# European Arms and Armor of the Late Sixteenth Century

An Interactive Qualifying Project Report

submitted to the faculty of the

WORCESTER POLYTECHNINC INSTITUTE

in partial fulfillment of the requirements for the

Degree of Bachelor of Science

By

Anthony Luvera

Kyle Merchant

Jonathan Riedel

Simon Yip

Date: February 23, 2004

Sequence: 48-JLS-0042

Approved:

Jeffrey L. Forgeng, Major Advisor

# *Abstract*

This project documents over 400 of the Higgins Armory Museum's European arms and armor from the period 1550-1600. Military tactics and significant historical events were studied to gain a better understanding of the artifacts studied. The examined artifacts are photographed and documented within this report, along with text documents pertaining to the historical accounts, military tactics, armor and weaponry of the period. Additionally this material was mounted on a website, along with a searchable database of the artifacts.

# *About the Authors*

**Anthony Luvera:**

Anthony Luvera is a senior mechanical engineering major. He enjoyed this project because it was a break from the type of work he typically does. He has also always had an interest history in general, particularly war history. In the future he hopes to work in the automotive industry, hopefully with formula one race cars.

**Kyle Merchant:**

Kyle Merchant is a third year chemical engineering student at WPI and author of the Tactics section of this project. Kyle joined the project team with an interest in military tactics and medieval weaponry, which contributes to his enjoyment of table top war games and other strategy games. Kyle also has an interest in photography, taking a number of the pictures displayed in the database. Kyle would like to thank his project team helping him make this a successful IQP.

**Jonathan Riedel:**

Jon Riedel is a senior computer science major. In his spare time he writes science fiction and fantasy, and that is largely why he decided to do this project. He wanted to gain a better understanding of historical weapons in order to improve his fantasy (sword and sorcery) style writing. He also enjoys web design and creating websites.

**Simon Yip:**

Simon Yip is currently a junior who is majoring in Computer Science. He enjoys learning new technology as well learning about the past. In this project, he most enjoyed photographing the artifacts.

# *Table of Contents*

# *Introduction*

European Arms and Armor 1550-1600 is a study of the transitional period sometimes known as the Elizabethan age. This was a dynamic period throughout Europe. One of the major changes was the fall of centralized religious power. In the centuries leading up to this period Catholicism dominated much of the spiritual, cultural, and political life of Europe. It had become the foundation by which European life was mandated. Many of the rulers were devoutly religious and felt it was necessary to preserve and strengthen the Catholic Church, which often meant shedding blood. However, in the sixteenth century the rise of Protestantism led to the decline of the once dominant Catholic power. In the Northern regions of Europe the people had become primarily Protestant, while the Southern regions remained largely Catholic.

The Catholic loss of power did not take place overnight and many men throughout Europe lost their lives fighting the religious battles that took place in the second half of the sixteenth century. The Holy Roman Empire, which was a group of semi-autonomous states roughly equivalent to modern Germany, was trying to hold its ground, not granting tolerance to states within the empire that were adopting various forms of Protestantism. The Netherlands, which was at the time under Spanish Catholic rule, was a prosperous merchant country and thus very important to Spain. When pockets of protestant resistance began forming, Spain, ruled by Phillip II, was forced to engage in many battles in an effort to maintain control. After years of battles the Spanish were eventually driven out. With a healthy supply of troops and financial support from England, the Netherlands won their freedom by defeating the Spanish.

While offering the Netherlands, along with additional protestant nations, support Queen Elizabeth, ruler of the English throne, was busy fighting for Protestantism within her own country. England's involvement in the Netherlands, coupled with English attacks on Spanish ships, infuriated Phillip II. Finally, in 1588, he launched an all out attack on England, known as the Spanish Armada. This mission failed, and as a result England had acquired nearly full control of the seas. The English control of the waters allowed them to trade freely, which generated great amounts of wealth for the country. It was during this time that England truly began its ascent to become a dominant European nation, a distinction it would maintain for centuries to come.

Meanwhile, France was involved in religious conflicts caused by the spread of Protestantism within France. Henry II, a devout Catholic, felt it was his duty to spread Catholicism. When Protestant pockets of "Huguenots" began forming in Southern France, Henry II vowed to unify France into a single Catholic nation. This caused a civil war that would last throughout the second half of the sixteenth century. His death in 1559 left a vacuum of power causing many of the noble families of France, some Catholic and some Protestant, to strive for control of the throne. The families would launch surprise attacks on one another that would eventually lead to full blown wars. There were eight wars of religion that took place in France, from 1550-1600. The Huguenots held their ground, and eventually won their freedom. The battles ended when the Edict of Nantes was issued, in 1598. It granted the Huguenots full rights to worship publicly, hold office, assemble, gain admission to schools, and even administer their own towns.

As a result of the many wars that were taking place, there was a need for increased technology. Each country wanted to have an advantage over its counterparts, so great amounts of time and money were spent trying to acquire that edge. New ignition systems were developed causing firearms to upend the military world. The longbow had become the ranged weapon of the past; armies were opting to use the arquebus and later, the musket. These weapons offered more power than the older missile weapons, and required far less training, which made them the ideal weapon for countries trying to increase the size of their armies.

In the second half of the sixteenth century firearms were taking precedence over other traditional battlefield weapons, but all armies had units equipped with swords, bows, blunt weapons, and several different polearms. During this period slashing weapons grew less popular compared to piercing and thrusting weapons. This could be accredited to armor, since the slashing motion could not penetrate it. Another reason slashing weapons saw their use decreasing was the increasing popularity of dueling, which emphasized the thrust.

Even though these outdated weapons found their use dwindling, they were still produced in mass quantities. There was still a demand for the older weapons. As the popularity of dueling grew, swords became a part of civilian dress, while some of the other weapons began to be used for decorative and symbolic purposes. Additionally, the second half of the sixteenth century saw weapons become easier to produce en masse with inventions such as the blast furnace, making them cheaper and more readily available.

This rise of firearms led to drastic changes in armor. Muskets were able to penetrate most armor, so in order to protect against this, armor had to be made thicker and the plates had to be reinforced. This resulted in much heavier armor. Armor capable of stopping bullets was too heavy for the average infantry soldier to use; this caused most soldiers to remove armor used to protect their arms and legs. They wore just enough to protect their head and torso during melee attacks. Cavalry, on the other hand, were able to continue to wear fuller armor because their horses carried all of the weight. Despite the reduction in infantry armor, armor was still produced in substantial quantities. Now, in addition to adding protection, armor was also used for ceremony, or for tournaments. Much of this period's armor was made as a mark of wealth.

Technical advancements in the sixteenth century led to a change in military strategy and organization. The proper implementation of firearms provided effective soldiers with very little training. This made infantry faster and cheaper to raise and organize compared to knights and other heavy cavalry, the former mainstay of the armies. No longer were years of training required to produce a competent soldier. Countries were now able to mass large armies which would soon lead to the foundation of modern, infantry-based military drill and discipline. Also during this time military theory began to develop, as greater armies brought greater responsibility for commanders. In the past the commander would often lead the charge into battle, but now the commander was more like a football coach, often not taking part in the battle but drawing up the schemes that would determine the outcome. Ideas of how armies should be constructed and campaigns carried out became more of an academic topic. Tactics were becoming systematized calculations rather than "on the fly" instincts.

Overall, the late sixteenth century was a period of revolutionary change. The effects of this period have had an impact that lasts into the present. The rise of England and their control of the seas eventually led to many Englishmen moving to the Americas and establishing colonies. Without the rise of English power the United States could very well have taken a much different form than it has today. As a result of firearms becoming part of the standard issue to troops, modern infantry-based armies were established. Soldiers no longer required extensive training; instead that training was given to the officers. This is comparable to the modern United States army. A soldier in the army requires only about five weeks of training before they are deemed ready for active duty, whereas an officer from West Point requires four years of training to ensure competence. In the past, wars were more of a wrestling match, where the most physical would win, but as a result of the changes that took place during the Elizabethan Age wars had become more like a game of chess, where the thinking man has the edge. Instead of just charging and fighting like in the past, soldiers employed patience and acted in a number of smaller regiments as opposed to one enormous regiment. Military tactics became more of a science than an instinct. The fact that training a soldier was much easier than ever before also created democratization amongst the members of that country. The distinct line between the upper class and the ordinary man was being somewhat erased. Since ordinary men were needed to make up the massive armies of the time, they demanded to have a say in the political issues. The rulers of the countries had to make agreements in order to strengthen their armies. The late sixteenth century laid the foundation for what was to be the future of warfare.

# *General History of Europe between 1550 and 1600*

By: Simon Yip

Europe between 1550 and 1600 was very chaotic as religion, power, and money influenced all the different nations. The Germans of the Holy Roman Empire struggled to take lands only to be stopped by the Ottoman Empire. The French were immersed in one of the biggest religious wars in history. Alliances were made and broken. Even through all the chaos, people learned, and adapted to shape their nations for a better world.

## Holy Roman Empire

The Holy Roman Empire was not a unified nation, but rather a group of autonomous states where the emperor only governed over the larger issues and those that concerned him on a personal or political level. The Empire ran from the borders of France to those of Poland. It was made up mostly of what is today Switzerland, Germany, Austria and western Poland. In the first half of the sixteenth century, the Holy Roman Empire found itself fending off the Ottoman Empire, which had based itself in Constantinople. These two empires would fight for power and land for generations. Clashes over religion would also serve to hurt the Holy Roman Empire in the long run.

The emperor in 1550 was Charles V, who was also King Charles I of Spain. Although he had wealth and power at his disposal, many researchers are surprised that he did not accomplish more than he did. Charles was an intelligent ruler, and had high expectations for his own reign. However, he was plagued with many responsibilities. Dividing his attention between his

alliances and religion would only serve to hurt him in the long run. He often had to rush to Italy's aid. Italy, at the time, was a group of independent states looking for power and requiring foreign assistance to continue a series of wars with each other. France and Spain were among those that were involved in these wars. Francis I of France and Charles were rivals.

The Ottoman Empire was a significant influence during this period. Charles had been fighting with the Sultan Suleiman the Magnificent. In 1535, Charles had a victory in Tunis, which was in Africa. The Genoese admiral Andrea Doria, who was an officer under Charles, led this expedition. However, Francis allied with Suleiman the next year. Although Francis had signed a peace treaty in 1538, he continued his alliance with the Ottoman Empire until 1542. Suleiman would ally with France the same year the alliance ended. Charles had allied himself with Henry VIII of England and forced Francis to sign the Truce of Crepy in 1543. The Truce would put Francis to shame for a while. Charles would renounce his claim to the duchy of Burgundy. Francis would renounce his claim to Naples, Flanders, and Artois. Francis died in 1547.

Many areas in Germany had adopted Lutheranism, or at least tolerated its presence. These states were at odds with surrounding states, as well as with the Pope and the Catholic Church. The Pope and Charles V worked together in an attempt to unite the many states under Catholic rule. Despite the previous successes of Charles V, he failed defeating Lutheranism in his own land. He failed for many reasons. Previously, Charles had put Martin Luther on trial. Martin Luther had issues with the Catholic Church and its teachings. He led what is known as the Reformation, also known as the Protestant Reformation. The Diet of Worms was designed to

suppress the spread of Lutheranism. This involved banning Luther from the country. However, this incident only fueled the Reformation. Charles's forces were severely weakened from the many battles with the Ottoman Empire. The fact that Charles had to pay the Ottomans because of the Truce of Crepy did not help the situation.

The Princes of Saxony conspired with Henry II of France, in a combined effort to weaken the Emperor's power. The Princes hoped to change the balance of power away from the Emperor and grant more rights to the Princes. The struggles between the Emperor's forces and the Princes' forces came to a bloody climax in 1552. With the threat of a full-scale war breaking out, peace temporarily was reached in the Settlement of Passau. The Princes hoped the Emperor would grant religious tolerance for the Protestants, however this was not the case. The Emperor had continued support from the southern lands of the Empire, including the backing of the Pope. In the end, the Settlement of Passau did little more than draw the division of forces throughout the land. It defined most of the northern and western states as Protestant, and the others as still being loyal to the Catholic Church. The conflicts continued as the Settlement of Passau provided very little peace.

The Empire was getting closer to dividing itself, and was on the brink of disaster. A full civil war would weaken the Empire and open it to outside threats. In 1555, Emperor Charles V had to agree to the Peace of Augsburg, which stated that no emperor or prince was to attack any state on account of religious faith. It also allowed northern and western states the ability to form their own Teutonic order, which is more commonly known as Prussia. This order was lead by Albert of Prussia. Prussia consisted of what is now northern Germany and Poland. The southern

and eastern states remained almost entirely Catholic. The role of Emperor, as a result of the Peace of Augsburg, became virtually powerless.

In 1556, Charles failed in his war effort against the Ottoman Empire because they were allied with France. He was forced to sign a treaty requiring him to pay money back to the Ottoman Empire for the wars. Later on, Charles V turned the rule of the empire over to his brother Ferdinand. He retired to Spain, leaving Ferdinand in a role where he was unable to stop the spread of Lutheranism. He also gave Spain to his son Philip II. Charles died in 1558.

Ferdinand I did not have much of an impact during his reign between 1558 and 1564. His son, Maximilian II, succeeded him. Maximilian II was religiously tolerant as he was sympathetic to Lutheranism. Ferdinand was not happy about it, so Maximilian was known officially as Catholic to keep his father happy. Maximilian helped the Protestants by giving freedoms and reform including giving priests the right to marry. However, he did not do anything extreme for the Protestants. As a result, he could not get support from them to deal with the Ottoman Empire as the reparations were being paid to the Ottoman Empire. The Protestants felt that he would not let them seek help from other Protestants elsewhere. Maximilian died in 1576.

Maximilian's successor, Rudolf II, was the eldest son of Maximilian II and Maria of Spain. Unlike Rudolf's father, he was intolerant of Protestants. Rudolf supported the Counter Reformation, also known as the Catholic Reformation. He was depressed and became insane. A revolt in 1604 in Hungary with influence by the Ottoman Empire made him give power to his brother Mattias. The revolt was a result of attempting to force Catholicism in Hungary. Rudolf

was forced by his brother give control of Hungary, Austria, and Moravia to him. Rudolf attempted to issue a charter in 1609 establishing religious tolerance in the area. However, this resulted in failure as Rudolf was forced again to give up Bohemia in 1611. Rudolf died in 1612 and his decisions resulted in a greater event, known as the Thirty Years' War (1618-1648). Mattias succeeded to the throne.

## France - The Huguenot Wars

Although fighting for control of the land is a critical part of many of the wars that occurred during this period, control over religion was the most important. Religious intolerance would fuel the fires of various religious groups. This produced forces that would change the face of the country, and the ruling king. For much of the first half of the sixteenth century, the kings of France had only one goal. They wanted to establish their empire in Italy. France had enlisted the help of the Protestant princes of Germany as well as the Ottoman Empire. Their goal was take control of Italy and its states for power. France could never truly succeed in conquering Italy by itself. Since it lacked a good navy, France could not take command of the shores. It was not able to afford a navy capable of the task. The seven failed campaigns sent into Italy produced some results though. Being sandwiched between the French armies and the Turkish navies took a huge toll on Italy. Italy, which had flourished as maritime nation and had provided the best connection for trade with India, was now in a time of cultural decay. Its influence and power was weakened and Italy found itself becoming second-rate and struggling to maintain what power it had left.

Henry II, the king of France, allied with non-Catholic powers to invade Italy. The French kings were nonetheless devout Catholics. They kept their church and state close together. Each helped assure the other's power. The church claimed the King to be acting in God's name, while the King declared Catholicism to be the only religion. To go against the church was considered treason against the King. As a result, any religion in France other than Catholicism was condemned. Henry was persecuting Protestants in France that were allying themselves with the Protestant powers in Germany. The Protestants who were emerging in southern France were being driven to seek refuge in Geneva. In 1559, the Treaty of Cateau-Cambresis ended France's war in Italy. Henry gave his daughter Elizabeth to Philip II of Spain to seal the deal. During the same year, Henry died in an unfortunate accident. In a jousting accident involving Gabriel de Montgomery, Henry received a splinter in the eye and he died soon after.

Henry II had been the stronghold of authority in France. His death left a vacuum of power, in that the noble families would seek this opportunity to impose their influence over the other families in hopes of gaining control over the throne. This would inevitably create problems in time. Henry's heir was Francis II who was only 15 years old at the time of Henry's death. Francis was married to Mary Queen of Scots, who was the niece of the Duke de Guise. He was head of one of the powerful families in France, who desired the throne. His family was struggling for control, as were the Bourbons of southern France and the Montmorency-Chatillons of central France. The Guises of eastern France had played a critical role in the campaigns against Italy. While the Bourbons and Montmorency-Chatillons were also Catholic, they supported the French Protestants. This division in the families became heated and also led to a division in the nation. The Protestants, who were now named the "Huguenots", had begun to

unite and grow in force. The word "Huguenot" was derived from the German word "Eidgenossen", which roughly means "Confederates".

The group of people referred to as the Huguenots are also known as Calvinists. John Calvin started this religion. He was born in 1509 and he died in 1564. He did not like the control of religion in France. In 1541, he took over Geneva and spread his teachings from there. He also died there. The spread of Calvinism was fast and far, which included Germany, the Netherlands, and Poland. However, it did not spread as fast in Poland due to Lutheranism.

Francis II died only a year after becoming king due to chronic respiratory problems he had had since birth. In 1560, Charles IX, Francis's younger brother, became king. Due to his age, his mother, Catherine de Medicis assumed the role of his regent, and took control over France until Charles became of age. Catherine proved to be a great strategist and politician. In order to counter the pressure of the Guise family, she had to support the Bourbons and the Montmorency-Chatillons, and that meant supporting the Huguenots. In 1562, Catherine made it legal for Huguenots to hold public services, outside town boundaries. In this same year, the Duke de Guise led a troop of men in an attack on a group of Huguenots who were holding a service inside a barn within the township of Vassy. This brutal attack, which left many dead, began the First War of Religion. This first war lasted for one year, where town after town would launch surprise attacks against one another.

The First War of Religion ended on March 12, 1563 with the Peace of Amboise. The terms of the agreement limited the areas of worship for the Huguenots and only nobles were

exempt from those terms. However, this did not truly resolve the fighting. Five years later, the Duke de Guise was assassinated in Orleans, but his family remained strong, gaining support and leadership from the Cardinal de Lorraine. Around this time, Catherine and Charles IX were traveling and meeting with other royal families and officials from surrounding lands to try to bring some unity to the region. When Charles met with the Spanish Duke of Alba, who was persecuting Protestants in the Netherlands, it sent a panic throughout the Huguenots of France. In 1567, the Huguenots rose again attempting to overthrow the power of the king and the Guises, in hopes to gain Protestant influence over the throne.

The Second War of Religion ended in 1568 with the death of the prince Montmorency, who was the largest supporter of the Protestants, and the Peace of Longjumeau was signed. The Peace of Longjumeau was drafted similarly to the Peace of Amboise and as a result did not appease the Huguenots for long. The Cardinal de Lorraine did not want the peace to last. In that same year, he made an attempt to capture both Prince de Condé and Gaspard de Coligny, two leaders of the Huguenots. They both escaped to La Rochelle, where they assembled an army. This began the Third War of Religion. This lasted for two years where the Huguenots focused on fortifying themselves in the Southwest. Many of the battles did not go in the favor of the Huguenots. In one battle, they lost Condé yet the Guises continued to show that they were incapable of defeating the Huguenots. The war ended with an agreement to grant added rights to the Huguenots, as the war was becoming costly to both sides.

Catherine's balancing game between the families finally failed when she helped the Guise family attempt an assassination on Coligny. This finally turned the Huguenots against her.

With the Bourbon and the Montmorency-Chatillon families decidedly against her, she convinced Charles IX that they were planning to overthrow him. On August 24, 1572, she sent her forces forth to hunt down and kill over three thousand Huguenots. Over the next two days, her army with the aid of the Guise's army executed over twenty thousand Huguenots. Today, it is infamously known as the St. Bartholomew Day Massacre. The Prince de Conde, the son of the late Louis, in order to get him to convert from Protestantism. Conde eventually escaped to Germany. This became a turning point not just in France's struggles with Protestantism, but throughout Europe. Protestants everywhere lost all tolerance and reserve regarding Catholic rule.

During November 1572, Charles declared war on La Rochelle because the people refused to pay their taxes. The army was lead by Henri d'Anjou. The town was also the supposed capital of the Protestants. Henry of Navarre was held hostage. Henry was the next in line to succeed Charles. Henry's capture would shift his position in favor of the Protestants later on. This was the Fourth War of Religion. Catherine called off the siege on La Rochelle because it hit their treasury rather hard and she wanted to prepare Charles against Duc d'Anjou for the throne of Poland. The Treaty of La Rochelle was signed as the Protestants were forced to pay their taxes. However, this would not keep them suppressed.

On May 30, 1574, Henry III ascended to the throne after his brother Charles had died. In the prior year, he had been elected king of Poland. Conde was raising troops and got support from the German princes. Henri de Montmonrency, the Sieur de Demville, and Governor of Languedoc brought a huge army to the Protestant side. This would be the start of the Fifth War

of Religion. Languedoc was a Catholic, however the region where he lived was Protestant. When 20,000 German troops invaded France in the spring of 1576 under Johann Casimir, Henry had to negotiate which resulted in the Edict of Beaulieu. This is also known as the Peace of Monsieur. This Edict was very beneficial to the. Navarre became the Governor of Guyenne, Conde was made Governor of Picardy, and Alençon was made Duc d'Anjou. Henry also agreed to pay the fees for Johann Casimir's mercenaries. However, the Parliament of Paris refused to recognize this Edict and this would cause some problems in the long run.

An assembly of the Estates General took place. The Guises formed the fanatical Catholic League, while the Huguenots were being driven with vengeance. Henry demanded new taxes and money to make this league and declared himself as its head. This would begin the Sixth War of Religion. Armies were created to put down and take back Protestant towns like La Charite in May of 1577. However, Protestant forces were bigger and there was no hope of victory in sight. Therefore, the Peace of Bergerac was signed in July. These would abolish the Catholic League.

The Seventh War started with Henry of Navarre's control of the city of Cahors in 1580. This war is also known as The Lovers' War. This involved some affair between Queen Margot of France and Navarre. This war was rather short as Navarre and Catherine signed the Treaty of Nerac, and the Peace of Fleix soon after.

Henry III tried to convert Navarre to Catholicism, but that failed because Navarre would have lost support of the Protestants. Henry of Navarre was heir to the throne in this alliance and thus Henry III wanted a legitimate transition for Navarre for the throne. The Duc de Guise

revived the Catholic League to keep a Catholic king in power. In 1584, another man also known as Henry would engage in a huge war known as The War of Three Henries, or the Eighth War of Religion. Henry III tried to control the league as he did before by making himself the head of it again. He signed the Treaty of Nemours in 1585, which nullify the Peace of Bergerac. This treaty also restricted Protestants from holding royal office, banning the Protestant religion, and force Protestants to change their face or face exile. This naturally led to war. Paris, although influenced by the Catholic League, was becoming more and more dissatisfied with Henry III for his failure to suppress the Protestants. On May 12, 1588, an uprising took place in Paris, which caused Henry III to flee the city.

In a meeting of the Catholic League, the Cardinal de Bourbon, Navarre's uncle, was the proposed heir to the crown. On December 23, 1588, Henry III invited him to his quarters for discussion and the Cardinal was killed. A similar fate occurred with Bourbon's brother, the Cardinal de Guise. Henry left Bourbon's younger brother, the Duc de Mayenne, alive to become the new leader of the Catholic League. Henry III formed an alliance with his Huguenot cousin Henry of Navarre. Since the Catholic League had been unhappy previously, an army was sent against Henry III. A monk named Jacques Clement assassinated Henry III on August 1, 1589. As a result, Henry of Navarre succeeded to the throne as Henry IV.

The Catholic League was not too happy about this. They caused uprisings and tried to keep the Protestants and others under their control. Henry wanted to keep his crown and did what he had to do. In September of 1589, Henry met Mayenne on the battlefield and defeated him at Arques. The Spanish paid Mayenne in an attempt to spread Catholicism in France. The

Cardinal de Bourbon, who was left in charge of the Catholic League, died, which affected the strength of the league. Henry besieged Paris in the spring and summer of 1590. He let the women and children to leave the city, as this was not normal for a military war. Henry withdrew his forces, as Philip II of Spain was smart enough to redirect his forces to the siege.

In 1593, the Catholic League held another meeting to name a candidate for the throne of France. This move backfired as Infanta, the daughter of Philip II, was suggested, and Salic Law stated that no woman can inherit the throne of France.Henry was wise enough that he figured out how to end this war. He rejected his Protestant faith and assumed the role of a tolerant Catholic king. This forced the Catholic League into submission. In the spring of 1594, Henry entered Paris and took back his country without a fight. He spent money to gain support instead of spending it for warfare. On February 27, 1594, he was crowned King of France at the Cathedral of Chartres. Spanish troops left the country and eventually would be directed by Philip to besiege French cities. Fortunately, Spain had financial problems and signed the Treaty of Vervins, which gave the captured towns back to France.

On April 13, 1598, the religious wars finally came to an end with the Edict of Nantes. This edict granted the Huguenots full rights to worship publicly, hold office, assemble, gain admission to schools, and even administer their own towns. This made him the most popular king in France during this period.

## Spanish Religious Wars

From 1556 until 1598, King Philip II ruled Spain. He was the son of Charles V of the Holy Roman Empire, also known as Charles I of Spain. Charles lost the throne in the Peace of Augsburg. He gave his throne in Spain to Philip. In the major part of Philip II's reign, Philip focused on fighting Protestantism in his country and any other place. He was an adamant defender of Catholicism. This and England being a crucial factor in these wars would be vital of what is to come.

Philip had married Mary Tudor of England in 1554 to drag England into the war with France. Henry II of France and Philip signed the Truce of Vaucelles on February 5, 1556. Lands taken over by Spain were given back to France including Metz, Toul, and Verdun. However, the French soon broke this treaty and conflict ensued. English and Spanish troops would have a major victory over France at St. Quentin in August 10, 1557. Mary died in 1558. War concluded in 1559 with the Treaty of Cateau-Cambrésis. France would end the war and Philip would marry Elizabeth of Valois to seal the deal.

Philip suppressed the Moriscos after revolts had occurred between 1568 and 1571. The Moriscos were also known as Moors and were converted Muslims. The suppression was needed to keep Catholicism in Spain, but also prevent them from helping the Ottoman Empire invade Spain. On October 7, 1571, the Battle of Lepanto dealt a significant blow to the Ottoman Empire. Philip's half-brother John of Austria led Spain in this battle. Other countries involved in this battle included Malta, Genoa, and Venice. The numbers in this battle were huge, including 4,000 prisoners taken, 2,000 Christian slaves freed, and 25,000 Ottomans killed in the

battle. John captured Tunis briefly in 1573 to 1574, however power was relinquished back to the Ottomans.

Philip had inherited the role of Duke of Burgundy from his cousin, which meant that Philip was in charge of the Netherlands as well. The Netherlands was a collection of autonomous states, which are currently known as Belgium and Holland. The Netherlands was also a very prosperous merchant country, and therefore very valuable to Spain. So when the country was starting to turn against its Spanish ruler, Philip needed to maintain control. Philip sent the Duke of Alba with an army to the Netherlands to suppress the Protestant revolts there. The Netherlands had many pockets of Protestant resistance. Once the Duke of Alba arrived in the Netherlands with his troops, he imposed a tribunal, which he called the Council of Troubles. To the Dutch and others, it was known as the Council of Blood. The council was responsible for killing thousands of Dutch people in order to quiet the Protestants, who were also known as Calvinists. Instead, the Calvinists grew stronger and forced Alba out of their country.

William, the Prince of Orange, was responsible for uniting the Catholics in the Southern Netherlands, with the Calvinists of the northern provinces, who rose against Spain. In 1576, the northern provinces succeeded in driving out Alba with the help of France and England, and the Netherlands passed an act to attain autonomy for country. The act was known as the Pacification of Ghent. It lasted for three years before the southern provinces made peace with Spain and formed what would eventually become the country of Belgium. The northern provinces continued the fight against Spain. In 1593, they succeeded in driving out the rest of the Spanish forces.

While Philip was fighting for control over the Netherlands, he was hesitant to engage England. Similarly, Queen Elizabeth I was fearful of the Spanish navy. She signed a mutual defense treaty with France in 1571, soon after the success the Spanish had against the Ottomans in the Mediterranean. In the 1570s, English ships began attacking and ransacking Spanish ships traveling from the New World. By 1585, the English were helping the Dutch drive out the Spanish army by sending troops and aid. With these two indirect attacks on Spain, Elizabeth I pushed Philip into a confrontation.

