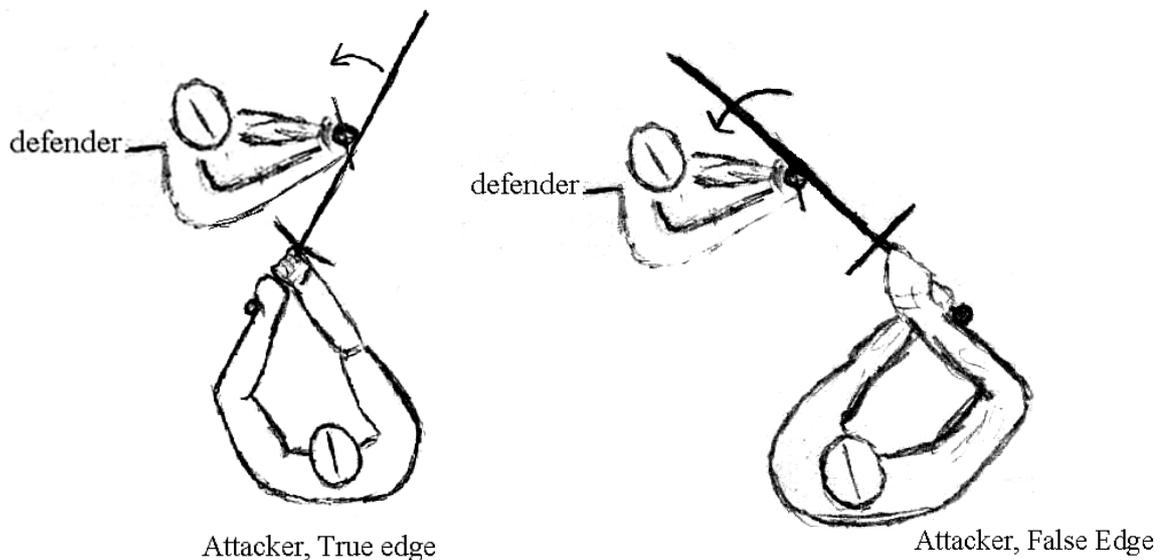
Figure 19: True Edge and False Edge Attacks

Figure 20 demonstrates the ranges of the true and false edge blows, or angle index, as seen from a top view. Shaded areas denote the area through which the sword can pass in delivering a true or false edge blow. Note the dashed line vector denoting where the opponent might be situated relative to the swordsman. A swordsman cannot comfortably swing a blow beyond the angle index. It is apparent that the true edge is not effective past approximately 11 o'clock but the false edge is effective up to at least 9 o'clock in this figure.
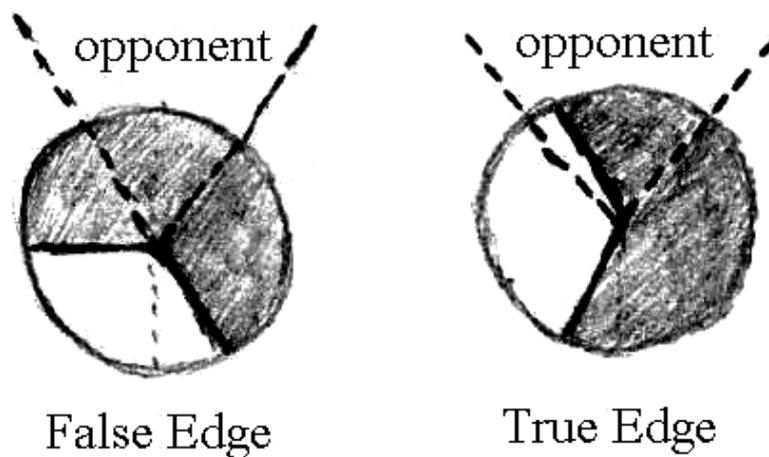
Figure 20: Range of False and True Edge Attacks

These factors explain why Meyer technique usually encourages initial powerful blows with the true edge followed by quick attacks of opportunity with the false edge.

Doubling

Doubling is a particular technique in Meyer that combines the elements of both true versus false edge and binding (19r).

This is to make a blow or device double in this way: strike first from your right to his ear, and then when the swords clash together, push your sword's pommel through under your right arm; rise at the same time with both arms and strike him with the false edge behind his blade on his head.

This handwork is for this reason called Doubling, because through it a blow is doubled or executed twice, first with the true edge, and then with the false.

In doubling, the attacker meets the defender's blade with the true edge, and then turns the weapon to use the false edge. Simultaneously, the attacker pushes up, moving his forte farther up the defender's foible, therefore taking control by binding the defender for a strike at his head. Figure 21 demonstrates doubling.

attacker

defender
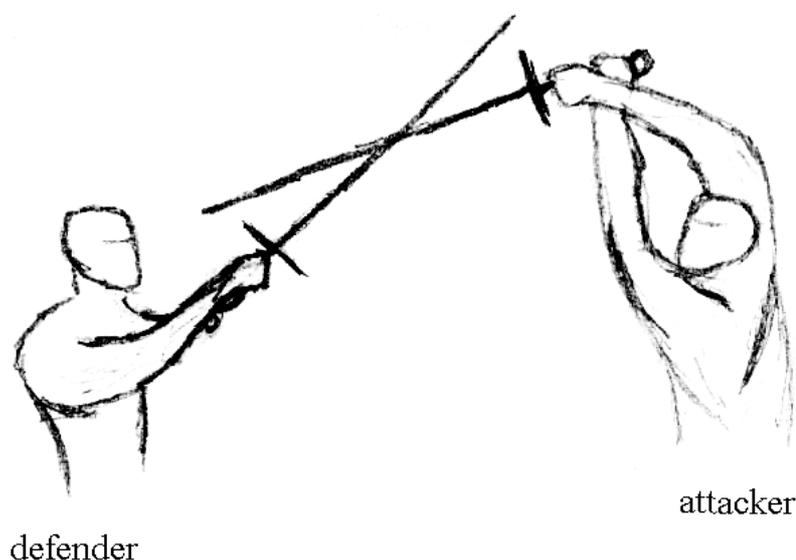
Figure 21: Doubling

To understand how this system works, the previously defined equations are combined, where $F = F_h*h/x$ and $F_{false}/F_{true} = F_{bicep}/F_{tricep}$ (see Binding and True vs. false edge). A ratio, γ, is defined as the force between the false edge and the true edge:

$$\gamma = 0.67 = F_{false}/F_{true} = F_{bicep}/F_{tricep}$$

The force of the attacker's initial blow where it hits the defender's blade is $F_{true} = F_h*h/x$, and the force of his second false edge blow against the defender's blade $F_{false} = 0.67*F_h*h/x$. The force of the defender's blow against the attacker's blade is simply $F_d = F_h*h/y$, because he uses the true edge.

To better understand this situation a ratio, η, is defined between x and y, where

$$\eta = x/y$$

The situation where the two swordsmen are at the moment of the second blow can be analyzed by setting these equations in a state of equilibrium:

$$\eta = x/y = \gamma = 0.67$$

For the situation of equilibrium, γ equals η. But for the attacker to gain an advantage, η must be less than γ. It is assumed that γ remains relatively constant, as this ratio is defined by physiological properties (strength of muscles). For the attacker to gain an advantage, x must be decreased and y increased, which makes sense from the discussion of binding. In other words, the attacker should move the point of contact toward his forte and toward his opponent's foible. In doubling, this event naturally occurs when the swordsman pushes his sword's pommel through under his right arm while raising both his arms at the same time.

This is not the only principle by which doubling is effective, however. Using the false edge, as was discussed, also adds the advantage of wrapping around the opponent's sword without much resistance in the necessary direction to perform the false edge attack. By this method, the attacker is able to wrap his sword around his opponent's sword striking him with a high blow to the head.

To clarify why there isn't much resistance in performing the false edge attack, consider the following situation. If a swordsman blocks an incoming attack with his true edge, then his attacker is exerting a force towards this swordsman's body. Since the opponent is exerting a force towards the swordsman's body and a false edge blow requires a pulling force that is also towards the swordsman's body, the swordsman can use some of the momentum generated by the opponent to deliver a false edge attack. This false edge attack would also require stepping to the side to avoid the opponent's falling sword.

Foot Placement

An important technical aspect depicted in Meyer is the placement of the feet (see Appendix A). By standing with the feet well apart, balance and stability are achieved in one's stance. To understand why this foot placement is important in stability and control, it can be modeled describing the relevant geometry. A line is drawn perpendicular from the center of mass of the swordsman to the floor and from the same center of mass to the rear foot, creating a right triangle as shown in the Figure 22 below.
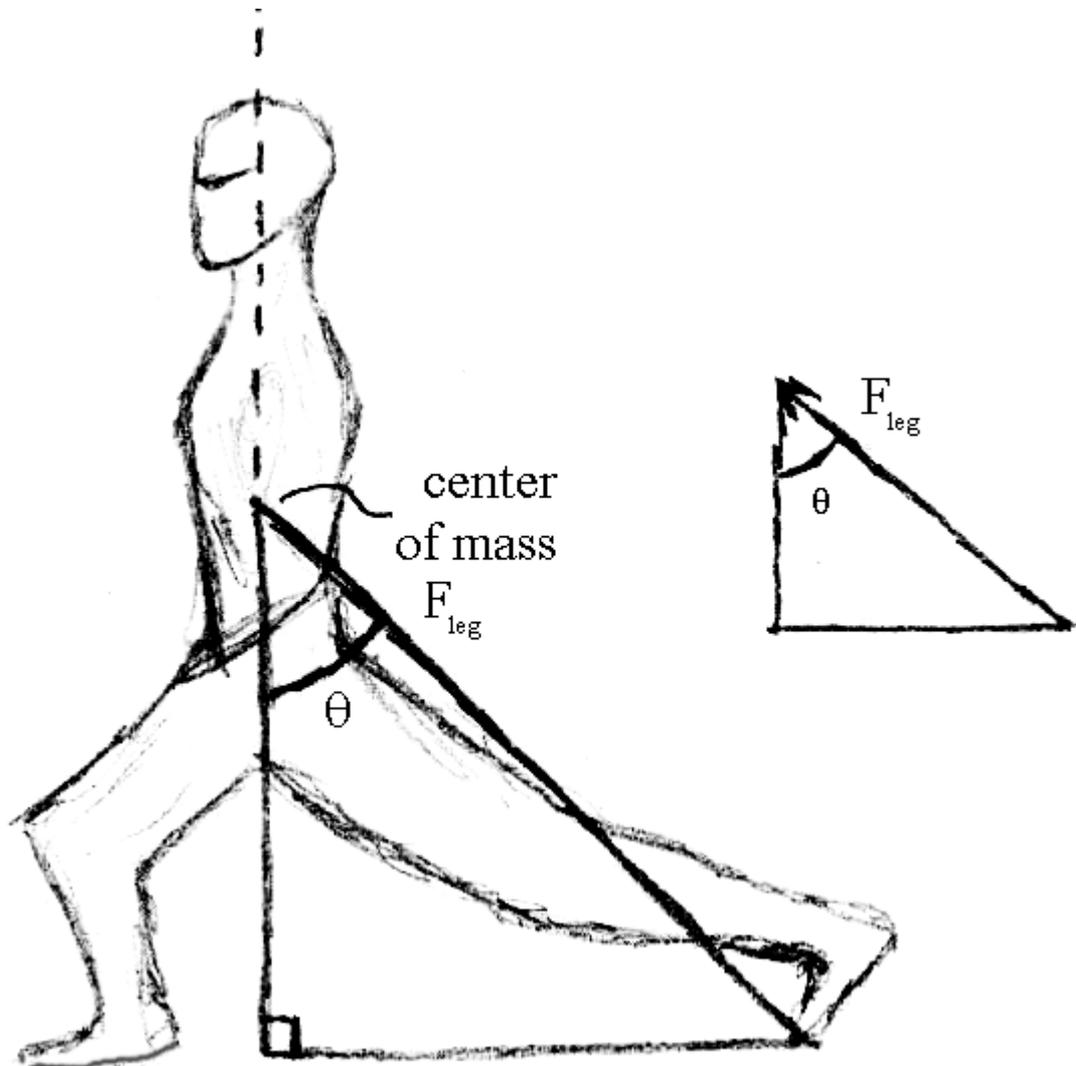
Figure 22: Foot Placement

The angle, θ , describes the angle at which the rear foot is placed with respect to the body. If a force is exerted on the swordsman by some push or blow, the rear leg exerts a force in response, thus keeping the swordsman upright and in control. The force that the leg exerts originates from the quadriceps. The average male can exert about 150lbs (68kg) of force with the quadriceps (these numbers are approximations that were generated from our own experiments). The leg force, $F_{leg}* \sin \theta$, opposes the force exerted against the swordsman at or below his center of mass. $F_{leg}* \sin \theta$ defines the horizontal component of the force that the leg exerts. As θ increases, the force that the leg is able to exert increases, keeping the swordsman more stable.

However, there is a trade-off. By drawing one's leg further back, thereby increasing θ, agility and maneuverability are decreased. On the other hand, if θ is too low, then the swordsman is standing straight up and maneuverability is again low, but stability is especially low. While standing straight up, the rear leg effectively is able to exert zero force in the horizontal direction against a blow received at or below the center of mass, knocking the swordsman off his feet easily. A happy middle must be established wherein θ is large enough to allow the rear leg to oppose incoming forces and create stability while also allowing adequate maneuverability.

Forces that are exerted at or below the center of mass compete against the force of the rear leg directly. Figure 23 shows the force diagram for forces exerted at or below the center of mass. The force, F_{AL}, exerts a horizontal component described by $F_{AL}*\cos(\varepsilon)$, where ε is the angle between the force F_{AL} and a line perpendicular to the ground. The swordsman remains in control when $F_{leg}*\sin(\theta)$ is greater than $F_{AL}*\cos(\varepsilon)$.
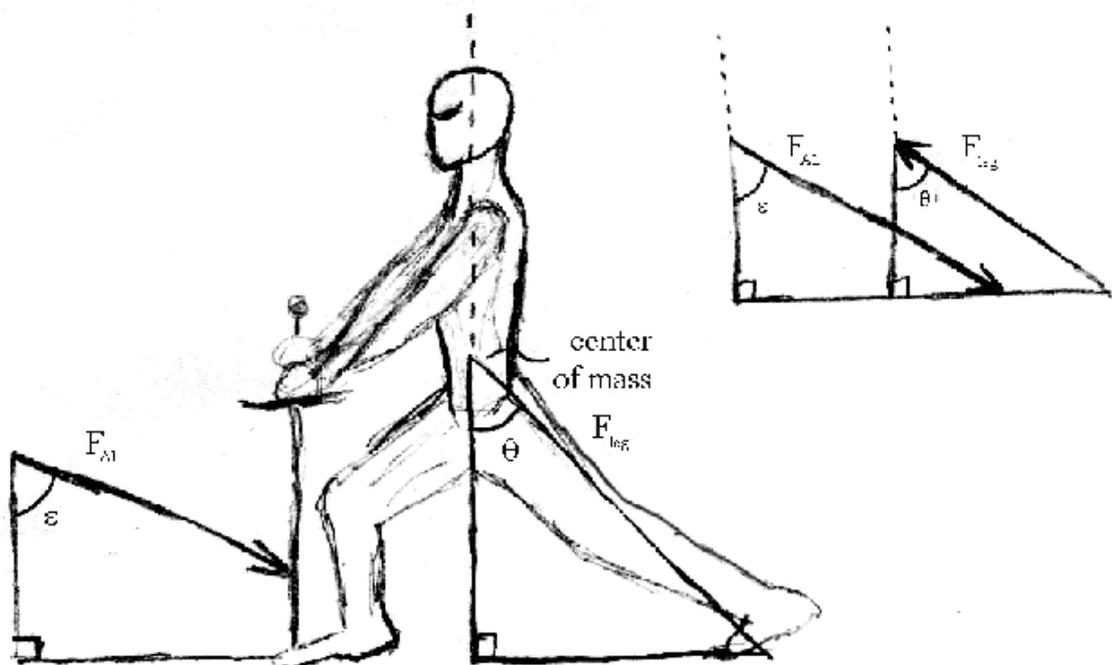
Figure 23: Force Diagram

However, most blows come in above the center of mass. In reality, the swordsman leans slightly forward and holds in his hands the long sword stretched out from his body. The outstretched sword creates a contact point at which opponent's blows are received. In Meyer such an example of an attack aimed above the center of mass is the High Blow:

The High Blow is a straight blow direct from above against your opponent's head toward his crown, which is why it is also call the Scalp Blow. (11r)

Figure 24 shows the realistic situation including the relevant geometry.
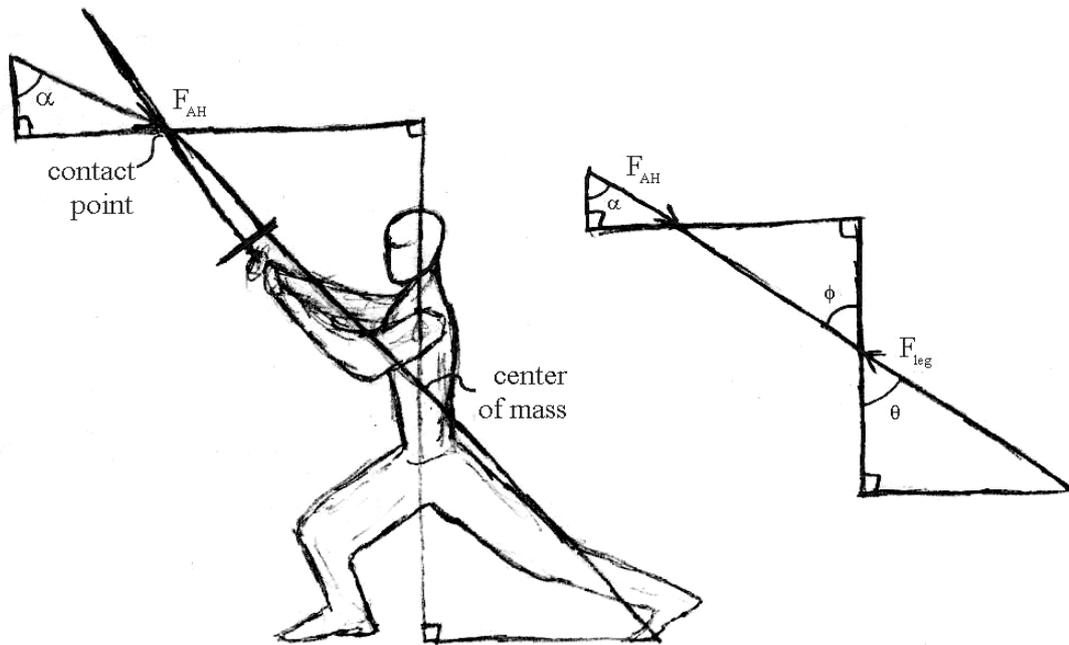
Figure 24: Forces When Receiving a Blow

An angle ϕ is created, which describes the angle between the swordsman's contact point, or where the blow is received, and the perpendicular line drawn to the ground through his center of mass. An incoming blow, F_{AH}, exerts a force above the center of mass with a horizontal component described by $F_{AH}*\sin(\alpha)$, where α is the angle between the direction of the blow and a line perpendicular to the ground. The force with which the leg force, $F_{leg}*\sin(\theta)$, then competes is described by

$$F_{AH}*\sin(\alpha)*\sin(\phi)$$

When the above expression, $F_{AH}*\sin(\alpha)*\sin(\phi)$, exceeds the force, $F_{leg}*\sin(\theta)$, which works against it, then the swordsman loses balance and falls back. Also, if ϕ is too much greater than θ, the arms become parallel to the ground, then the swordsman will fold against the blow. If ϕ is too much less than θ, the arms become perpendicular to the ground, then the swordsman will again fold back away from the blow. These two situations, ϕ is too big and ϕ is too small, behave mechanically the same way as if the swordsman's arms were at his sides. Any attack received above the center of mass will make the swordsman lose his balance and fall back. In practice, this situation is avoided by maintaining a wide stance with the arms up, keeping the angle θ about equal to the angle ϕ.

For horizontal components of forces exerted on the swordsman, the above models apply. However, these models are not very practical in this application even though in principle they correctly explain the situations. A more practical model would be one that considers the arms giving out first because they are much more likely to give before the legs and the body against both the horizontal and vertical forces. Therefore, models based on the strength of the arms are used for exploring the vertical component of an opponent's blow exerted on the swordsman. These models consider the moment of inertia, M, on the outstretched arms of a swordsman. Figure 25 shows a segmentation model for the arm holding a sword. This model is called a segmentation model because it divides the arm into two segments, the upper arm and the forearm. Each segment is analyzed individually by summing up the forces and moments. The first situation that we are going to examine relates to a low blow parry being used to counter a high blow in Meyer.
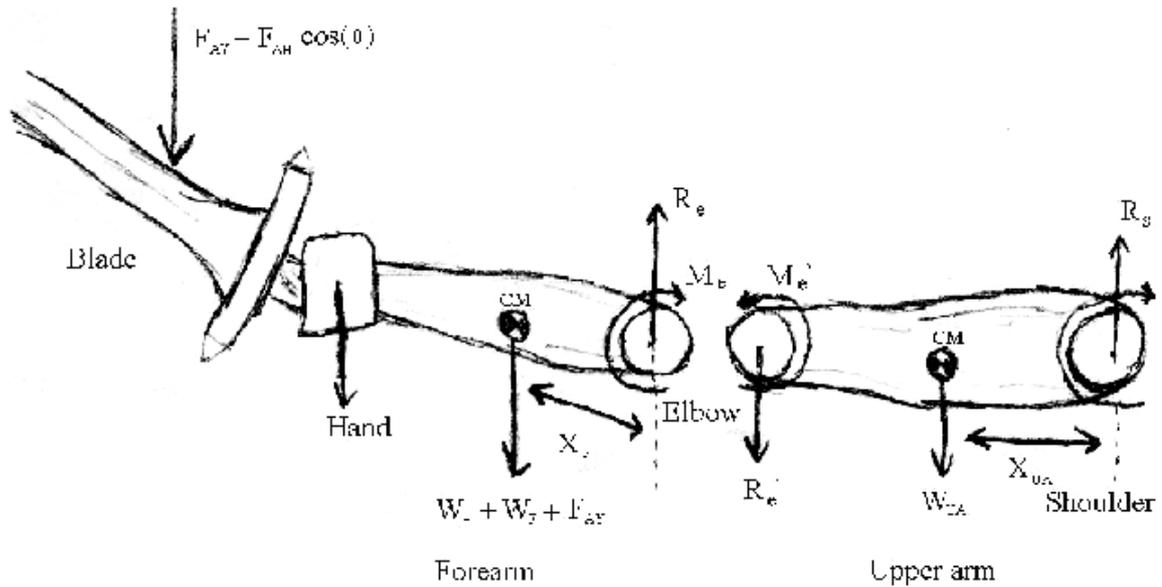
Figure 25: Segmentation Model of an Arm Holding a Sword