After Mary, Queen of Scots, was executed, Philip made a decisive move. He gathered his army and navy, and on May 30, 1588, he sent an armada of more than 130 ships and 25,000 men to invade England. England's pact with France proved most valuable. The barges, which were meant to carry the Spanish troops from the coast on the Netherlands to the coast of England, were not allowed to leave the coast of France. The ships had been allowed to port in France, where they were waiting to travel down to the shore to the Netherlands. However, France made good on their pact with England, and did not permit the barges to leave. To make things worse for Spain, the Armada was scattered by fierce channel winds, which blew them past the English fleet. England's ships were aided by Dutch warships, and with the advantage of now being upwind of the Armada, the English gained the upper hand. The English ships were smaller and more maneuverable, while the Spanish ships were laden with troops. The English kept their fleet upwind and attacked from a distance, slowly picking off the Spanish fleet. Unable to force their way back through the English Fleet, the Spanish had no choice but to go around England the long way. As they made their way around the northern coast of Scotland, numerous ships

were lost in the turbulent waters, and many ships were lost. This was seen as a great victory for England, as well as for all of the Protestants in Europe.

In 1580, King Henry of Portugal died, leaving no children. Philip took the opportunity to attack Portugal and in 1581, he was crowned King of Portugal as Philip I. Portugal was treated well until his descendents Philip III and Philip IV. Philip III succeeded after Philip II's death on September 13, 1598. Peace with England would follow in 1604 and a twelve-year truce with the Netherlands followed. However, it would not be quiet for Philip in his later years.

## Sea Trade and the New World

As the New World continued to grow and change, trade would continue to be important. Naval power would become a factor as it was crucial to trade. Trade with America and Africa was becoming increasingly more important to Europe. To avoid conflict and ensure the stability of trade, the Pope had drawn up the Treaty of Tordesillas in 1494, which vaguely defined the Spheres of Influence as being between the 41st and 44th lines of longitude. However, in 1553, things became heated for the first time: English ships set sail for the Guinea Coast. The Portuguese claimed the African Seas to be their own. When Portugal discovered that the Spanish were already trading in the New World, Portugal came at odds with Spain. Through interpretation, Portugal claimed the Coast of Brazil, the East Indies, and all of Africa south of the Canary Islands. Spain claimed the rest of America and everything west of the line of partition.

Beyond the trade for gold, silver, and other valuables, the Pope endorsed the slave trade. The traders quickly decided that Native Americans were hard to control and Africans could be

made into effective workers more easily. Native Americans knew the land and were had friends they could escape to. The Africans were unfamiliar with the land, and therefore less able to escape. Soon, Spanish, Portuguese, and English alike, were taking African slaves to the Americas to do much of their work for them.

In 1562, England began its slave trade. As plantation colonies were started in the New World, they would gain very much. Sir John Hawkins led these expeditions. However, Spain would not allow it since they felt that they should be able to control the transatlantic slave trade and succeeded in doing so. This prevented England from continuing the slave trade for a hundred years.

The Protestants soon took notice of the value of sea trade, and they did not need to pay heed to the spheres drawn by the Pope. England constantly went into Portugal's sphere and took a particular interest in trading with the Guinea Coast. England, however, did not go into Spain's sphere. Spain's navy was too powerful to be challenged, and England considered its trade with the Netherlands too valuable. England would not remain fearful for too long, however. With the wealth sea trade was bringing in, and the economic flux that England was seeing as a result, many English were eager to set sail for trade or piracy in the New World, with dreams of becoming rich. Soon, England would build a strong navy. In 1563, there were 400 English and Huguenot pirating ships abroad, which were responsible for capturing 700 Spanish vessels.

In 1574, Spain decided that it had had enough of England's harassment, and Phillip II made plans to attack the English fleet. Before he could launch his assault, an epidemic broke out

in the Spanish fleet. Menendez, who was in charge of the fleet, died. Spain would wait until 1588, when it would amass its famed Armada. It hoped to lead its armada up the English Channel, through the English Fleet, and set London ablaze. In 1580, Spain had annexed Portugal, and now Philip had everything he needed to defeat Elizabeth. Unfortunately for Spain, the campaign proved to be a disaster as most of the Armada was lost or captured. As a result, this left England as the true naval power.

## Elizabethan England

By the middle of the sixteenth century, England was already a Protestant nation. England had separated itself from the church under King Henry VIII. The Pope's refusal to grant him a divorce from his first wife, Catherine of Aragon, and the fact that the Church was not popular in England at that time for its recent policies, led to the Parliament in England declaring the king as the head of the Church of England.

Despite the separation from the church, most of England tried to follow the ways of Catholicism as closely as possible. Henry died in 1547, leaving a council in charge of England until his son came of age. His son, Edward VI, was the son of one of Henry's six wives, Jane Seymour. Edward was plagued with bad health however. Edward wanted to keep England Protestant. However, Mary Tudor demonstrated that she wanted to bring back Catholicism by holding Mass, which was forbidden by law. She was the daughter of Henry VIII and Catherine of Aragon. Mary was also the cousin of Emperor Charles V. To prevent Mary from bringing Catholicism back to England, Edward VI brought in important people such as John Dudley, Duke of Northumberland and Henry Grey, Duke of Suffolk. They made plans to prevent Mary

to come to power. Suffolk's daughter Jane Grey was to be put into power before Mary and Elizabeth, the daughter of Henry VIII and Ann Boleyn. However, the plan did not go as expected as Mary had plans of her own.

Mary knew of this plan to put Jane on the throne. After Edward had died from his poor health on July 6, 1553, the Duke of Northumberland informed Jane that she was to be queen. Mary needed to confirm the death of Edward, because it was treason to declare yourself the ruler when the previous ruler is still alive. She had been acquiring support for her reign and the Privy Council in London confirmed her right to rule. The Council previously was misinformed about Mary's right to the throne due to Edward's plan. Those that were involved in Edward's plan were jailed and a few were executed, including the Duke of Northumberland. Some people were released on Mary's lenience. The Duke of Suffolk was lucky to be one of those that were released. However, Mary's acts of compassion eventually led to discontent among the people.

Mary had been actively advocating in bringing England back into Catholicism and this resulted in plots to take her out of power and replacing her with Elizabeth. Sir Thomas Wyatt and the Duke of Suffolk led rebellion for this cause, but this failed and they were locked up. Jane, who was previously locked up, was to be hanged as well as her followers. Elizabeth was questioned by Mary, but was sent away since she had no involvement in the plans.

Charles V had suggested that Mary should marry Philip of Spain and in March of 1554, the two were married. Henry VIII had passed laws allowing him to sell lands gained by the dissolution of the monasteries. Mary however, reversed these laws and she executed heretics

who spoke against Catholicism. In January 1555, she arrested John Hooper, John Rogers, and John Cardmaster for speaking out and they all died by burning at the stake. Approximately 275 people died from these burnings due to Mary's aggressive stance to bring back Catholicism and thus she would become known as "Bloody Mary".

While the burnings continued, Mary had trouble producing a child. She would continue to act if she were pregnant. It has not been determined if she was indeed pregnant, and miscarried, however her state was degrading as her husband Philip went back to Spain due to a war with France. Mary eventually made a will to put Elizabeth into power as Mary hoped that Elizabeth would go with Catholicism. Mary died November 16, 1558. The next day, the news of Mary's death was known and so Elizabeth I succeeded her half-sister Mary to the throne of England.

England had suffered a food shortage from 1556 to 1557, and England's population had suffered quite extensively. Elizabeth I found herself with an empty treasury, and in charge of a nation that owed large debts to other countries. The outlook at her succession to the throne was grim to say the least. It was with such a grim beginning that Elizabeth's highly successful reign became so legendary in English culture. One of the saving graces of the time was the establishment of trade with the Muscovites to the north in 1557. Explorations sent in hopes of finding a northern route to India had instead introduced the English to trade with Russia. This new route of trade proved to be profitable and gave a boost to England's economy. Trade was also improved when Elizabeth I ordered the restoration of coinage, where all English coins were melted down and reissued with a higher silver content. To add to the improvement of trade was

the establishment of the Royal Exchange in 1560, which offered a more suitable place of trade than the restrictive streets of London.

When Elizabeth was crowned queen of England, her cousin, Mary Stuart was in France, getting an education. Elizabeth, wishing to establish a relationship between herself and Mary, sent an agreement to Mary asking Mary to recognize Elizabeth as the Queen of England. Mary, having nearly equal claim to the crown, refused to sign the Treaty of Edinburgh for that reason. France withdrew their troops from Scotland and they would not further meddle with the affairs of Scotland as a result of the treaty. Also, England and Scotland would be divided between the cousins, granting Mary rule over Scotland, and Elizabeth uncontested rule over England. With Mary refusing to give Elizabeth a reply, Mary was denied passage through England to Scotland. Mary was kept in France until she made a daring run across English waters to Scotland and arrived there on August 19, 1561. With Mary in Scotland, the Catholics of England had their figurehead, and gained unity through their faith. Elizabeth's distrust of Mary would continue to grow.

As Mary tried to do her best to survive in Scotland, her support for Catholicism did not help, since Scotland was a Protestant country. Mary was married on July 29, 1565 to Henry Stewart, Lord Darnley. This marriage did not sit well with the Protestants. Lord Darnley was getting ambitious for power and he hated the relationship between Mary and her secretary David Rizzio. Rizzio was murdered on March 9, 1566 while having a conference with Mary. This murder was planned by Darnley and with other lords. Mary became very weary of her marriage with Darnley. In June of 1566, she befriended James Hepburn, the Earl of Bothwell. She

expressed her discontent to him and plans were hatched for Darnley's assassination. However, these plans may have not had Mary's involvement. Bothwell was the most likely person to have been involved. On Feb 10, 1567, Darnley died in a mysterious explosion. This death caused the people in Scotland to hate Mary more than before.

Mary was married on May 15, 1567 to the Earl of Bothwell, and that hurt her reputation with the Protestants even further. Both Mary and Bothwell tried to leave the country, but were caught and imprisoned at Lockleven Castle in June of 1567. On May 2, 1568, she escaped the castle and was able to recruit a large army. However at the Battle of Langside on May 15, 1568, she was defeated and fled to England to beg for Elizabeth's help. Elizabeth locked Mary up without any sympathy. Mary got caught up in the Babington plot, which eventually resulted in her execution. Babington was a Catholic from Derbyshire who involved in a plot to overthrow Elizabeth. However, he was caught and Mary was implicated in this incident. As a result, Mary was executed on Feb. 8, 1587. Mary was the most unfortunate Queen in regards to holding power.

In 1562, the Religious Wars began in France. King Charles IV of France had signed a mutual protection agreement with Elizabeth in 1571, where they agreed not to attack one another. This was to avoid weakening one another, and opening the door for Spain to attack them. Despite the agreement, England and France were at great odds with one another. Charles IV was a devout Catholic, and despised Protestant England. Charles IV often granted aid to Mary, and supported her efforts to take the crown of England from Elizabeth. Similarly, Elizabeth would grant aid to the Huguenots fighting in France, Prince Condé, one of the

Protestant leaders in France, and to the Protestants in the Netherlands. Elizabeth was a very canny supporter, however. She often only granted aid when it was most beneficial for her to do so. She only granted the Netherlands help when they seemed ready to surrender to Spain. In this way she helped prolong the war for the Protestants, and kept the Catholics' focus off of her. She was able to avoid attacks from the Catholic Church until 1570, when her actions prompted Pope Pius V to excommunicate her from the Catholic Church. This threat on the Queen stirred the emotions of the English people, and united the people to support her. This eased the tensions between the Catholics and Protestants in England, and created a national unity that would strengthen England.

In 1585, Sir Francis Drake launched a large assault upon Spanish trade in the New World. These attacks, which lasted for almost a year, dealt a hefty blow to Spain by greatly reducing its incoming wealth, and succeeded in infuriating Philip II. Feeling his losses, Philip began plotting an attack on Elizabeth. Philip amassed his Armada to attack England. Despite Elizabeth's inadequate response to the known threat, the attack went awry for Spain. From 1589 to 1592, England and Spain became engaged in a naval war. In 1598, Philip died of sickness. Queen Elizabeth went on to rule England until her death in 1603.

## Technology

Improvements in technology were made towards improving military capabilities. Although previously cannons were used in certain roles, technology would expand their usages and advanced their rate of deployment. The European world would benefit from these advances. Cannon technology became vital during this period as huge advances were made. Previously,

cannons were expensive, had an extremely slow rate of fire, and were inaccurate. They were mainly used to destroy structures in siege warfare. The only people that would use it were the rich and nobles including royalty. Cannons became better over time at overcoming the problems mentioned above. Commanders realized the importance of them and used them for defense and immobile positions. However, they were ineffective for use with the sea, but new technology would combat that problem.

William Levitt and Peter Baude constructed the first one-piece cast iron cannon. This was heavy, but that did not stop it from being deployed on coastal forts in England. This weapon became the most powerful weapon for a hundred years to come. However, this weapon ended up on the black market and enemy hands. Although the Spanish made attempts to acquire it for the Armada, it was not enough as their whole fleet had mostly bronze cannons. The Weald in Southern England was partly responsible for the new cannon technology. They were the biggest iron producers in England for quite a while, as far back as the 1200s. Henry VIII of England was taking advantage of this as warfare was maturing.

In 1541, Levitt was the royal "gunstone maker". By 1549, 53 forges and blast furnaces would be used to produce iron for the military. The iron industry doubled within 25 years as 110 forges and blast furnaces were producing iron and cannon very quickly. England became the major exporter of cannon. In 1592, the Dutch received 200 cannon to fight the Spanish. Even merchant ships paid for cannon to fend off pirates. The Weald iron industry grew rapidly until its decline in the 17th century when the New World started producing cheaper iron.

# *Armor of Europe between 1550 and 1600*

By: Jonathan Riedel

The Elizabethan Age saw many changes in the armor worn on the battlefield. Due to the effectiveness of firearms, soldiers were steadily reducing the amount of armor they wore on the battlefield, some completely abandoning it. Heavy cavalry wore the closest to a full suit of armor since the horses allowed the soldier to travel and fight without becoming worn out from the weight. Infantry typically wore much less armor, since they had to walk while wearing it. Ranged units wore the least of all, since they needed high visibility and mobility.

Italian Closed Helm, 1570
Accession #207

There are many pieces to a full suit of armor, and this is best illustrated through the heavy cavalry. Each part of the body had some form of armor designed specially for it. The head is a very vulnerable area, and throughout history, the helmet has been the single most common armor element. On almost any suit of armor, some form of helmet could be found. Helmets used in the late 16th century include both open and closed faced helms, burgonets, and morions.

To connect the helmet to the pauldrons and breastplate, and provide protection around the neck, a gorget was worn. Gorgets are commonly referred to as collars and neck-guards, and come in single and double plate forms. Single plate gorgets consist of one piece of plate, while

double plate gorgets are comprised of two pieces of plate hinged together. Most gorgets extend down over the chest and back, to provide additional protection to the neck (Blair 1982: 197). They tend to vary substantially in the protection they offer though, some covering very little (Stone 1961: 250).

German Gorget, 1570-1620
Accession #2384

For protection of the torso, a cuirass could be used. This was a breastplate and backplate combination connected by straps, buckles or other methods (Stone 1961: 195-196). When a breastplate was used in a suit of armor, a back plate was also attached to protect the entirety of the back. These plates provided complete torso protection (Blair 1982: 150). Under this armor an arming doublet would be worn to provide padding and protection from the armor (Stone 1961: 18).

The arms are a very difficult area to protect with plate armor, because they must remain highly mobile in battle. To provide protection to the joints that plate armor cannot effectively cover, a mail sleeve would be worn beneath the pauldrons on the upper arms. Connected to the gorget by a buckle, the pauldrons protect much of the upper arms. Pauldrons are comprised of a series of 'lames', which are plates connected together on sliding rivets to allow the arms to move relatively freely. The pauldrons extended down from the neck, and covered the shoulders and upper arms. Some suits of armor had a cut away section of the right pauldron to allow a lance to sit more comfortably under the arm. (Blair 1982: 361) Vambraces were used to protect the rest

of the arms while still allowing full arm motion from the elbow down. The vambraces are comprised of an upper and lower cannon, as well as a cowter for the elbow (Blair 1972: 125). The hands were also a tricky area to protect. To cover them a pair of fingered or mitten gauntlets were used. Depending on the situation, these mittens could be very large and heavy. By the end of the 16th century, gauntlets had been abandoned for war although they were still used in the tournament (Stone 1961: 245).

German Vambrace
1550-1600
Accession #608

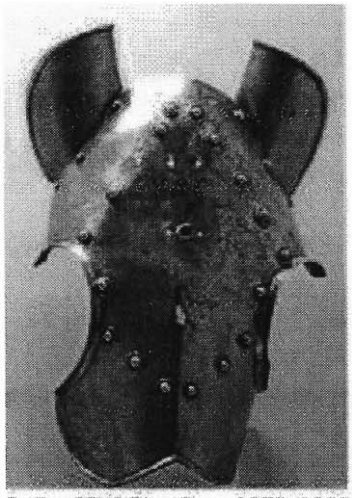
Attached at the waist to a cuirass or breastplate was a skirt and a rump-guard combination. The skirt protected the front, while the rump-guard covered the rear. These pieces were comprised of a series of lames, formed like an apron, riveted together to allow leg motion. Attached to the bottom of the breastplate could also be a pair of tassets, which covered the thigh area. The tassets consisted of a series of lames, and extended downwards towards the knee for each leg. Attached to the bottom of skirts on certain types of plate suits was a pair of cuisses. The cuisse was strapped to the thigh of the user, and was also comprised of a series of lames to allow movement. The cuisse typically covered everywhere but the back of the leg. Attached to the bottom of the cuisse is the poleyn, which protected the knee. The poleyn was riveted to the cuisse and greaves to act like a joint for the user. (Blair 1982: 382) The greaves were comprised of a series of riveted lames, to protect the shin and ankle area. Attached to the bottom of the greaves were the sabatons, connected by a pin. The sabatons were a form of plate covering for the feet. Towards the end of the 16th century, greaves and sabatons were almost completely replaced by sturdy boots.

Heavy cavalry units wore the most armor, weighing between 50 and 70 pounds. They typically wore what is known as cuirassier armor. This is a three-quarter armor suit covering everything except the feet and lower legs (Oakeshott 1980: 209). Cuirassier torso armor consists of a heavy, slightly articulated breastplate and a thinner back plate. This armor was thick enough to be musket proof and ranged between 16 and 20 gauge in thickness. It was also designed to deflect their enemies' attacks with its broad features. This was highly effective against hand weapons (Wilkinson 1970).

In addition to this armor, they wore closed helms, arm protection such as gauntlets and vambraces, gorgets, and long boots. The helmets were heavy and closed with beavers, also called buffes, to protect the face. The beavers were held in place by straps or were bolted to the breastplate. Heavy cavalry protected their arms as well, wearing vambraces connected with pauldrons to protect the shoulders and besagues to cover the vulnerable armpit. Also they wore gorgets to protect the neck. This was worn under the breastplate and was connected to the rest of their arm armor. (Stone 1961: 563)

The armor did not stop with the rider; his horse was also lightly armored. They typically wore a small chanfron and crinet. The chanfron covered the front of the horse's head. The type used during this period covered to just below the eyes. This led to it being called the half-chanfron. A few samples of full-length chanfrons were still around in the period, but they were essentially phased out. The crinet was worn on the neck, consisting of narrow strips of steel or

strips of steel alternating with mail. This offered the horses a minimal amount of protection (Blair 1972: 184-187).

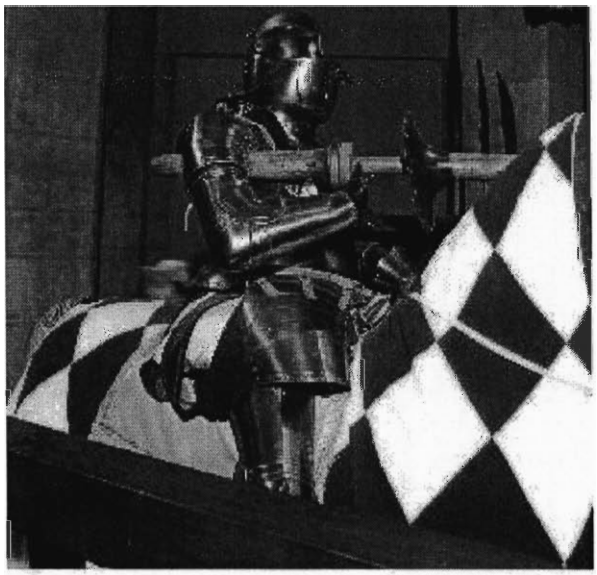

Italian Half Chanfron, 1570-1580
Accession #1507

Not all cavalry was heavy, during this period most of the riders wore much lighter armor. The second type of cavalry was medium cavalry. These riders were often called demi-lancers. Their armor had a lance rest as well as complete arm protection like heavy cavalry. They wore half armor that had lobster-tail tassets protecting the knees. They either wore closed helmets like the heavy cavalry or an open casque (Ashdown 1909: 307). The helmet typically included many parts. It had an umbril, also known as a brim, projecting over the eyes; ear flaps hinged to the sides; between one and three upstanding combs; a panache, or plume holder, at the base of the skull; and commonly included a buffe strapped around the neck. Also, these helmets were typically very decorated (Stone 1961: 152).

Since these heavier armored horsemen were easy targets for firearms, light cavalry started coming into use. They wore much less armor, and this allowed them more speed and mobility. These units were called either dragoons or pistoleers and tended to wear armor called the Allecret. This consisted of a breastplate without a back plate and tassets reaching to the middle of the thigh. This protected the vital parts of the body, without hindering movement of the limbs (Ashdown 1909: 307-313). They also wore a collar, spaulders and an open helmet. Instead of wearing full gauntlets, they only wore one on their left hand. This type of gauntlet was called a bridle guard and it allowed them to protect the one arm they typically could not

move because of needing to control the horse (Oakeshott 1980: 209). Sometimes this guard was actually closed so they literally could not let go of the bridle (Ashdown 1909).

There was a large degree of variety for light cavalry though. This was most visible in the arm armor and helmet. Another option for these riders was to wear a burgonet to protect the head, a mail shirt and gauntlets. A final variant on the arm protection was to wear laminated monions covering only the shoulder cap and outer side of the upper arm (Kelly 1931). This armor was much lighter than the rest, since they had very few heavy plates on (Oakeshott 1980: 209).



German Jousting Armor, 16th century
Accession #2881

The next type of cavalry armor was tournament armor. It was not designed for real battle, so it offered specialized protection. In jousting, the fighters knew that the attack was coming from the front left, so the armor was made much thicker there. They either had specialized armor or wore reinforced battle armor (Blair 1972). The front plate was often 3/16 inch thick with 1/8 inch thick plates on the extremities. The added thickness often led to the armor weighing as much as 150 pounds (Valentine 2000). This is the type of armor which most often saw the use of the locking gauntlet, when it was not banned from the tournament (Stone 1961). Also, in addition to the added protection, it was often highly decorated with etchings or other designs painted on it. The one type of decoration they

did not use was flutings, since those tended to guide the opponent's lance into vulnerable zones (Ashdown 1909: 275-307). The horses had special armor as well in the joust, often wearing blind chanfrons. This chanfrons had no opening for vision so that the horses would not shy away from each other (Blair 1972: 187)

The final type of armor was ceremonial armor. This saw no combat of any form, and was generally much thinner with elaborate decorations. The form tended to be similar to the Maximilian style armor of the previous period. This armor was solely designed to impress at formal events (Ashdown 1909: 275-307). Sometimes this form of armor would be covered with fabric or a richly decorated robe would be worn over this armor (Blair 1972: 140).

Infantry wore much less armor than the heavy cavalry, although occasionally they wore similar armor to the dragoons. Foot units fell into two broad categories, close combat units and ranged units. The most common close combat units were armored pikemen and dry pikemen, although other weapons were also used. These infantry units typically wore a form of open-faced helmet and some sort of torso armor. They rarely wore anything on the legs and the arms were typically lightly armored. The ranged units wore very little armor at all (Oakeshott 1980: 209).

Armored pike units wore the heaviest armor of the infantry, about 25 to 40 pounds worth (Ffoulkes 1912: 116-119). To protect their head they wore burgonets like the light cavalry. Their arms were also protected, often including the use of pauldrons, vambraces and occasionally gauntlets. The use of gorgets and tassets was another similarity these soldiers had

with cavalry. There were differences though, a noticeable example being the use of corslets to protect their body (Kelly 1931: 75-78). A corslet was light plate armor strong enough to withstand pistol shots, which were weaker than musket shots. This plate was typically held on by straps in the back, since a back plate was rarely worn (Stone 1961: 192-193).

In the rear of the formation were the dry pike units who wore either jacks with mail sleeves and open helms or no armor at all. These jacks were a padded coat interlined with metal plates or horn. It was very light and offered little protection. It was also very inexpensive, making it perfect for rank-and-file soldiers like dry pike units (Stone 1961: 310).

The last units to be considered were ranged units. These were the soldiers who stayed far from the hand-to hand-combat and were equipped with firearms or bows. There were two types of missile units, shot and archers. Both these units prized visibility and did not need much protection. They wore different armor than most of the close-combat soldiers, and they varied from each other mainly in the helmet. (Blair 1972: 138)

Typically shot units wore very light armor or none at all. They wore open helms like the burgonet for good visibility of their targets. They also wore jacks like the dry pikes (Oakeshott 1980: 209). Alternatively they sometimes wore buff coats and portions of mail armor. A buff coat was a heavy leather coat typically able to resist a sword cut. It often was long skirted and without a collar (Stone 1961: 152). By the end of the century they were only wearing the burgonets or even just a regular hat. (Kelly 1931: 74-78) Archers on the other hand typically wore light torso armor like a jack or a mail shirt. Other times they only wore a helmet. The

main difference is they preferred the morion to the burgonet. This provided good protection and maximum visibility (Blair 1972: 138).

In general, the foot soldiers started to strip away armor during the end of the 16th century since it was becoming more hindrance than benefit (Oakeshott 1980: 209). Due to this, those who fought hand-to-hand often wore half-armors, like the before mentioned corslet and cuirass. They tended to strip away the arm and leg armor, since it hindered their movement the most. Over time many soldiers, especially ranged fighters, came to discard armor completely. There simply was little benefit to wearing armor since a musket shot went through a light armor as easily as it went through normal clothing (Wilkinson 1970).

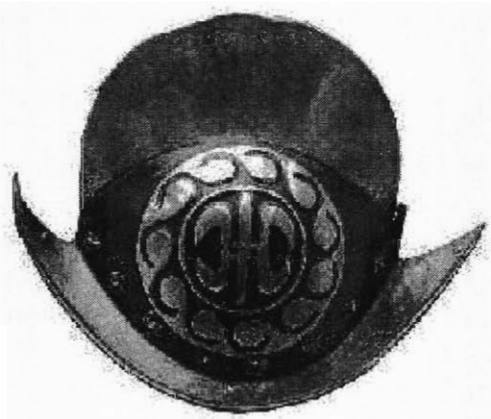
## Armor by Body Part

There was a substantial amount of variety for means of protecting each body part. The three parts with the most used options were the head, torso and hands. There were several styles of armor used to protect the head and torso. Additionally there were many different specialty gauntlets to protect the hands. The arms, neck and legs had few options, since these were the pieces most often discarded during this period.

### Helmets

A number of different forms of helmets were being used during the second half of the 16th century. Closed and open faced helm designs from previous years continued their use during this time. Close helmets covered the entire head, and only had very small slits for the user to see out of. This provided substantial protection to the user, but drastically limited vision

and head movement. Open faced helms had a much larger viewing area in the front of the helmet. These helmets provided less protection than closed helms, but allowed the user a much broader field of vision. Two other forms of open faced helms that were used during this time were the morion and the burgonet.



German Comb Morion, 1570-1620
Accession #2384

The morion was a fairly new form of helmet adapted from the earlier kettle hat. It was created by Pompeo della Chiesa of Milan (Norman 1964: 72). Morions had a brim coming to a bent peak at both the front and back of the helmet. Additionally, the skull of the helm had a comb running from the font to the back. These helmets were commonly used by infantry, while cavalry typically used open and closed faced helms (Fliegel 1997: 63). Some forms of morion, such as the peaked Italian form, did not include a comb. These forms simply came to a large peak at the top of the helm (Mann 1962: 39). Due to the large, flat area on the morion, this helmet was ideal for decoration.

A Savoy Burgonet, about 1600
Accession #1142

A helm used by both infantry and cavalry alike was the burgonet. The burgonet was a light, open-faced helm, with a peak above the eyes for protection. To both sides of the helm were hinged cheek pieces. These allowed the bearer to open and close the cheek pieces at will, to allow for extra protection, or extra vision when needed. (Fliegel

1997: 74) The cheek pieces also allowed easy removal of a helmet from the head. Burgonets could have visors attached as well, to help protect the front of the face.

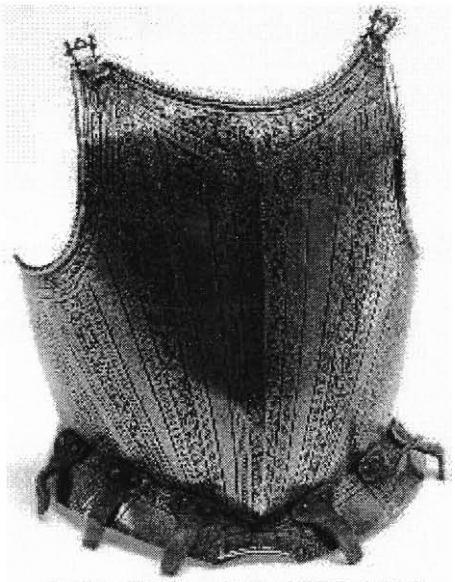
During the 16th century, the comb began to come into heavy use. A comb is a raised edge that extends across the central line of the skull on a helmet, starting at the brow and extending to the nape. While combs can be found before this period, from 1550-1600 is when combs became increasingly pronounced on helms. Combs continued to increase in size until around 1590, when they started to shrink. While most helms typically used a single comb in the center of the helmet, occasionally two smaller combs can be found running parallel on certain helms, flanking the main comb. (Blair 1962: 137) Combs were sometimes used for decoration, and often had plume-holders attached to the comb of the helmet with small rivets. (Dean 1915: 137) These holders were typically found on the back of the helmet.

**Breastplates**

The breastplate was the most frequently altered piece of armor during the late 16th century. Breastplates could be found in ridged styles, peaked styles, and long-bellied styles. Eventually, most countries adopted the peascod form of breastplate.

In the mid 16th century, the typical breastplate was the ridged form. This breastplate was typified by its low neck and high waist. As time went on the neck was raised and the waist was lowered to allow for more protection. In Germany, the breastplate "developed a vertical keel and projected more prominently in the center" over time. (Norman 1964: 67) Eventually, the German breastplate came to a peak at the belly of the breastplate, which is known as the peaked

breastplate. The long-bellied breastplate was created in countries with Italian influence on armor. This form of breastplate was flatter and had a longer waist than the ridged style. However, by 1580 the peascod form of breastplate became the most prominently used in Europe.


Italian Breastplate, 1575-1600
Accession #2777

The peascod form of breastplate appeared in Italy in 1570, and soon after in Germany. This form had a waistline sharply pointing down at the center. The belly section of the breastplate was a hump-like projection, overhanging the waist at the point of the breastplate. (Norman 196: 67) Throughout Europe in the sixteenth century this form of breastplate was adopted by foot and horse alike.

It is important to note that there was a substantial amount of variety in torso protection. Each type of armor had a differently constructed breastplate, the primary difference being how much protection it offered. Heavy cavalry wore the musket proof cuirass, lighter cavalry often wore the allecret, and heavy pikemen wore the pistol proof corslet. Some did not wear breastplates at all, instead wearing a padded coat like a jack or buff coat. Depending on the soldier's role, they would wear different armor (Stone 1961).

**Gauntlets**

Although gauntlets were much less used during this period, they still played some important roles. They were largely found outside of battle in tournaments and duels. Most of

the time gauntlets were used for a specific purpose. A good example of this is the bridle guard, which was the one type still found in battle. This was designed to allow the rider to maintain his grip on the horse. The left arm was largely immobile because of the need to control the horse, making it vulnerable to attack. Wearing this helped to reduce the risk (Stone 1961: 245).

Italian Fingered Gauntlet, 1570
Accession #207

A variant specifically for the tournament is the locking gauntlet. This gauntlet had much longer finger plates that would overlap with the wrist plate. Where they overlapped they could be locked in place using a catch. This prevented a fighter from being disarmed, since his sword was locked in his hand. Obviously this prevented a substantial advantage, resulting in it being banned for a time from tournaments (Stone 1961: 419).

A third specialty gauntlet was the gaunti di presa. This was an Italian gauntlet with a very narrow cuff extending practically to the elbow. It had finger scales that tended to overlap towards the wrist and the palm was covered with mail. This style was also used primarily on the left hand and was favored by duelists because it could be used to parry an attack or even to seize the opponents weapon (Stone 1961).

Other styles were worn as well. Some soldiers wore rather large and heavy mitten gauntlets. These allowed very little flexibility for the hand but also provided the largest amount of protection.

## Armories and Armorers

During the second half of the sixteenth century, four major armories began to gain prominence across Europe. These armories were the Augsburg armories, the Nuremberg armory, Landshut armory, and Greenwich armory. There were other armories as well, but none as prominent. Many of these armories, especially those in Milan (Italy), were making munitions-quality armor rather than high-quality armor. Still there were some high-quality armor producers as clearly illustrated by the Augsburg armories. In general, if a soldier or nobleman wanted armor, they looked to either Germany or Italy.

The Augsburg armories in Germany were perhaps the most famous of the period. This was because of the high quality armor and decorations they used. Augsburg would make armor for Spain, Austria, Bohemia, and many other countries. Some of the famous armorers to work in Augsburg were Desiderius Helmschmid, Mathias Frauenpris, Hans Lutzenberger, Wolf Neumaier, Wilhelm Seusenhofer, Konrad Richter, and Anton Peffenhauser. However Augsburg began to decline shortly after 1600 when it lost many of its well-known armorers. Additionally, it did not help that Peffenhauser eventually moved to Landshut, to oversee the armory there (Pfaffenbichler 1992: 15).

The second was the Nuremberg armory, which produced lower quality armors than Augsburg. Nuremberg was the home of the famous armorer Kunz Lochner, who is known for his etching. Other armorers include Heinrich Lochner, Wolfgang Grosschedel, Wilhelm von Worms the Younger, and Sebald von Worms. (Norman 1964: 68)

The third armory was the Landshut armory in Southern Germany. They primarily made armor for Spanish royalty, so their armor was very decorative and well made. Anton Peffenhauser, originally a master armorer from Augsburg, oversaw this armory. This helped prompt Spain to cease ordering armor from Augsburg in 1560 and begin utilizing Landshut for most of its armor instead.

The final major armory of the time was the Greenwich Armory in England. Greenwich created very high-quality armor for privileged people. Most of their business was to noblemen and the court of Elizabeth I. Since their clientele were so esteemed and wealthy, the armory was able to focus on high-quality armor and decoration rather than munitions armor. Some of the famous armorers from Greenwich include Jacob Halder, Erasmus Kyrkenar, and John Kelte (Pfaffenbichler 1992: 36).

Some other armories active in the late 16th century were the Royal Armory at Aarboga in Sweden, Innsbruck in Austria, and the numerous armories in Milan. The Swedish Royal Armory focused mainly on creating munitions armor, but created some fine armor as well. Innsbruck was run by armorer Jorg Seusenhofer until he was eventually replaced by Wolfgang Kaiser and Melchion Pfeifer (Norman 1964: 68). Milan and the other armories in Italy were essentially armor factories. Plates were beaten out in special mills and then given to an armorer to shape. Oftentimes a complete suit would have pieces made from many different workers, each specializing in a specific part. This assembly-line process allowed Milan to supply enough armor for 4000 cavalry and 2000 infantry in a matter of days (Ffoulkes 1912). It also meant

workers could specialize in pieces or jobs. Hammermen only hammered plates. Millmen polished the metal but did not shape it. Finishers put the armorer together and fit it to the buyer or specifications (Pfaffenbichler 1992).

**Guilds**

At each of these armories, a guild controlled the structure and social standing of the armorers. These guilds were very powerful, and provided social security to those that worked for them. Due to the limited market for armor in the 16th century, these guilds were highly restrictive. To keep a small workforce, the guild placed restrictions on apprenticeships and journeymen positions. Each guild had a different set of rules for the armorers, apprentices, and journeymen.

In Nuremberg, apprentices had to be citizens, and were required to study under a master Nuremberg armorer for a minimum of four years. Once the four years were complete, the apprentice became a journeyman to one of the masters. Each master could have up to four journeymen. To become a master, the journeyman had to create a number of trial pieces of armor. He could construct one trial piece a year and five masters in the guild had to approve it. Once it was approved, the journeyman was allowed to create that piece of armor on his own without supervision. However, this meant it could be years before a journeyman was allowed to create a full suit of armor. To get past this, many journeymen would sub-contract certain armor pieces to other armorers, so they would be able to craft full suits. (Pfaffenbichler 1992: 26) Of course, exceptions could be made during times of crisis for the guild, or if deadlines needed to be met.

Augsburg created more restrictions on entrance to their armorer's guild in 1562 to share the limited amount of work they received. Apprenticeship and journeyman status each lasted four years but could be skipped under certain conditions. Sons of armory masters were exempt from apprenticeship since the needed skills were typically passed down through the family. Additionally, a person could skip journeyman status entirely if he married the widow of a master armorer. A journeyman's trial piece consisted of a full suit of plate armor, which was required to be approved by four master armorers at Augsburg. Once it was approved, the journeyman was upgraded to master status. Other restrictions included fines for selling armor without a mark or identity. (Pfaffenbichler 1992: 28)

The life of an English armory apprentice was very restrictive. The apprenticeship lasted for seven years. During this time, all armor created by the apprentice needed a master's approval and seal to be sold. During this time, if an apprentice was "caught carrying a sword, brawling, dicing, or frequenting ill-repute houses, he was publicly whipped" (Pfaffenbichler 1992: 29). Once the apprentice finished his apprenticeship, he was allowed to create and sell armor on his own, as long as it had the guild stamp. The guild stamp provided proof that the armor was of high quality.

Italy did not have as much restriction as other countries, since they largely produced munitions armor, but they were forced to invoke some restrictions as the need for armor declined. Italy's armories can best be compared to a business or factory, since they emphasized quantity and not quality in the late 16th century. This meant that Italian armor was of much

poorer quality during this period. In 1587 they created the rule that an armorer could not open their own shop until they had practiced making armor for 8 years. Following this practice period they had to present a trial piece to the guild and, on acceptance, register their mark (Pfaffenbichler 1992).

**Armorers' Income**

Being an armorer had the potential to be very profitable, but only for a select few merchant armorers. One prominent armorer was Anthon Peffenhauser. He was one of the most important Augsburg armorers in the late 16th century due to his skill. He was so wealthy, and had such influential clients, that the armorers' guild was unable to enforce guild restrictions on him. This was shown when he had to deliver 600 suits of armor in 12 weeks. He imported 300 from Nuremberg, which was in clear violation of the guild's regulations. They attempted to fine him 600 florins for this, but his influence with the city council allowed him to ignore the fine. In fact since he was so influential he became a member of the great council of Augsburg and also became a warden of the guild.

Most armorers were much less influential. The typical armorer only earned around 15 florins a year and often worked at arsenals maintaining and repairing munitions quality armor. In Greenwich the chief armorer earned 17 pounds a year. Junior armorers and millmen would earn 15 pounds. Locksmiths who worked with the armorers would get 12 and apprentices earned 9. In addition to the money, they were given four yards of broadcloth and three yards of carsey for clothing as well as all the equipment they needed. In Innsbruck journeymen and polishers earned one florin a week while apprentices earned half a florin.

The final class of armorers consisted of the court armorers. They were attached to various nobility and mainly performed maintenance. Despite this fact, they still earned about six times as much as other armorers and typically had very close relationships with their patron (Pfaffenbichler 1992).

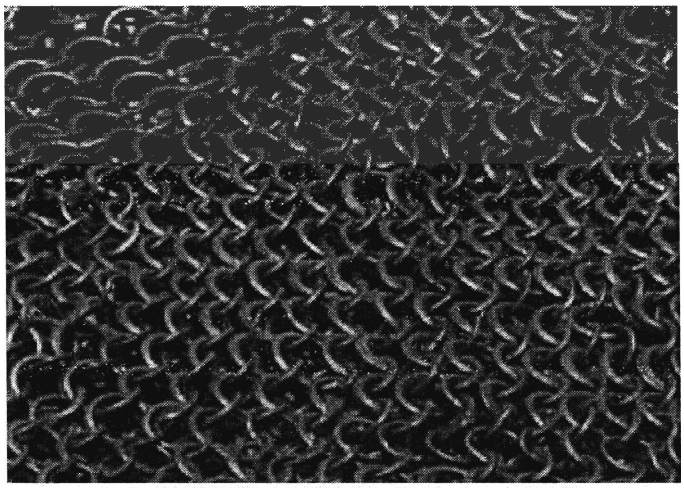
## Armor Creation

During the Elizabethan age, new inventions allowed better quality iron to be made. These advances did little to change the overall processes for creating mail or plate armor. The metal needs to be cut, shaped, hardened and decorated before it is completed. The next step was to stamp the armor with the armorer's stamp and possibly a guild stamp. Lastly, some of the armor was proofed against firearms and other weapons.

Blast furnaces were one invention that benefited armorers. In a blast furnace, charcoal and limestone were added to iron ore. The blast furnace applied a huge amount of heat to the components which chemically separated the liquid iron from the liquid slag. The resulting iron was poured off and the final product was known as pig iron. (Peacey 1979: 6) This new process was able to produce high-quality iron in much larger quantities in less time and less cost. This increased availability of iron allowed the creation of more steel, which was highly sought after for the creation of armor in the 16th century.

To create mail armor, an armorer first created the wire for the rings. To accomplish this, the armorer drew iron or steel through small holes, slowly reducing the diameter of the iron.

Eventually, the iron was drawn through a small enough hole where the wire could be used to create the mail rings. While the rings were worked cold, they had to be soft enough for the armorer to shape. The first step in the annealing process involved heating the metal. Following that the metal was allowed to cool to the point that it would be soft enough to work and cool enough to handle. Rings were connected in a variety of patterns, created by adding or removing rings from rows of mail. Sections of mail were then riveted together, using rivets of wire. The rivets were always made of iron, no matter what the composition of the mail was. Increasing the number of rings strengthened some forms of mail. Some forms even doubled up the rings on each piece (Pfaffenbichler 1992: 56). While this did increase the protection of the mail, it increased the weight of the armor drastically.



European Chainmail Fragment, 16th century
Accession #2991.2

The creation of plate armor was a difficult task. For plate armor, the armorer started with a billet of metal, and had to hammer it into flat plates. A billet was an ingot or bar of iron or steel that was used for armor manufacturing. The armorer would then create a wooden pattern for each piece to be made. For high quality armor this would be measured from the buyer while for munitions quality it would simply be an average size template. These patterns would be placed on the plates and the armorer would cut out shapes for the armor using giant shears that provided added leverage and made cutting the metal easier. Then they trimmed the plates further with hand shears and hand-filed the edges (Valentine 2000).

After the pieces were ready, the armorer hammered the plates into the proper form using metal stakes and formers. Some of these shaping tools were anvils, pype stakes, creste stakes, vysure stakes, curace stakes, and stake for the hedde pecys. The pype stake was a round, horned anvil used for forming tubes. The creste stake was used to beat up a chest area in a breastplate. The vysure stake was used to help create visors. The curace stake was used to help form a cuirass. The final stake, called the stake for the hedde pecys, was used to form helmets. Each of these stakes had a corresponding hammer, specifically for use with each stake. (Pfaffenbichler 1992: 62) Most metals were worked cold, but were kept soft enough to manage using annealing. To finish a piece of armor, an armorer might turn over the edge. To do this, the armorer bent the edge of the armor around a piece of wire. This edge prevented glancing blows to a user's joints.

To finish the armor, an armorer would strengthen the armor. One method to harden the armor after forging was case-hardening. Using this method, a piece of iron armor is wrapped in lard and goatskin, covered in clay, and then heated. The end result is a form of semi-steel, which is almost as strong as steel, on the outside of the armor. However, the inside of the armor was still as soft as the iron when forged. (Pfaffenbichler 1992: 64)

A second method to strengthen armor was tempering. This method required steel armor. To begin, the armorer would heat the armor until it was red hot. Then, the piece of armor would be quenched in a cool medium. These mediums could be water, oil, or air. The faster the quenching, the harder the steel would be. Water was the medium that cooled the metal fastest, which also made the metal the most brittle. Using oil, molten lead, or air took more time, but

also reduced how brittle the metal became. To solve the problem of brittle steel, the armorer would heat and quench the piece a number of times, reducing the brittleness of the armor. This process required very accurate timing for the heating and cooling processes. Armorers used the color of the heated steel to determine what temperature the armor had reached. If the armor was heated too much or too little, or if the quenching process was incorrect, the effect on the armor would be reversed. Simpler methods of tempering were developed for less skilled armorers, while still increasing the strength of the armor. Augsburg and Innsbruck were the most effective at steel tempering, using a two-stage process of heating and quenching to temper the steel. (Pfaffenbichler 1992: 64)

After the metal work was done, the next step was to apply a stamp to most pieces. The stamp acted as an identifying mark of the armory and armorer who created the piece. Some armor was tested for strength against weapons, including firearms. These tests included either being shot from relatively close range with a firearm or striking the piece with a hand weapon. This armor was called "Armor of Proof" because it was proven to hold up in combat. Once the armor passed inspection, it would be polished and decorated. Polishing was either by hand or a water powered polisher. The final step was to fit the armor with padding and straps, so it would fit the user. Most armor had padding extend over the edge of each piece, to prevent the armor from scratching itself (Pfaffenbichler 1992: 66). The straps and padding were typically contracted out to leather-workers since they were outside the armorer's expertise (Valentine 2000).

## Decoration

Decoration of armor took on a whole new meaning during the late 16th century. Certain forms of armor were created solely as a piece of art. One of the most common forms of armor decoration during this time was etching. Two prominent etchers were Mathias Frauenpreiss and Kunz Lochner. Other methods besides etching were used, but they were not as popular. Decorating armor was typically done by artists rather than by the armorer himself. This work was typically contracted out.

Etching was used in previous eras, but it was during this time that the German etchers perfected the form. To begin etching a piece of armor, the etcher coated the armor in some form of acid-resistant varnish, oil paint, tar, or wax. Next, he used a needle to scratch the design into the coating. This exposed the metal in those areas. Then he dipped the piece of armor in nitric acid to partially dissolve the metal in the exposed areas. The armor was then cleaned with turpentine and was left with acid-etched engravings. Often the etching was blackened with lamp black and oil. The armor was heated until the oil evaporated, leaving a shiny black coating on the etching. (Pfaffenbichler 1992: 68)

During this time, a number of armorers made themselves known with the art of decoration and etching. One of the famous Augsburg armorers was Mathias Frauenpreiss. Frauenpreiss created a complete garniture for Emperor Maximilian II in 1550 with the help of painter Jörg Sorg. During his career as an armorer and etcher, Jörg Sorg created an extensive book containing descriptions of 45 different suits of armor created by Augsburg armorers. This book has been instrumental in identifying a number of suits of armor, finding out who helped

create each suit, and what patron the suit was for. Without the book, it would have been very difficult to complete such a task, since many armorers from Augsburg used very similar designs for armor and etching.

Another famous armorer from the time is Kunz Lochner the Younger. Lochner was a Nuremberg armorer from 1510 to 1567, using exquisite forms of etching in his work. Kunz created a garniture for Duke Johann Friedrich II von Gotha, but the armor was lost in World War Two. Lochner also created a suit of armor for Sigismund II August of Poland in 1555. The importance of this suit of armor is the uniqueness of the decoration. Lochner covered the armor with a strap work of colored enamels on top of his gilded etching. (Norman 1964: 68) Only two such examples of this form of decoration still exist today.

Armor was decorated other ways as well. Sometimes it was fluted, embossed or engraved. These methods were usually used for ceremonial armor since they weakened the protection offered by the suit. Fluted armor was being made by the Germans and Italians, and consisted of a number of grooves and fluted columns on the armor, which looked somewhat like ridges across the armor. Embossing was a method of hammering into a piece of armor to create a relief image. This image could then be decorated further with other decorative methods. To accomplish this, artists used small dots to create the image in the armor. They made these dots with a blunt iron or wooded scalpel that they hammered on the plate. Engraving was done by making incisions directly on the plate with a burin, a piece of tempered iron that has a cutting edge.

Some methods which did not reduce the protection were bluing, Goldschmelz and gilding. Bluing the armor was accomplished by heating a piece of armor the point it turns the color blue, at 310 degrees, and immediately cooling it. The armor retains the blue color from the heating. Goldschmelz, which was still popular in Germany, consisted of applying gold to a blued surface. This created the appearance of blue and gold on the armor. Lastly, gilded armor was coated in a thin layer of silver or gold. To accomplish this, the silver or gold would be mixed with mercury, because the gold and silver would not stick to the armor on its own. The mercury mixture was then applied to the armor. After the gilding, heat was applied to remove the mercury, and leave the gold or silver applied to the armor (Pfaffenbichler 1992: 66). (Pict: Decorated armor from previous)

Cooperation between armorers and artists was common during the Elizabethan Age. The armorer would develop the armor with his own unique design and the artist would use his talents to etch and decorate the armor. Many of these collaborations took place through family ties. It was common for artist and armorer to marry into the same family, for instance the artist Jörg Sorg married the daughter of armorer Colman Helmschmid (Pfaffenbichler 1992: 68). Armorer relations were also maintained in the same manner. Augsburg armorer Hans Burgkmair the Elder married the sister of armorer Colman Helmschmid. These relations allowed easy cooperation on creations of suits of armor. These close ties resulted in artists sharing their etching designs with each other, which made it very difficult to identify the creators of certain suits of armor unless they are signed.

## Cost of Armor

The cost of armor obviously depended on the quality. Quality was influenced both by decoration and where the armor was made. Munitions quality armor was relatively inexpensive, between 1.5 and 4 florins. Light infantry armor would cost about 7 florins and cavalry armor would cost between 35 and 150 florins depending on the quality. High quality armor cost even more, ranging as high as 400 florins. About a third of the cost for decorated armor went towards paying craftsmen hired to etch, gild or otherwise decorate it. It was not uncommon to spend 100 ducats on gilding and 100 florins on etching. A much smaller portion of the cost went towards the supplies needed. Armories would spend around 15 pounds a year on steel, 21 pounds on coal and 5 pounds on buff leather. Of course the prices varied depending on the quality of the materials. For instance, in 1562 a ton of Spanish iron would cost 12 pounds while the same amount of English iron would cost 12 pounds, 10 shillings. This was because the English iron was usable for higher quality armor (Pfaffenbichler 1992).

## Wearing Armor

While it was possible to move with little hindrance in armor, wearing a harness was not the same as everyday dress. Due to that fact, many nobles were raised wearing armor. Most often the wearer required assistance to put the armor on and had to wear a substantial amount of padding. Like clothing though, quality armor was made to measure. Munitions armor was merely made from a mould, so it presented a much poorer fit.

The process of putting armor on starts with the padding. Complete clothing was worn for legs, arms, body and even the head to prevent the armor from chafing and to keep the soldier

warm. Additional padding was worn at the joints and where chafing was the largest threat. The armor itself tended to be lined with silk, velvet, cloth, leather or other fabrics, but these did little to protect the wearer's skin. The torso was another matter, a shirt tends to shift when a person exercises and while wearing armor, this cannot be adjusted since the plates are in the way. This led to the wearing of a thick doublet lined with silk, but no actual shirt. As for warmth, metal can change temperature relatively fast, so if it is cold outside the soldier would be very cold without the clothing. The opposite holds true for heat, the armor could get hot enough to burn after being out in the hot sun all day (Ffoulkes 1912).

Next comes wearing the actual armor. Arming a person starts at their feet and works up the body. Everything overlaps other pieces if possible, since this provides the greatest protection. The order for a complete suit is the sabatons, jambs, knee-cops, cuisses, mail skirt, gorget, breast and back plates, vambraces, pauldrons, gauntlets and finally the sword belt and helmet. These pieces were not always worn, but they were usually put on in a similar order (Ffoulkes 1912).

Most often a man required assistance putting on a full suit of armor. The process was rather complicated due to the numerous hooks, straps and laces which had to be set. Surprisingly this did not hinder the wearer too much. This was because the pieces were specially contoured to the man's body as well as the weight being evenly distributed over the entire body. The result of this careful design was that the harness did not overburden or restrict the wearer's movement. He was left flexible enough to mount or dismount his horse as well as move nimbly on foot (Royal Armouries 1990).

# *Weapons of Europe between 1550 and 1600*

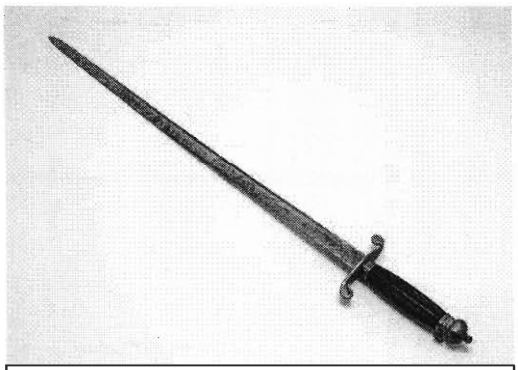
By: Anthony Luvera

## Swords

Changes in battle formations during the fifteenth and sixteenth centuries led to swords taking on more important roles during combat. All European soldiers at this time carried some type of sword as well as a dagger for close combat situations; however, civilians would also have some sort of facility with the use of a sword. Due to the many uses of the sword in the Elizabethan age a variety of swords were produced. Swords were now being made for foot soldiers, and not only cavalry. Swords became more specialized during this period, with several different types and lengths of swords being developed each with a separate purpose. The thrusting function of the sword was emphasized, and blades became more rigid (Blair 1979: 472). The reason thrusting weapons were preferred could be credited to the growing popularity of private dueling. Toward the end of the sixteenth century, as firearms were in increasing use, swords found their usefulness on the battlefield more limited, and became more restricted to dueling. The old method of settling a quarrel by formal combat in the lists was being replaced by the duel, and gentlemen for the first time began to wear swords as part of everyday dress (Blair 1962: 5). The swords these men began wearing were symbols of their status. As a result of the new sword wearing trend, the designs of cross guards, pommels, and blades became very highly ornamented. In addition extra emphasis was placed on protecting the hand; many swords were altered to provide this protection.

The sixteenth and seventeenth centuries are known as the peak of sword production, the quality of the swords produced during this time frame having set the standard for manufacturing swords. During the sixteenth century, there were five main classes of swords crafted. These were the two-handed sword, the short sword, the bastard sword, the estoc, and the rapier/reitschwert. These swords were used for a number of reasons. Some continued to be used on the battlefield while others were primarily used by civilians for settling disputes. There was also an abundant use of swords that were produced for ceremonial purposes.

Short swords stood around 38 inches long. This type of sword usually had quillons that formed a figure-of-eight. The more common form of the short sword was those with curved blades, although there were many that had straight blades. Short swords had broad, straight, two-edged blades and simple hilts of distinctive form (Blair 1962: 9). All have grips that would swell out at the bottom of the hilt, towards the pommel. The short sword's small size allowed it to be carried easily as a weapon of defense, and even concealed if necessary (Oakeshot 1980: 126). The short sword, like the rapier, was often worn as a symbol of status, and meant its bearer could settle matters of dispute at any time.



Short Sword
Accession #: 344.a
Probably English
Late 18th-early 19th

During the sixteenth century short swords began to be called hangers. The hanger was very much an all purpose weapon and was carried by many people: by civilians when something more suitable for hand-to-hand fighting than the rapier was required, for example when traveling (Blair 1962: 9). Because of their small

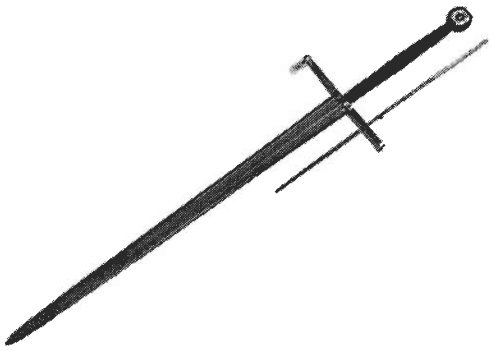
size, they were both quick and easy to maneuver. This type of sword was the preferred sword of infantry soldiers during warfare. It was designed especially for the use of foot soldiers when rushing upon a knight who had been dismounted in the cavalry charge, or for close encounter of infantry against infantry (Ashdown 1909: 334). They were useful for both cutting and thrusting, making them a versatile weapon. However, most of the short swords of the sixteenth century were primarily slashing weapons; this is what caused its decline in use. Since many of the soldiers of the age were equipped with plate armor, a primarily slashing weapon was often ineffective. Typically, foot soldiers would prefer a weapon that could both cut and thrust, although thrusting, which was able to puncture the plate armor that was being worn, was much more appealing to the Elizabethan soldiers.