First, the forearm segment is dealt with. The forces are summed as the vertical component of the attack force, FAY, the weight of the blade and the weight of the forearm, which are all negative as these forces are directed vertically downward. This vertical component of the attack force, FAY, is found by $FAH*\cos(\alpha)$, using the same FAH as in the model above. The forearm reacts with a normal force in the positive direction, Re, to keep the forearm raised and in equilibrium. The equation describing the sum of these forces is then:

$$\Sigma\, F_{forearm\ segment} = -\, F_{AH}*\cos(\alpha) - W_B - W_F + R_e = 0$$

Moment of inertia describes a rotational force, and is defined as force multiplied by the distance between an axis of rotation and the point at which the force is applied. Summing up the moments, the weight of the sword and the vertical component of an attack from an opponent are multiplied by the distance from the elbow. The weight of the forearm is multiplied by the distance from its center of mass to the elbow. These moments act negatively against the moment that the elbow exerts to maintain equilibrium as in the equation:

$$\Sigma\, M_{forearm\ segment} = (-W_B - F_{AH}*\cos(\alpha))*(x_B) + (-\,W_F)*(x_F) + M_e = 0$$

M_e could originate from either F_{bicep} or F_{tricep} above, depending on the orientation of the forearm with respect to the incoming attack. Figure 26 shows an example where M_e originates from F_{tricep}.
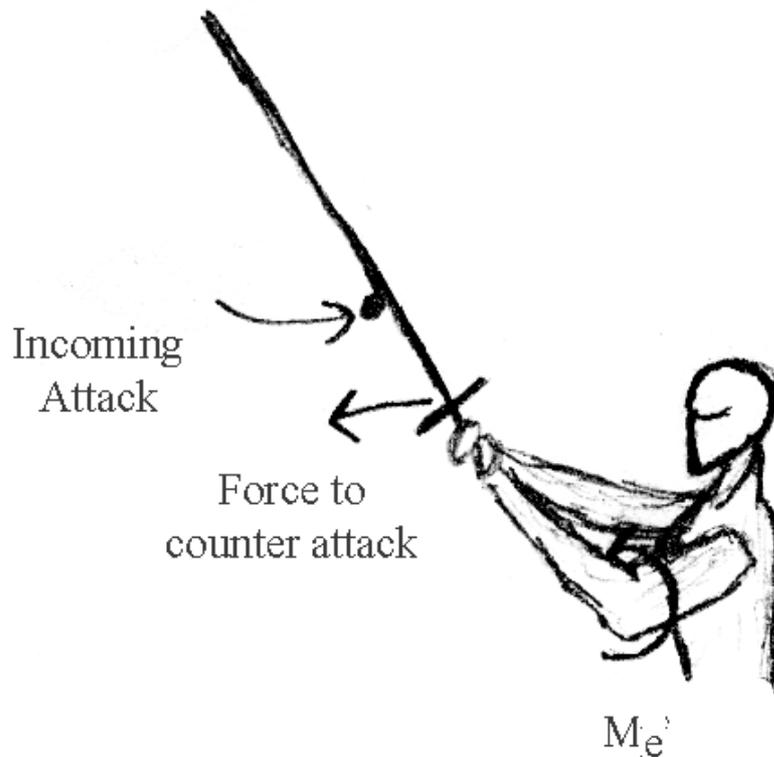
Figure 26: Origin of M_e

Next the upper arm segment is dealt with. The forces are summed as the overall downward force of the forearm segment, R_e` and the weight of the upper arm, which are all negative as these forces are directed vertically downward. $R_e$` is the negative force in relation to R_e because it is oriented in the opposite direction. The upper arm reacts with a normal force in the joint, R_s, in the positive direction to keep the upper arm raised and in equilibrium. The equation describing the sum of these forces is then:

$$\Sigma\, F_{\text{upper arm segment}} = -R_e` - W_{UA} + R_s = 0$$

Summing up the moments, the weight of the forearm segment is multiplied by the distance from the shoulder. The weight of the upper arm is multiplied by the distance from its center of mass to the shoulder. These moments, along with the moment of the elbow, act negatively against the moment that the shoulder exerts to maintain equilibrium as in the equation:

$$\Sigma\, M_{\text{upper arm segment}} = (-R_e`)*(x_e) + (-W_{UA})*(x_{UA}) - M_e` + M_s = 0$$

Ms originates from the force that the shoulder is able to exert in a rotational direction. The shoulder is capable of exerting about 70lbs (31.5kg) vertically upward, generated from our experiments.

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For these models, only one arm was modeled using segmentation analysis. It should be pointed out that in practice, both arms are holding the sword and therefore share the forces exerted on the sword by an attack and by the sword's weight. So, for the above equations, the attack force, FAH, should be divided by two and the weight of the sword, WB, should be divided by two to better model the forces and moments acting on one arm.

Attacks with a downward swing, that is, with a vertical component pointing up from the ground, are modeled differently. The vertical component is found using the same trigonometric principles as was used to find the horizontal component. The force that the swordsman exerts against these blows is created by a fraction of the swordsman's weight plus the force that he exerts downward against the opponent's upward blow. In the case of failure, the swordsman's arms would give in a similar way as described above with the arm models. An example in Meyer of such a case would be when a low blow parry is being used to counter a high blow.

Stepping with the Blow

When talking about the blows (11r) and the guards (5v), Meyer talks about stepping into or away from the action in order to make the swordsman open to swing or position the sword. There is more to stepping than just placing the swordsman in an open position: much of the force that is put into a blow comes from the step. Also, with the guards more force can be successfully accepted by stepping back away from the blow. This aspect of stepping back goes back to our discussion of foot placement. The reason to step back is to get the swordsman in a position where he is most stable.

The more complex situation comes from stepping into a blow. When the swordsman steps into a blow he is creating a momentum toward his opponent. The greater the momentum put into a blow, the more forceful the blow will become. The momentum of the attack, P_A, is generated by the weight of the swordsman, $W_{swordsman}$, and the velocity created by stepping, V_{step}.

$$P_A = W_{swordsman} * V_{step}$$

Greater momentum can be achieved by using the rear leg to push the swordsman faster into a blow. The point at which the greatest amount of force occurs is just as the stepping foot is placed back on the ground. Ideally this point is where you would want to make contact with the opposing swordsman. In Meyer's words:

…every blow must have its own step, which shall take place at the same time as the blow… (23v)

Once that foot is firmly on the ground, some of the velocity component of the momentum gets taken away because the swordsman needs to stop himself to maintain stability and essentially remain standing.

History of the Long sword

Introduction

The use of the long sword required the knowledge of several techniques and moves. In 1570 Joachim Meyer published a fighting manual that taught the use of the long sword as well as other weapons. This publication is probably the most complete long sword fighting document known. It contains detailed descriptions of attacks and their corresponding defenses. To interpret Meyer's manual using biomechanics however we need to look at the long sword itself more closely and its history.

The long sword when it first appeared was used as a cutting weapon but became a thrusting weapon as well from the 14th century onwards (Michael Coe, p44). Because swords have a unique shape which doesn't allow too much variation or it looses its purpose, the development of the long sword was slow. Hilt, pommel and blade developed independently and almost any pommel can be found with a certain blade or grip, making it difficult to give long swords a chronological order. Each piece of the long sword has to be looked at separately as they changed independently (Claude Blair, p1).

There are two slightly different types of long swords, one being a hand and a half sword and the other one being a two handed sword. The hand and a half sword, which appeared before the two hander, can be used with either one or two hands. There is room on the grip for barely two hands but the sword can still be used effectively with only one hand. The two handed sword on the other hand has a grip which will fit two hands and requires the use of both hands to be effective.

1200-1300

Swords which are considered long swords because of their use and structure first appeared in the mid 13th century (Michael Coe, p44). The average length of the two-handed sword was 25 to 40 in. and grew to 45 to 55 in. towards the end of the 13th century (Claude Blair, p2).

Quillons

Most swords had long straight or slightly arched quillons in the period 1100 to 1350 (Claude Blair, p3).

Hilt

From the mid 13th century onwards the hilt or grip was long enough to grab with two hands if required. This gave the user the option to use the sword as a more powerful thrusting weapon instead of mainly a cutting weapon (Claude Blair, p2). The grip was usually made up of two pieces of wood wrapped by leather and wire but more valuable kinds of variations also existed (Claude Blair, p1).

Blade

13th century swords became more and more thrusting weapons instead of just cutting weapons. There is evidence that swords were used as thrusting weapons as early as the third quarter of the 13th century. It is believed that the increase in plate armor contributed to the long sword being used as a thrusting weapon. The exact forms of the blade are however not known (Claude Blair, p2). Blades were made sharper to make up for the increase in armor that was used. (Richard Akehurst, p7).

Pommel

From 1150 onwards many pommels were mushroom or tea-cosy shaped. Some swords also had lozenge shaped pommels. Most of these shapes were used until the third quarter of the 13th century (Claude Blair, p2).

The most common pommel shape was the wheel, which was widely used starting 1150. The wheel developed from just being a narrow disc to having chamfered borders to each face around 1200. The pommel became thicker after 1250 and the chamfer was usually concave (Claude Blair, p3).

1300-1400

Early during the 14th century two handed swords started appearing which required using both hands for an effective blow (Michael Coe, p44). These long swords were usually 60 to 70 in long and weighed 5 to 8 lbs. The two-hander was not as hefty as it looked but its use was considered a special skill and usually resulted in extra pay (Michael Coe, p48).

Quillons

14th century quillons or cross guards were either straight or curved. Curled ends however aren't found until the end of the century. The guard was thicker in the middle starting in the 14th century. This gave the swords the ability to receive harder blows on the cross guard and not break (Michael Coe, p45).

Hilt

From around 1400 some hilts had a hock shaped branch which protected the swordsman's fore finger (Claude Blair, p4).

Blade

Blade forms of the second quarter of the 14th century were sharp pointed, with either diamond or hexagonal shaped cross sections (Claude Blair, p2).

Pommel

Triangular and wedge shaped pommels with the narrow end towards the grip started appearing in the second quarter of the 14th century (Claude Blair, p3). Spherical and cubed pommels however were rare (Michael Coe, p46). After 1450 the pommel returned to the simple disc shape with lenticular cross section. A lot of wheel pommels used in the 14 century were polygonal (Claude Blair, p3).

The triangular pommel consisted of a simple flat triangle with truncated apex on top. It turned into a kite shape in the 3rd quarter of the 14 century and kept the shape until 1400 (Claude Blair, p3).

1400-1600

After 1400 not many changes occurred to the long sword. Some special variations like wavy blades did appear but most swords looked very similar to the swords of the previous century. Some pommels from previous centuries also started reappearing on swords. The use of the long sword diminished after 1600 when other more effective weapons appeared.

Quillons

From 1475 onwards many swords had upward curving quillons and became more often scrolled around 1500 (Claude Blair, p3).

Blade

In the second quarter of the 15th century a special form which was triangular or square cross sectioned known as the estoc appeared. This sword was used widely used in the cavalry (Claude Blair, p2).

In the late 15th century some long swords also started having partly or fully wavy blades with a second cross bar. The second cross bar is located about 1 foot from the top of the blade and is about ¾ of the length of the main cross bar. This type of blade's main purpose was to not enter the opponent's body too deeply preventing continued battle (August Demmin). It may have also served as a second protection against a very hard hit.

Pommel

After the 15th century the triangular pommel's sides became concave and the base became more convex. This was very common until the end of the 15th century. Another shape formed like a lozenge with concave sides developed into a pear shape by the end of the 15th century (Claude Blair, p3).

The conical or scent stopper shape is a polygonal cross section with truncated apex of the top and the base domed. This shape appeared in 1350 and evolved into a pear shape as well after 1450. The original shape was very popular at the start of the 15th century (Claude Blair, p3).

Other Resources

Meyer Foot Placement Examples
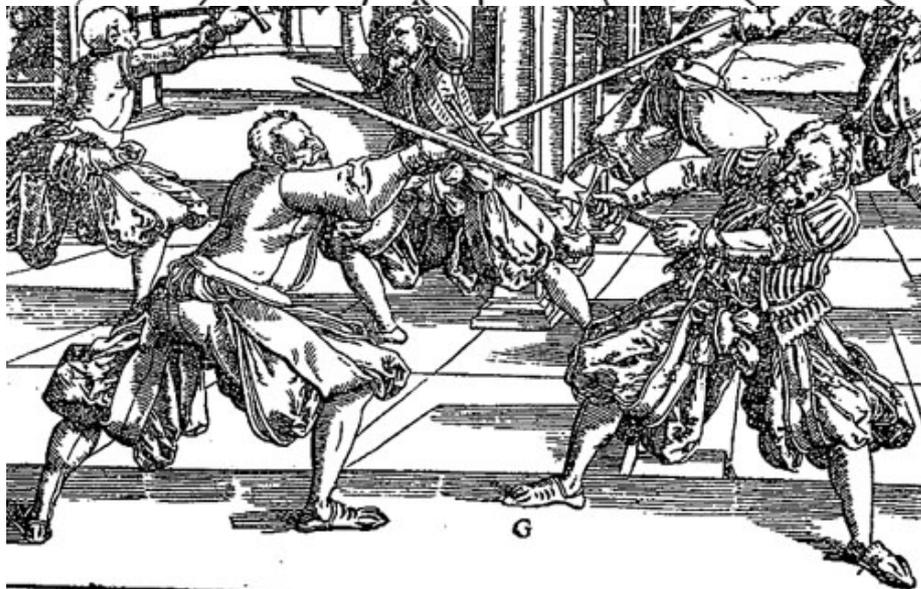
Images depicting foot placement in Meyer's style

Fiore dei Liberi, *Flos Duellatorum (1410)*

Background to the Text

Fiore appears to be a skilled swordsman. He studied the art of using the sword, the lance, the dagger, and wrestling techniques. His studies include both foot combat, and combat on horses for all the weapons previously mentioned. He learned his techniques mostly from Italian masters, but was not limited to the Italian style. He also studied with some foreign masters. He wrote the book for the purpose of teaching the art of swordsmanship and fighting on a horse. Fiore also realized that this would be an important tool for the survival of this type of fighting. By survival, I believe that Fiore was referring to the continued practice, and knowledge of the art of fighting with these weapons. In the book, Fiore only describes those techniques that he saw, used, or created. He chose to leave out the least safe techniques.

The Weapons

In this book Fiore describes techniques of wrestling, techniques using swords, lances, daggers, and pole axes for both foot combat and combat on horses. For the purpose of this analysis I will be concentrating on the techniques described by Fiore that use the long sword.

Text and Illustrations

The text and illustrations that are presented in this book appear to be the author's own work. The illustrations are generally crude and don't accurately represent the ways in which most people's bodies can maneuver. This inaccuracy is especially apparent when the swordsmen are in close combat. There are some instances where it seems like the people in the pictures don't have any joints and their limbs are made out of rubber.

Technique Analysis

Stance

By studying the pictures in Fiore, I noticed that most of the techniques used the same stance. The stance most commonly depicted by Fiore is where one foot is placed diagonally in front of the other foot. In most cases, both of the swordsman's feet were pointing towards the opponent. On some occasions, the back foot is turned sideways so that it is perpendicular to the front foot.

I get the impression that the change in foot position is used to gain some extra balance when executing a particular technique. The knees of the swordsmen are bent slightly in most of the pictures in Fiore.

The upper body changes more often than the lower body does, although it still appears to only have two basic positions. When the swordsman is attacking their opponent their upper body is turned sideways with their shoulder pointing towards the opponent. This is especially apparent during thrusting attacks. During these types of attacks the swordsman will lean over their rear foot and pull back the sword with both arms. This position then allows the swordsman to put their whole body into the thrusting movement. The other common position for the upper body is to have the chest facing towards the opponent. This position seems to be mainly used during defenses.

The pictures in Fiore support this hypothesis, but I feel that there was more of a twisting motion being executed during the parries and other defenses. Since Fiore only seems to present snapshots of the techniques I suspect that the position where the chest is facing the opponent is just a depiction of somewhere in the middle of the movement. I would imagine that having your chest facing your opponent would be a very dangerous position because it leaves the defender very open, and gives the attacker a large target. The upper body is generally shown as being held in an upright position. There are some instances where the weight is being shifted forward or back, in small amounts. I interpret these movements as allowing the swordsman to put more force into an attack, or letting them better avoid an attack. However, I would imagine that shifting the upper body too much would result in the swordsman becoming off balance, making them unable to maneuver their weapon and making it very easy for the opponent to take advantage and knock the swordsman to the ground.

The same stances are used in both unarmored combat, and armored combat.

Guards

Fiore portrays about a dozen different guards, starting positions for attacks and defenses (Carta 17 B – Carta 17 A / p.152 – p.155). The main distinction that I see with the different guards is the placement of the sword. Along with the placement of the sword comes a certain body position to maintain balance, but I would think that the body position naturally goes along with the sword position.

There are both defensive guards and attacking guards. Some of the defensive guards include the Proud Woman's guard, which is used to defend against thrusts. There are also a couple of variations on this guard, such as the Proud Woman's guard upward. Another defensive guard is the Iron Door position. It is used to parry cuts and thrusts as well. The remaining guards are mostly used for attacks, but some of them can be used to defend. The attack guards position the swordsman in such a way that it makes it easy for them to make quick cuts and thrusts. The thrusts are generally made toward the chest and throat of the opponent. Often the swordsman will go right back to the guard after they strike. Some examples of offensive guards are: the Boar's Tooth, the Long position, the Front position, etc.

Footwork

Fiore neglects to describe the footwork used to execute the techniques that he discusses. Since the foot positions seem to be the same throughout the techniques, I have come to believe that the swordsman generally moved by shuffling in the direction in which they desired to move. Another possibility that I have considered is that they may have pivoted on one foot. The pictures in Fiore sometimes show the left foot as the leading foot, and other times the right foot. These examples support my pivoting hypothesis. Also, I would assume that by pivoting it would allow them to move faster than shuffling, allowing the swordsman a better chance of avoiding attacks and a quick method of counter attacking. Due to these limited movements, I would say that the combats were most often fought in a linear pattern.

Attacks

There are several different manners in which a swordsman attacks their opponent. An important attack is one that is a direct followup from a defense. In other words, most of the attacks occur almost simultaneously with a parry or some type of block. Executing attacks in this

manner kept the combats very fluid and intense. This attack seems to be a key to being a good swordsman. By looking through Fiore, I get the impression that it is probably the most common type of attack. Another common attack is where the swordsman swings the sword at the opponent in a cutting motion. These attacks are generally aimed at the head or midsection. With this weapon, this attack could be very deadly because it was such a large powerful weapon. This type of attack could be executed using the blade of the sword, or in some cases the hilt or pommel. Thrusts were also very important attacks. They usually targeted the upper body of the opponent. These seem like they would probably be a finishing maneuver, or death blow. The swordsman would crouch back a little on the foot that is set further back, and then lunge forward towards their opponent. This attack was very forceful because of the great momentum that a swordsman could build up by putting all of their weight into the attack. For this maneuver, the point of the blade was the part of the sword being utilized. Another common attack was one in which some grappling was involved. This attack was used in close combat, and it had many possibilities. For this type of attack, the swordsman would use their free hand to grab the opponent, and make it so that they were unable to maneuver as well. At this point the swordsman would just try to strike the opponent. They would use any part of the sword that they could to make some sort of contact with just about any part of their opponent's body. It seems like the most common parts of the sword to use were the hilt and the pommel and they were generally aimed at striking the head of the opponent.

Defenses

There are several different ways in which a swordsman defended attacks made by their opponent. When the swordsman was defending against thrusts and cuts, they would generally use the blade of their own sword to try to parry the opponent's attack. This defense appears to be a very effective maneuver. A good swordsman will always try to use this type of defense in combination with an attack. They will try to make it so that as they block the opponent's attack they are putting themselves in such a position that they are able to immediately attack. I would imagine that the ability to use this technique well is a great factor in giving one swordsman an advantage over the other. Another main type of defense was to be able to use their free hand, the hilt, or the handle of the sword to redirect an oncoming attack. A swordsman would sometimes use their free hand to redirect a thrust or cutting move, but I didn't see many examples of this technique in Fiore, and I would guess that it would be a very dangerous method of defense. This defense was mostly important during close combat. It appears to be an effective defense, but I think that it probably involves a greater level of skill than the parries using the sword do. A third important defense is the ability to get out of the way. The swordsman can pivot on one foot allowing them to move quickly and possibly allowing them to completely avoid an attack. I imagine that a really experienced swordsman could probably be able to anticipate certain attacks during a battle, which would allow them to get out of the way of the attack and put themselves in a position to strike.

Targets and Purpose

The attacking techniques that Fiore depicts in his book mostly target the head, neck and chest. He says that the attacks are never aimed at hurting the hands, but rather the thrusts are always aimed at the body from the knees upward (Carta 12 B / p. 142). This is true for unarmored combat, but when he starts talking about armored combat there are a few instances where the technique is meant to hurt the opponent's hands, or knock the opponent down by striking low on the legs. During armored combat less focus is put on the chest as a target, probably due to the amount of protection that it has. Most of the techniques are to try to get under the armored plating of the neck and face, as well as the armored joints of the arms.