The most popular of the swords seen on the battlefield during this time were the two-handed swords, which was both a thrusting and slashing weapon. Although, its use on the battlefield, much like the other swords began to decline, during the second half of the sixteenth century. These two-handed swords could be up to six feet and were used throughout the sixteenth century, particularly by infantry soldiers, who were often smaller than the sword itself. Two-handed swords weighed anywhere from 2.5 to 3.5 kilograms. They usually would have a large ricasso, which was covered in leather, so that the sword could be held below the quillons and used more effectively in close quarters. At some point along the ricasso two parallel prongs would protrude, perpendicular to the blade. The two-handed sword usually had a simple

Two-Handed Sword
Accession #: 2743
Germany
4th quarter of the 16th century

cross guard, often arched, and one or two side rings (Blair 1962: 6). The cruciform hilt would have a handle that was large enough to be firmly grasped by two hands. Many would be much longer so that the user's hands could be held apart, in order to give a fulcrum effect, allowing the swordsman to maneuver the sword with greater efficiency. The pommels of two-handed swords would also be large, which also aided in making the sword easier to maneuver.

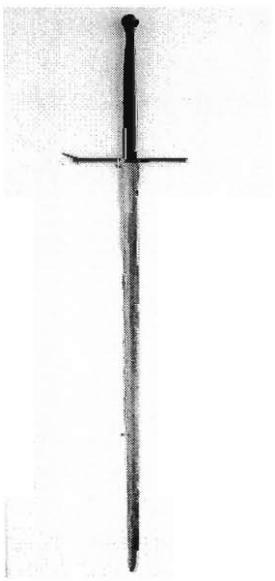
Due to the enormous size of the two-handed sword it required a strong man to wield the weapon; usually it would be swung in a circular motion to fend off many opposing soldiers. It could be used to take on many men; a soldier wielding a two-handed sword could kill or wound a number of attackers in close combat situations. It was ideal for the situation of few soldiers versus many. However the sweeping circular swings of this great sword could just as easily wound other members of the user's army by accident. Thus its overall effectiveness on the battlefield was determined by the circumstances of each individual battle. Many times this weapon was limited to banner defense due to its limitations in close combat situations. This weapon continued to be used throughout the sixteenth century and many armies such as the German, Landsknecht and Scottish troops favored the use of the two-handed sword well into the seventeenth century. This weapon was also mostly effective for shorter battles since the very size of it exhausted many of its users.



Bearing Sword
Accession #: 1901
Germany
15th-16th century (hilt decorated during 17th)

One of the primary uses of the two-handed sword during this time was as a bearing sword for ceremonial purposes. The sword was the first weapon that was not some form of modified tool,

its design was for the purpose of killing, and thus it was seen as a symbol of a warrior. Due to its extensive use as a bearing sword its design, like many of the other swords of the time, became extremely elegant so that only the rich could afford these highly decorated swords. In fact many of the swords used for ceremonial purposes were so highly worked that they would be unfit for battle conditions. Popes or bishops would bless these swords and give them to selected rulers or noblemen that the church wished to honor. Another way the sword was used as a bearing sword was when it was handed down form one generation of a family to another. There would be a ceremony in which the father would hand down his sword to his eldest son, the sword symbolizing that the boy had become a man.



hand-and-a-half sword
Accession #: 3285
Europe
16th-19th centurv

The bastard sword, also known as the hand-and-a-half sword, stood between forty and fifty inches tall. The grip of the sword had enough room usually for two hands, and the weapon was balanced to allow the user to wield it with one or two hands. The bastard sword could be used as either a thrusting or a slashing weapon. It could be effectively used with one hand, but if one wanted to apply extra force to the blow, the free hand could be placed around the bottom part of the hilt or the pommel. The bastard sword had a double-edged blade, and its length placed it between short swords and two-handed swords. It was not as big as the two-handed sword but it could still apply enough force to take off an arm or a leg of the nemesis. The quillons of the bastard sword were either straight or in some cases curved either vertically or horizontally. This sword was favored heavily in Germany and Switzerland (Blair 1979: 81). The German bastard swords had cruciform hilts, with more

developed guards resembling basket hilts. The Swiss bastard swords had a slightly curved blade and an asymmetrical pommel. The Swiss hilts also had knuckle guards, curved quillons, and ring guards.

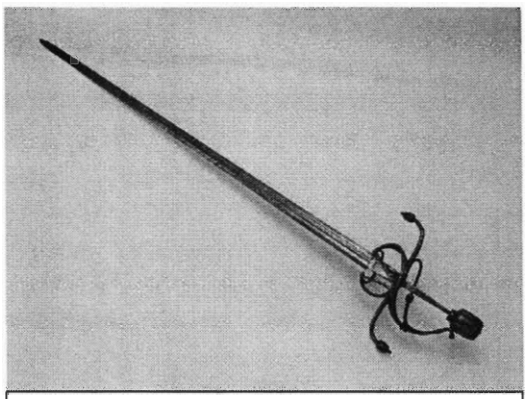
During the Elizabethan age the primary use of this weapon on the battlefield was as a secondary weapon for many of the gunners and pike men. It would be held in the scabbard of the user and only used in dire circumstances, where military formations had been penetrated by the opposing army.

Estocs were swords with long blades and fairly long grips used for thrusting. The blade was of either a hexagonal, triangular, rhomboid, or rectangular shape, and sloped to a tip at the end. The estoc could be considered a short lance rather than a sword, since it was typically shaped like a lance and its primary use was as a thrusting weapon. As the sixteenth century came to an end the use of the estoc was dwindling. This was a sword that was used by knights, which were a dying breed. Through the ever increasing development of the firearm as well as the effectiveness of the pike, cavalry charges were becoming obsolete. The estoc also typically had a cross-shaped hilt. Some blades had a smooth edgeless portion the user could grip to deliver a more powerful blow. The estoc was used as an auxiliary weapon for cavalry in battle (Blair 1979: 491). Used with a hand on the hilt and a hand on the blade, estocs were used by knights to pierce the armor of their foes. While the estoc has a fairly long blade, it was not used for slashing or cutting (Oakeshot 1980: 134). The weapon was suitable for penetrating thrusts between armor plates or chain mail. Although the use of the estoc was decreasing, the weapon was still being produced throughout the sixteenth century, and as was the case with the other

types of swords, alterations were being made. The traditional cross guard was not the only kind of hilt found on estocs. They were fitted with some form of a side ring-often filled with a solid plate after c.1550-with or without arms and other branches above the cross. At the end of the 16th century the simple cross-shaped hilt was replaced by a stout grip, protected by an extended cross guard called a quillon block, designed to entangle the opponent's blade and protect the hand. The estoc was popular in Eastern Europe, where it remained in use by Russia and Poland until the late 17th century.

In order to get an understanding of the rapier it is beneficial to look at its use, and some general history on dueling. During the Elizabethan age the rapier was primarily used for dueling. Dueling required the use of the edge as well as the point, thus most of the rapiers of this time were two edged. In the second half of the sixteenth century it was very common for men to carry some form of sword. Civilians were quite violent, and had high regard for settling personal disputes by dueling. The rapier was more effectively lethal than anything else available to the everyday man. This was a time where civilians who had never seen each other, would fight to the death at the drop of a hat. The Elizabethan age was a time of quick tempers, and urban riots were quite common. This fighting technique did not appeal to only one group of people, instead it appealed to all. The upper class also began to use dueling as a method of solving personal altercations. As a result dueling became a part of everyday European culture, it was considered a gentlemanly art. Due to the extreme amount of urban violence, schools were founded and literature was written teaching the proper techniques of dueling. This type of schooling was indeed a necessity because at any moment a man could find himself challenged to fight. In order to maximize their opportunity of victory, many men sought extensive training.

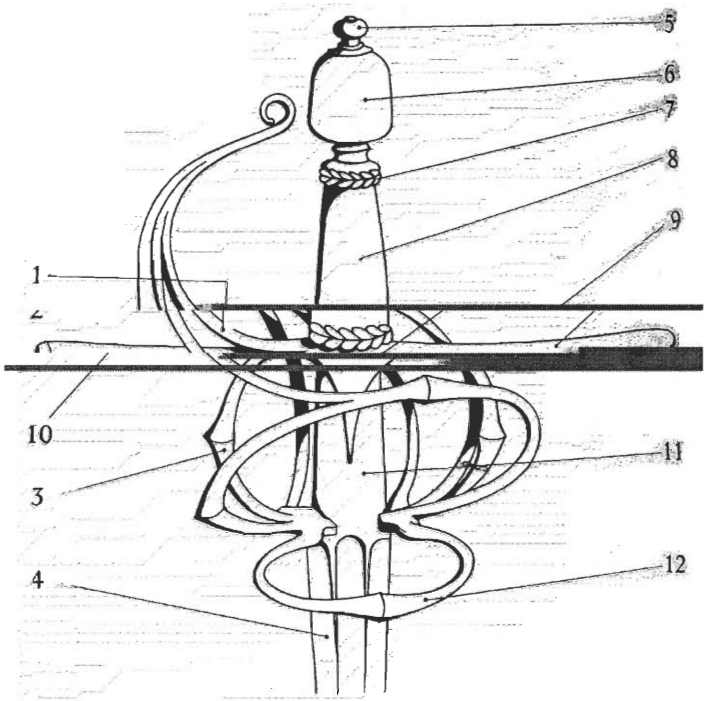
The rapier, which was a modification of the one-handed sword, was made for both defense and attack. The idea behind the rapier is that it can parry incoming attacks, as well as thrust at your opponent. Because of this, it was better to use the rapier without armor, to allow maximum movement to parry with. The rapier was used entirely for civilian swordplay and personal altercations, and was rarely used on the battlefield. These swords formed a part of a man's wardrobe; the quality of the rapier varied depending on the status of the individual. Since the rapier was an article of fashion it was quite common for it to come with a matching dagger. The rapier was lighter than most swords, and had a double-edged and pointed blade, and the point of the blade was used as the main method of attack. The blade would taper from the hilt to the point. Using the point of the blade as a primary attack forced sword makers to change the structure of the sword's guard, since these methods of attack forced swordsmen to hold their blades differently. This caused drastic changes in the quillons of the rapier: most were curved and had a number of different branches that connected to the blade. Another feature was the basket hilt which was a bowl shaped guard, which was placed where the quillons would typically be. This bowl would protect the hand while fencing. Also created to protect the hand was the cup hilt. Cup hilts were a common form where long, straight, and curved quillons were used in conjunction with a cup shaped finger guard at the base of the blade which was as a rule highly decorated (Ashdown 1909: 336). The blade of the rapier was gradually lengthened over time, allowing skilled



Rapier
Accession #: 3044
Europe, perhaps Germany
Late 16th-early 17th

swordsmen to hit their enemy more easily as well as stay out of their reach. The reitschwert, commonly referred to as a swept-hilt rapier, is very similar to a rapier. However, the reitschwert had a sharper blade for cutting. It was often difficult to tell them apart from a rapier, which is why they are usually called swept-hilt rapiers (Oakeshot 1980: 135). Although the rapier also had a sharp edge, the reitschwert acted as a much better cutting weapon. Most well made rapier blades have been traced to cities in Italy, Spain, and Germany, from where they began their circulation throughout Europe (Blair 1979: 402).

Another sword that was falling out of use was the falchion. The falchion had a single-edged broad blade, intended for chopping. The blade could be curved or straight, with a slight cusped tip at the end of the blade. Pervious versions of falchions were much larger and broader, and the sword slimmed and shrank in size over time (Coe 1989: 47). Falchions fell out of favor early on in the sixteenth century, vanishing around 1560. Due to the fact that the swords used during this time focused on thrusting, there was a need for narrower and longer swords. This caused the falchion to become very rare in the latter part of the sixteenth century.




*Hilt of a swept-hilt rapier. 1. knuckle guard; 2. counterguard; 3. arms of the hilt; 4. blade; 5. button; 6. pommel; 7. ferrule ("Turk's head"); 8. grip; 9. quillon block; 10. quillons, fore and rear (or cross guard); 11. ricasso; 12. side ring.*

**Hilts**

The hilt varied from sword to sword. Many of the blades of swords were identical to many other blades, yet the differences in these swords were apparent due to the vast variations of the hilt. While some hilts were small and simple, others were intricate and exquisite. At the top of a hilt is the pommel, which in some cases could be gripped by a wielder for added leverage. From the early sixteenth century on the pommels of the sword were, with the exception of few, either globular, ovoid, fig-shaped or some variation thereof (Blair 1962: 5). Below the pommel is the grip, where the weapon is held. Below the grip is the quillon block. The quillon block connects the grip to the quillons and the ricasso. The quillons extend forward and behind the quillon block, providing a guard for the wielder's hand. Quillons, also known as cross guards, typically extended either outwards or curved inwards towards the blade. The ricasso is an unsharpened section of the blade below the quillon block, which in some cases could be gripped with the index finger for added leverage on the weapon. Between the quillons and the ricasso, there could be two arms extending outwards. These arms hold up the guards on some forms of hilts. These hilts can include outer- and upper ring-guards, knuckle-guards, back-guards, and loop-guards. Upper-ring guards typically extend from the quillons or the quillon block. Outer ring-guards surround the lower end of the ricasso, and typically connect to the two arms. Knuckle-guards lie forward of the grip, usually extending from the forward quillon to the pommel. Loop guards linked upper- and knuckle-guards, or connected upper- and lower-guards. Back-guards guarded the back of the hilt above the quillons, surrounding the ricasso (Oakeshot 1980: 128). With so many possible parts for hilts, a number of very unique forms of hilts were developed across Europe.

The hilts of the sixteenth century can be categorized into four main types: the quarter hilt, the half hilt, the three quarters hilt, and the full hilt. Quarter hilts typically consisted of quillons, arms, a lower ring-guard, and occasionally a single-loop back-guard. Half hilts were made of quillons, arms, some form of double ring-guard, and possibly a double-loop back-guard. Three quarter hilts were comprised of a single rear quillon, arms, two to three ring-guards, loop-guards, knuckle-guards, and sometimes double-loop back-guards. Full hilts were made of quillons, multiple ring-guards, multiple loop-guards, multiple knuckle-guards, and treble-loop back guards (Oakeshot 1980: 139). While these categories fit most hilts of the time, many variations and adaptations of hilt forms were developed.

During the sixteenth century, many of the swords and hilts were created in Germany, Switzerland, Spain, and Italy. All of these countries created bastard and short swords. Estocs were produced in France, while the sword took on the name "tuck" when made in England, "stocco" in Italy, and "stock" in Germany. Rapiers were mostly created in Spain and Italy, but at the end of the century Germany also started the craft (Wallace Collection). German style hilts can be typically identified by their unique forms of pommels. During the 16th century, Germans used both drop-shaped and cone-shaped pommels. German hilts typically had a single inner and outer ring-guard. The Swiss used rounded pieces of metal to form the guards, rather than flat pieces. Swiss hilts are also known for primary and secondary knuckle-guards, trefoil ring-guards, and non-connecting loop-guards. Spanish hilts had double-ring guards, or 2 prongs extending upwards in place of a run-guard. Spanish hilts also had longer grips than most other hilts. (Oakeshot 1980: 131).

A finished sword would usually require the work of several different people. However, the most daunting task belonged to the bladesmith. The steel used for making swords is an alloy that needed to be developed by combining iron ore with just the right amount of carbon. High carbon steel is hard, which allows for a good edge although it also makes the sword brittle. Low carbon steel creates a softer edge, but the sword is much more flexible. The ideal sword would be the median of the two types of steel, so that it had a good edge but at the same time was flexible enough so that it did not break when used. In the eastern European countries the technique used to evenly distribute the iron with high carbon content with the iron of low carbon content was forging. The concept was to take layers of iron with differing levels of carburization and combine them so that the final product would have an equal carbon distribution. These layers would be heated and shaped using a hammer and an anvil. This method was also used in the western European countries except it was called pattern welding. Another method used for making swords was the action known as 'puddling' where molten iron ore was stirred in a crucible while air was forced through it. The resulting metal is high purity and is suitable for adding high carbon products such as charcoal, thus producing the desired steel. For power the smith would use water-mills. Without these mills the smith would not be able to heat his furnace enough to cast iron. Another technique the smith would use was quenching and annealing. The smith would take the hot sword and cool it by placing it in water. This improved the quality of the sword by softening the metal and thus giving it the desired effect of decreasing the brittleness of the material. The chief sword making areas seem to be Cologne and Passau along the Solingen in the north and Milan, Brescia and Toledo in the south (Norman 1964: 105).

Once the sword had taken on its general form, the decoration process would begin. Etching involved covering the sword with paint or wax and then scraping out the desired pattern. After the pattern was completed, the blade would be submerged in an acid bath. The acid would eat away at the unprotected metal leaving the desired pattern. Gilding was done by making a paste that consisted of gold and mercury; this paste would get coated onto the blade. After heat was applied the mercury would melt off, leaving a thin deposit of gold on the metal.

After the blade was complete the sword would go to the hiltmaker. Hiltmaker's tasks were getting harder throughout the Elizabethan age the designs were becoming more elaborate, and swordsmen also required far more protection than they had in the past. Hiltmakers attatched guards, grips, and pommels and the now complete weapon was sent to the sheather or scabbard maker until finally it would reach the guilder who fashioned the belt and hanger (Wilkinson 1978: 56).

## Daggers and Knives

During the latter part of the sixteenth century the dagger began to be carried far more than it had ever been in the past. The greatest reason for this was the need for a parrying weapon to hold in the left hand while dueling, amongst civilians.

The dagger had always been one of the standard weapons carried by all soldiers, as a last resort during closely fought battles. Its smallness allowed it to be carried easily as well as making it a handy weapon in any hand-to-hand fight with the enemy, which may have taken place during a battle. During this time there were four primary daggers that were being used.

Weapons such as the ballock knife and Swiss dagger continued through most of the sixteenth century, but with marked alterations, while the most changed of all were the quillon daggers, offering almost a new type in the left hand daggers at the close of the period. Finally, there was also an entirely new form in the so-called Landsknecht daggers of central Europe (Peterson 1968: 36).

The most widely used dagger of this time was the quillon dagger. They were the daggers that were used in dueling, making them an important part of civilian dress. By the Elizabethan age dueling had become a part of every day European life. The quillon dagger was used in the left hand to parry the opponents' rapier thrusts. However, these daggers were not restricted to dueling and could be used on the battlefield.

It was so popular as a parrying weapon that was held in the left hand that in the second half of the sixteenth century it became known simply as the left-hand dagger. Opponents would face each other, thrusting with the rapier while parrying with the left-hand dagger simultaneously. Since it was a defense weapon the quillons had to be strong enough to withstand an enemy thrust. In the case of quillons, the longer the better, longer quillons allowed the user to block more rapier thrusts. It was also helpful to have curved quillons so that they could catch and entangle the blade of an opponent's rapier by simply rotating the wrist. If one could manage to disarm his opponent of their rapier, he would obviously be at a distinct advantage, thus curving the quillons in ways that could tie up the rapier was emphasized. Another reason for all of the curves on the quillons was that they were made to match the rapier, whose design at the time was emphasizing protection of the hand through curved quillons along with many other

methods. Since all left-handed daggers were made en suite with a rapier of one form or another, the terminals of their quillons almost always duplicated those of the sword with which they were mated (Peterson 1968: 42). Most of the left-hand daggers produced during the latter part of the sixteenth century also came with some type of ring guard or a shell on the side of the quillons to protect the knuckles. This was extremely necessary since the left hand dagger was a parrying weapon whose primary purpose was to entangle the opponent's rapier. In order to do this the left hand would have to be protected from the enemy thrusts, or else there would be a high risk of the left hand being disabled.

The blade most often tapered from the ricasso to the point and had a diamond shape in cross section. Like its corresponding rapier the dagger blade was also being made longer and narrower to emphasize thrusting. The pommels also matched that of their accompanying rapier, where there were a variety of shapes and sizes. Due to this increasing use of this left handed parrying weapon as well as them being constructed to match a rapier, the overall design of this weapon became much more decorated. Decorations in both pommels and guards varied with gilding, chiseling, enameling, gold and silver damascening or encrustations and etching being among the most popular types of enrichment (Peterson 1968: 43). The higher quality blades were ridged and grooved in differing patterns, with holes of many shapes in them. The purpose of these grooves and holes was not only for decoration, though this was the primary reason, it was also done to decrease the weight of the weapon making it easier to use. These types of daggers were most popular in Spain and Italy, although they were used throughout Europe.

Ballock knives consisted of two different types. One followed the old, generally phalliform pattern in its hilt; the other boasted a hilt with grips that swelled towards the pommel so that they almost resemble an inverted cone (Peterson 1968: 37). These forms were nothing new and had existed for a number of years; however it was during the latter part of the sixteenth century that these forms began to become highly exaggerated. The phalliform hilts were constructed so that they were far thinner than they had ever been in the past. The grips were long, almost columnar, sometimes fluted and frequently faceted (Peterson 1968: 37). Also, much like the trend with swords, these blades were being made longer and narrower to emphasize the thrusting function of the weapon. The blades were slender, double-edged and so thickly diamond shaped in cross section that they could almost be considered four sided (Peterson 1968: 37). The grips on Ballock knives were one piece, from the pommel, which was usually rounded, to the globes at the base of the blade. Both types of the Ballock knife were identical except for their unique grips.

Another type of dagger that was being used during the second half of the sixteenth century was the Swiss dagger. This was a modified version of the pre-existing baselard dagger. The metal-shod crosses at both ends of the grips had assumed their characteristic curved shape (Peterson 1968: 39). The Swiss daggers were different only in minor refinements to the grips and blades, but also in the design of the scabbard. The grips on Swiss daggers differed from the grips of the baselard daggers in several ways. Instead of the slender straight-sided form that had characterized the type since its earliest days in the baselard family, the Swiss daggers developed relatively broad grips with slightly convex edges and a low median ridge down both of the broader sides (Peterson 1968: 38). The points where the grips met the crosses, at the top and the

bottom, were often slightly curved. Also, the sides of the crosses also became flat, unlike the rounded form that it previously had. The blade was also being changed; the tapering effect that had been used in the past was being phased out by a slightly leaf-shaped blade that tapered from hilt to point along a curved line. This blade was double-edged and diamond shaped in cross section, although not nearly as thickly diamond-shaped as the Ballock knives.

All of these changes were minor in comparison to the changes that were taking place in the scabbards of the Swiss dagger. Instead of the older, simpler style where two pieces of wood covered with leather and mounted with a metal throat and chape, a new design was being used. For Swiss daggers the metal mounts began to expand in size and complexity until the entire front of the sheath was covered in brass or silver and frequently gilded (Peterson 1968: 39). The scabbards became much more highly ornamented than they had ever been in the past, with intricate designs being etched and engraved into them. This was an extremely popular dagger in its native land, Switzerland. The user would usually carry this weapon horizontally along the lower back, with the hilt to the wearer's right, so that it could quickly and easily be grabbed by the left hand and used.

The fourth type of dagger that was used during the second half of the sixteenth century was the Landsknecht dagger. There were two varieties of this type of dagger. The first type of Landsknecht dagger was a variation of the rondel dagger. It was characterized by an all metal hilt that usually flared upwards from guard to pommel, so that the grips became a sort of inverted cone (Peterson 1968: 45). The pommel was usually a flat cap that was sometimes slightly rounded. The grips were ribbed either horizontally or spirally to provide added grip. The guard

was a flat plate, lobed, and bent towards the blade. Often there were three lobes, two serving as quillons, and the third, bigger than the others, in the center on the obverse side, serving as an additional guard (Peterson 1968: 45). In most cases the blade was straight, double edged and tapered from hilt to point. This design had an unusually large scabbard that was circular in cross section and heavily mounted in iron, many times they would have several prominent moldings.

The second type of Landsknecht dagger was similar to the second type in the scabbard. It also had a heavy scabbard that was circular in cross section and frequently featured raised moldings. The difference was in the design of the hilts. The guard consisted of shorter quillons and a side ring similar to the guard that was used in left-hand daggers. The grips were usually wrapped with twisted wire, and the pommels might be urn-shaped, pear-shaped, or inverted cones. Unlike the popular Landsknecht type, which was usually quite plain, these daggers were often enriched with silver overlays and etching on the metal mounts of the sheath and on the guard and pommel (Peterson 1968: 45). These daggers started to be produced during the last quarter of the sixteenth century and were very rarely seen throughout the entire seventeenth century, thus they had a short life, making them extremely rare. Most of these daggers were produced in Germany, most notably Saxony. For this reason they are often referred to as Saxon daggers of the Landsknecht form

.

## Bows and Crossbows

During the 16th century, mechanical projectile weapons were starting to get phased out due to the ever increasing use of firearms. Most firearms were much easier to operate than a bow or crossbow, and required much less training. With bows, an archer was forced to draw the

string and aim at the same time, which required a great deal of strength and skill to achieve accuracy. In order to become a skilled archer many years of practice was required. Firearms simply required aiming and the pull of a trigger, thus even the weakest of men could be trained to be a formidable force on the battlefield in only a couple of days. Nonetheless, mechanical ranged weapons were still widely used at the time, and continued to be used for hunting well into the eighteenth century. There were many advantages the longbow had over the primitive firearm, however with the increasing effectiveness of the hand gun, its use steadily declined.

The early firearm and the crossbow were very similar. Both had been primarily used as a defense weapon against enemy sieges. Both were heavy and very slow to reload thus limiting them to their role as a defensive weapon. The hidden advantage of the shoulder arms was that they allowed the troops to be spaced much more closely than crossbows would permit. This meant that the requisite degree of fire density could be achieved on the battlefield (Hall 1997: 133). The soldier no longer needed the excessive space required to fire the crossbow. Due to the inaccuracy of both weapons at this time it was essential that many shots be fired at a general broad target, such as an opposing military formation, rather than each soldier firing at an individual target. It is inevitable that the fifty shots fired from a dense military formation will have more hits than twenty-five shots fired from a less dense formation.

The longbow was the most common form of bow. Long after the introduction of firearms in Europe, the longbow was still heavily favored until almost the end of the 1500s, especially in England, where subjects were encouraged to practice their skills at the longbow from the age of 14. The English firmly believed that the longbow, their national weapon, was superior to the

early firearm, in both range and accuracy. However, the primary reason the English believed that the longbow was the most effective weapon on the battlefield was the rate of fire, far greater than that of firearms or the crossbow. A trained archer could fire 8-10 shots per minute, and exceptional archers could fire up to twenty. This was far greater than the two or three that could be fired using a firearm or crossbow. Even though this weapon did not have the power of a firearm or crossbow it was powerful enough to be the primary weapon of an English army that had come to dominate, in the sixteenth century. A strong man wielding a longbow could wound an enemy at about 250 yards, kill at 100 yards, and penetrate armor at about 60 yards. Another advantage of the long bow was the simplicity in production. It was far cheaper to manufacture a long bow than it was to produce a firearm.

The longbow stood about six feet to six feet seven inches in length, and had a thick center, which tapered towards both ends. It was produced by bowyers who would usually receive the wood already cut into staves; their job would be to finish the bow. The finishing process consisted mainly of giving the stave its final shape, putting notches in the ends, sometimes with the addition of horn tips, for the attachment of the string, and binding the center for a handgrip. Bowstrings were commonly coated with flax, made of either gut or sinew, and potentially required considerable strength to string onto a bow. The longbows were typically made from yew or sometimes elm, and the bow and strings were often coated in a combination of wax, rosin, and tallow. Longbows were carried unstrung and required restringing every time they were used.

The arrows were made by a separate group of craftsmen, the arrowsmiths or fletchers. Common length for longbow arrows was approximately three feet, and they were commonly feathered with goose feathers. The shaft, or stele, or the arrow was often made of ash because of that wood's strength and flexibility, and sometimes made of metal, making a single piece with the arrowhead. During the sixteenth century, due to better armor, narrower more rigid arrowheads were needed. The arrows were sharply tipped, to allow for maximum penetration at a very small point of contact; for example, a pyramid shape with three or four sides, a leaf shape of thick diamond section and a thin needle-like 'armor piece' of square section (Blair 1962: 33). These arrows were usually stored in a belt, or stuck into the ground in front of an archer. The feathering of the arrows, set slightly diagonally, caused the arrows to rotate in the air, helping increase the weapon range as well as accuracy. When drawing the longbow string, the archer had to fight against up to a 150-pound pull (Wilkinson 1978: 62). Although, many authors deduce that the longbow required a force of about forty to fifty Newton's to draw it back to the shooter's ear (Hall 1997: 19). The tension in the bow that was caused from the pull is what would propel the arrow forward. Because of this, aiming the longbow was more difficult than aiming firearms. However, because of this pull, these arrows were, at times, devastating to chain mail armor. The arrows from a long bow could easily penetrate chain mail armor, although the development of plate armor is what caused the long bow to rapidly decline in use. Arrows fired from a long bow were often ineffective against plate armor and rounded plate armor in particular; the arrow would only be able to penetrate the armor if it struck it at a right angle or if it was fired from close range.

To fire the longbow, the archer held the bow at the full length of his left arm, straddled his feet, and faced the direction his feet were lined up in. The notch of the arrow was held to the middle of the bowstring by the fore, middle, and ring fingers. The arrow was drawn to approximately four inches below the archer's eye, causing the arrow to be shot with an upward arc (Tunis 1954: 60). For shorter distances, this caused the archer to aim below his target to avoid the arrow sailing over its target. As distances increased, however, the archer was forced to aim at points above the target to counteract the force of gravity.