Judging by the targets of most of these attacks, I believe that they were mainly intended to cripple and in many cases kill the opposing swordsman.

Distance

The distance at which opposing swordsmen fight changes throughout the battle. There are many techniques where the swordsmen are fighting at a distance which seems to be equal to that of a sword length. There are just as many techniques where the swordsmen are within an arm length of each other, or closer. When the fighters are further apart, they use the blade of the sword, swinging it in cutting motions. I would say that eventually there arises an opportunity for one of the swordsmen to move towards the other. This opportunity would bring the swordsmen closer together and they would now have to adjust their fighting style. When in close combat, the hilt and pommel of the sword are put more to use. Also, only one hand is usually left on the sword while the other hand is used to grapple with the opponent. At some point during this close combat the opposing swordsmen probably push off of each other, at which point they would go back to being further away from each other. For this reason, I believe that a combat would usually consist of these varying distances.

Combat Sequences from the Text

Fiore doesn't present any combat sequences. All of the pictures depict a snapshot image of the technique, and the descriptions describe the purpose of the technique. There doesn't appear to be any type of progression from one technique to another forming sequences.

Artifacts

The following five artifacts from the Higgins collection were examined and compared to the findings on the artifact document. Each sword was also photographed and has a short description. The descriptions of the swords are summarized descriptions from the HAM artifact database.

Higgins Armory Collection

Item# 2483

DESCRIPTION: Steel. Long double edge blade of flattened hexagonal section, expanding gently to triangular point. Long rectangular ricasso with pair of pointed lugs. Broad iron crossguard curving gently towards blade with voluted terminals & projections. Pair of large open side rings with trilobated, pointed & voluted projections within. Guard is blackened with chiseled crescents & filed notches. Restored black wooden grip with 3-stage molding at mid-height. Mushroom-shaped iron pommel, cut into 4 vertical facets, colored & decorated to match crossguard. Late 16th or early 17th century. German.

Although not as heavy as it looks, this sword definitely requires the use of both hands and is considered a two handed sword. The hexagonal blade and the pommel shape were common place in the late 14th century onwards. The second cross guard also appeared on many swords from the 15th century onwards. It is believed to be used to protect the user's hand if he holds the blade while receiving a blow. The curved quillons were common starting in the early 14 century but the scrolled ends didn't appear until the late 14th century. In the 15th century and beyond the scrolled ends of the quillons became very popular.

Item# 2964.2

DESCRIPTION: Double edged blade tapering to acute point with wide shallow fuller on each face to about half length where blade becomes lenticular in section. Remainder is flattened hexagonal in section. Blade possibly cut-down bearing sword with brass inlaid "running wolf", cross, etc. Hilt modern, of blackened iron, straight guards, expanding to ends, with 2 sets of concentric triple side rings. Leather-covered asymmetrical 2 stage grip with raised bands. Conical pommel tapering to base with incised leafed decoration above. German, 15-16th century.

This sword also appears to be a two hander because of the size of the grip. The straight quillons are uncommon for the 16-17th century since most were curved upwards. Carvings however has quite common in later periods. The marking of the "running wolf" seems to also be from a later period as it is more stylized.

No #75

DESCRIPTION: Steel double edge flattened hollow-ground hexagonal section blade tapering gently at about 1/2 its length becoming lozenge section to spear point. Both forte faces have brass-inlaid stylized "A" crossed at its apex. Restored crossguard, arms curving towards blade & expanding into squared terminals. These are deeply chisel-roped on obverse. 2-stage wooden grip wrapped in dark brown leather with spiraled cord beneath. Iron square, flattened hexagonal section pommel with traces of black paint. Pommel possibly from 15th c. Italian sword. Restored composite probably done in 19th c. German, 15th-16th century.

This piece is a one and a half sword as there is room for two handed use but the sword is small enough not to require two hands at all times. The sword is also blade heavy which would indicate two handed use. The square pommel is very rare on swords of this period. Most pommels where triangular or wedge shaped. The quillons are typical for the age of the sword. Upwards curving quillons started appearing in the early 14th century and were common on swords in the late 14th century. The engraved "A" may be a marking by the sword smith or a custom request by the owner.

Item# 1199
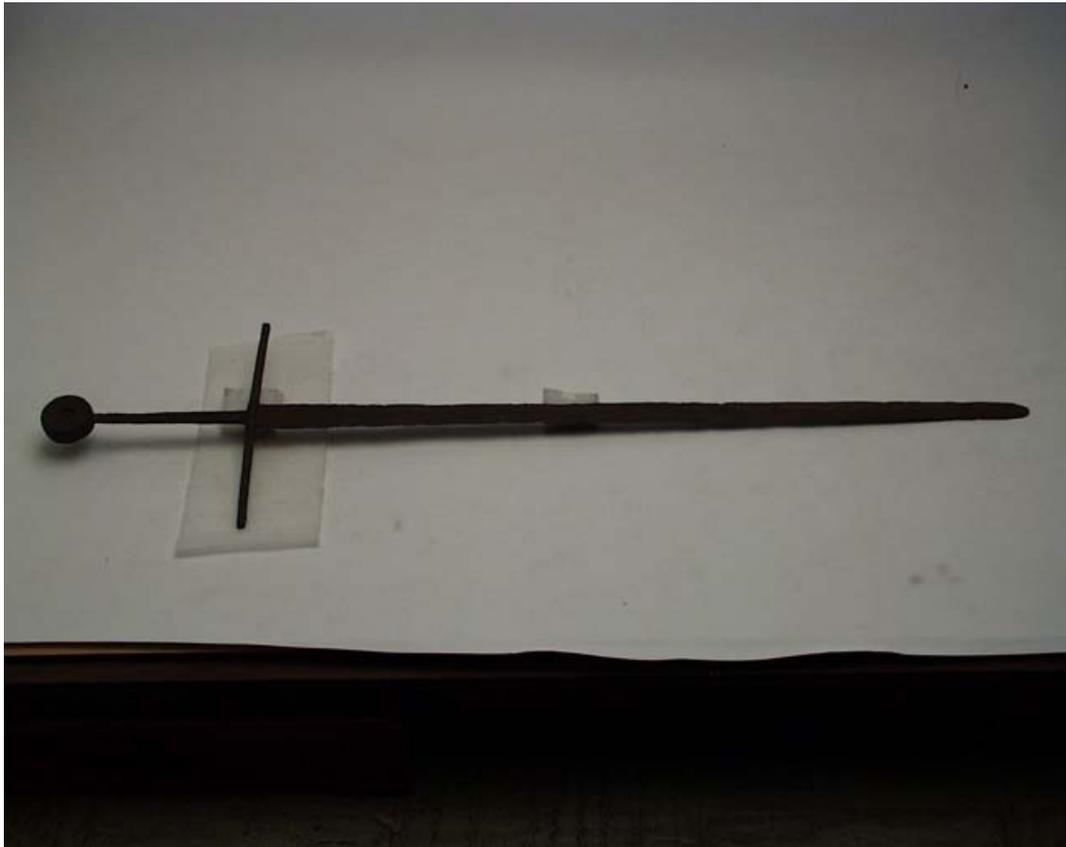
DESCRIPTION: Long, slightly tapering blade, double-edged of flattened, hexagonal section over its length. Straight crossguard of rectangular section slightly bent toward the blade. Long tang with thick discoid pommel without button. Faces of pommel have circular recess with raised dot in center. No marks visible. This sword is believed to be central European and from about 1360-70.

This sword has a very simple shape which is common for its date. The quillons are not curved which would not be expected for a late 14th century sword. The flat disc-shaped pommel is also very simple for its period.

DESCRIPTION: Excavated. Triangular, cut-and-thrust double-edged blade, tapering uniformly to acute point. Flattened hexagonal section with wide medial fuller on both faces, fading out just below half of length where blade essentially elliptical section to point. Wide crossguard of rectangular section, without taper, having straight terminals. Arms gently curved towards blade. Long, strong tang of rectangular section, parallel-sided over 3/4s of length whence tapers into pommel through which it passes & is peened at end. Thick, heavy, discoid oval pommel flattened at ends, with chamfered edges. German or Swiss, 1350-1425

This hand and a half sword has slightly curved quillons which would be expected for a sword during the late 14th century. The three slashes on the pommel and on the blade probably were markings that were made during production to ensure that the pommel is attached to the matching blade.

Wallace Collection Images

Plate 105 · MEDIAEVAL SWORDS. IXTH–XIVTH CENTURIES

Plate 107

Plate 106 · LATER MEDIAEVAL SWORDS. XIVTH–XVTH CENTURIES

Plate 108

Plate 109

HAND-AND-A-HALF SWORDS, GERMAN (MUNICH), XVITH CENTURY.
CALENDAR SWORD, GERMAN (SOLINGEN), XVITH-XVIITH
CENTURY; AND TWO OTHERS