The crossbow is another variant of the bow. In the crossbow, a small bow was attached to the end of a wooden shaft called the tiller by either gut bindings or a metal bridle. When the user pulls the bowstring, he secures it to the nut, usually made of bone, which is set into the shaft. A release lever is located below the shaft, and allows the nut to rotate when pulled. The nut releases the string and the arrow is fired (Wilkinson 1978: 54). This mechanized variation of a bow allowed for the string to be cranked into a position that provided much more leverage; this would result in a much more powerful discharge that could be very destructive. The total weight required to draw the string of the bow seven inches, or from a state of rest to the catch of the lock is 1200 pounds

Crossbow
Accession #: 196
Belgium
17th-19th century

or over half a ton (Payne-Gallwey 1958: 14)! This factor however was determined by the material of the bow.

The bow was crafted of yew wood, ash, or steel. The bowstring was made of sinew or gut. The arrow of a crossbow, called a quarrel or bolt, was shorter than a bow arrow, and was thicker as well. It was made of a wooden shaft with a conical or pyramid shaped iron head and was fitted with feathers, or vanes, which were set at angles. These feathers made the bolt more accurate by causing it to rotate upon being fired into the air, helping the bolt to be more stable in its flight and hold its direction.

The three main loading mechanisms that were used on crossbows that existed during the Elizabethan age were the goat's-foot lever, the windlass and the cranequin. The goat's-foot lever was the simplest of the designs. The simplicity and convenience of the lever were so evident, that long after crossbows had been discarded in warfare, it was popular for binding the steel bows of smaller weapons used in sport or at a target- in the latter, till as recent a date as the close of the eighteenth century (Payne-Gallwey 1958: 86).

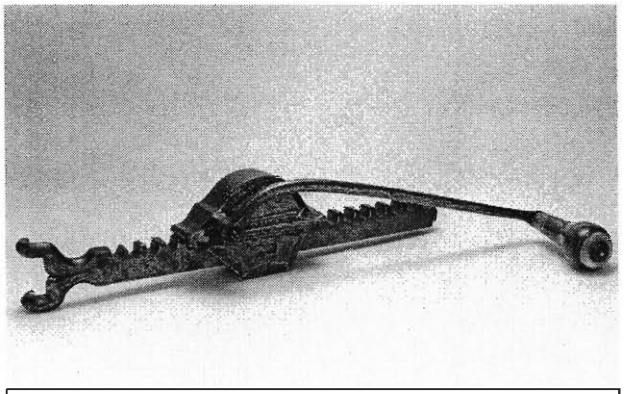
It was used by hooking the claws of the lever over the center of the bow string. There was an iron pin which protruded out on both sides of the stock. The prongs of the fork that were on top of the stock rested their ends on the pin. The mechanism was activated by holding the bow in a rested position either with the left hand, or in the case of mounted soldiers on rings or other protrusions of the saddle. The lever would then be pulled towards the user with the free right hand. The leverage obtained from the fork of the lever, as you pull its handle back, will

enable you to stretch the bow-string to the catch of the lock smoothly and quickly (Payne-Gallwey 1958: 88). More powerful versions of the crossbow had to be rested on the ground in order to pull back the lever.

The second loading mechanism used in crossbows was the windlass. This was a method that was used for the most powerful crossbows, ones that consisted of steel bows and required a large draw weight in order to bend the bow. This was a system that consisted of pulleys and cords. The pulleys were rotated by turning a crank; this would in turn wind up the cable that was connected to the bow string causing the desired draw weight, thus creating the desired tension in the bow. This system is much like the modern day fishing poles reeling in a fish. This system created an enormous amount of power in the string and was simple and easy to use. This type of design was unfavorable due to the fact that it required a long and heavy stock and the cord would at times create problems, by becoming entangled or snapping.

The other loading mechanism that was used on crossbows was the cranequin. This was a device that used a rack and pinion system. The cranequin was a slow device although it was extremely durable. It works like many modern day car jacks, and some early clocks that had to be wound. It consisted of two primary parts; one was a rectangular ratchet that had grooves along the inner face, perpendicular to the shaft of the crossbow. This ratchet was connected to the bow string, and was capable of movement in the vertical direction, or along the shaft. The other part was stationary; it consisted of a cylindrically shaped outer shell that had a rotating shaft with a handle connected to it. Inside this shell there was a large grooved cylindrical piece, which had another smaller grooved cylindrical piece attached to its bottom face. Both of these

discs were able to rotate. The cranequin was activated by the user rotating the shaft. When the shaft is rotated it causes a spindle, which has grooves aligned with the larger cylinder to spin.



Cranequin
Accession #: 3020.1
Switzerland
About 1550

When the larger cylinder starts spinning the conjoined smaller grooved cylinder also begins to spin. The grooves of the smaller cylinder interlock with the grooves on the ratchet, thus displacing the ratchet in the negative vertical direction. This provides the necessary draw weight in the bow string that is required to discharge the bolt or arrow. The benefits of the cranequin loading mechanism were that a long and heavy shaft was no longer needed, and since cables were not involved it was much more dependable than the windlass.

By the second half of the sixteenth century the use of the crossbow was rapidly declining. The crossbow which was once looked at as the most powerful weapon of war was being replaced by the hand gun. By the second quarter of the sixteenth century most European rulers replaced all their crossbowmen with gunners, Sweden being exceptional in retaining the older weapon until 1570 (Blair 1962: 35). One reason the crossbow was dwindling in use was that it could not compete with the efficiency of the long bow. Crossbows tended to be very slow to reload causing many to favor the use of the long bow. Crossbowmen could typically only fire 1 arrow per 6 shots by an archer (Tunis 1954: 65). Some of the advantages of the crossbow were that it could be carried ready to fire, and they could be held effortlessly while aimed. They also

required less physical strength to reload than the longbow. This allowed soldiers to fire instantly with a crossbow when the need arose, and then continue with another form of weapon.

Although the crossbow was more powerful than the longbow, and could be used in more cramped positions, the crossbow was less useful in wet weather, and the longbow arced faster, could shoot a larger number of bows at once with equally dense formations, and had a larger range than the crossbow. Even though the crossbow was proven inferior to the firearm as well as the longbow, in terms of battlefield effectiveness, both foot and mounted soldiers continued to use the crossbow throughout the sixteenth century.

## Firearms

Although gunpowder, which is a mixture of saltpeter, charcoal and sulfur, had been developed in the eleventh century by the Chinese for the purpose of fireworks, it didn't make its first appearance in firearms until the fourteenth century. The prior existence of the cannon undoubtedly led to evolutionary thinking, the development of a weapon using the same principles as the cannon that could be carried and operated by a single man. The primitive form of the hand gun was merely a small cannon, which was extremely difficult to use. The user would have to aim it, light it, and also hold the gun; this could be an extremely daunting task. Firearm use grew in importance during the fifteenth century due to the improvements that had taken place in the design. The guns became much safer to use as well as becoming more accurate and powerful. The production of hand-free ignition systems coupled with a number of other adjustments caused the weapon to be much more effective than it had ever been. Due to these improvements the weapon was seen more frequently on the battlefield. During the late

sixteenth century, firearms started becoming even more prevalent and began to change the way that battles were fought. The guns of this time were much more efficient than they had been in the past. Many of the problems were gradually taken care of during the previous two centuries, and the gun had become the primary weapon of war. As a result of the firearm's steadily improving effectiveness, its use on the battlefield was essential to any army that wanted to achieve victory.

The firearms were commonly made of an iron or steel barrel and a wooden stock. Firing early guns involved the soldier holding the weapon under his arm or resting it on his shoulder, while using the other hand to hold a smoldering matchcord to a touchhole on the gun, which led from a pan containing the priming powder to the barrel of the gun, where the main charge of gunpowder was. The smoldering matchcord would ignite the priming powder, which in turn ignited the main charge. Because of how difficult and awkward it was to aim the firearm while both aiming and igniting the gunpowder, new forms of ignition were invented, freeing both of the soldier's hands to aim the gun. By the sixteenth century, the trigger, or sear lever, of the gun was protected by a trigger guard, preventing the firearm from discharging accidentally, and the pan that contained the gunpowder was covered by a lid which could be manually turned to cover the gunpowder, preventing it from getting wet or being blown away by wind.

As a result of two hands being used for aiming, many new shapes of gun came about. The French form of butt had been a downward-curving stock extending from the end of the barrel. Because of the curved butt of the gun, it had to be shot pressed against the chest. This form had tough recoil, and was difficult to aim. The stock of the gun began to be shaped so that

it could fit into the shoulder rather than over or under it. This new type of butt allowed the recoil to be absorbed by the shoulder, which was necessary considering how powerful the guns were becoming. The Spanish were the first country to develop this new type of gun butt. Eventually, but not immediately, most countries adopted similar characteristics to the Spanish gun butt (Blackmore 1965: 13).

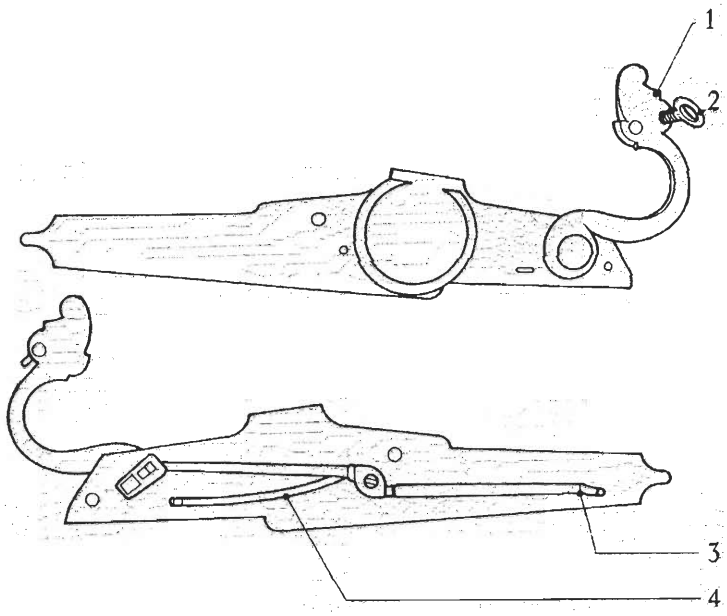
By the middle of the sixteenth century the accuracy of some guns were also being improved by the rifling of the barrels, meaning that they were produced with spiral grooves on the inside so that the bullet would have a spin when exiting the bore. However this method to increase accuracy was mostly used on a small number of hunting rifles, during the latter part of the sixteenth century. This effect could be compared to throwing a football, when the ball has rotation it can travel much further as well as being much more accurate. Unfortunately, most of the guns that were used on the battlefield did not have this innovation and were forced to deal with the many flaws of the smoothbore barrels. Unlike the beneficial spin imposed by rifling, smoothbore spin was uncontrolled; neither the axis of spin nor the speed of rotation could be predetermined (Hall 1997: 135). The bullets would be deflected in the direction of its original rotation; much like a curveball will have a much different path than a fastball pitch in baseball. This is caused by the by the bullet ricocheting off of the inner wall of the barrel many times before it leaves the gun, thus an immeasurable and uncontrollable spin is developed. This deflection requires energy, thus reducing the velocity of the traveling bullet making it less effective. Due to this uncontrolled spin as well as other factors, musketry alone could expect to hit a given target with 10-20 percent of the shots attempted, and the average was surely more like

five percent (Hall 1997: 133). Thus the only effective use of early firearms was when firing at a large group of people, such as an opposing army formation.

There were also a number of other factors that negatively affected the path of a bullet. One of the biggest factors was aerodynamic drag, which is the effect of air resistance. The bullets of the time were lead spheres, which have high levels of drag, largely because they create wakes disproportionate to the thin cross-sectional area. Modern tests showed that bullets were decelerated at a rate of 2.4 meters per second for every meter of distance traveled during the first twenty four meters of trajectory (Hall 1997: 137). This results in the bullet loosing about half of its velocity during the first one hundred meters of flight. All missiles will constantly decelerate when fired, although with a spherical bullet the loss is much more dramatic. Due to this early modern weapons have a shallow zone generally measuring less than 100-200 meters in which gunfire is likely to be lethal to its target (Hall 1997: 138). During the Elizabethan age the use of plate armor, meant this number often would have to be as low as 25-30 meters in order in order to penetrate the strong armor. Another factor that negatively would effect the rotation of the bullet was its actual shape. Since soldiers were required to make all of their own bullets many of them would be flawed, either with air pockets in the lead or just being produced not completely spherical. Both these factors would cause unwanted spin on the bullet making it even less accurate than it already was. In practical terms the smoothbore guns had a serious problem with accuracy that could not be remedied by any change in design, manufacturing, or training in marksmanship (Hall 1997: 144).

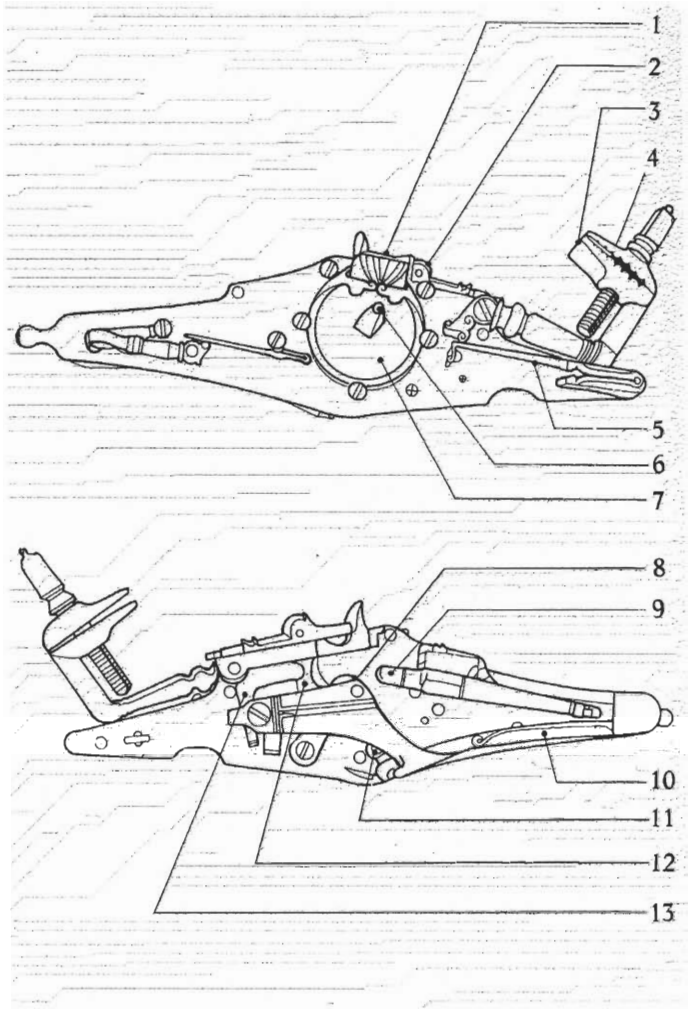
**Ignition Systems**

The cheapest and most common form of ignition during the sixteenth century was the matchlock. This new mechanism allowed the user to hold and aim the gun using two hands; ignition of the main charge could be produced by the movement of the fingertips pulling the trigger. These firearms used a Z or S shaped lever, depending on which way it was looked at. One end of the lever was the trigger; the other end known as the 'serpentine' held the matchcord, which was made of twisted flax, hemp, or cotton and soaked in a saturated solution of saltpeter, allowing it to burn slowly. When the trigger was pulled, the 'serpentine' holding the matchlock cord would depress onto the powder, discharging the weapon (Blackmore 1965: 9). The trigger of the weapon required force due to the sear spring, when the trigger was pulled it would displace a lever causing the rotation of the 'serpentine'. This was indeed a simple design from an engineering standpoint. This mechanism meant that the bearer could now hold and aim the gun without having to worry about holding the match as well. The matchlock firearm possessed some important weaknesses that would be taken care of in the development of new more complex firing mechanisms. It still took some time to ignite the matchcord, and it was difficult to keep the cord burning in damp weather. In fact it was not uncommon for a gunman to never get his matchcord lit in the first place, making




*Serpentine. 1. match holder; 2. thumb screw; 3. sear lever; 4. spring.*

the weapon useless. Also this matchcord would constantly have to be moved forward as the cord would burn back. Despite this, however, it remained in use up until the late 1600s because of its ease and low cost of manufacture in comparison to more sophisticated ignition systems.

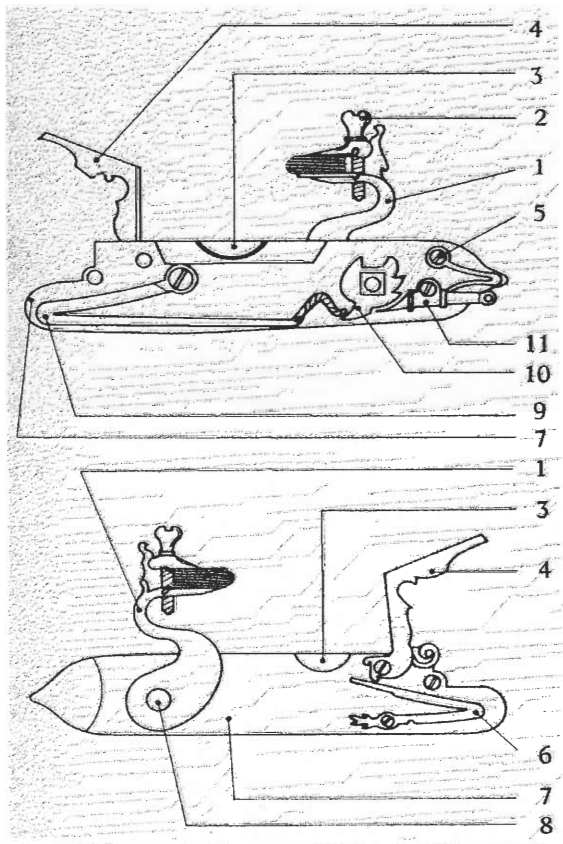



*Wheel-lock. 1. priming pan; 2. sliding pan cover (to hold priming powder in pan); 3, 4. jaws of the cock; 5. cock spring; 6. wheel spindle; 7. wheel; 8. wheel bridle; 9. sear lever; 10. main spring; 11. chain; 12. arm of pan cover; 13. pan-cover spring.*

The second form of ignition of the time was the wheel-lock, which eliminated the use of a burning matchcord to ignite the powder. The design of the wheel-lock mechanism worked in much the same way as a modern lighter. It had a serrated spring-loaded wheel that could rub rapidly against a piece of pyrite, producing sparks to ignite the priming powder. A V-shaped spring was used to rotate the wheel, which was connected to a chain by a key. When the key was turned, the chain tightened, causing the spring to rotate the wheel (Blackmore 1965: 19). Johann Kiefuss of Nuremberg originally developed this design in 1517; there is some controversy over the possibility of the idea for the wheel-lock mechanism being developed earlier by Leonardo da Vinci, but there is no dated proof of this. Wheel-lock guns were not commonly used until 1570, and their use began to decline around 1620. The wheel-lock could be fully prepared for shooting in advance, which would be vital for its eventual

use by members of the cavalry. The major benefit of the wheel-lock firing mechanism was it allowed the gun to be carried ready to use. The wheel-lock firearm represented a great advance over the matchlock firearm technically, but the fragilility and high manufacturing cost of the weapon prevented it from replacing the matchlock firearm outright. It was a favorite, however, with those who could afford it for themselves, and the more expensive arms were artistic creations, beautifully decorated with fine engravings on rare inlays (Canby 1964: 65).

The flintlock mechanism was the third form of firearm developed during the period, dating to 1547. In the flintlock mechanism, a beak-shaped cock held a small piece of flint between its jaws. When the trigger was pulled, the cock snapped down onto an angled piece of flat steel, generating a spark towards the priming powder in the priming pan (Blackmore 1965: 28). The earliest form of a flintlock firing mechanism was known as a 'snaphaunce', which originated in Scandinavia in the middle of the sixteenth century; other versions soon appeared in various parts of Europe (Akehurst 1972: 8). While true flintlocks had an integrated striking surface and pan-cover, the snaphaunce's did not. The simplicity of the flintlock mechanism made it inexpensive to manufacture as well as more reliable, although the matchlock ignition remained prevalent until the late1600s. On a snaphaunce mechanism, the



*Flintlock. 1. cock; 2. jaw screw; 3. priming pan; 4. steel (frizzen); 5. sear spring; 6. steel spring; 7. lock plate; 8. cock screw; 9. mainspring; 10. tumbler; 11. sear and trigger lever.*

pan-cover had to be removed separately, allowing the powder to remain protected until discharge (Blair 1979: 282). This created an issue for flintlocks however, because they could accidentally discharge while loaded. Another problem that may have occurred with the flintlock is the flint would at times shatter when colliding with the priming pan. If this were to happen the gun would be useless until the flint was replaced.

These ignition mechanisms could be mounted on a variety of firearms, each with different features and varying bores, or measures of the diameter of the barrel. Gun bores were calculated according to the number of lead balls of the diameter of the lead balls of the diameter of the bore that went to make one pound, so the greater the number the smaller the bore (Akehurst 1972: 12).

The pistol was one type of firearm that was common in the late sixteenth century. The match-lock ignition system which allowed a gun to be carried ready to caused the development of the pistol. The pistol was a one-handed gun that was about one foot long. They could be concealed easily, fired with one hand, and were often carried by cavalry into battle.

The pistol had brought back some of the effectiveness of the cavalry, whose role had diminished since firearms were killing their horses and penetrating their armor before they could get close enough to make a difference in the battle. The European cavalry eagerly adopted the use of the wheel-lock ignition system; they could use firearms in a far more efficient manner. They didn't need to constantly make adjustments of the matchlock cord, which required both hands. By the end of the sixteenth century, pistols were standard equipment for European

cavalry. Most would carry three of them, two in their holsters and one in their right boot. The use of this type of firearm restored the need for cavalry in battle.

The pistol was one of the more accurate of the early firearms, however only at short range. These guns were intended for and much more effective when fired close to a target. To use them to try and kill a long range target would have been a waste of time. Tests of some of the pistols that existed during this time showed that from a distance of 8.5 meters, a 9.54 kilogram bullet would only penetrate armor between 2.8 and 3.0mm thick. At the moment of impact the bullet was traveling at 436 meters per second and with a total kinetic energy of 907 joules (Hall 1997: 142). This kinetic energy would all be absorbed when penetrating the armor, thus the bullet would at most leave its wearer with a bruise.

Another one of the types of firearm was the arquebus; it was a term that was used to describe a light gun which could be used without extra support from a rest. The arquebus had a barrel that was approximately 2 1/3 feet long, and was 3 feet long overall, with a bore of 17 (Blackmore 1965: 47). They could be fired with one hand if necessary, since they were fairly short, and were used by the harquebusier, a type of mounted soldier. Modern tests conducted with the arquebus show that a spherical shot penetrated 152mm into a target of dried firewood at a range of 30 meters and 113mm into the same target at 100 meters. However, the bullets were able to penetrate a mild steel target an average of 2.7mm at a range of 30 meters and 2mm at a range of 100 meters (Hall 1997: 145). This test shows that the arquebus would often fail to penetrate plate armor unless fired from a close range.

The carbine was another form of gun, short, light, and originally designed to be carried by lightly armored cavalry. The carbine had a barrel of 30 inches in length, with a bore of 24 balls to the pound, and an overall length of 44 inches (Blair 1979: 113). The carbine differed from the arquebus in that it had a flintlock ignition system. It was about the same length as the musket except it had a smaller bore.

One of the most typical guns of an infantryman was the caliver. Calivers were very similar to arquebuses, but with a barrel length of 39 inches, a total length of 4 ½ feet, and a bore of 17 (Blackmore 1965: 13). It was a matchlock gun that was intermediate in size between the musket and the carbine (Stone 1961: 158).

Towards the end of the sixteenth century, many smaller firearms were being replaced with muskets across Europe. Muskets were first produced by the Spanish in the middle part of the sixteenth century; the musket is basically a larger and heavier version of the arquebus. A standard musket had a barrel between 40 and 50 calibers long, and had a bore of 12 (Blair 1979: 341). These guns fired much larger balls than calivers, and were also much heavier to carry. The weight of the projectiles was nearly twice as much as the arquebus projectiles, a comparative 1.2-1.4 oz. to 0.7 oz. Due the increase in the weight of the bullet the shot fired from a musket had much more of a penetrating power than the arquebus, even though they traveled at roughly the same velocity. The velocities at which the bullets would leave the barrel were about 1490 feet per second. This was a very powerful weapon at this point of discharge, easily able to penetrate even the strongest armor, however it lost velocity rapidly due to factors mentioned earlier The musket also required a musket rest to support it, a long wooden pole with a wide fork

at the top and an iron base which could be stuck into the ground at the bottom. The increase in barrel length and ball size was worth the extra weight, however. Muskets had much more range and accuracy than the caliver, and they also had great power. A standard musket could penetrate armor at 120 paces away (Oakeshott 1980: 41). By 1600, muskets were common across Europe, and were quickly becoming the favored form of firearm.

As a result of the increased power in addition to becoming easier to use, firearms thus reduced the effectiveness of armor. Armorers would test their work by discharging firearms at the armor in the presence of the client; many bullet marks on armor from this period come from such tests, rather than from battlefield bullets. However, the new forms of firearms were able to pierce most forms of non-reinforced armor (Blair 1972: 117). The use of reinforced armor was attempted, but the sheer weight of the armor needed to protect against firearms was increasingly impracticable for a soldier.

There were a number of variations in firearms in Europe at the time. Most areas had no standards for firearms, but England was an exception. By the end of the sixteenth century the standard infantry weapon was a musket with a barrel length of 4 feet and a 10 bore (Akehurst 1972: 12). One area in which the guns greatly varied was in the elegance of the design. Many guns, especially pistols, were very highly decorated. In fact some guns were so richly decorated that their sole purpose was being used on ceremonial occasions, many would never even be fired. The intricate carvings in the handle would at times make the gun difficult to use. Many noblemen carried these types of guns and considered them works of art. The latter part of the sixteenth century was a time that was known for the use of inlays and veneers on gun stocks.

Stags horn was the most popular inlay but bone, ivory, and mother-of-pearl were all used. Veneers were of such woods as burr walnut and ebony and also of such rich materials as tortoise shell, ivory or mother-of-pearl (Akehurst 1972: 106). One country that was noteworthy for their skillful decoration was Germany. The craftsmen of Nuremburg and Augsburg were particularly skilled with crafting metal. Due to the high demand for these intricate designs many skilled craftsmen would leave their native lands, and produce the desired weaponry in locations where the demand was highest. This explains how some similar designs may have been produced far from where their form had originated.

Even though there had been many advances in the production of firearms, they were still not perfected. By the Elizabethan age guns had already taken on the form that they have today. However there was a far greater likelihood that the user would encounter problems when using the gun. For one thing the guns, particularly muskets were quite cumbersome. Also each man had to carry his gunpowder in cartridges that he slung around his shoulder. It was essential to carry individual cartridges because if too much gun powder was used the barrel might blow up in the soldier's face. On the other hand if not enough powder was applied the discharge might not be strong enough to reach the target. Another problem that the gunmen had was keeping their bullets in the barrel. Since the barrel did not secure the bullet, it would slip out if it were held at a downward angle. All of the previous problems could all be prevented by just being careful, however, there was one problem that was inevitable. The primary disadvantage to the weapons of this time was that they took an extremely long time to reload. It took so long to reload that in order for it to be effective on the battlefield; new strategies had to be implemented. To compensate for the reloading time armies would stand in square or rectangular formations. The

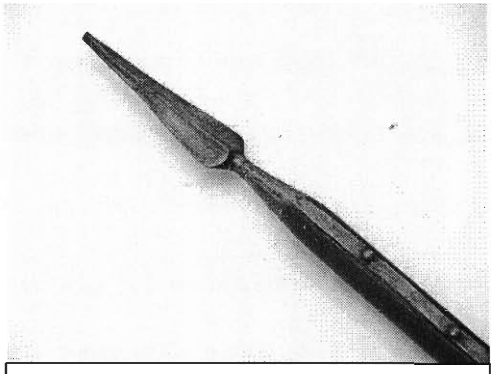
first line would fire a shot and then quickly retreat to the back of the formation to reload their weapon, this process would repeat as many times as necessary.

During the latter part of the sixteenth century weapons were also used carried by many civilians. During this period crime was rampant, with many criminals carrying weapons. Things got so out of hand that European leaders such as Henry VIII passed ordinances that made the possession of firearms a crime. Murderers and robbers would walk the streets armed and looking to prey on any person they could. This caused many of the law-abiding citizens to purchase guns in order to fend off the delinquents. The most common gun carried by criminals and the innocent alike were matchlock hand pistols, which were favored because they were much easier to conceal than many of the other guns, and could be fired with little or no inconvenience. Guns as well as swords and daggers had become the weapon of the criminal as well as the weapon of civilian defense.

Some improvements that were being made to the gun at this time involved new methods of making the barrel and fitting it to the stock. The old method of manufacturing was to cast the barrel in one piece. Now the barrel was forged into an open tube and its breech end was closed with a screwed plug. The touch-hole was drilled into the side and a separate pan with a pivoted cover was attached to it (Blackmore 1964: 8). Of all the changes that had taken place over the sixteenth century the constant improvement of the ignition systems, which eventually allowed the guns to produce their own fire, was the largest factor that accounted for the widespread use of firearms.

## Haft Weapons

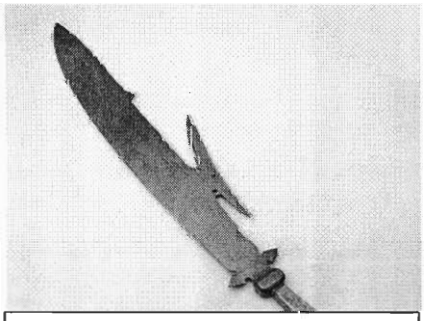
The pike was the most common weapon seen on the battlefield in the latter part of the sixteenth century. The pike was the longest haft weapon of the sixteenth century, ranging in length from 16 to 22 feet, with a weight of about 12 lbs. (Blair 1979: 366). It was tipped with a leaf or lozenge shaped head, with shaft being made of ash and the head made of steel. The term pike is of French origin and the weapon was used in ancient times, but it was the Swiss who helped greatly revive the use of the pike during the fifteenth century keeping it in use well into the seventeenth century, when it was eventually phased out by muskets and bayonets.



Pike
Accession #: 1299
Germany or Austria
17th century

Before this revival, weapons of such extraordinary length were all but forgotten. The key difference between the Swiss pikemen and those of earlier times was how the Swiss used the weapon. The length of the pike made them very useful against cavalry units. It was superior to shorter polearms against cavalry and weapons such as the lance, since the shorter weapons often could not reach the enemy. Typical pikemen had both a pike and a sword. One common stance for a pikeman was kneeling on one knee, pike braced against the foot for a cavalry charge, with a sword in the other hand for close combat (Blair Encyclopedia: 366). However, during the Swiss revival of the pike, pikemen were often used not only in defense and in sustaining attacks, but also to counterattack opponents and overpower them. Pikemen, in preparation for battle, would stand shoulder-to-shoulder several rows deep with their weapons held forward through their own ranks, and advance against infantry. Armies commonly used pikemen to protect cavalry and halberdiers during retreats, as well as to defend against enemy charges.

The primary use of the pike during this time was to protect the shot, during the very slow reloading time. The reloading of a musket was a process that took roughly a minute or so complete. During this time the gunners were extremely vulnerable to enemy attacks. As a form of protection the pike men would assemble into a square formation so that they could have their pikes pointing in every direction, this wall resembles the natural defense mechanism used by the porcupine. Few horsemen would be courageous, or stupid enough to attack on of these square formations. However, this was still an extremely dangerous job since the pikeman's job to protect the gunners at all costs. They were extremely vulnerable during the Elizabethan age due to the fact that the cavalry was at the time equipped with pistols, and the fact that an extremely determined knight could not be stopped. Even if the knight and horse were killed trying to penetrate the pike wall; the pikeman could still be crushed by the weight of the horse. The employment of the pike on the battlefield depended entirely on the capacity to recruit and train men willing to engage in this hazardous and comparatively poorly rewarded form of warfare (Hall 1997: 38).

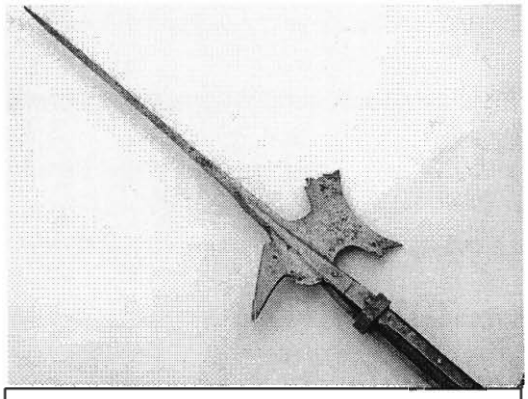


Glaive
Accession #: 110
Italy
Late 16th-early 17th

Many forms of haft weapons were getting phased out during this time, and found use mostly as ceremonial and guard weapons. The glaive was a haft weapon with a large, flat, curved blade at the top. The broad, flat head made the glaive very easy to decorate, making it very useful for palace guard weapons or for ceremonial use. It was popular in both Germany and Italy, where they were used as palace-guard weapons or could be decorated with

any coat of arms in parades. Some later versions of the glaive had flukes protruding from the back of the curved blade.

Most halberds were about six feet long and two inches in diameter, although many were much greater in length (the longer models were mostly used for ceremonial purposes and had symbolic meaning) with an intricate head at the top that combined the advantages of both the spear and the ax. The head had a very long, sharp tip at the top, with a blade and fluke to the sides, and a powerful spike within the axis of the staff, ideal for piercing armor. It was essentially a weapon used by foot soldiers.

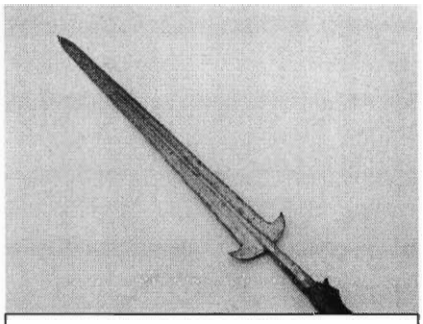


Halberd
Accession #: 3041.3
Germany or Austria
Late 16th-early 17th

The forms of this weapon varied in a number of ways. The blade was large and crescent shaped, forming a large, flat area with the fluke (Blair 1979: 193). This once again made an ideal surface for decoration for use as guard or ceremonial arms. Another feature of this weapon was steel straps that extended down from the head of the axe to as far as four feet. These were to keep the halberd head from being chopped off by the sword of an opposing knight (Gamble 1981: 36). The halberd was both a cutting and thrusting weapon, and was used in battle by the Italian, French, and Swiss military, however this weapon was being phased out and rarely saw use on the battlefield during the Elizabethan age. While the halberd was in use around 1550, by the end of the century the weapon had fallen to the power of the firearm (Blair 1979: 195). Even though its

use on the battlefield became obsolete, its use as a symbol of rank continued into the eighteenth century. It continued to be carried by sergeants in the English army.

The third ceremonial and guard weapon was the partisan. This polearm had a broad pointed blade at the top, and was a thrusting weapon only. Each side had a tapered cutting edge. At the base of the blade, two lugs protruded at an angle on either side. This made the partisan an ideal weapon for both cutting and thrusting (Blair Encyclopedia: 360). It was always found to be symmetrical both sides balancing in form. The large flat areas on the partisan were also decorated often, occasionally taking on emblems representing an officer's rank. All of these forms of polearms fell out of favor by 1600 to the new forms of firearms. However, the partisan like the halberd took on a symbolic meaning in the British army; it was a symbol of rank carried by captains.



Partisan
Accession #: 109
Italy
Last quarter of the 16th century

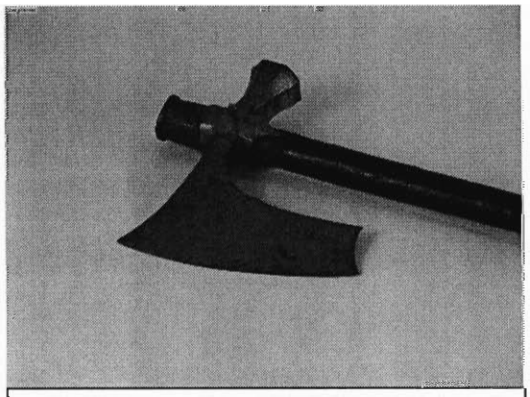
Another weapon that was similar to the partisan was the corsesca. It consisted of a long double edged blade that was triangular in form. It had two projections of various forms that were symmetrical, like the partisan, although they were usually much larger in the case of the corsesca. They were smaller than the primary blade, although not by much.

A specialized type of polearm is the lance. Commonly referred to as cavalry spears, lances were about 14 feet long, and had a tapered conical shape until the grip, tipped extremely sharp for piercing the enemy. Unlike most polearms, lances are gripped from the rear, allowing

cavalry to wield lances with one hand, and keep their enemies at a safe distance. War lances had an extra cut out section in the grip for the bearer to hold onto. Rests were required to protect the user from the recoil of the lance striking the victim. This rest was a small bracket fixed to the right side of the breastplate to support then lance. Because of their length, the butt of the lance was braced under the armpit of the user (Wilkinson 1978: 307). The English developed smaller forms of lances, called demi-lances. These lances were made so that the wielder would not have to rest the lance underneath their armpit, and avoiding possible injuries (Oakeshott 1980: 197). Cavalry used their right arms to aim the lance at the opponent. Until the widespread use of firearms, cavalry armed with a lance and swords were considered the most dangerous force on a battlefield. For jousts, blunt tips were affixed onto the points of lances, often referred to as a "courtesy lance". This allowed knights to joust without the fear of being impaled by a lance.

## Blunt Weapon

In the Elizabethan Age, the blunt weapons of war began to take new form. The mace, similar in design to a club, was a favored hand weapon of cavalry, and also used by foot soldiers. Maces before the Elizabethan Age usually consisted of sharp piercing metal heads attached to a strong shaft. The mace was particularly effective at piercing armor. Two new styles were developed after 1550. One used a steel globe at the end of a shaft. Attached to the metal



Czekan
Accession #: 3006
Perhaps Germany or Eastern Europe
Late 16th century

globe were spikes in every direction. Second was the bulawa, which was used entirely for bludgeoning. It had a small, pear-shaped head attached to the end. This form of mace had no spikes (Oakeshott 1980: 66).

In the early 16th century a new type of war hammer, which was usually thrown, was used in central Europe. These throwing hammers, shaped like crosses, had pointed arms and handles and were intended to whack and wound a target. Horsemen also used war hammers in the 16th century. However, these hammers took on a smaller, short-handed form. The czakan, known for its use in Eastern Europe, is a typical representation of a hammer from this era, being constructed of a long curved fluke with a light face.

# *Military Tactics of Europe between 1550 and 1600*

By: Kyle Merchant

The late sixteenth century was a transitional period for military tactics in Europe. The changes that occurred during this time were primarily in response to two technological advances made in the previous hundred years. The development of bastioned fortifications, as well as the firearm, completely reshaped the European army during the sixteenth century. Armies became larger, differently organized and equipped, and ultimately more expensive to raise and maintain (J.R. Hale 1985: 47). This changed the way battles were fought and how armies were commanded. With the larger armies came greater responsibilities as a commander, raising questions as to what makes a "good" commander and how to train such a person. In the end how battles were fought saw the greatest change, with death tolls being higher and the duration of battles being longer.

## Tactics and Technology

Technology tends develop and evolve in response to a previous technology that proves to be effective. In most cases, a device can be traced from its invention back through time to the Renaissance or earlier. Likewise, technology developed during the sixteenth century can also be traced back to previous technology as either response or source. Military tactics tend to focus around technologies that are either an effective offensive against a strong defensive or vice versa. Cannons are an example of an effective offensive against the defense of a castle, while pikes are examples of a strong defense against the offensive charge of heavy cavalry. Both developed in

response to a previous existing technology. The technology acts as a driving force for change, which can be seen in the late sixteenth century as tactics began to change.

**Bastioned Fortifications**

One technology that defined the tactics of the late sixteenth century was the bastioned fortification. A product of the early sixteenth century, its use and development would define how armies were constructed and used through to the seventeenth century. Bastioned fortifications proved to be significant by increasing the difficulty of sieges and ultimately lengthening wars (J. R. Hale 1985: 47). To counter the firepower of artillery, walls were designed lower and thicker, but this increased the chance of surprise attack from the ground (Parker 1988: 10). The effectiveness of flanking fire was already known and engineers were quick to integrate it into fortifications. Angled bastions proved to be the most effective design employed, allowing ample flanking fire, as well as acting as gun platforms to suppress enemy artillery fire.

Leon Battista Alberti is the one accredited by the majority for devising the concept of the bastioned fortification in 1440s. However, his treatise remained unpublished until 1485, which is when we begin to see in Italy the building of fortifications capable of withstanding bombardment by artillery. It is in this paper titled De re aedificatoria that Alberti emphasized the strength of sharp angles and suggests building fortifications in "star shapes." Filarete's Trattato di architettura (written c. 1460) supported Alberti in this claim. However, neither man had originally intended for the design to be used for flanking fire (J. R. Hale 1985: 12).

No single nation is credited for the first use of bastions as a means of supplying flanking fire, rather the use of the design evolved throughout Europe, though it was the Italians who seem to be the fastest in building the fortifications (J. R. Hale 1985: 2). Italy had bastioned fortifications in place as early as the turn of the 16th century, while it was after 1530 that the angled bastion spread across the Alps. However, this migration was fast. By 1544 fifteen strongholds in the Netherlands alone had been built, while France had over 100 Italian engineers working at bolstering the northern defenses of the country. By 1572 nearly 43 kilometers of bastioned walls had been erected throughout the Low Countries (Parker 1988: 13). Even England in 1540 had 24 garrisoned fortresses in place on the southern coast, with more being built or planned.

The reason for this rapid investment in fortification and defense was related to factors that had developed earlier. First was the increasing importance of cities to a nation. Intellectual and economic centers, cities had become the backbone of a country during the Renaissance. They were also manufacturing and recruitment centers, making them crucial to war efforts as well as prime targets for the enemy. Due to the rapid expansion of cities, defenses of any significant amount had yet to be put around them, and those that were in place were made obsolete by the strength of the cannon. The cannon is the second reason for the rapid development of defenses. The fall of Constantinople in 1453 was thought to be the end of walled fortifications, even Machiavelli stated in 1519 "No wall exists, however thick, that artillery cannot destroy in a few days" (Parker 1988: 10). This vulnerability of cities helped to spur this rapid development of fortifications.

The siege of Ostend lasted from July 15, 1601 to September 15, 1604 with the city's capture. Prior to this period three-year sieges were unthinkable, however in the late 16th century sieges would last on the order of several months, if not years (J. R. Hale 1985-2: 191). Sieges were won or loss due to starvation rather than successfully storming the wall. And with the capture of cities and fortresses being critical to victory, the bastioned fortification ultimately lengthened wars.

As with any new technology, bastioned fortifications were not cheap. The cost of design, materials, labor, and time added up quickly. In addition, the cost of maintaining a garrison to man the fortifications made building them a costly investment. An example of this cost is the 7-kilometer enceinte of Antwerp, with nine bastions and five gates. This cost the city one million florins or nearly two hundred thousand dollars (Parker 1988: 11). This created a greater effect of war on citizens than before. Through taxes, the cost of fortifications was placed on the citizen. Sieges brought the war front to the home causing havoc for families, especially when starvation hit. In some cases commanders would reduce food consumption by having the 'unneeded' (women, children, and the elderly) removed from the city (J. R. Hale 1985-2: 192). This not only made wars costly monetarily but in life as well.

**The Firearm**

While fortifications reshaped the way wars were fought, firearms reshaped the armies that fought the battles. The harquebus was a weapon easy enough to use without significant training and was powerful to punch through all but the heaviest armor. The harquebus completely replaced the bow and arrow as the primary shot weapon. Even England, where the

long bow was a celebrated weapon, saw its eventual replacement by the harquebus. Most importantly, though, the gun saw the end of the heavy armored men-at-arms and a complete change in the use of cavalry.

Firearms were used as early as the fourteenth century, but did not become a viable replacement for the bow until the late 15th century. There after the firearm was rapidly accepted by nearly every major army in Europe. The reason for this goes back to the Hundred Year's War. England had a number of decisive victories including Crecy, Poitiers and Agincourt, where the missile weapon resisted the men-at-arms. It was after the battle of Agincourt that France had an increasing attraction to missile weapons. In 1445, the composition of the French army was changed from a 1:2 ratio archers: men-at-arms, to a 2:1 ratio.

A reason for France's hesitance with the use of archers was the time needed to train them. Effective archers require years of training, and when a large army is required it is difficult and costly to raise enough archers to the fill the requirement. It is the attraction to missile weapons that made the firearm such an attractive alternative. It required minimal training and the guns could be rapidly mass produced. There were of course downsides to the firearm; its slow rate of fire, its poor accuracy, and high costs were still outweighed by the ability to field large numbers of missile troops at once. These downsides however did contribute to the rapid development of the firearm during period, making it more than a comparable replacement to the bow.

While the firearm was widely used in the early 16th century it did not become the primary weapon until the late 16th century. Armies became comprised of a 1:1 ratio of

harquebusiers to pikemen. Cavalry also began using firearms with the introduction of the pistol in 1546. This rapid increase in the use of firearms was because of their effectiveness against pikemen. Pistols proved to be even more powerful against pikemen, as light cavalry had the ability to rapidly flank a phalanx. Along with the increased number of firearms came the increasing importance of training. No longer could an army rely on its physical superiority to win a battle, training became a key element in the building of an army.

The widespread use of firearms, like bastioned fortifications, increased the cost of war. Unlike bows and swords, which were typically the possessions of the soldier, harquebuses were supplied to the soldier. These mass amounts of weapons were manufactured at great cost to the governments. Between 1520 and 1532 Charles V borrowed the equivalent of nearly 1 million pounds sterling (Parker 1988: 62). This seemingly large amount for a 12 year span was easily over shadowed by the over 2 million pounds sterling borrowed by Spain between 1552 and 1556, showing the dramatic cost increase in warfare. The cost for Spain was so high that the country declared bankruptcy 3 times before the turn of the century, and continued needing extra cash through most of the 17th century (Parker 1988: 63).

The firearm had monumental impact on the tactics of the late 16th century. It changed armies by increasing the need for drill training. Battles became ranged contests rather than hand-to-hand fighting. And wars became far more expensive to finance and maintain. Combined with the impact of bastioned fortifications, the late 16th century saw a complete revolution in military practices. Shot was no longer used for a support role, the backbone of armies was firearms.

Wars were fought over cities through sieges, with battles fought to break or sustain those sieges. War had changed with more changes yet to come.

## The Weapons of War

In 1550 most European armies were comprised similarly. Armies were primarily infantry supported by light cavalry and artillery. The primary weapons were the pike and harquebus for the infantry, the pistol for the cavalry, and cannons were the main guns of the artillery. Other weapons, such as the halberd and two handed sword, were used sparingly for specialized purposes. The backbone of the army was the infantry, making up the largest portion of an army in manpower. Examples of this include the standing army of Venice 1555: of the 6,500 men enlisted, 5,000 were infantry. The same can be seen in the French Catholic army at the battle of Dreux in 1562. The Catholics fielded 17,000 men of which 15,000 were infantry (J. R. Hale 1989: 53).

### Infantry

Infantry were equipped primarily with one of two weapons: the pike or the harquebus. Armies of the late 16th century had a 1:1 ratio of both weapons, each serving a specific role in relation to each other. The pike was not a new weapon by any means, used by the Greeks back in antiquity; the pike regained popularity in the 15th century due to the military dominance of the Swiss. The pike in tightly packed squares called phalanxes, proved to be an effective weapon against cavalry in the battles of Morgarten (1315), Laupen (1339), and Sempach (1386). It was then in the 15th century that the Swiss began hiring themselves out as mercenaries; this act

further spread the use of pikes as a way to counter cavalry charges. After the battle of Dornach in 1499 against the army of the Holy Roman Empire, Emperor Maximilian began training his own men in the same fashion as the Swiss.

The Landsknecht, as these new German units were called, were also hired as mercenaries and proved that pikes were also effective against infantry charges. In the battle of Bicocca in 1522, a force of Landsknecht stood up to a charge of 16,000 Swiss. A similar outcome was seen in the earlier battle of Marignano in 1515. In both cases the landsknecht were supported by small squads of hand gunners. This was significant as firearms and artillery prove to be the weakness of the tightly pack phalanx. In the battle of Ravenna (1512) serious losses were taken from the firing of hand guns. This created the massive increase of hand gunners in armies in the latter half of the 16th century.

Firearms were very effective against infantry, but their slow rate of fire and poor hand-to-hand equipment made the pike a necessary weapon against cavalry and charging infantry. At the end of the sixteenth century the ideal company of 100 men had 60 firearms, 30 pikemen, and 10 other weapons, primarily halberds (Cruickshank 1966: 114). These were only ideal numbers; due to the cost of firearms, there was typically a 1:1 ratio of firearms to pikes with the other weapons filling in the gaps. These 100 man companies would form blocks out on the field with each weapon in a certain spot serving a specific role.

The pikes held the fronts and sides of the square holding off enemy frontal assaults. The halberds and the like were in the back to rush in if the company were to be engaged in hand-to-

hand. The hand gunners had two positions. To give them a clear lane of fire, hand gunners would set up on the wings of the company's square. If the enemy charged, the hand gunners would fall back to the center of the square to be defended by the pikes and halberds. Because the hand gunners needed to be mobile and often were not in hand-to-hand combat situations, they had less armor than the rest of the infantry.

Hand gunners were equipped as such. Besides their gun, hand gunners carried a 3 foot sword and a 10-12 inch dagger for hand-to-hand. Their armor was a jack of mail over a doublet of leather with a skull cap as their head protection (Cruickshank 1966: 116). On the other end of the spectrum the pikeman was armored with a corselet, pauldrons, vambraces, tasses, and gauntlets. On his head he either wore a burgonet or morion. The pike itself was 18 feet usually constructed of ash and tipped with metal. The men who carried halberds wore similar armor to the pikemen.

**Cavalry**

The 15th century saw the complete disappearance of the men-at-arms on the battlefield. The combined effectiveness of the pike and firearm made the heavy cavalry near useless in combat. Completely encased in metal, men-at-arms were little more than show pieces by the end of the century. They were sometimes used as all-metal command posts, but that was the closest men-at-arms saw combat (Cruickshank 1966: 118). Even the medium-heavy cavalry were decreasing in number as firearms became more effective at penetrating armor. It was the light cavalry though that came into its own during this time period.

Armored with only a leather jack and steel skull cap, the strength of the light cavalry was mobility (Cruickshank 1966: 119), which prevented the light cavalry from suffering the same fate the men-at-arms and heavier armored cousins faced. Effective as scouts, the mobility of the light cavalry allowed for easy detection of the enemies' flanks. Combined with the 1546 invention of the pistol, the light cavalry became effective flanking units. Armed with three single shot pistols and a lance, the light cavalry would move around the side of the enemy forces usually engaging enemy cavalry first and attacking the infantry flank. The lance was eventually dropped to allow the cavalry to fire while on the move. These pistol armed cavalry became known as dragoons and were the principle offensive units in the next century.

**Artillery**

Artillery was a new field in the 16th century military. While cannon and heavy guns had been in use for over a century at this point, it was primarily for sieges on fortifications. During the early part of the 16th century the effectiveness of flanking fire was discovered and became a primary strategy in 16th century battles. Spanish artillery fire forced the French out their entrenched position at the battle of Ravenna in 1512 (J. R. Hale 1989: 50). Beyond the power of artillery, commanding artillery became a position of prestige and the weapons themselves mascots of the army.

Artillery was more of an art form than a science at this time. Much of the work was either from experience or was guess work. Artillery had one of the heaviest equipment requirements in the army, but little of it was personal weapons and armor. The Artillery positions were usually fortified requiring shovels and trench diggers to build the needed

fortifications. Also carriages and horses were needed to transport the heavy guns to their position. Gunpowder and cannonballs were also in large stock, though the rate of fire of most cannons at this time did not require a large supply during a battle. The artillery had its own company of pikemen and musketeers to protect it in the battle, as well as the firing crews themselves.

## The Chain of Command

Armies have always had a command hierarchy and the 16th century is no different. And like most chains of command through the ages there was one man in charge of the forces. During the 16th century this was the king, but it was not always possible for the king to be on the field, so instead there was an appointed general or commander to physically lead the troops into battle. While the army's structure was seeing major changes, the chain of command saw more subtle changes during the 16th century. Generalships were still appointed to nobility and no formal training was given to any leader. More major changes to the army's command hierarchy would occur during the 17th century.

A General was all powerful on the battlefield having the final immediate word immediate in that the basic plans for the war such as where to attack, how many to attack with, and the administrative part of war was handled by the king and government. In the case of England, the Privy Council made most of the decisions on the conduct of the war. These decisions however could not account for all the possible circumstances a General might face, so the orders were typically sparse and General was given charge to make more specific decisions (Cruickshank

1966: 44). The General was also in charge of appointing his commanders beneath him, including his second-in-command.

The second-in-command or High Marshal had two primary functions besides understudying the general, administration of justice and the management of camp (Cruickshank 1966: 47). As administrator of justice, the High Marshall took on the role of police chief and judge. He ensured that all the soldiers knew the laws, enforced them, and made rulings on those who disobeyed, investigating the more serious ones personally. Camp management entailed choosing the site, setting the site up, maintaining watch over the site, and breaking camp down when leaving.

Under the direct command of the High Marshal was the Provost Marshal who was the military police. He dealt with the less grievous violations of law and acted as the keeper of the peace through most of the army. In rank between the High Marshal and Provost Marshal were the Lieutenant Generals of Infantry and Horse. Both acted as commanders during battle of their respective parts of the army. There was also the Master of Ordnance who held the difficult job of commanding the artillery during battle and maintaining the firearms stores for the battle. This included everything from the cannons to pistols. He was also in charge of fortifying the positions where the guns were to be in battle. This bloated responsibility came due to the unknown needs of artillery and the increased use of firearms with few having the knowledge to maintain the guns.

Below the Generals were commanders in charge of specific functions or duties of the army. Quarter-Master, Trench-Master, Forage-Master, Scout-Master, and Carriage-Master were charge of what their name implies. The Quarter-Master was in charge of the living quarters of troops and officers for example. Most answered directly to the High Marshal except the Trench-Master who answered to the Ordnance Master during the time of battle.

Prior to the development of professional soldiers, the remaining command was made up of the complex obligations between troops. The removal of the feudal system created a vacuum between the upper level command and the individual companies of troops making it difficult to convey orders. This vacuum was filled with several new ranks. First was the Sergeant-Major, who was in charge of all the companies, but acted as the voice of the upper command. He was assisted by four of corporals of the field in commanding the captains. On the field the Sergeant-Major would be in front of the army with a Corporal at each flank and rear, with the fourth being a spare.

**Regimental Command**

One of the more subtle changes to the army during the 16th century was the organization of troops. Prior to the 1500s, the regiment was almost synonymous to an army, but as armies got bigger in the early 16th century more subdivisions were made to better command the soldiers. By the mid 16th century regiments had shrunk in size to nominally 1,000 men, composed of ten 100 a companies. Each regiment was commanded by a colonel and each company by a captain. There was a great debate at this time about the proper size of companies and regiments. England had started with 5,000 man regiments with 500 man companies. This dropped to 4,000 men and

soon followed by 3,000. By 1589, the English expedition to France saw regiments of 1,000 men, which had by then become a continental standard.

Within each company was another set of officers selected by the company's captain. The second-in-command was the lieutenant. There was also an ensign-bearer, two sergeants, two drummers, a preacher, a cannoneer, a surgeon, and about six corporals (Cruickshank 1966: 57). The ensign-bearer carried the company colors and also was to take command should both the captain and lieutenant fall. Sergeants were in charge of drilling the men and rationing equipment and food. The corporals were each in charge of a 20 man section which they were to lead into battle. The drummers were to keep time during marches and the surgeon was the company doctor. Like wise the preacher was to keep the men in faith. The cannoneer was a very new and specialized position in the company. He was in charge of the company's firearms and where they were placed and fired during battle.

The company was a complete fighting force in itself, but the upper layers were there to maintain control and coordinate the thousands of troops that made up of an army. The command of the army was soon to see a major overhaul. Most command positions in the latter half of the 16th century were still given to those of noble birth, however already a debate had begun on the proper training of a commander. Physical ability was no longer the prime quality for a commander. The need for commanders trained in the use of artillery and firearms as well as some knowledge in tactics was needed. These are changes that were about take place in the 17th century.

## Recruiting an Army

With armies becoming larger in the 16th century, the greatest burden on any country was gathering enough men to fight a war. Contrary to the popular belief that every man fought for his country during the Renaissance, only at most 5% of the recruitable population went to war (J.R. Hale 1989: 75). This was primarily due to the inherent pacifism that had arisen in the middle class during this time. This made recruitment or at least recruitment of any quality men difficult (J.R. Hale 1989: 100).

In the case of England where the recruitable population was small to begin with a solution was developed. Rather than demanding military service of all men, weapons were to be provided. Ten income classes were created ranging from 5 to 10 pounds a year, to those who made 1,000 pounds or more. Each class had to provide specific equipment. In the case of the lowest class, a coat of plated armor, a bill or halberd, a helmet, a sheaf of arrows and long bow were to be provided. For the highest class 16 horses, 60 suits of light armor, 40 pikes, 20 bills or halberds, 20 harquebus, 50 iron helmets, and 30 long bows. The fines for not supplying this equipment were hefty, 12 shillings a month for missing arrows and 10 pounds a month for a horse.