Plate 109

EARLY RENAISSANCE SWORDS, AND A FALCHION WITH THE ARMS OF
MEDICI. XVITH CENTURY

Plate 110

TWO-HAND AND OTHER SWORDS
TWO GROTESQUE VISORS, XVITH CENTURY

Plate 114

83
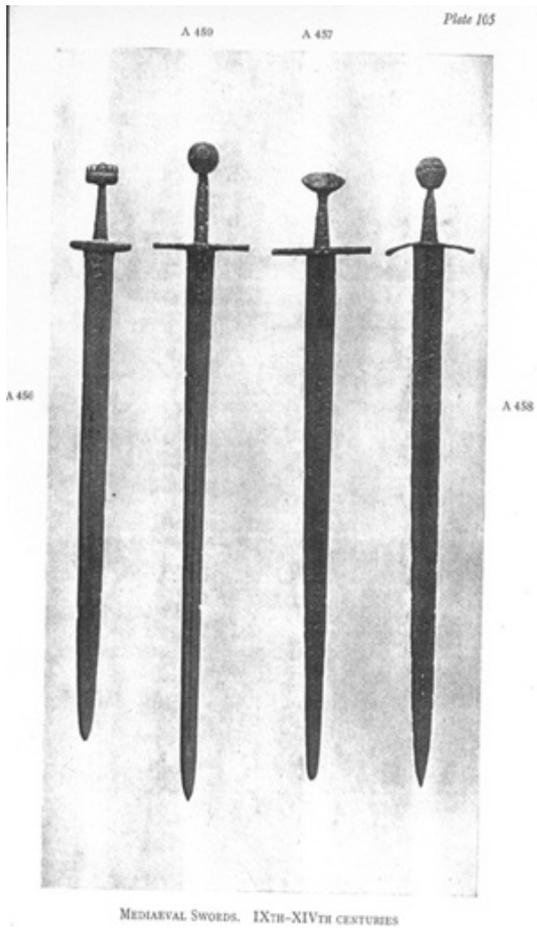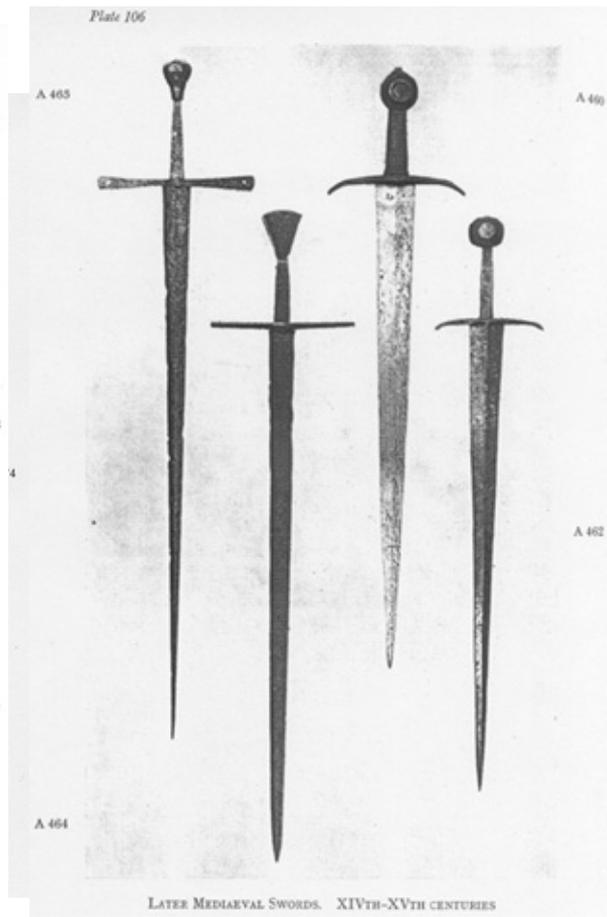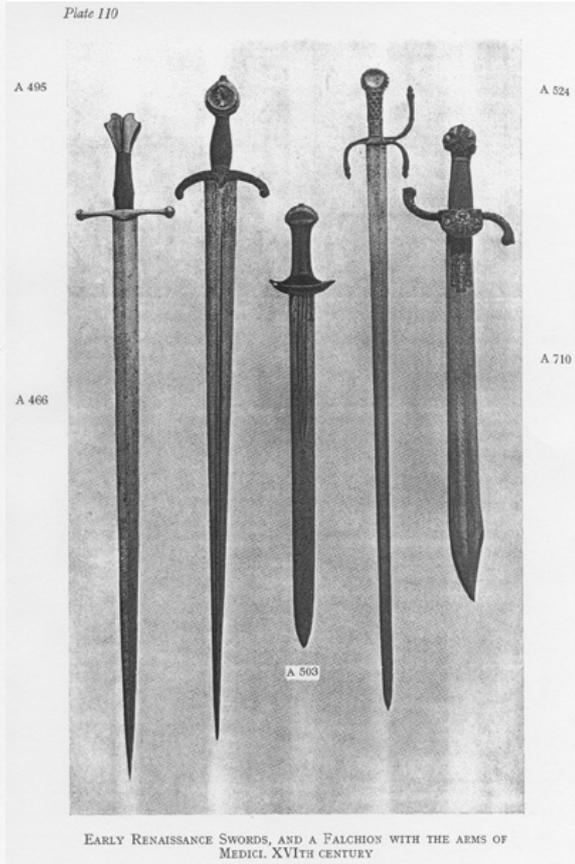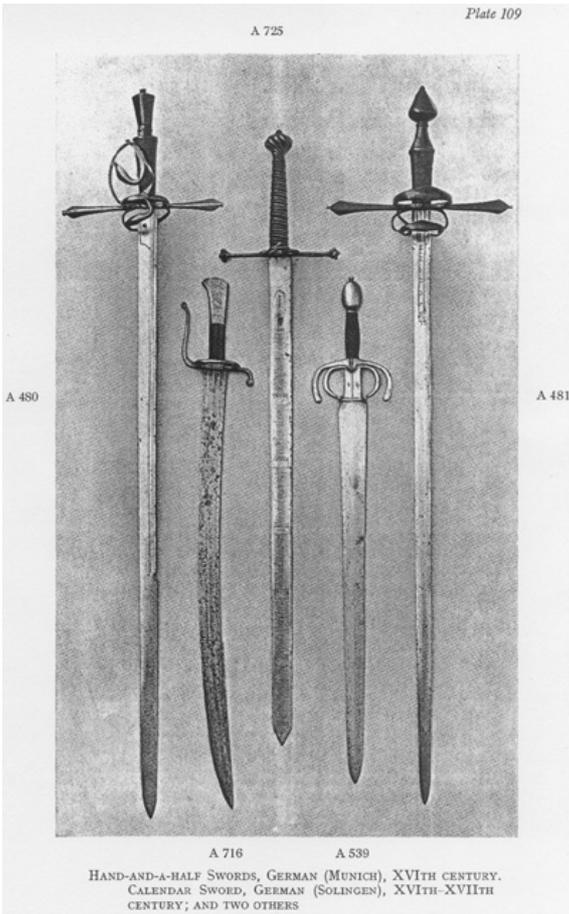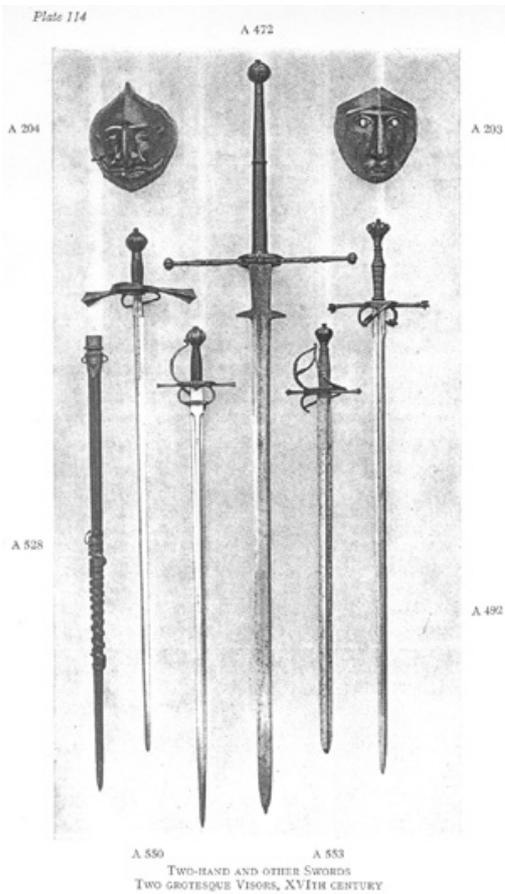
History of Metallurgy

The metal that a sword can be made out of has varied throughout the entire existence of the sword. Some of the early swords were made of bronze (although there were swords of different metals before this "bronze age"). Bronze is an alloy of copper and tin that is harder than iron, has a relatively low melting point that allows it to be cast easier, and is more resistant to corrosion than iron. However it was iron that eventually became the metal of choice for the sword blade. The benefit of iron was that it was much more readily available. It is also a more ductile metal meaning that it would not shatter as easily as bronze would. However, this is also a disadvantage because a soft metal does not hold a sharp edge for too long. Sword smiths eventually found that if iron was heated in the presence of leaves, grass, twigs, or other such objects they could increase the hardness. (Agricola. *De Re Metallica*. Book IX P423) What they were actually making was the metal known as steel, a combination of iron and roughly 2 percent carbon (plus some other trace elements).

Steel is formed out of a lump of raw iron ore. There are several steps to get from the ore to the finished product and many ways of performing those steps were used over the years. An ore is a material the contains a metal in such quantities that it can be mined and worked. In an ore, the metal is usually contained in chemical combination with some other element. In all commercial iron ores the metal occurs as an oxide, a carbonate, or a sulfide. Converting iron ore into a form of useable iron is called iron smelting. There are many different forms of iron and steel the main classes being pig iron, wrought iron, Bessemer steel, open-hearth steel, crucible steel, alloy steel, cast iron, and steel castings. For our research we are mostly concerned with pig iron, wrought iron, cast iron and crucible steel.

Pig iron is the product into which the iron ore is first converted in a blast furnace. Iron ore is placed in a blast furnace along with limestone, which is used as a flux[1] and melted with either coke[2], or charcoal used as fuel. The metal obtained is "pig iron." It is drawn from the furnace and cast into small bars, known as "pigs." It is from this that most other types of forged iron and steel are formed.

In the making of wrought iron, pig iron is melted in what is known as a puddling furnace, in which most of the remaining undesirable elements are separated from it, forming a puddle. The temperature of a puddling furnace is kept high enough to melt pig iron but not high enough to keep the wrought iron in a liquid state. On account of this difference small particles of iron, when they have become free from impurities, will partially congeal, forming a spongy mass. This mass is divided into puddle balls or lumps weighing 200 pounds each, which are formed into "blooms" and then, while still hot, rolled into bars.

Crucible steel is made by adding carbon to wrought iron. Small pieces of wrought iron are placed in airtight crucibles containing the required amount of charcoal. This is then melted in a furnace and the metal cast into ingots, which are hammered and rolled to the required size. The

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[1] Flux is crushed stone which melts and either prevents the formation of oxides and other undesirable elements, or dissolves oxides and facilitates their removal
[2] a refined form of coal that is strong and almost smokeless

adding of carbon to wrought iron in order to convert it into steel gives the steel the property of being capable of hardening; that is, of assuming greater hardness if heated to a given temperature and then quenched in water or oil.

Cast iron is made from pig iron by melting the pig iron in a cupola furnace and adding certain percentages of cast iron scrap. It is then poured in the molten state into molds shaped according to the required size and form of the castings it is desired to make.

According to one of the older texts on metallurgy, *De Re Metallica* by Agricola, the easiest and oldest method of iron smelting is the direct reduction of malleable iron from ore. The ore was smelted in a large crucible on a furnace. First charcoal was thrown into the crucible and heated, and then crushed iron ore mixed with unslaked lime was sprinkled over that. Then more charcoal was thrown on, followed by more iron ore; this process was repeated until a pasty heap was produced. The mass was then cooled and hammered until all of the slag, the impurities of the ore, was removed and the iron was condensed and flattened. It was then beaten by a water powered iron hammer and cut into pieces small enough to be reheated by the blacksmiths. Basically this was the standard method at the time of roughly forming wrought iron.

Another method of iron smelting was used to make a form of cast iron. Using iron ore that melts when heated, they removed the metal and eliminated other substances, through the use of a large blast furnace. The furnace was filled with small lumps of ore and charcoal. The high temperatures of the furnace allowed molten metal to be yielded, allowing malleable wrought iron to be formed from the iron ore. The charcoal and temperatures would cause the earthy materials to form a separate material called slag; this would float near the top while the partially reduced iron gathers at the bottom. This is the cast iron, which when drained and cooled is generally brittle, fusible, and has variable properties.

In the 1700s they began seeing the relationships between iron ore and charcoal and in the type of cast iron they formed, as seen here in an excerpt from *On the different metallic states of Iron.* (1768)

> The white cast iron is brilliant in its fracture and is crystallized in large facets; it is harder and more fragile than the others. It is never used for works that must resist a certain stress.
>
> Gray cast iron, whose fracture is matte and grainy, is more flexible than the preceding one and is more easily cut. This substance is also crystalline, but it crystallization is more confused.
>
> Finally black cast iron is even more rough in its fracture; it is composed of less adherent molecules, which crumble more easily. It has no use other than to be remelted with the white cast iron.

These three states of cast iron have no relation to the qualities of the wrought iron. Whatever color the cast iron may be, it is impossible to judge from a glance the nature of the wrought iron that will be obtained from it; and whatever the nature of the ore it is always possible to give to the cast iron whichever of the characters is desired. If in the smelting of the ore as little of the charcoal is used as possible, the cast iron is white; it becomes gray when the amount of charcoal is significantly increased in charging the furnace; and finally becomes black when the use of that combustible is greatly increased. Thus charcoal is the only cause of the

color shown by the fracture of cast iron and largely determines its imperfect ductility and the greater or lesser ease with which it's machined.

Their main fault was that in explaining the difference between the irons, they did not even notice that the main distinction was a structural one, namely whether the carbon was present in the elemental state of graphite or whether it occurred in crystals of iron carbide.

Also described in *De Re Metallica* is the process for making steel by cementation. A large crucible and bellows are set up, so that the nozzle of the bellows is directed at the center of the crucible. The crucible is then filled with high-quality charcoal and surrounded by rock to keep the iron and charcoal in place. When the charcoal has been kindled and the crucible is glowing, a mixture of iron and flux is poured into the middle of the crucible. Into the middle of this mixture is then added four masses of iron. This is then heated for 5 to 6 hours in an intense fire. Afterwards the mass is taken and pounded on an anvil, and quickly tempered with water. When tempered, it is replaced on the anvil and broken into fragments. Out of the fragments pieces of iron that have been partially or wholly changed to steel are removed and broken up. These pieces are put back into the crucible and made purer. They are heated and each mass is removed and formed into bars. These are immediately placed in the coldest running water available. Being suddenly condensed the bars are changed into a more pure form of steel, harder and whiter than iron. The science behind cementation is that the iron has experienced at least the beginning of fusion; the bars have absorbed carbon for the charcoal in which they were packed. They are more brittle that they were before; their fractures are brilliant and no longer fibrous, which is the natural effect of the high temperatures they have undergone favored by contact with carbonous material. The iron has also changed in nature and composition, increased in weight, and its properties are changed. It has become a form of steel called blister steel due to its surface being covered with blisters and its mass shot through with cavities.

By the late 1700s the processes of refining steel had become even more of a science rather than a craft. They took the blistered steel and forged it to compact it by blows with a hammer and to hot-weld together the parts that the bubbles of effervescence had separated. This mechanical operation changes the texture of the parts of the metal, but does not give fibers to the steel, it gives it grain. After having being forged the fracture of the steel is no longer shiny, it is gray and granular. In being converted to steel, not only does the iron become harder and more brittle but also it becomes fusible.

There was a lot of superstition and lore passed down from master to apprentice surrounding steel making, methods that people knew did a certain thing but they didn't know why, so the methods were often full of ideas that worked but were odd and unrefined. This is one method for hardening iron from a pamphlet printed in Nuremberg in 1532:

> Take the stems and leaves of vervain, crush them, and press the juice through a cloth. Pour the juice into a glass vessel and lay it aside. When you wish to harden a piece of iron, add equal amount of a man's urine and some of the juice obtained from worms known as cockchafer grubs. Do not let the iron become too hot but only moderately so; thrust it into the mixture as far as it is to be hardened. Let the heat dissipate by itself until the iron shows gold-colored flecks, then cool it completely in the aforesaid water. If it becomes very blue, it's still too soft.

Many odd items and ideas were used to change the hardness of iron and make steel. The instructions in the pamphlet tell of many things that can be distilled in ordered to make a mixture to quench the iron in: human excrement, red land snails, root of oxtongue, dragonwort and vervain, mustard and vinegar, human hair, varnish, juice of earthworms and dragons blood.

Recipes tell which items to mix to harden, soften, solder, and etch steel. The early process of hardening iron to steel was a single-stage one, an interrupted quench so that the steel came out of the bath at the desired hardness. Much of the mystery and concoctions were associated with this, because what they did know is that pure cool water cooled steel too fast. It may be that the organic matter in the bath also prevented too prompt a reoxidization.

We know now that quenching does not change the nature of steel, it does not alter the composition, it is a mechanical operation. The rapidity of the cooling, or the sudden retreat of the matter that held the molecules of the red-hot steel a certain distance apart from each other, leaves a greater energy to the force that brings them together. These molecules join together with a greater acceleration force that is less restrained. They come closer together and have a greater adherence to each other. But since the force that causes this only acts at insensible distances, the entire mass does not participate in the condensation. It retains a greater volume and a lesser density, it becomes more fragile. In hardened steel the contacts of the molecules are closer together but less numerous, the secondary elements are harder, and their adherence is less.

In Italy the book *De la Pirotechnia* was printed in 1540 by Vannoccio Biringuccio. It took a more scientific approach to making steel than some of the earlier works. Steel at the time was generally made in hearths by holding wrought iron in prolonged contact with the charcoal fuel, however this required a lot of skill, and because it was so difficult, in many smelting areas little steel was intentionally made. In *De la Pirotechnia* the author describes the secrets of using herbs and other items as discussed earlier, but in more depth and also somewhat more scientifically and described the color of the steel at different stages of tempering;

> Other secrets are the various tempering with water, herb juices, or oils, as well as the tempering of files. In these things, as well as in common water, it is necessary to understand well the colors that are shown and thrown off on cooling. It is necessary to know how to provide that they acquired these colors well in cooling, according to the work and also the firmness of the steel. Because the first color that is shown by steel when it is quenched while fiery is white, it is called silver; the second which is yellow like gold they call gold; the third which is blueish and purple they call violet; the fourth is ashen gray. You quench them at the proper stage of these colors as you wish the more or less hard in temper. If you wish it very hard, heat your iron well and quench it rapidly in the tempering bath that you have prepared or in clear cold water.

De la Pirotechnia was one of the first texts that could really be used as a guide and truly comprehensive book on metallurgy.

> Steel can be made from any kind of iron ore or prepared iron. It is indeed true that it is better when made from one kind than from another and with one kind of charcoal than with another; it is also made better according to the understanding of the masters. Yet the best iron to use for making good steel is that which by nature is free from corruption of other metals and hence is more disposed to melt and has a somewhat greater hardness than the other. Crushed marble or other rocks readily fusible in smelting are placed with this iron; these purify the iron and almost have the power to take from it its ferruginous nature, to close in porosity, and to make it dense and without laminations.
> Now in short, when masters wish to do this work they take iron that has been passed through the furnace or obtained in some other way, and break it into little pieces the quantity that they wish to convert into steel. Then they place in front of the *tuyère* of the forge a round receptacle, half a *braccio* or more in diameter, made of one third clay and two thirds charcoal dust, well pounded together with a sledge hammer, well mixed, and then moistened with as much water as will make the mass hold together when it is pressed in the hand. And when this receptacle has been made like a cupeling hearth but deeper, the tuyere is attached to the middle so that its nose is somewhat inclined downwards in order that the blast may strike in the middle of the receptacle.

Then all the empty space is filled with charcoal and around it is made a circle of stones and other soft rocks which hold up the broken iron and the charcoal that is also placed on top; thus it is covered and a heap of charcoal is made. Then when the masters see that all is afire and well heated, especially the receptacle, they begin to work the bellows more and to add some of that iron in small pieces with saline marble, crushed slag, or other feasible and nonearthy stones. Melting it with such a composition they fill up the receptacle little by little as far as desired.

Having previously made under the forge hammer three or four blooms weighing thirty to forty pounds each of the same iron, they put these while hot into a bath of the same molten iron. The masters of this art call this bath "the art of iron". They keep it in this melted material with a hot fire for four or six hours, often stirring it up with a stick as cooks stir food. Thus they keep it and turn it again and again so that all solid iron may take into its pores those subtle substances that are found in melted iron, by whose virtue the coarse substances that are found in the bloom are consumed and expanded, and all of them become soft and pasty. When the masters have observed this they judge that the subtle virtue has penetrated fully within; and they make sure of it by testing, taking out one of the masses and bringing it under a forge hammer to beat it out, and then, throwing it into the water while it is as hot as possible, they temper it; and when it has been tempered they break it and see whether every little part has changed its nature and is entirely free inside of every layer of iron. When they find it has arrived at the desired point of perfection they take out the lumps with a large pair of tongs and they cut each one in six of eight small pieces. Then they return them to the same bath to heat again and the add some more crushed marble and iron for melting in order to refresh and enlarge the bath and also to replace what the fire has consumed. Furthermore, by dipping that which is to become steel in this bath it is better refined. Thus at last, when these pieces are very hot, they are taken out under the forge hammer, and made into bars. After this while they are still very hot and almost white of color because of the heat, in order that the heat may be quickly quenched they are suddenly thrown into a current of water that is cold as possible.

Also mentioned in that text are the kinds of steel that are highly praised from different areas. A type called Valcamonica from Italy, and also the famed Damascene is mentioned along with guesses as to how the Damascene is made.

I do not know how those people obtain it or whether they make it, although I was told that they file it, kneed it with certain meal, make little cakes of it, and feed those to geese. They collect the dung of these geese when they wish, shrink it with fire, and convert it into steel. I do not much believe this, but I think they do is by virtue of tempering, if not by virtue of the iron itself.

Although early metalworkers had many different "recipes" for making steel, in their fundamental level they were all the same. Iron was heated in the presence of high-carbon materials allowing the iron to absorb the carbon and become harder. Some of the more relevant processes of steel production for the manufacturing of swords were those of making wootz and crucible steel.

Wootz was made by heating crushed iron ore heated by a charcoal fire in a cone shaped furnace. While being heated, the iron is separated from the ore and it forms a lump of metal. This lump is removed from the furnace and beaten repeatedly to remove any impurities such as coal from the fire. After this process it was reheated again and hammered while still glowing hot. This further purified the metal. While it was still hot, it was broken into smaller pieces that were put into crucibles with the aforementioned leaves, twigs, etc. and heated for a few hours at very high temperatures. These were then air cooled to form little "cakes" of steel (Gogan. *Fighting Iron*. P45). These cakes would eventually make it to the sword smiths where they were "hammer welded" into the actual blades. The process of hammer welding is for the most part given away by the name. Bars, or in this case, cakes, of steel are heated until they are bonded. Then they are repeatedly folded, hammered, heated, folded, hammered, heated, etc. until for all intents and purposes they were combined into one alloy. This would then be quenched (quenching is the rapid cooling of a metal) and occasionally treated with a weak acid to bring out the contrast in the different types of steel. This is shown well in the following picture:

2 cm
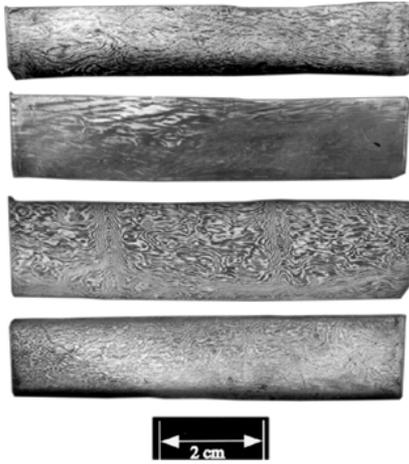
The reason these blades could perform so well (as in having both flexibility and rigidity) was that they were not composed of one type of steel. As is seen in the images, there are darker and lighter bands of steel. This is because of the differing amounts of carbon from one "cake" to another. This allowed the properties of the hard and soft steel to in essence be blended together, thus creating both a flexible blade and one that would hold an edge well.