Gathering the actual troops was typically a local responsibility. In the case of England the county was responsible for recruiting a required number of troops, based on the number of men needed and the size of the county. The man in charge of raising a body of troops was the lieutenant who could recruit any man between the ages of 16 and 60 (Cruickshank 1966: 23). There were of course exceptions to this rule, Lords and their servants were not required to serve,

as well as clergy men and justices of the peace. Members of the government were also excused from service. After removing all of the excused population the remaining men was less than 25% of the starting total.

The actual recruitment involved two types of troops, volunteers and conscripts. The volunteers need little explanation as they were men who simply wished to join the army and fight. Conscripts made up the majority of the recruitment, coming from two sources, honest, hard working men, and the less desirables of the county. While the first was the preferred choice, problems arrived when disbanding companies of honest citizenry. Most men are not the same when they return from war, making employers hesitant about rehiring the returning man. This created an unemployment problem leading to civil unrest and other domestic problems. The second choice was the more common, though it did have its drawbacks.

The recruits were collected at the musters where they were trained and equipped. In some cases due to time some were not trained and just sent off to war with the equipment on their backs. In the end, the recruitment process took months and never produced the results that were wanted. Typically there were still too few men and not nearly any of them at the quality expected. None-the-less these were the men that fought the wars for the countries of Europe.

## The Theory behind it All

While the late 16th century was a revolutionary time for the military itself, military strategy and tactics took a backseat in all the changes. The firearm was still a recent invention and no strategies other than basic movements had been developed for it. The combination of the

pikemen and the musketeer made for very stagnant infantry, more inclined to defense than offensive maneuvers. Cavalry was so stripped down that it either lacked the armor to be effective in combat or lacked the mobility to get to combat. In the words of Michael Roberts: "Strategic thinking withered away; war eternalized itself."

One main reason for the lack of military strategy was the commanders themselves. A debate had arisen during this time about the education of military leaders. In 1570 Sir Humphrey Gilbert suggested the erection of a military academy in London as well as a curriculum for it. However, its cost was high and the Queen refused its to build it, seeing no need for professional military leaders. Europe would not see a professional military academy until 1608 when four opened in Padua, Verona, Udine, and Treviso. From then on professional military education became a must, but that is an issue of the 17th century.

The 16th century was a transitional time in Europe for military tactics. This change was more due to the changing armaments and structure of the army than new tactics and strategies on the battlefield. The firearms and fortification made battles far more stagnant, while the lack of military training in the commanders prevented the development of any creative tactics. The changes begun in the 16th had yet to be completed, and would not be fully complete until after the Thirty Years War, only to began changing again. The 16th century saw the implementation of new technology, but the ability to use it to its maximum potential was still far behind. The military revolution of the Renaissance had only begun. It can be said that the late 16th century saw the first recognizable steps towards the modern day army.

# *Conclusion*

The project European arms and armor 1550-1600 required a years worth of work to complete. The project began in the in the final semester of the 2002-2003 academic year and continued until the third semester of the 2003-2004 academic year. This project was a continuation of JLS-0030, which was a similar project completed another group. The goal was to expand the previous report into a product worthy of being turned into a website. In each of the four terms of the project there were specific criteria that we had to meet, in order to successfully complete it. The project was divided into four separate portions, each being focused on by one member of our team, which eventually consisted of four members. It was the responsibility of each member to write a synopsis of their specific topic. Later museum artifacts relevant to the subject matter were photographed and documented. The final product was the creation and display of a website containing the studied material and a final report consisting of each members documented articles.

## PQP

The project began with a Preliminary Qualifying Project, or PQP. The primary reason for the PQP was to produce a project proposal. The proposal contained an introduction, plan of work, and an annotated list of sources. The introduction stated subject matter to be studied and its importance, as well as a project objective. The plan of work was a timeline, which set dates on when certain aspects of the project should be completed. The most important part of the PQP phase was to establish an annotated list of sources. This allowed us to compile a thorough list of books that we felt would help us in completing this project, this list proved to be a strong starting

point when the 2003-2004 academic year got underway. The bulk of this work was completed by J.R and Kyle, the two members of the team that were signed up from the start of the project, and Emmanuel who ended up leaving the project team. A replacement member, Anthony, was added in order to fill the vacated position and made contributions to the bibliography and plan of work sections.

## A-term

The first full credit term of this project consisted of implementing the background research that was planned in the PQP. Before this term even began a final member was called, Simon, this proved to be a helpful addition. During the PQP the members of the team split the subject matter into three sections military tactics, as well armor and weapons. Each one of these topics was to be focused on by one of the team members. This left us with one uncovered topic, the history component. When Simon was added to the team it was only natural that he worked on the historical component.

This term was quite time consuming and consisted of frequent trips to the Higgins Armory library as well as the Clark library. Every week it was expected that certain portions, based on the timeline formed in the PQP phase, of each members section be submitted so that we could get feedback from the instructor. The primary goal of this term was for each member to have a final draft of their own sections. This was for the most part met by the two members of the team, J.R working on the armor and Anthony who was responsible for the weapons sections. However, the military tactics and historical components seemed to be progressing at a slower pace. There were also numerous other tasks that had to be completed during this term. We had

to formulate a list of all the Higgins Armory artifacts, pertaining to our criteria, which was European arms and armor dated 1550-1600. This list was essential for the work that had to be completed during upcoming term. Another task that had to be completed before the start of the next term was an orientation on artifact handling, which was the primary element of the work to be completed in the second term.

## B-term

The second full credit term of this project required the handling and documentation of a great deal of the Higgins Armory museum's European artifacts dating 1550-1600. These artifacts needed to be photographed so that they could be added to Armory's database. Each Wednesday throughout the term the team would meet up and take a number of photographs of the artifacts belonging to the Higgins Armory museum. This process required a quick setup procedure; a large roll of white paper was used to provide the background for each picture, while a white nylon screen and reflectors were used to proportion the light that was applied on the objects. Several pictures were taken of each artifact using a Minolta DImage 7 digital camera. After each session these pictures were burned onto a CD-R. On a weekly basis the team would meet up to edit the pictures taken during the previous week. The process began by first deciding on which picture of each object we thought was best. After that was done the selected pictures were then cropped, and in some cases rotated. Any picture we felt required even more editing was done using Adobe Photoshop CS. After each week we would then burn the selected photographs onto another CD-R, from which the photos were ready to be added to the database. Overall, our group photographed over 200 artifacts.

Another one of the major aspects of the second term was to brainstorm some ideas about the website. We were required to come up with a detailed description of what our website would look like as well as some type of eye candy component. The layout of the website was fairly simple, header, side menu (as well as what components we would list), and some type of eye candy to be displayed on the home page of our website. The eye candy we decided on was to provide a video in which the pike drill as well as the procedure for firing a musket would be demonstrated, in full costume. This was originally planned to be done inside the Higgins Armory museum, however, this was not possible due to the fact that the pike was doing damage to the floor. We considered our options and decided to do the recordings on the Worcester Polytechnic Institute campus. Due to Massachusetts firearm laws we were not able to bring the musket outside of the museum, so that production was halted. Therefore we were left with only the pike drill demonstration as eye candy for our website. This required borrowing an artificial pike from the museum, as well as a full costume from the instructor, Jeffrey Forgeng. This proved to be a difficult task. It is daunting enough to maneuver a weapon of such stature, let alone perform the pike drill to precision. The pike drill alone could be considered a valid IQP project. This was done just prior to winter break so we weren't able to do much with our recordings until we got back from break. After we were finished recording the pike drills we had to edit the tapes using Adobe Premier Pro. Adobe Premiere Pro allowed us to remove the audio portion as well as to provide us with the editing capability needed to improve our footage. For our eye candy component we decided a slide show would be the most useful technique, in making the pike drill video as accurate as possible.

## C-term

The final term of this project consisted of pulling everything together and building the website. For this term we were faced with four obstacles; the website, putting together the database, as well as pulling together each team members' documents and writing up the additional texts required in order to complete the hard copy of the report. Though each member of the team made contributions to each of these sections, the workload was divided up so that each person was responsible for one of those four sections. J.R took the website portion, Simon worked on the database, Anthony worked on the additional texts while Kyle pulled all the texts together and was responsible for producing the hard copy of the report.

For the website, which was the primary objective of this project, we used a basic layout and incorporated our text and eye candy components into it. As a starting point we looked over a similar website, Arms and Armor of East Asia, which was a website designed by a previous IQP team. We used CSS to ensure that we would have a consistent format for all of our pages, and to assist in our layout. In truth Microsoft word and its ability to convert text to html made things much easier. It allowed us to save a substantial amount of time in updating the pages. The most difficult part of the web design portion was making the page more compatible with browsers other than Internet Explorer. Browsers such as Mozilla have much weaker support for CSS. Another of the time-consuming aspects of the web design was to create the buttons and images for the site. We had limited access to image editing programs, so it took a while to make some of the images presentable.

The first step in completing the database was filtering the Higgins database, so that it contained only artifacts from our time period. This ended up being roughly 600 artifacts. After that all of the pictures that related to the filtered entries needed to be gathered. After completing the "mini-database", the Access file was converted to a text file. This text file was imported to a MySQL database. The MySQL database is held on the WPI servers. This proved to be long and tedious work. The work itself was simple, but took a while to complete due to the number of entries in the database, as well as pictures having to be picked out. The easiest part of this portion was converting the database to text and then importing the text file into the MySQL database. The database was based on the work done by a previous IQP team that studied South East Asian arms & armor because of its flexibility. The old html was stripped so that it could be easily integrated with our site. The previous search engine was slightly modified based on suggestions from the instructor.

The final portion that needed to be completed during D-term was combining all of the texts into one report. Before this could be done the abstract, introduction, and conclusion needed to be completed. Once they were completed the process was simple, consisting mostly of copying and pasting. However, formatting issues also needed to be addressed. At the end of D-term the team was required to submit three bound copies of the report, a cd-rom containing an electronic version of the project report, project proposal, and the electronic material created by the team (e.g photographs and website), as well as each member submitting a portfolio of the work they did during the term.

## IQP

This project was performed by four members of the WPI community. It was an Interactive Qualifying Project (IQP), which is a mandatory project for all undergraduates seeking a degree. This project is designed to challenge students to identify, investigate, and report on a topic in which technology is related to society. The IQP stresses the use of teamwork in an attempt to give students the opportunity to work in a setting that simulates the real world. In retrospect we feel as though we accomplished our goals for the project. Although it wasn't always in the most efficient manner, the work we completed was high quality, and met the criteria of the project description. One area that could be expanded in the future is the pike drill. In attempting to demonstrate the pike drill we soon realized that it was no moderate task. An accurate demonstration would require months of background research and training.

As a team we not only gained the knowledge of European arms & armor but also about teamwork. The project itself could not have been completed without the combined efforts of each member. This project has given us valuable cooperation skills that we will soon be applying in the real world.

# *Bibliography*

## General History of Europe between 1550 and 1600


MacCaffrey, Wallace T. (1992) Elizabeth I: war and politics, 1588-1603, Princeton, N.J.: Princeton University Press.

This book discusses England's political structure. It illustrates how they maintained control within their own country as well as they military and political involvements with other countries. Discusses in particular Queen Elizabeth's own political and strategic methods.

Strickland, Agnes. (1906) *The Life of Queen Elizabeth*, London: J. M. Dent & Co.; New York: E. P. Dutton & Co.

This book depicts the life of Queen Elizabeth in a chronological progression. It can be used to cross-reference events in Europe with the reactions of Queen Elizabeth and England.

Jenkins, Margaret, Elizabeth. (1959) *Elizabeth the Great*, New York: Coward-McCann Inc.

It focuses on Elizabeth's political and military strategies and on why she was such a power.

Smith, Lacey Baldwin. (1976) *The Horizon Book of the Elizabethan World*, New York: American Heritage Pub. Co.

Tells a general story of what was happening in Western Europe during the Elizabethan Age.

Denniston, J. (1851) *Memoirs of the Dukes of Urbino*, London: Longman, Brown, Green, and Longmans

In the style of a journal, this book helps illustrate the events, involvements and politics of Italy during the sixteenth century.

Coudy, Julien. (1969) *The Huguenot Wars*, Philadelphia-New York-London: Chilton Book Company.

Gives the chronological outline of the Huguenot Wars, including what led up to it with the initial call to arms, as well as depicting the fortunes of Henry of Navarre.

Dinkens, A.G. (1966) *Reformation and Society in the Sixteenth-Century Europe*, London: Thames and Hudson.

This book starts with the original Medieval Tensions and how they led up to the destabilization of the church. It discusses Luther, and the introduction of Protestantism. It covers the German society and how it was effected, and goes into Germany's First Expansion.

Chastel, Andre. (1968) *The Crisis of the Renaissance, Skira*, Cleveland, Ohio: The World Publishing Company.

Oman, Charles William Chadwick. (1936) *The Sixteenth Century*, New York: Dutton.

Discusses Papacy and the Holy Roman Empire. There are several sections on the tendencies of individuals, including the Kings of France, Charles V, Henry VIII, Philip II, Gustavas Vasa, Scandinavian Protestantism, Elizabeth and Catherine de Medici. It also covers the Italian Wars, the Religious Wars, and the Occult.

Lortz, Joseph. (1968) *The Reformation in Germany*, London: Darton, Longman & Todd, New York: Herder and Herder

Begins talking about the social and political settings before the Reformation, then goes into the beginnings of Lutheranism and the decision for the Reformation. Discusses the Reconfiguration, the Decline and Renewal, as well as the military and political struggle that settles the Issue.

Ozment, Steven E. (1975) *The Reformation in the Cities: The Appeal of Protestantism in the Sixteenth-Century Germany and Switzerland*, New Haven: Yale University Press.

Discusses the general pattern that the cities and their people went through during the revolution. This book depicts both the social and economic impact that the Reformation had on the people of Western Europe.

Ranke, Leopold von. (1966) *History of the Reformation in Germany*, New York: F. Unger Publishing Co.

This book is laid out in a very accurate timeline of events surrounding the reformation. The chronological order of the book makes it easy to cross-reference many events in Germany with those happening elsewhere.

Bloch, Marc Leopold Benjamin. (1966) *French Rural History: An Essay on its Basic Characteristics*, Berkeley: University of California Press

Discusses the French occupations for land, while pointing out the social and economical settings of France's agrarian life. Points out the social grouping during the time, and tells about the Agricultural Revolution.

Ramsey, Ann W. (1999) *Liturgy, politics, and salvation: the Catholic League in Paris and the nature of Catholic reform*, Rochester, N.Y.: University of Rochester Press

Focuses on the Catholic reform that was happening in France during the later half of the sixteenth century. Gives much insight on the economical and social movements at that time.

# Armor of Europe between 1550 and 1600


Arador Armour Library (2003), *Glossary of Armour Terms*. Available online

http://www.arador.com/glossary/index.html

An online glossary of armour related terms. Alphabetically sorted and covers a lot of terms.

Blackmore, Howard. (1965) *Arms and Armour*. London: Studio Vista.

A general history of arms and armor.

Blair, Claude. (1972) *European Armour circa 1066 to circa 1700*. B.T. Batsford, Ltd., London, 1958; 2nd ed. New York: Crane, Russak and Co.

Has small section on armor used through the Elizabethan Age including the most important achievements at the time and explains the phasing in of firearms and phasing out of armor worn.

Bull, Stephen. (1991) *An historical guide to arms and armor*. New York: Facts on File.

Describes portable arms and armor from the time of the Greeks and Romans to the early 19th century. Additionally covers various types of armor including sporting armor and hunting armor.

Coggins, Jack. (1966) *The Fighting Man*. New York: Doubleday and Company.

This book gives detailed descriptions of the methods of fighting for every era of time. It explains the different roles of the armour in the Elizabethan Period.

Dean, Bashford (1915). *Collection of Arms and Armor Including the William H. Riggs Donation*. New York: Metropolitan Museum of Art.

Categorical listing of most arms and armor from the William H. Riggs Donation with pictures and general history on each piece.

Dillon, Harold Arthur Lee-Dillon. (1968) *Armour: An Elizabethan armourer's album and Armour notes*. York, Pa.: G. Shumway.

Ellis, John. *Cavalry* New York: G.P. Putnams's Sons, 1978. 357.1 E15c

Shows the progression of the horseman throughout the medieval period. Has a focus on the adoption of mounted Pistoleers, which were becoming common place during the Elizabethan Period.

Ffoulkes, Charles John (1945), *Arms & armament : an historical survey of the weapons of the British army*. London : G. G. Harrap and company ltd.

Historical survey of the weapons of the British army.

Ffoulkes, Charles John (1909), *Armour & weapons*. Oxford, Clarendon Press.

Information on armour and weapons.

Ffoulkes, Charles John (1913), *Decorative ironwork from the XIth to the XVIIIth century*. London, Methuen & co., ltd.

Information on ceremonial and decorative armor.

Ffoulkes, Charles John (1916), *Inventory and survey of the armouries of the Tower of London.* London, H.M. Stationery off.

Inventory and information on the London armouries.

Ffoulkes, Charles John (1967), *The armourer and his craft, from the xith to the xvith century*. New York, B. Blom.

Describes types of armour, products of individual armourers, examines periods for effectiveness, convenience, construction methods, decoration and more. Includes a glossary of terms.

Fliegel, Stephen N. (1998) *Arms & Armor, The Cleveland Museum of Art*. Cleveland: The Cleveland Museum of Art.

General background info on categorical listed arms and armor in The Cleveland Museum of Art. Pictures included with captions and dates on where the arms and armor were from.

Fliegel, Stephen. (1997) *The Making of Armor.* Cleveland: The Cleveland Museum of Art.

Describes all major manufacture techniques used by armorers. Describes certain suits of armor and how they were designed uniquely for individuals and troops.

Gamber, Ortwin. (1972) *Glossarium armorum*. Graz, Akadem. Druc- u. Verlagsanst.

Glossary of armor, text is in Czech, Danish, French, German, Russian, Spanish, Polish and Italian.

Gardner, Robert Edward. (1936) *Arms fabricators, ancient and modern*. Columbus, Ohio: R.G. Adams.

A compilation of the names and dates of gunsmiths, bladesmiths, armourers, bowyers and cannoniers offered with such pertinent data upon their lives and activities as is discoverable together with three hundred sixty-eight identified poincons

Grancsay, Stephen U. (1986) *Arms & Armor*. New York: Metropolitan Museum of Art,

This book contains listings of specified armor and pieces. The list includes helmets, shields, shafted weapons, daggers, firearms, crossbows, shields, breastplates, and back plates.

Grancsay, Stephen V. *Catalogue of Armor: The John Woodman Higgins Armory Museum*. Worcester: Higgins Armory Museum, 1961.

The original silver-colored catalogue, almost exclusively of armor. It should be recognized that much of the information contained therein is quite outdated.

Hammond, P. T. (1986), *Royal Armouries : official guide*. London : Trustees of the Royal Armouries with Philip Wilson Publishers.

The official guide to the Royal Armouries in London.

Hewitt, John. (1855-1860) *Ancient armour and weapons in Europe*. Oxford, London: J. Henry and J. Parker.

Ancient armour and weapons in Europe: from the iron period of the northern nations to the end of the seventeenth century: with illustrations from contemporary monuments

John Woodman Higgins Armory (1961), *Catalogue of armor: the John Woodman Higgins Armory*. Worcester.

Catalogue of armor for the Higgins Armory.

Karcheski, Walter J. Jr. (1995) *Arms and Armor*. Boston: Little Brown and Company.

Includes armor terms and various names for each type of armor. Small amount of relevant pictures with descriptions.

Karcheski, Walter J., Jr. (1995) *Arms and Armor in the Art Institute of Chicago*. Boston: Bulfinch Press.

This book is a basic categorical listing of the arms and armor acquired by the Art Institute of Chicago. There are dates, brief backgrounds, and pictures of most items.

Karcheski, Walter J. Jr.(1993). *The Neremburg Stechzeuge Armours*. Journal of the Arms and Armour Society vol. 14(4).

Features information on armor from the Higgins armoury. Discusses armor from a variety of time periods and has pictures.

LaRoca, D. J. (2000). *A Notable Group of Late Sixteenth Century Etched Italian Armour*. Journal of the Arms and Armor Society vol. 16(4), 181.

Description and pictures of an Italian suit of armor.

McElvogue, D. M. (2000). *An analysis and Description of Firearms and Assorted Artifacts off a Late Sixteenth-Century Vessel Wrecked off Aldeney, Channel Islands*. Of the Arms and Armor Society vol. 16(4), 198. Photographs and diagrams of recovered artifacts.

Nickel, Helmut. (1991) *Arms & Armor from the Permanent Collection*. New York: Metropolitan Museum of Art. Pictures of arms and armor from the Metropolitan Museum of Art. Tells where each arm or armor was acquired and where they were used in Europe and in which period of time.

Norman, Vessey. (1964) *Arms and Armour*. London: Octopus Books Limited. This book contains detailed descriptions of how mail, scale armor, plate armor and other related armor were developed. It also gives a look at who manufactured armor and what the finest achievements of the age were. It tells of the effects firearms had on armor and describes various weapon types.

Oakeshott, Ewart. (1980) *European Weapons and Armour*. North Hollywood: Beinfeld Publishing Inc. This book includes information on how the handgun was developed and used in battle. It describes various weapons such as staff-weapons, axes, maces and contains information on swords in the early 17th century.

Peacey, J. G and Davenport, W. G. (1979). *The Iron Blast Furnace*. New York: Pergamon Press. This book discusses how an iron blat furnace works. This book goes in depth on the process the iron goes through in a blast furnace.

Pfaffenbichler, Matthias. (1992) *The Armourers. Medieval Craftsmen Series*. Toronto: University of Toronto Press. Armourers are named in this book for their suits made and other arms they have developed. Also described is how the armourers had their own unique design for the pieces they created.

Royal Armouries (1996), *Royal Armouries Museum*. Leeds : Royal Armouries Museum Information on Great Britian's Royal Armouries Museam.

Stone, George Cameron. (1961) *A glossary of the construction, decoration and use of arms and armor in all countries and in all times, together with some closely related subjects*. New York: Jack Brussel Pub. A weapons and armor dictionary.

Wallace Collection and A. V. B. Norman (1986), *European arms and armour supplement*. London : Printed for the Trustees by Balding + Mansell. Supplement dealing with European arms and armour.

Wallace Collection and Guy Francis Laking (1910), *Catalogue of the European armour and arms in the Wallace collection at Hertford House*. Under the authority of the Trustees. London, Printed for H.M. Stationery off.

Catalogue of the Wallace collections European armour and arms.

Wallace Collection and J. G. Mann (1938), *General guide to the Wallace Collection. Brief guide to the arms and armour*. London : Printed for the Trustees of the Wallace Collection.

A brief guide and overview to the Wallace Collection.

Wallace Collection and J. G. Mann (1945), *European arms and armour : with short descriptions, historical and critical notes and numerous illustrations*. London : Printed for the Trustees by W. Clowes and Sons, Ltd.

Has descriptions, historical and critical notes and numerous illustrations from the Wallace collection.

Wilkinson, Fred. (1978) *Arms and Armour*. London: Hamlyn Publishing Group Ltd.

Traces the history of armor and edged weapons in Europe from ancient times through World War II. Also includes info on armorers of the time and has pictures of famous garnitures made for kings.

Williams, Alan (1997). *The Grosschedel Fam ily of Armourers of Landshut and their Metallurgy*. Journal of the Arms and Armor Society vol. 15(5).

A running history of the Landshut Armourers. Includes information on specific ones as well as 27 specimins.

Williams, Alan and Anthony de Reuck(1995), *The Royal Armoury at Greenwich, 1515-1649 : a history of its technology*. London: Trustees of the Royal Armouries.

A history of the Greenwich royal armory and its technology.

## Weapons of Europe between 1550 and 1600

Akehurst, Richard. (1972) *Sporting Guns*. London: Octopus Books.

This book gives accurate descriptions of many of the firearms that existed in thesecond half of the sixteenth century.

*Archery in Medieval Times*. [http://historymedren.about.com/cs/archery/] About.com.

A list of several sites on bows and crossbows.

Ashdown, Charles Henry. (1909) *British and Foreign Arms & Armor*. London: Edinburgh: T.C. & E.C. Jack.

Discusses various pieces of weaponry as well as armor that was being employed in the second half of the sixteenth century.

Blackmore, Howard. (1965) *Guns and Rifles of the World*. London: Chancellor Press.

Large scale history on firearms and their introduction to warfare. Explains from what weapons they were developed and early techniques used as well as what weapons they replaced.

Blair, Claude. (1962) *European and American Arms c. 1100-1850*. New York: Bonanza Books.

Describes and compares arms from Europe and America and how they relate to each other. Points out distinct differences between styles of making the arms.

Blair, Claude, and Leonid Tarassuk, eds. (1982) *The Complete Encyclopedia of Arms and Weapons*. New York: Simon and Schuster.

Includes names, history, and pictures of arms and weapons. Explains who used what type of weapon and where they used it. Contains detailed info on swords, spears, axes, lances, bows, etc.

Coe, Michael D., et al. (1989) *Swords and Hilt Weapons*. New York: Weidenfeld and Nicholson.

History and development of types of swords. Also includes descriptions on different types of hilts such as: quarter hilts, half hilts, knuckle guards. Describes how different hilts were used depending on the type of sword.

Dean, Bashford (1915). *Collection of Arms and Armor Including the William H. Riggs Donation*. New York: Metropolitan Museum of Art.

Categorical listing of most arms and armor from the William H. Riggs Donation with pictures and general history on each piece.

*Fencing and Swords*. [http://historymedren.about.com/cs/fencingandswords/] About.com.

A list of several sites on fencing and swords. Not all are of the target timeframe.

Fliegel, Stephen N. (1998) *Arms & Armor*, The Cleveland Museum of Art. Cleveland: The Cleveland Museum of Art.

General background info on categorical listed arms and armor in The Cleveland Museum of Art. Pictures included with captions and dates on where the arms and armor were from.

Grancsay, Stephen U. (1986) *Arms & Armor*. New York: Metropolitan Museum of Art.

This book contains listings of specified armor and pieces. The list includes helmets, shields, shafted weapons, daggers, firearms, crossbows, shields, breastplates, and back plates.

*Gunpowder Weapons of the Late Fifteenth Century*. [http://www.xenophongroup.com/montjoie/gp_wpns.htm] Société de l'Oriflamme.

The evolution of gunpowder-based weapons, with illustrations.

Hall, Bert S. (2002) *Weapons and Warfare in Renaissance Europe: Gunpowder, Technology, and Tactics*. Johns Hopkins University Press.

Contains information on the origin and evolution of gunpowder-based weapons and their impact on Renaissance and medieval warfare.

Hardy, Robert. (1976) *The Longbow*. New York: Arco Publishing Co.

Long history overview of the longbow describing major developments to the longbow. Describes how training with the longbow was carried out, how the longbow was used in combat, and how the longbow was made and repaired.

Hayward, John. (1976) *Virtuoso Goldsmiths and the Triumph of Mannerism 1540-1620*. London: Sotheby Parke Bernet Publications.

Focus with this book is primarily on the Elizabethan Age and how mannerism affected warfare. Included in the warfare are arms and armor changes and armorers' new techniques.

Karcheski, Walter J. Jr. (1995) *Arms and Armor*. Boston: Little Brown and Company.

Includes armor terms and various names for each type of armor. Small amount of relevant pictures with descriptions.

Karcheski, Walter J., Jr. (1995) *Arms and Armor in the Art Institute of Chicago*. Boston: Bulfinch Press

This book is a basic categorical listing of the arms and armor acquired by the Art Institute of Chicago. There are dates, brief backgrounds, and pictures of most items.

Nickel, Helmut. (1991) *Arms & Armor from the Permanent Collection*. New York: Metropolitan Museum of Art.

Pictures of arms and armor from the Metropolitan Museum of Art. Tells where each arm or armor was acquired and where they were used in Europe and in which period of time.

Norman, A.V.B. (1985) *English Weapons and Warfare, 449-1660*. New York: Dorset Press.

This book contains a history of English warfare and the weapons they used. It provides information about the change in weaponry from the mid-fifth century until the mid-seventeenth century. This book goes into detail about how and why the weapons were created.

Norman, A.V.B. (1980) *The Rapier and Small-Sword, 1460-1820*. London: Arms and Armour Press.

Described in this book is the rapier and small-sword's history and development. This book describes how each weapon was created and how each part was made. It includes information on hilts and how armies used both types of weapons.

Norman, Vessey. (1964) *Arms and Armour*. London: Octopus Books Limited.

This book contains detailed descriptions of how mail, scale armor, plate armor and other related armor were developed. It also gives a look at who manufactured armor and what the finest achievements of the age were. It tells of the effects firearms had on armor and describes various weapon types.

Oakeshott, Ewart. (1980) *European Weapons and Armour*. North Hollywood: Beinfeld Publishing Inc.

This book includes information on how the handgun was developed and used in battle. It describes various weapons such as staff-weapons, axes, maces and contains information on swords in the early 17th century.

O'Connell, Robert L. (2002) *Soul of the Sword*. New York: Simon & Schuster

This book contains an illustrated history of weaponry and warfare throughout history. It includes references to the different types of swords that existed during the Elizabethan Age.

Orso, Filippo. (1554) *MS Book of Sword Designs*. London: Victoria and Albert Museum.

Has useful information on almost every type of sword made in the 16th century as well as pictures. Tells how certain swords were created through various blacksmith methods. Also has information on how long swords usually took to forge.

Stone, George Cameron. (1961) *A glossary of the construction, decoration and use of arms and armor in all countries and in all times, together with some closely related subjects*. New York: Jack Brussel Pub.

A weapons and armor dictionary.

Payne-Gallwey, Ralph. (1958) *The crossbow, medieval and modern, military and sporting; its construction, history & management*. London: Holland Press.

This book gave very good information not only on the crossbow, but also the longbow. It gives experimental results on ranges and velocities of the arrows and bolts, fired from the crossbow and longbow.

Peterson, Harold L. (1968) *Daggers and fighting knives of the Western world, from the Stone age till 1900*. New York: Walker.

This book discusses several types of knives and daggers. It discusses how they were used, what they looked like, and how the designs changed from century to century.

Reid, William. (1976) *Arms through the Ages*. New York: Harper & Row.

This book has a general background on how arms have evolved over the centuries. There are dates and brief background history on arms and descriptions of how they were used in combat.

Silver, George. (1599) *Paradoxes of Defence*. [http://www.pbm.com/~lindahl/paradoxes.html]

An electronic copy of an old text on fencing. Discourages use of the rapier and espouses the short sword as the superior weapon.

*The Geometry of Warfare*. [http://www.mhs.ox.ac.uk/geometry/intro.htm] The Museum Of The History Of Science, Oxford, England.

An exhibit on the mathematics of warfare. Including rangefinders and such for directing artillery. Pictures and descriptions.

*Vincente Saviolo, his practise*. [http://www.cs.unc.edu/~hudson/saviolo/] Tom Hudson and Jennie Radovsky.

An electronic copy of an old text on "managing weapons, and dealing in honorable Quarrels". Includes illustrations.

Walczak, Bartlomiej, and Grzegorz Zabinski. (2002) *Codex Wallerstein : A Medieval Fighting Book from the Fifteenth Century on the Longsword, Falchion, Dagger, and Wrestling*. Paladin Press.

A study of a German manuscript on fighting techniques using fifteenth-century weapons.

Wilkinson, Fred. (1978) *Arms and Armour*. London: Hamlyn Publishing Group Ltd.

Contains information on different types of spears and bows.

## Military Tactics of Europe between 1550 and 1600

Bradbury, Jim. (1985) *The Medieval Archer*. New York: St. Martin's Press. 355.8

This book focuses on the medieval archer and mainly the archer's effectiveness in the late 15th century. However it covers the gradual removal of archers in the Elizabethan period, science with the main adoption of muskets.

Bryce, Walker. (1981) *The Armada the Seafarers.* New York: Time Life Books. 942.005

The book has documents and illustrations of Spanish and European Armadas.

Corvisier, Andrea. (1979) *Armies and Society in Europe 1495-1789.* Bloomington:Indiana University Press.

Cruickshank, C. G. (1946) Elizabeth's Army London: Oxford University Press.

Davies, Edward. (1619) *The Art of War and English Traynings.* London: Edward Griffin.

Late for the period by 19 years and a bit focused, however it is a primary source and useful.

De Gheyn, Jacob. (1999) *The Exercise of Armes : All 117 Engravings from the Classic 17th-Century Military Manual.* London: Dover Publications.

Ellis, John. (1978) *Cavalry.* New York: G.P. Putnams's Sons. 357.1 E15c

Shows the progression of the horseman throughout the medieval period. Has a focus on the adoption of mounted Pistoleers, which were becoming common place during the Elizabethan Period.

Hale, J.R. (1986) *War and Society in Renaissance Europe.* New Haven: Yale University Press

McNeill, William Hardy. (1982) *The pursuit of power: technology, armed force, and society since A.D. 1000.* Chicago: University of Chicago Press.

Hall, Bert S. (1997) *Weapons and Warfare.* Baltimore: John Hopkins University Press.

Heath, Ian. (1997) *Armies of the 16th Century.* London: Foundry Books.

Oman, Sir Charles. (1989) *A History of the Art of War in the Sixteenth Century.* London, Greenhill Books. 355

This book had very descriptive sections on Tactics and Strategy, its use of battles as examples helps to bring to light the intricacies of fighting during the late 16th century.

Parker, Geoffrey. (1988) *The Military Revolution: military innovation and the rise of the west, 1500-1800.* Cambridge: Cambridge University Press.

Pepper, Simon. (1986) *Firearms & Fortifications.* Chicago: University of Chicago Press,

Focuses mainly on artillery and gunpowder weapons in southern Europe.

Tincey, John. (1988). *The Armada Campaign.* New York: Osprey Pub Co.

A source covering not only the soldiers of the Elizabethan period but also the Naval forces, particularity that Spanish Armada.

Tincey, John. (1988) *Elizabeth's Army and the Armada Campaign 1588.* Essex: Partizan Press.

Webb, Henry J. (1965) *Elizabethan Military Science "The Books and the Practice".* Milwaukee: University of Wisconsin Press. 355.0942

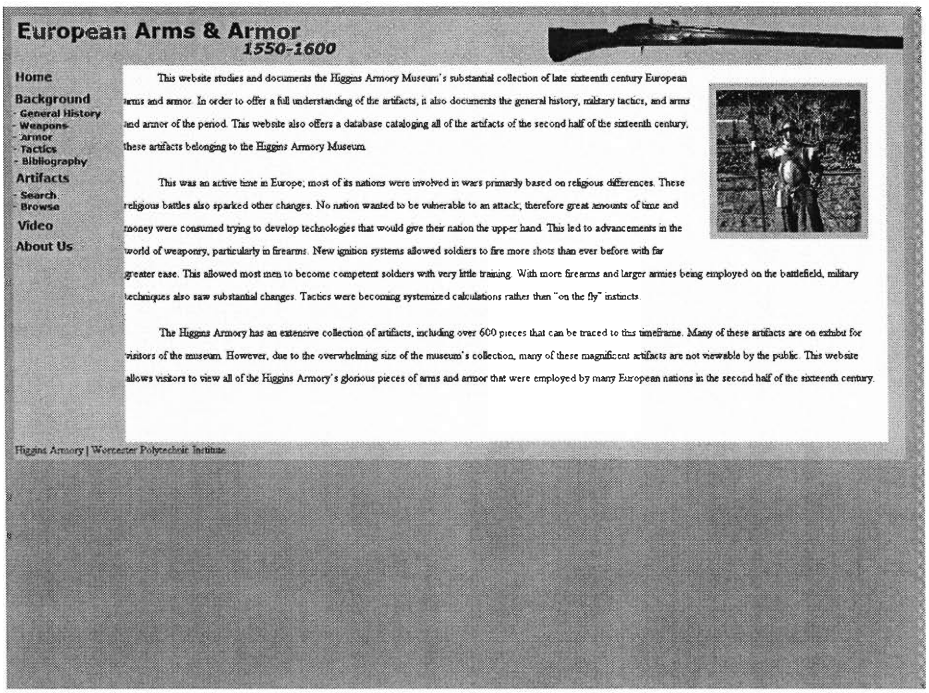
An excellent resource covering the Military Organization and Strategy of the sixteenth century.

Wise, Terence. (1976) *Medieval Warfare.* New York: Hastings House.

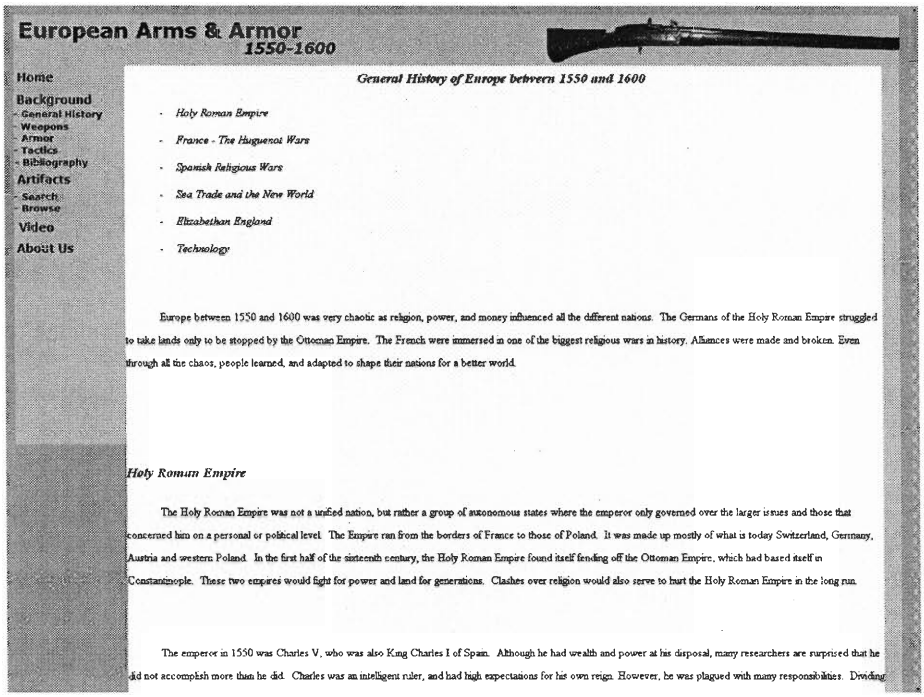
This book is an excellent source for tactics and strategy regarding late 16th century.

# *Appendix A: Website*

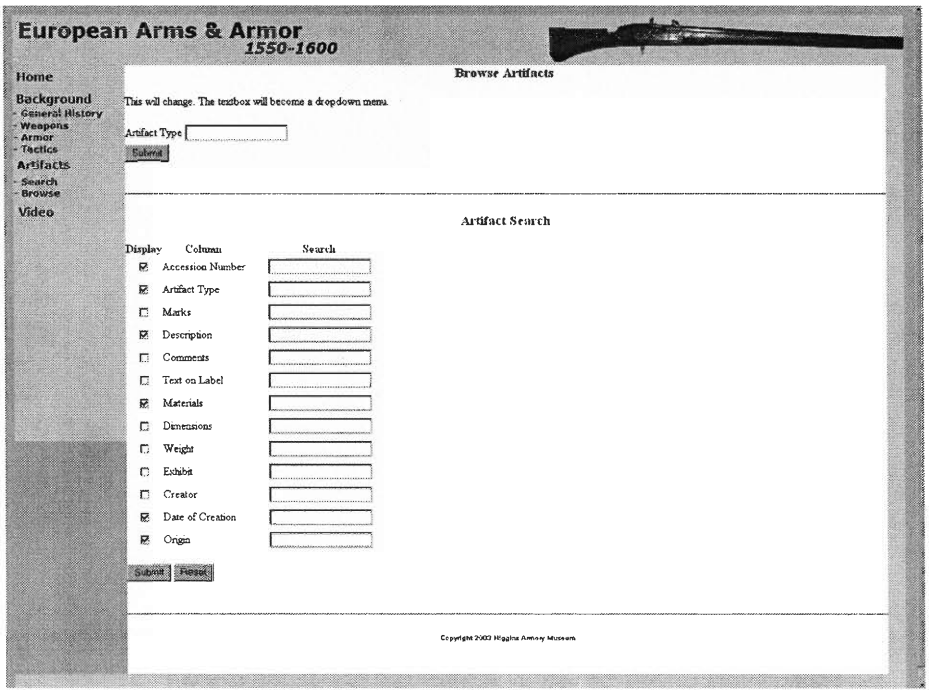
Below are screenshots from the website the project put together comprising of the above document, a searchable database of the Higgins armory artifacts from the 1550-1600 time period, and a video of pikemen drills based on the drill manual by De Gheyn.



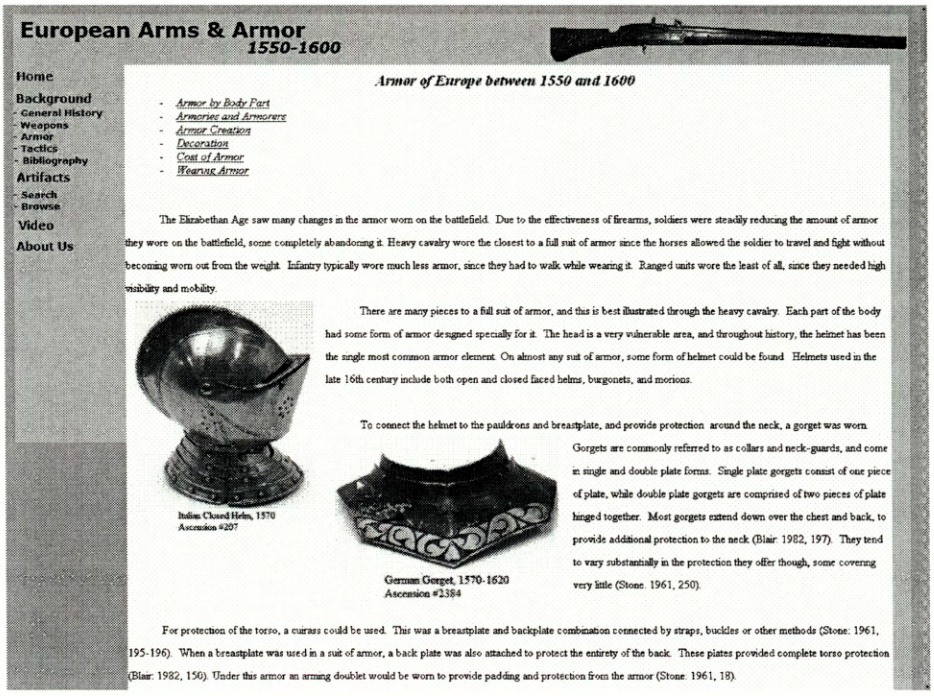

Above is a screenshot of the home page.



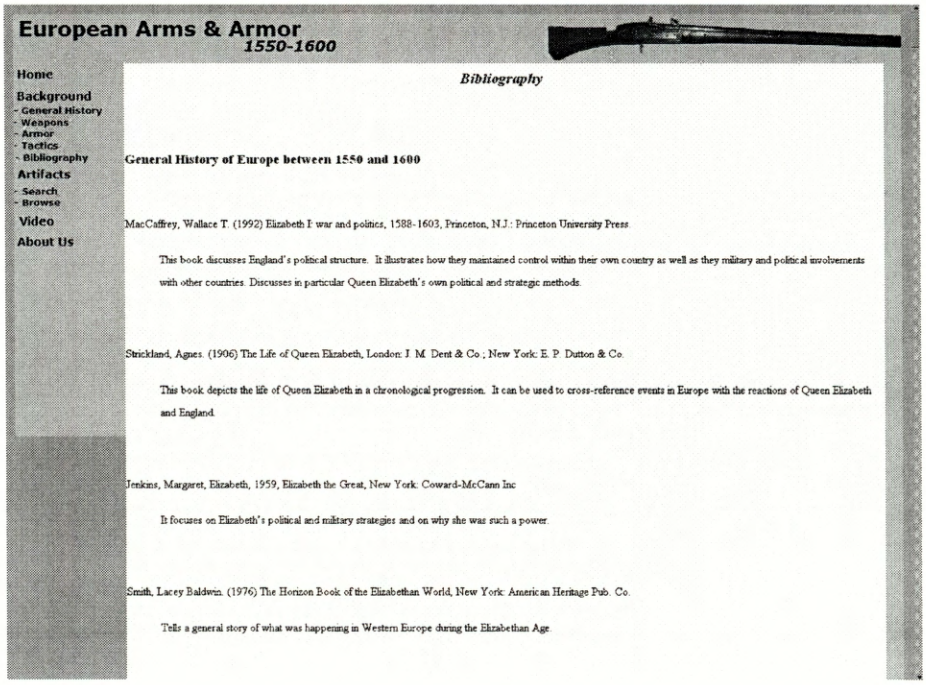

Above is a screenshot of the general history page.



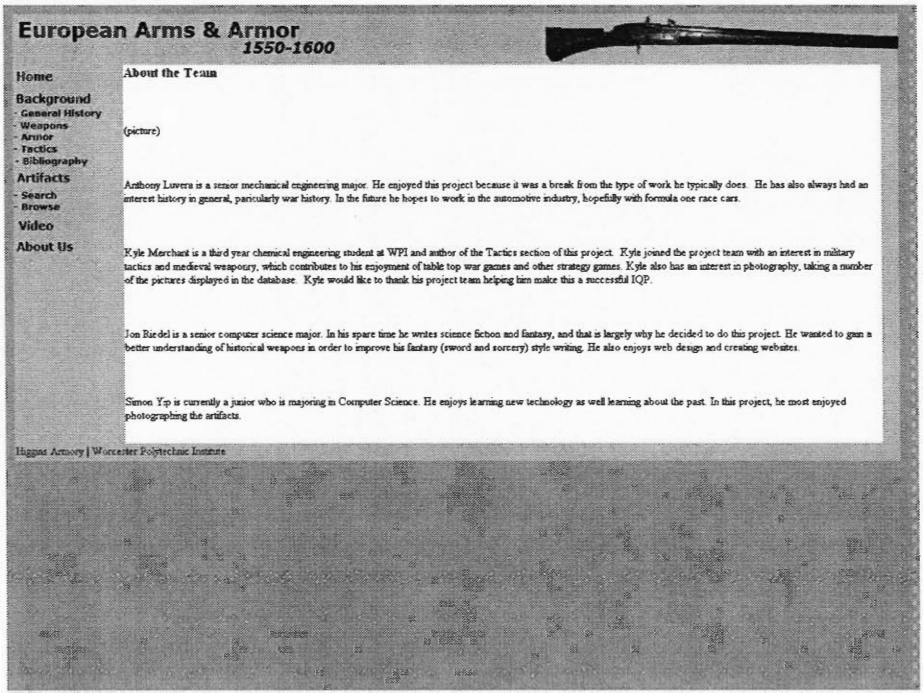

Above is a screenshot of the browse page.



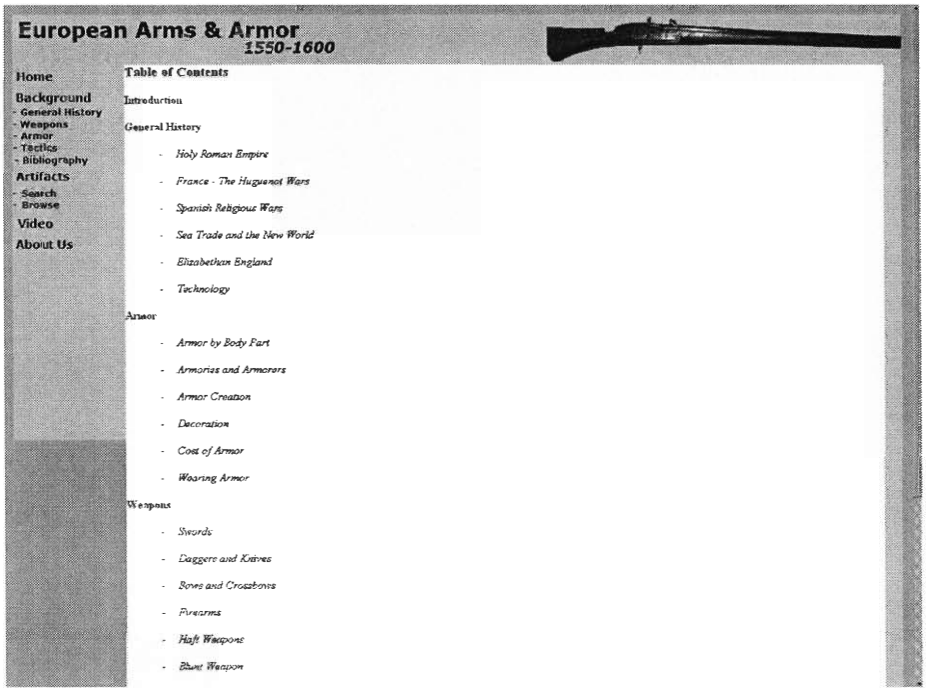

Above is a screenshot of the armor page.



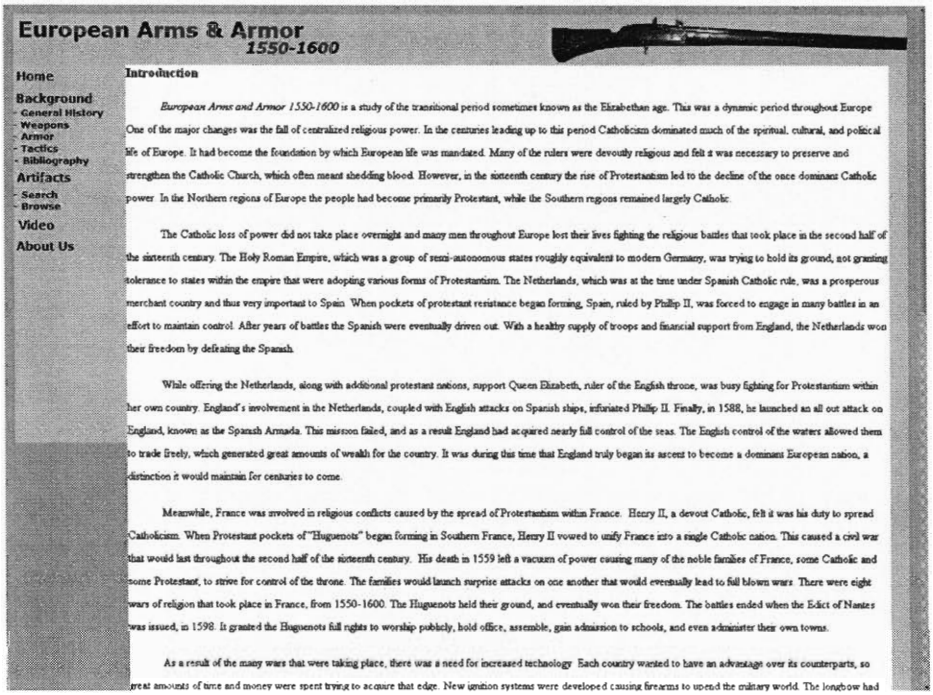

Above is a screenshot of the bibliography page.



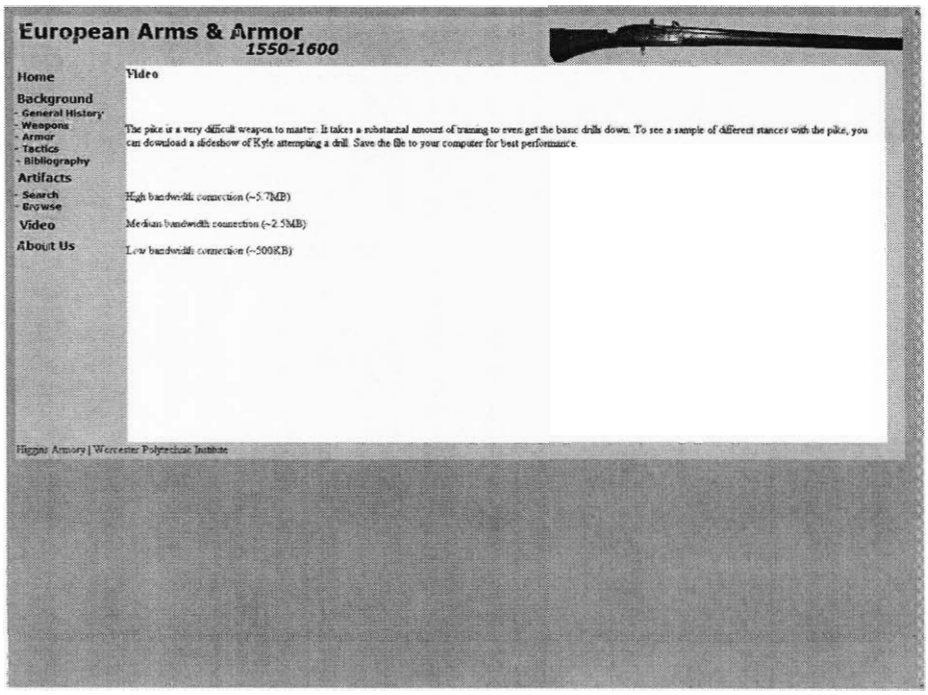

Above is a screenshot of the about us page.



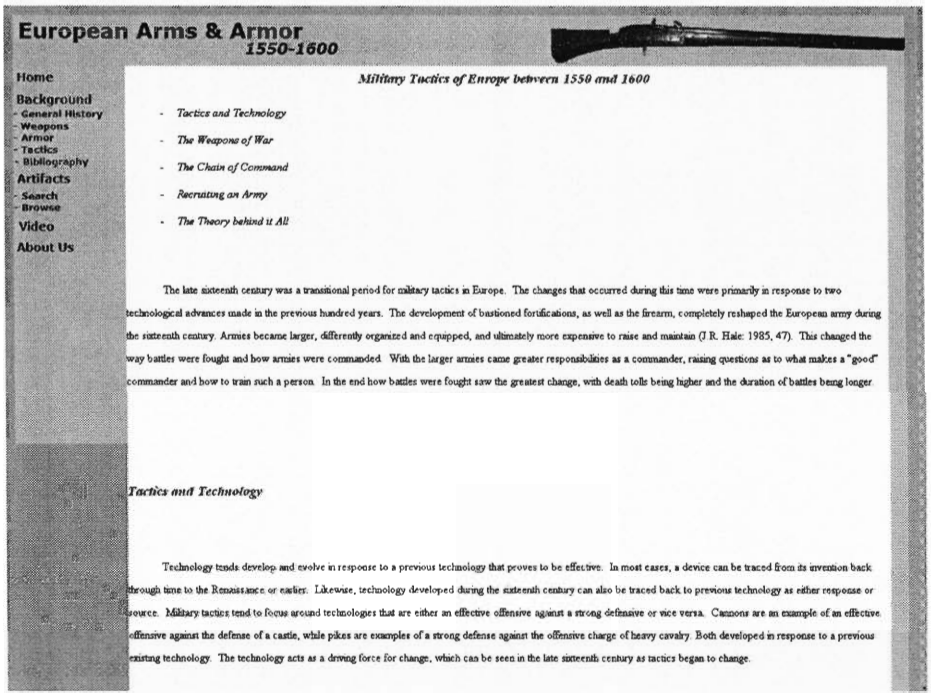

Above is a screenshot of the table of contents page.



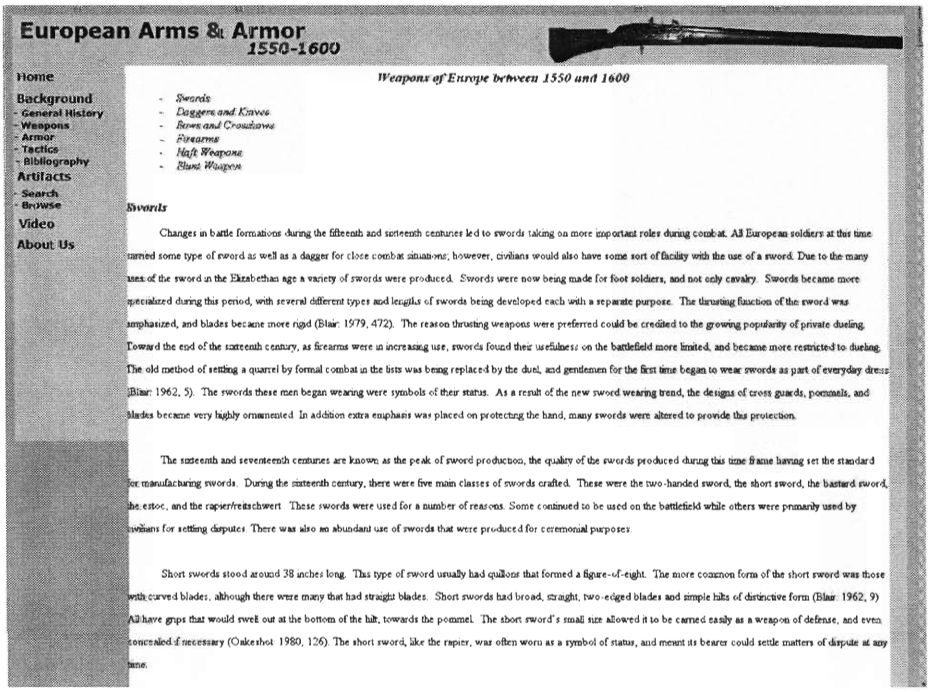

Above is a screenshot of the introduction page.




Above is a screenshot of the video page.




Above is a screenshot of the tactics page.




Above is a screenshot of the weapons page.