Crucible steel is produced in nearly the same way as wootz is. Its difference is that it is created with wrought iron and carbon objects or previously carbonized iron. Like wootz, it is heated at very high temperatures in crucibles. But because it is heated in a closed environment, there are no impurities that are absorbed into the steel as it is formed. (Gogan. *Fighting Iron*. P47) This crucible steel could then be cut into bars and sent off to sword smiths where they would undergo the same process of blade making as with wootz.

There is further evidence that sword smiths obtained steel from a supplier rather than making their own steel. "Carburisation of iron is a slow process and it was not economical for the individual smith to produce his own steel, which was expensive and sparingly used. It was usually imported from Sweden, Russia, or Spain, since native ores were generally unsuitable for conversion during the medieval period." (Cowgill. *Knives and Scabbards*. P8). This is pertaining to a period that is before the industrial era, and deals specifically with knife blades. However, it is known that in this time period many blade smiths made blades for both swords and knives.

We have found many reports and methods of how to use steel from different ironworks differently. Steel from all of the regions of Europe had different properties and thus there was different advice as to how to forge with each and different techniques for quenching the different steels.

The common steel in France was Soret, Clamecy, or Limousin steel; sold in small square pieces, the texts I have found say that it was good for heavy pieces. But it was cheaply produced and therefore probably used more for plows and other farming implements. The recommended quenching process for this type of steel was to heat it to just beyond cherry red, douse the steel with salt and put it into fresh water until cold; this would generally yield a steel that was less likely to break.

Piedmont steel was reportedly good for forging cutting implements, but one had to watch to make sure the pieces didn't feel stiff when handled and there were no yellow-looking spots in a fracture, which was proof that the steel would be difficult to use. There is also mention of an alternative kind of Piedmont steel formed from an unusual method that was particularly strong and good for making things used for violent and forceful work. There are warnings about quenching this type of steel too hot, and ruining it.

Reports are that some of the best steel available was from Germany, called Carme steel or steel with a rose. It had a reputation for being of excellent quality and was used to make swords and other cutting tools. There are extensive instructions on how to quench this type of steel, probably because it was good quality and hence expensive, and it was imperative to do it right the first time. Recommended techniques include, greasing the blade or putting wooden shavings on it and allowing the grease or wood to burn on the piece before putting it into a running stream or river. The German ironworks in Innsbruck seem to be famed for making some of the highest quality iron. Why isn't clear but one theory is that it might be possible that the German iron-smelters had discovered the uses and properties of manganese, which hardens steel, without knowing it. Knowing only that when they mixed a certain type of rock into the steel in a certain way, better steel was produced.

You may find evidence of its appreciation even in Shakespeare's time in *Othello, "a sword of icebrook's temper."* In the early editions of the play the word is Isebrook which is the anglicized version of Innsbruck.

The Spanish ironworks were also reported to produce steel in large sized bars that took a lot of work to properly temper and quench. But the steel was good for a lot of heavy-duty tools such as anvils and heavy hammers. Also produced was another kind of steel from Spain called acier de Grain or acier de Mondragon. It was a preferred source of steel for the exterior parts of the Toledo blades.

The Weald of southeast England is largely in Sussex, Kent and Surrey. Ironstone in the clay formations was exploited for iron smelting from about the 2nd Century BC until early in the 19th century AD. In 1496 the first documented blast furnace was established in England, on Ashdown Forest in Sussex, and within fifty years the bloomery furnaces had been superseded by the technology of the blast furnace. Making use of water power derived from the many streams in the Weald, a massive expansion of the industry during the second half of the 16th century resulted in over a hundred blast furnaces and associated finery forges being established in the Weald, a number unequalled in any other region of Britain. In the seventeenth century reports are that the iron works in Sussex produced close to 8 tons of iron each "founday", a founday being about 40 weeks which was how long they kept the furnaces burning. The metal was cast into "sows" weighing 600lb to a ton. They then melted off a piece of the sow and beat it with sledges and treating it with water bringing it to a bloom, thus making a plate of iron approximately 33 sq. ft. It is unclear however, the size of plate delivered to the armorer or sword smith.

History of Sword Manufacturing

Sword making has been a "science" that in the past was thought of as having almost mystical qualities. Sword smiths who forged high-quality swords were viewed as mystics, and their names would be well known throughout the surrounding lands. Even in more modern times, the sword or blade smiths who could repeatedly create highly effective blades would earn themselves a highly revered name. Some of the more famous sword smiths were those of Toledo in Spain, Solingen in Germany and the Damascus smiths. It is said that Damascus Swords can be bent so that the tip touches the hilt, and yet still hold a fine cutting edge (Gogan. *Fighting Iron*. P37).

Now although saying the word "sword" can almost instantly bring up images in one's mind, there are literally thousands of variations. To get it clear what a sword is (if anyone is confused), Encyclopedia Britannica defines it as "a preeminent hand weapon…consisting of a metal blade varying in length, breadth, and configuration, but longer than a dagger, and fitted with a handle or hilt usually equipped with a guard."

The processes for manufacturing crucible steel were some of the main methods of steel production for sword smiths before the industrial era. However, once the industrial period came around, the method of sword making was increasingly more exact as knowledge of metallurgy and material science became greater. The swords of the British military were made by following a strict set of rules for example. The following is the list of steps that are documented in John Latham's *British Military Swords* (P53-54):

- A bar of steel 12 in X 1 in X 5/8 in is heated to red heat and drawn out by mechanical hammers (Ryder Hammers – a series of pistons driven by a belt, each bas equipped with a different shaped hammer-head impinging on complementary shaped anvil.) until it is 20 in X ¾ in X ½ in.
- Reheat steel and pass it through rollers that stretch and shape into required dimensions.
- Should reheated and goes back to Ryder Hammers and drawn out shaped into the tang. This is a more recent method. The previous method was: shoulder opened with chisel when hot and a soft iron tang is hammer-welded onto the blade.
  - ❖ All government specifications for swords up until about 1880 stated: "The tang to be made in best wrought iron, neatly and soundly shut on at the shoulders, the shoulders to consist of equal parts of iron and steel." Later specifications came with the above statement, with an addition: "… or the blade and tang made of one piece of steel, solid throughout."
- Blade taken to grinding mill. This removes excess metal and brings blade to final dimensions. The grinding wheel was continually fed with water to keep the blade cool.
- Blade returns to smithy and hardened by heating in gas oven to specified temperature then quenched in whale oil (a non-mineral oil that doesn't change steel and cools at the required rate). The blade is now very brittle.
- Next it is tempered in a bath of molten lead until the temperature of the steel is equal to the temperature of the lead. The blade is also straightened at this stage (done by hand on an anvil using a fixed fork and hammer and checked by eye).
- Blade then cooled in open air.
- Blade polished.

This process was done on a large scale, as it had to fill the government contracts that would include hundreds of swords at a time. The steel used for these more modern swords would most likely be crucible steel as it could be produced in very large quantities for a relatively low cost.

For other swords from the 18th century onwards, a similar process was used. As Frederick Wilkinson describes the process a sword smith obtained a cast steel bar. This bar was then cut into lengths sufficient for two blades, and then fed through grinders until it is correctly shaped. After this the blade was heated and then tempered in warm oil, finished off by polishing on grinding wheels (Wilkinson. *Swords & Daggers*. P58).

The sword smiths themselves were well known among their respective communities. Mowbray tells of the LePage family in Paris, that "The name of LePage on a weapon became a mark of artistry, accuracy and dependability," and "… holders of this name acquired acclaim and wealth serving a variety of masters." (Mowbray. *American Eagle Pommel Swords*. P131). While the LePage family did not limit themselves to only making swords (they were an arms manufacturer, thus they manufactured swords and guns), their early success was due to their skill at constructing swords.

During the pre-industrial era in Western Europe, there were a few areas of noteworthy sword manufacturing that took hold around the 15th century. In Germany there were the smiths in Solingen, Passau, and Cologne. France had Poitou, Bordeaux, and Savoy. Italian swords were from Milan and Brescia. Spain had the Toledo smiths. Britain itself was a little slow in making a name for itself in the area of sword production, but eventually the Sheffield Cutler's Company was formed in 1624. (Wilkinson. *Swords and Daggers*. P57) In fact, British swords were not known for being quality swords. However, there was an Englishman that wanted to give Britain a name in the sword smithing industry. Frederick Wilkinson documents this in *Swords and Daggers* (P58):

> "Blade making in Britain had fallen off so much that in 1783 the London Cutler's Company sought government permission to import blades duty free from the Continent and this provoked a Birmingham tool maker, Thomas Gill, to declare that he could produce British blades of equal quality. In 1786 the Honourable East India Company ordered 10,000 blades and each was to be subjected to a bending test. Of the 2,700 English-made blades 1,084 failed the test; of 1,400 German blades only 28 failed, and of Gill's 2,650 only 4 failed. In addition to the bending test Gill had his blades struck flat, as hard as possible, on a block of cast iron and edgeways on a block of wrought iron and it is reported that some cut through the block."

America also had a need for swords, and many domestic sword smiths took up shop in the 18th century. The main location for sword production was in Philadelphia. An interesting fact was that, despite many domestic sword smiths, most of the blades of American swords were actually Solingen-produced blades (Mowbray. *American Eagle Pommel Sword*. P142). The domestic sword smith businesses were for the most part either family-run affairs, or immigrants that had been smaller-time smiths in Europe. As stated above, they all seemed to set up shop in Philadelphia. A little background information is given on many of these Philadelphia smiths in Mowbray's *The American Eagle Pommel Sword*. There was Lewis Prahl, who worked as a blacksmith, yellow smith (working with brass), gunsmith, and sword smith although his sword smithing was limited (Mowbray. *American Eagle Pommel Swords*. P160). The Rose family were sword smiths only. They were well known for producing high quality blades, with no surface blemishes (Mowbray. *American Eagle Pommel Swords*. P171). Emmor T. Weaver was known for his silver mounted straight-bladed swords. These were not as dressy as some of the other products of the time, but were known to be reliable. He was also involved in Freemasonry (Mowbray. *American Eagle Pommel Swords*. P173). There was also a man named Frederick Widmann, a German immigrant and a "mystery man" historically. He produced high quality swords, but unfortunately never became too successful. He never married and thus had no children to assist him with his work, so he had to stick to smaller jobs (Mowbray. *American Eagle Pommel Swords*. P180).

The sword as a weapon of war did manage to survive for quite a long time. Its origins date back to around 1000 BC and possibly even earlier. However it became less favorable as long-range fighting started to take hold. Gun barrels are also made of steel and as steel could be mass-produced, so could guns. Due to the higher demand for pistols and rifles, weapon-smiths

chose to manufacture gun parts rather than swords or other bladed weapons because of the profitability of guns. Because of this, fewer swords were manufactured and they moved more to being decorative pieces than functional weapons.